Department of Environmental Quality
INL Oversight Program

ENVIRONMENTAL SURVEILLANCE PROGRAM
QUARTERLY DATA REPORT

October - December, 2022

Boise Office
1410 N. Hilton
Boise, Idaho 83706
208-373-0428

Idaho Falls Office
900 N. Skyline, Suite B
Idaho Falls, Idaho 83402
208-528-2600

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Table of Acronyms

aCi/L - attocuries per liter
ATR - Advanced Test Reactor
BEA - Battelle Energy Alliance, LLC
BLR - Big Lost River
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CFA - Central Facilities Area
CFR - Code of Federal Regulations
CITRC - Critical Infrastructure Test Range Complex
DEQ-INL OP - The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program
DOE - U.S. Department of Energy
EBR I & II - Experimental Breeder Reactors I & II
EFS - Experimental Field Station
EIC - electret ionization chamber
EML - Environmental Monitoring Laboratory
EPA - Environmental Protection Agency
ESER - Environmental Surveillance, Education and Research Program
ESP - Environmental Surveillance Program
ESRP - Eastern Snake River Plain
ESRPA - Eastern Snake River Plain Aquifer
Ft bls - feet below land surface
HPIC - high-pressure ion chamber
IBL - Idaho Bureau of Laboratories
ICPP - Idaho Chemical Processing Plant
ICP - Idaho Cleanup Project
ISB - In-situ bioremediation
IDL - instrument detection limit
INL - Idaho National Laboratory
INTEC - Idaho Nuclear Technology and Engineering Center
ISU - Idaho State University
LLD - lower limit of detection
LSC - liquid scintillation counting
MCL - maximum contaminant level
MDA - minimum detectable activity
MDC - minimum detectable concentration
MFC - Materials and Fuels Complex
µg/L - micrograms per liter
mg/L - milligrams per liter
MP - milepost
mrem - millirem or 1/1000th of a rem
mR - milliRoentgen
mR/hr - milliRoentgen per hour
µR/hr - microRoentgen per hour
MV - Magic Valley
NIST - National Institute of Standards and Technology
nCi/L - nanocuries per liter
NCRP - National Council on Radiation Protection and Measurements
NOAA - National Oceanic and Atmospheric Administration
NRF - Naval Reactors Facility
PBF - Power Burst Facility
pCi/g - picocuries per gram
pCi/L - picocuries per liter
pCi/m^3 - picocuries per cubic meter
QAPP - Quality Assurance Program Plan
QA/QC - Quality Assurance/Quality Control
RCRA - Resource Conservation and Recovery Act
RPD - relative percent difference
RTC - Reactor Technology Complex
RWMC - Radioactive Waste Management Complex
SD - Sample standard deviation
SMC - Specific Manufacturing Capability
SMCL - secondary maximum contaminant level
TAN - Test Area North
TDS - total dissolved solids
TMI - Three Mile Island
TRA - Test Reactor Area
TSP - total suspended particulate
TSS - total suspended solids
USGS - U.S. Geological Survey
VOC - volatile organic compound
WLAP - Wastewater Land Application Permit

Introduction

The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program (DEQ-INL OP) conducts an Environmental Surveillance Program (ESP) at locations on the INL, near the boundaries of the INL, and at distant locations to the INL in accordance with accepted monitoring procedures and management practices. This program is designed to provide the people of the state of Idaho with independently evaluated information about the impacts of the Department of Energy's (DOE) activities in Idaho.

The primary objective for DEQ-INL OP's ESP is to maintain an independent environmental monitoring and verification program designed to verify and supplement DOE's environmental data and programs. This program also provides the citizens of Idaho with information on current and proposed DOE programs that has been independently evaluated to enable them to reach informed conclusions about DOE activities in Idaho and potential impacts to public health and the environment.

Results of the ESP are published using two distinct reporting formats: quarterly data reports and an annual ESP report. The annual ESP report is designed for a broad audience and summarizes the results of the ESP for the previous four quarters. The annual report's primary emphasis is to focus on trends, ascertain the impacts of DOE operations on the environment, and confirm the validity of DOE monitoring programs. This quarterly report is designed to document the results of the ESP on a quarterly basis and provide detailed data. It is organized according to the media sampled and also provides a quality assurance assessment.

Air and Precipitation Monitoring Results

The ESP operated eight air monitoring stations on and near the INL as well as two monitoring stations distant from the INL during the fourth quarter, 2022 (**Figure 1**). These stations employed instrumentation for collecting airborne particulate matter, gaseous radioiodine, precipitation, and water vapor for tritium analysis (**Table 1**). The Shoshone-Bannock Tribes operated an air monitoring station located at Fort Hall. The Fort Hall station uses identical instrumentation and sampling protocol as the ten stations operated by the ESP. The DEQ-INL OP reports the Fort Hall station data as an additional distant site.

Airborne particulate matter was sampled using both high-volume (8x10-inch filter) and low-volume (47-mm filter) total suspended particulate (TSP) air samplers. Historically, several of these air samplers were found to be operating outside of their expected flow rate range. A calibrated flow rate gauge was taken into the field weekly to measure the sample start and stop flow rates of these samplers. The calibrated flow rate gauge measurements are used for the activity concentration calculations in the suspect measurements. Activity concentrations from these calculations are footnoted as estimates. Weekly gross alpha and gross beta particulate radioactivity results for 47-mm filters from the low-volume TSP samplers are presented in **Appendix A** and summarized as a range of results in **Table 2**. Results are within the expected historical range.

Composites of 47-mm filters collected from low-volume TSP samplers during a calendar quarter are analyzed using gamma spectrometry. Composites of 8x10-inch filters collected from high-volume TSP samplers during each calendar month are also analyzed using gamma spectrometry. Typically, gamma spectrometry results are only reported when exceeding a minimum detectable concentration (MDC). Gamma spectrometry results for the fourth quarter of 2022 for 47-mm and 8x10-inch TSP filters are presented in **Tables 3** and **4**. For both filter sizes, the only reported gamma-emitting radionuclide concentration greater than MDC was beryllium-7 (Be-7), a naturally occurring, cosmogenic radionuclide. For the Monteview 8x10-inch filter December composite, the Cs-137 concentration was

equal to the MDC and greater than 2 SD but less than 3 SD. The result is considered a questionable detection and J-flagged as an estimate. The MDC for cesium-137 (Cs-137) is also reported for all locations since Cs-137 is the most likely of the man-made gamma emitting radionuclides to be detected.

Beginning in the first quarter 2022, quarterly composites of 8x10-inch filters collected using high-volume TSP samplers are analyzed using radiochemical separation techniques. Results from these composite filter analyses are typically presented in the following quarter's report. The samples are analyzed for Strontium-90, Plutonium-238, Plutonium-239/240, and Americium-241. Measurable quantities of these radionuclides are expected in the environment due to historic above ground testing of nuclear weapons, and possibly from INL programs. DEQ-INL OP's action levels of 19 for Americium-241 (Am-241), 190 for Strontium-90 (Sr-90), 21 for Plutonium-238 (Pu-238), and 20 for Plutonium-239/240 (Pu-239/240) (in 1 x 10^{-5} pCi/m^3) are 10 percent of the compliance values listed for the specific radionuclides in 40 CFR 61, Appendix E, Table 2. Field sample concentrations which exceed these amounts require further investigation.

Radiochemical separation analysis results for 8x10-inch TSP particulate filter composites collected during third quarter 2022 are presented in **Table 5.** Strontium-90 (Sr-90) results were greater than MDC at the on-site locations Big Lost River Rest Area and Experimental Field Station, and at the distant locations Craters of the Moon and Idaho Falls. These four filter composites were recounted for Sr-90 by GEL Laboratories at the request of ISU-EML. The recounts were in relatively close agreement with the original analyses for two of the four samples (Idaho Falls and Rest Area), so the original analyses are considered official. The recount analyses for the Experimental Field Station and Craters of the Moon did not agree with the original analyses, so both the original and recounted analyses are considered estimates (J-flagged). Also, the Idaho Falls Sr-90 result did not agree with the Idaho Falls duplicate TSP sampler result. Further analyses of these filter composites were not possible. The validity of these Sr-90 results is questionable. See the **Quality Assurance** section – **Laboratory QC Issues** for an explanation of significant quality control issues associated with these Sr-90 results. The field sample Sr-90 results are well below the DEQ-INL OP action level. There are no greater-than-MDC results for Pu-238, Pu-239/240, or Am-241 for the third quarter of 2022.

Radioactive iodine samples are collected weekly. Samples are collected by drawing air through a canister filled with activated charcoal using a low-volume air pump. The activated charcoal contained in the canister traps the radioiodine by adsorption onto its porous surface. Each week, canisters are collected from all eleven air monitoring stations and analyzed together as a composite using gamma spectrometry (**Table 6**). If Iodine-131 is detected in this grouping, the canisters are individually analyzed. No radioactive isotopes of iodine, specifically Iodine-131, were detected on the weekly charcoal cartridges used to collect this nuclide during the fourth quarter of 2022.

Atmospheric moisture was collected by drawing air through hygroscopic media at each of the 11 monitoring stations. This moisture was stripped from the hygroscopic media and analyzed to calculate the atmospheric tritium concentration. Reported values are the result of either a single sample or a weighted mean based upon the volume of air sampled when more than one atmospheric moisture sample was collected during the calendar quarter. Atmospheric tritium concentrations and their weighted quarterly means are presented in **Table 7**. All individual sample atmospheric tritium concentrations and weighted mean concentrations were less than MDC for the fourth quarter of 2022. All results are well below the DEQ-INL OP action level of 150 pCi/m^3 (40 CFR 61).

Precipitation samples were collected at six monitoring locations during the fourth quarter of 2022. Precipitation samples were analyzed for tritium and man-made gamma emitting radionuclides. Reported values were either the result of a single sample or a weighted mean when more than one precipitation sample was collected during the calendar quarter. Tritium and man-made gamma emitting radionuclides were below minimum detectable concentration in precipitation collected during the fourth quarter of

2022. Analysis results for Tritium (H-3) and Cesium-137, the most likely to be detected of man-made gamma emitting radionuclides, are presented in **Table 8**.

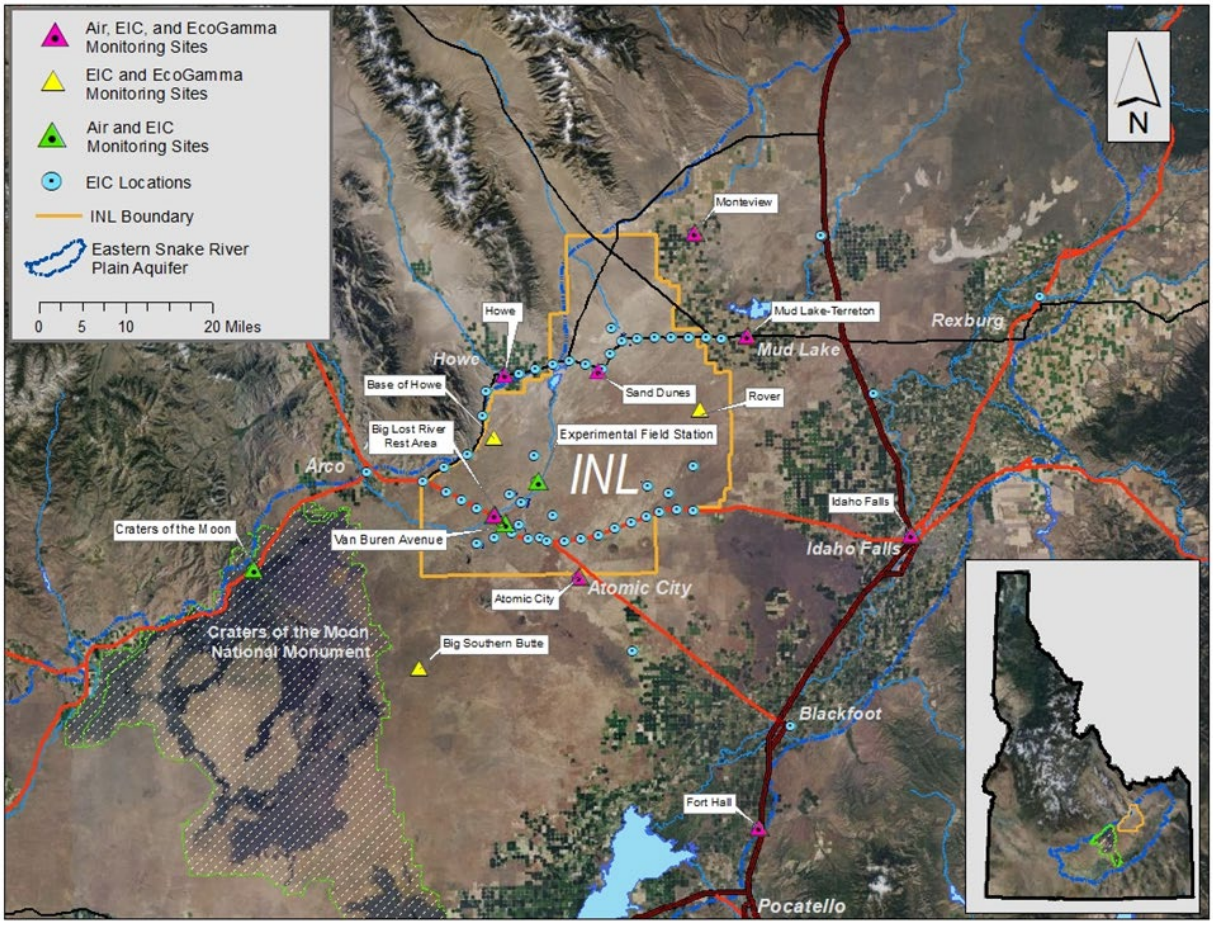

Figure 1. Air and radiation monitoring locations.

Table 1. Sampling locations and sample type

Station Locations	Sample type[1]			
	TSP	Radioiodine	Water Vapor	Precipitation
On-site Locations				
Big Lost River Rest Area	□	□	■	■
Experimental Field Station	□	□	■	
Sand Dunes Tower	□	□	■	
Van Buren Avenue	□	□	■	
Boundary Locations				
Atomic City	□	□	■	■
Howe	□	□	■	■
Monteview	□	□	■	■
Mud Lake	□	□	■	■
Distant Locations				
Craters of the Moon	□	□	■	
Fort Hall[2]	□	□	■	
Idaho Falls	□	□	■	■

[1] □Samples collected weekly; ■ Samples collected quarterly.
[2]TSP and radioiodine samples collected by Shoshone-Bannock Tribes.

Table 2. Range of gross alpha and gross beta concentrations for 47-mm TSP filters, fourth quarter, 2022.

Station Location	Concentration					
	Gross Alpha			Gross Beta		
On-Site Locations						
Big Lost River Rest Area	-0.2	-	2.1	9.0	-	47.8
Experimental Field Station	0.2	-	2.2	10.4	-	49.4
Sand Dunes Tower	0.0	-	2.4	11.0	-	50.7
Van Buren Avenue	-0.1	-	1.6	11.5	-	47.3
Boundary Locations						
Atomic City	0.0	-	2.0	10.4	-	50.0
Howe	-0.2	-	1.9	11.6	-	47.8
Monteview	-0.3	-	1.7	12.2	-	63.9
Mud Lake	-0.4	-	2.0 J[2]	12.4	-	58.0
Distant Locations						
Craters of the Moon	-0.1	-	1.7	10.4	-	44.8
Fort Hall[1]	0.1 J[3]	-	2.3 J[3]	11.1 J[3]	-	46.5 J[3]
Idaho Falls	0.0	-	2.1	11.2	-	54.5

Note: Concentrations are expressed in 1 x 10^{-3} pCi/m^3.

[1]Operated by Shoshone-Bannock Tribes.
[2] Estimated volume. Results are J-flagged as (usable) estimates.
[3] Improper sampling orientation with the filter not fully exposed to the ambient air. Results are considered (usable) estimates

Table 3. Gamma spectrometry analysis data for 47-mm TSP filters, quarterly composite samples, fourth quarter, 2023.

Station Location	Naturally Occurring Radionuclide Beryllium-7			Man-Made Gamma Emitting Radionuclides		
	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC[2]
On-site Locations						
Big Lost River Rest Area	67.7	4.5	1.4	0.00	0.05	0.09
Experimental Field Station[5]	76.6	5.0	2.5	0.04	0.11	0.19
Sand Dunes Tower	70.7	4.5	1.7	0.07	0.10	0.17
Van Buren Avenue	69.9	4.6	1.5	-0.06	0.06	0.11
Boundary Locations						
Atomic City	68.2	4.5	1.9	0.04	0.08	0.13
Howe	67.7	4.5	1.5	0.01	0.07	0.11
Monteview	65.2	4.4	2.3	0.05	0.08	0.14
Mud Lake	64.8 J[3]	4.4 J[3]	2.2 J[3]	0.02 J[3]	0.08 J[3]	0.16 J[3]
Distant Locations						
Craters of the Moon	75.9	4.9	1.6	-0.01	0.06	0.11
Fort Hall[1]	72.1 J[4]	4.6 J[4]	2.0 J[4]	0.04 J[4]	0.08 J[4]	0.14 J[4]
Idaho Falls	78.6	4.9	1.8	-0.01	0.07	0.13

Note: Concentrations are reported in 1 x 10^{-3} pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC is for Cs-137. No man-made gamma emitting radionuclides were detected.
[3]Air volume was estimated in at least one weekly TSP sample for this location. Results are J-flagged as estimates.
[4] Improper sampling orientation with the filter not fully exposed to the ambient air. Results are J-flagged as estimates.
[5] No samples due to planned power outage for weeks 9/28-10/5 and 10/5-10/12/22. Partial samples due to planned power outage for weeks 10/19-10/26 and 10/26-11/02/22.

Table 4. Gamma spectrometry analysis data for 8x10-inch TSP filters, monthly composite samples, fourth quarter, 2022.

Station Location	Month[4]	Naturally Occurring Radionuclide Beryllium-7			Man-Made Gamma Emitting Radionuclides		
		Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC[2]
On-site Locations							
Big Lost River Rest Area	Oct	100.8	5.8	0.6	0.03	0.03	0.04
	Nov	110.0	6.4	1.1	0.04	0.04	0.07
	Dec	88.2	5.1	0.7	0.00	0.04	0.07
Experimental Field Station	Oct[6]	114.0	6.6	0.9	0.06	0.05	0.07
	Nov	120.1	6.8	0.9	0.02	0.04	0.06
	Dec	80.0	4.7	0.9	0.03	0.03	0.05
Sand Dunes Tower	Oct	91.9	5.3	0.6	0.02	0.03	0.05
	Nov	120.4	6.9	1.0	0.04	0.03	0.05
	Dec	75.8	4.5	0.8	0.00	0.03	0.05
Van Buren Avenue	Oct[5]	88.2	5.1	0.6	0.03	0.03	0.06
	Nov	112.7	6.4	0.7	0.01	0.04	0.07
	Dec	70.4	4.2	1.0	0.02	0.03	0.06
Boundary Locations							
Atomic City	Oct	106.9	6.1	0.6	0.04	0.03	0.05
	Nov	146.5	8.3	0.8	0.00	0.04	0.06
	Dec	95.9	5.5	0.7	0.01	0.04	0.05
Howe	Oct	91.2	5.3	0.6	0.01	0.02	0.03
	Nov	103.7	6.1	1.2	0.05	0.04	0.06
	Dec[8]	67.6	4.0	0.7	0.00	0.03	0.05
Monteview	Oct	103.8	6.0	0.6	0.01	0.02	0.04
	Nov	111.8	6.5	1.3	0.04	0.04	0.06
	Dec	145.8	8.3	0.9	0.04 J[9]	0.03	0.04[9]
Mud Lake	Oct	109.5	6.3	0.6	0.02	0.03	0.04
	Nov	123.5	7.1	0.7	-0.01	0.03	0.05
	Dec[7]	81.9	4.9	1.3	0.05	0.05	0.08
Distant Locations							
Craters of the Moon	Oct	120.8	6.8	0.6	0.02	0.02	0.04
	Nov	99.9	5.8	0.9	-0.01	0.03	0.05
	Dec	73.8	4.4	0.7	0.01	0.03	0.05
Fort Hall[1]	Oct	105.8	6.0	0.6	0.02	0.03	0.05
	Nov	128.6	7.3	0.8	0.02	0.05	0.08
	Dec	95.0	5.6	0.8	0.01	0.03	0.06
Idaho Falls	Oct	110.9	6.3	0.5	0.03	0.02	0.04
	Nov	134.2	7.7	1.1	0.04	0.04	0.06
	Dec	106.5	6.1	0.7	0.01	0.03	0.06
Idaho Falls Duplicate[3]	Oct	109.6	6.3	0.5	0.01	0.02	0.04
	Nov	129.5	7.5	0.7	0.01	0.03	0.04
	Dec	102.7	5.9	0.9	0.04	0.04	0.07

Note: Concentrations are reported in 1 x 10^{-3} pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC is for Cs-137. No man-made gamma emitting radionuclides were detected.
[3]A duplicate 8x10-inch filter TSP sampler is currently being operated at the Idaho Falls location.
[4]Five filters/composite for October; four filters /composite for November and December, with exceptions noted.
[5]Four filters/composite for October at Van Buren Avenue.
[6]Four filters/composite for October at Experimental Field Station, with two partial sample filters due to total and partial power outages.
[7]Three filters/composite for December at Mud Lake because of a mechanical failure of the pump.
[8]Two filters at Howe had estimated volumes. Results are considered usable estimates.
[9] Concentration is equal to MDC and greater than 2 SD but less than 3 SD. Result is considered a questionable detection and J-flagged as an estimate.

Table 5. Radiochemical separation analysis results for 8x10-inch TSP particulate filter composites collected during third quarter 2022.

Station Location	^{90}Sr			^{238}Pu			$^{239/240}Pu$			^{241}Am		
	Value[1,8]	±2SD	MDC	Value[1]	± 2SD	MDC	Value[1]	±2SD	MDC	Value[1]	±2SD	MDC
On-Site Locations												
BLR[4] Rest Area	2.59[7]	1.84	2.54	0.08	0.11	0.14	0.07 UJ[6]	0.11	0.17	0.17	0.23	0.31
BLR Rest Area recount	2.32[7]	2.30	3.68	-	-	-	-	-	-	-	-	-
EFS[3]	10.08[7] J	3.76	2.72	0.04	0.21	0.40	0.06 UJ[6]	0.26	0.50	0.02	0.17	0.35
EFS[3] recount	3.11[7] J	2.33	3.39	-	-	-	-	-	-	-	-	-
Sand Dunes	-0.02	1.22	2.10	0.09	0.17	0.23	0.04 UJ[6]	0.14	0.23	0.11	0.19	0.17
Van Buren	0.50	0.88	1.47	-0.03	0.14	0.36	0.15 UJ[6]	0.26	0.40	0.04	0.26	0.54
Boundary Locations												
Atomic City	1.49	2.04	3.41	0.04	0.14	0.24	0.20 UJ[6]	0.25	0.33	0.03	0.17	0.32
Howe	1.34	1.67	2.77	0.18	0.28	0.39	0.36 UJ[6]	0.43	0.65	0.19	0.23	0.25
Monteview	1.38	1.99	3.37	0.11	0.25	0.40	0.09 UJ[6]	0.25	0.44	0.02	0.19	0.41
Mud Lake	-0.25	0.76	1.33	0.00	0.12	0.17	0.15 UJ[6]	0.23	0.32	0.05	0.14	0.15
Distant Locations												
Craters of the Moon	3.76[7] J	2.12	2.56	0.07	0.25	0.42	-0.13 UJ[6]	0.20	0.64	0.06	0.18	0.31
Craters of the Moon recount	0.10[7] J	1.23	2.40	-	-	-	-	-	-	-	-	-
Fort Hall[2]	0.85	0.84	1.36	0.09	0.25	0.44	0.00 UJ[6]	0.18	0.39	0.14	0.22	0.30
Idaho Falls	20.18[7]	6.29	3.30	-0.02	0.13	0.30	0.10 UJ[6]	0.26	0.46	0.07	0.19	0.33
Idaho Falls recount	18.68[7]	5.69	2.35	-	-	-	-	-	-	-	-	-
Idaho Falls Duplicate[5]	0.08	0.66	1.14	0.16	0.28	0.24	-0.10 UJ[6]	0.19	0.57	0.19	0.22	0.24

Note: Concentrations are reported in 1 x 10^{-5} pCi/m^3 with associated uncertainty (± 2 SD), minimum detectable concentration (MDC), and correspond to filter composites collected during the calendar quarter.

[1] Measurable quantities of these radionuclides are expected in the environment due to historic above-ground testing of nuclear weapons, and possibly from INL programs. DEQ-INL OP's action levels of 19 for americium-241, 190 for strontium-90, 21 for plutonium-238, and 20 for plutonium-239/240 (in 1 x 10^{-5} pCi/m^3) are 10 percent of the compliance values listed for the specific radionuclide in 40 CFR 61, Appendix E, Table 2.
[2] Operated by Shoshone-Bannock Tribes.
[3] EFS - Experimental Field Station.
[4] BLR – Big Lost River.
[5] Dup – Duplicate TSP sampler being run at the Idaho Falls location.
[6] Blank sample Pu-239/240 analysis result for this batch of samples exceeded the MDC. The less-than-MDC field sample results are qualified as non-detected estimates (UJ).
[7] Four filter composites were recounted for Sr-89/90 by GEL Laboratories. The recounts were in relatively close agreement with the original analyses for two of the four samples (Idaho Falls and BLR Rest Area), so the original analyses are considered official. The recount analyses for the Experimental Field Station and Craters of the Moon did not agree with the original analyses, so both the original and recounted analyses are considered estimates (J-flagged). Also, the Idaho Falls Sr-89/90 results did not agree with the Idaho Falls duplicate TSP sampler result.

Table 6. Iodine-131 activity in weekly charcoal filter composites, fourth quarter, 2022.

Start Date	Collection Date	Iodine-131 activity (pCi/composite)		
		Activity	± 2 SD	MDA[1]
09/28/22	10/05/22	-0.44	1.53	2.65
10/05/22	10/12/22	0.02	1.26	2.17
10/12/22	10/19/22	0.52	1.47	2.48
10/19/22	10/26/22	0.45	1.50	2.53
10/26/22	11/02/22	0.01	1.92	3.27
11/02/22	11/09/22	1.24	1.91	3.16
11/09/22	11/16/22	-1.11	2.06	3.56
11/16/22	11/23/22	-0.48	1.50	2.61
11/23/22	11/30/22	0.75	1.73	2.89
11/30/22	12/07/22	0.87	1.85	3.09
12/07/22	12/14/22	0.23	1.16	1.98
12/14/22	12/21/22	0.09	1.17	2.02
12/21/22	12/28/22	-0.05	1.35	2.30

[1]The minimum detectable activity (MDA) is established for the least efficient counting position in the eleven-cartridge composite. Based on a typical 20,000 ft^3 (566 m^3) air volume per cartridge, and eleven cartridges per composite, the highest I-131 MDA of 3.56 pCi/composite is equivalent to a maximum MDC of 5.7 $x10^{-4}$ pCi/m^3.

Table 7. Tritium concentrations in air from atmospheric moisture, fourth quarter, 2022.

Station Location	Start Date	Collection Date	Tritium		
			Concentration	± 2 SD	MDC
On-site Locations					
Big Lost River Rest Area	09/28/2022	10/26/2022	-0.11 J[1]	0.22	0.38
Big Lost River Rest Area[4]	10/26/2022	12/14/2022	0.14 J[1]	0.15	0.25
Big Lost River Rest Area	12/14/2022	12/28/2022	-0.13	0.14	0.25
Big Lost River Rest Area Mean	**09/28/2022**	**12/28/2022**	**0.01 J[3]**	**0.17**	**0.29**
Experimental Field Station	10/05/2022	11/16/2022	0.17	0.16	0.27
Experimental Field Station	11/16/2022	12/14/2022	0.15	0.13	0.21
Experimental Field Station	12/14/2022	12/28/2022	-0.01	0.15	0.25
Experimental Field Station Mean	**10/05/2022**	**12/28/2022**	**0.13**	**0.15**	**0.24**
Sand Dunes Tower	09/28/2022	11/02/2022	0.15	0.21	0.35
Sand Dunes Tower	11/02/2022	12/28/2022	-0.13	0.22	0.37
Sand Dunes Tower Mean	**09/28/2022**	**12/28/2022**	**0.00**	**0.21**	**0.36**
Van Buren Avenue	09/28/2022	10/26/2022	-0.04	0.23	0.39
Van Buren Avenue	10/26/2022	12/28/2022	-0.01	0.17	0.29
Van Buren Avenue Mean	**09/28/2022**	**12/28/2022**	**-0.02**	**0.20**	**0.33**
Boundary Locations					
Atomic City	09/28/2022	10/19/2022	0.15	0.23	0.39
Atomic City	10/19/2022	12/19/2022	0.17	0.15	0.25
Atomic City	12/19/2022	12/28/2022	-0.10	0.30	0.51
Atomic City Mean	**09/28/2022**	**12/28/2022**	**0.14**	**0.19**	**0.32**
Howe	09/28/2022	10/26/2022	-0.12	0.25	0.43
Howe	10/26/2022	12/14/2022	0.10	0.14	0.23
Howe	12/14/2022	12/28/2022	0.07	0.15	0.26
Howe Mean	**09/28/2022**	**12/28/2022**	**0.02**	**0.18**	**0.30**
Mud Lake	09/28/2022	10/19/2022	0.05	0.27	0.45
Mud Lake	10/19/2022	11/30/2022	0.11	0.17	0.28
Mud Lake	11/30/2022	12/28/2022	-0.04	0.15	0.26
Mud Lake Mean	**09/28/2022**	**12/28/2022**	**0.05**	**0.19**	**0.32**
Monteview	09/28/2022	10/19/2022	0.21	0.27	0.45
Monteview	10/19/2022	12/14/2022	0.00	0.16	0.27
Monteview	12/14/2022	12/28/2022	-0.04	0.22	0.37
Monteview Mean	**09/28/2022**	**12/28/2022**	**0.06**	**0.20**	**0.33**
Distant Locations					
Craters of the Moon	09/28/2022	10/26/2022	0.01	0.20	0.34
Craters of the Moon	10/26/2022	11/09/2022	0.06	0.19	0.32
Craters of the Moon	11/09/2022	11/30/2022	-0.02	0.12	0.21
Craters of the Moon	11/30/2022	12/28/2022	-0.01	0.14	0.23
Craters of the Moon Mean	**09/28/2022**	**12/28/2022**	**0.01**	**0.16**	**0.27**
Fort Hall[2]	09/28/2022	10/26/2022	-0.21	0.28	0.49
Fort Hall	10/26/2022	12/19/2022	0.06	0.16	0.26
Fort Hall	12/19/2022	12/28/2022	-0.16	0.21	0.35
Fort Hall Mean	**09/28/2022**	**12/28/2022**	**-0.05**	**0.20**	**0.34**
Idaho Falls	09/28/2022	10/19/2022	0.04	0.27	0.46
Idaho Falls	10/19/2022	11/16/2022	0.02	0.19	0.32
Idaho Falls	11/16/2022	12/28/2022	-0.01	0.15	0.26

Idaho Falls Mean	**09/28/2022**	**12/28/2022**	**0.01**	**0.19**	**0.33**

Note: Concentrations are reported in pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).
[1] Air volume was estimated. Results are qualified as (usable) estimates (J).
[2] Operated by the Shoshone-Bannock Tribes.
[3] One or more individual results for this location are qualified as estimates. Weighted mean is therefore qualified as an estimate (J).
[4] New gas meter deployed during this sampling period.

Table 8. Tritium and gamma-emitting radionuclide concentrations from precipitation, fourth quarter, 2022.

Station Location	Start Date	Stop Date	Tritium			Cs-137		
			Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
On-site Locations								
Big Lost River Rest Area	09/28/22	11/30/22	0	100	160	0.0	1.7	2.9
Big Lost River Rest Area	11/30/22	12/28/22	-20	100	170	0.0	1.8	3.0
Big Lost River Rest Area Mean	**09/28/22**	**12/28/22**	**-12**	**100**	**166**	**0.0**	**1.8**	**3.0**
Boundary Locations								
Atomic City	09/28/22	11/23/22	10	100	160	0.5	0.7	1.4
Atomic City	11/23/22	12/28/22	-70	100	170	0.0	1.1	2.0
Atomic City Mean	**09/28/22**	**12/28/22**	**-39**	**100**	**166**	**0.2**	**0.9**	**1.8**
Howe	09/28/22	11/23/22	-40	90	160	0.1	1.3	2.1
Howe	11/23/22	12/28/22	10	100	170	0.2	1.1	1.9
Howe Mean	**09/28/22**	**12/28/22**	**-10**	**96**	**166**	**0.2**	**1.2**	**2.0**
Mud Lake	09/28/22	11/30/22	70	100	160	1.0	1.0	1.6
Mud Lake	11/30/22	12/28/22	-80	100	170	0.7	1.1	1.8
Mud Lake Mean	**09/28/22**	**12/28/22**	**-5**	**100**	**165**	**0.9**	**1.1**	**1.7**
Monteview	**09/28/22**	**12/28/22**	**-60**	**100**	**170**	**1.7**	**1.9**	**3.1**
Distant Locations								
Idaho Falls	09/28/22	11/16/22	-60	90	160	-0.1	1.0	1.7
Idaho Falls	11/16/22	12/28/22	-70	100	170	0.8	1.4	2.4
Idaho Falls Mean	**09/28/22**	**12/28/22**	**-64**	**94**	**164**	**0.3**	**1.2**	**2.0**

Note: Concentrations are reported in pCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Environmental Radiation Monitoring Results

The ESP operated 13 environmental radiation stations during the fourth quarter of 2022 (**Figure 1**). To detect gamma radiation, each station is instrumented with triplicate electret ionization chambers (EIC), and 10 of the stations also are equipped with an EcoGamma gamma radiation monitor with low and high range Geiger–Müller detectors. (**Table 9**).

The Shoshone-Bannock Tribes operate an air monitoring station at Fort Hall which is also equipped with EICs and an EcoGamma, both of which are owned and operated by the DEQ-INL OP. The DEQ-INL OP reports these results as a distant site.

EcoGammas are instruments capable of real-time measurements and are sensitive enough to detect small changes in gamma radiation levels. The real-time gamma radiation measurements collected by the EcoGammas at each location are transmitted to DEQ-INL OP and presented graphically via the worldwide web at https://www.deq.idaho.gov/idaho-national-laboratory-oversight/inl-oversight-program/gamma-radiation-measurements. Historically, DEQ-INL OP has used high-pressure ion chambers (HPIC) for real-time gamma radiation measurements. We completed a change-over of removing the old HPICs and replacing them with EcoGammas at each of our monitoring stations in the first quarter 2022. Slight differences between EcoGamma data and historical HPIC data are expected.

EICs are a passive-integrating system that provides a cumulative measure of environmental gamma radiation exposure in the field. EICs are deployed, collected, and analyzed quarterly. EICs offer an inexpensive methodology to measure gamma radiation over a wide area, particularly in regions which do not have a power source. EICs can also provide valuable gamma radiation data in the event of an emergency. For this reason, EICs are deployed at 67 locations by DEQ-INL OP in a widespread network around the INL measuring external radiation. This information is tabulated in **Appendix B.**

These two systems are used by DEQ-INL OP to measure external gamma radiation for various radiological monitoring objectives. **Table 10** lists the average and median radiation exposure rates and exposure rate ranges measured by EcoGammas for the fourth quarter 2022. **Table 11** lists the EIC monitoring results for fourth quarter of 2022. Overall exposure rates were within the expected historical range of values observed by DEQ-INL OP for background radiation.

Table 9. Summary of instrumentation at radiation monitoring stations.

Station Location	Instrument Type	
	EcoGamma	EIC
On-site Locations		
Base of Howe	■	■
Big Lost River Rest Area	■	■
Experimental Field Station		■
Rover	■	■
Sand Dunes Tower	■	■
Van Buren Avenue		■
Boundary Locations		
Atomic City	■	■
Big Southern Butte	■	■
Howe Met Tower	■	■
Monteview	■	■
Mud Lake/Terreton	■	■
Distant Locations		
Craters of the Moon		■
Fort Hall	■	■
Idaho Falls	■	■

Table 10. Average, median, and range of gamma exposure rates, fourth quarter 2022, from EcoGamma network .

Station Location	Exposure Rate (µR/hr)			
	Quarterly Average*	± 2 SD	Median	Range**
On-site Locations				
Base of Howe	13.4	2.3	13.5	10.0 – 21.2
Big Lost River Rest Area	14.1	1.8	14.2	10.9 – 19.1
Rover	14.5	2.1	14.6	11.4 – 19.9
Sand Dunes Tower	14.0	1.8	14.1	10.8 – 20.5
Boundary Locations				
Atomic City	13.3	2.0	13.3	10.3 – 18.0
Big Southern Butte	13.6	2.5	13.8	9.5 – 20.1
Big Southern Butte duplicate[1]	12.5	2.1	12.3	10.0 – 17.1
Howe Met Tower	13.0	1.8	13.0	9.9 – 18.9
Monteview	13.2	1.9	13.3	10.1 – 20.2
Mud Lake / Terreton	13.0	1.8	13.0	10.0 – 18.6
Distant Locations				
Fort Hall	12.2	1.7	12.2	9.7 – 19.2
Idaho Falls	14.1	1.6	14.1	11.3 – 21.4

*EcoGammas are sensitive electronic devices that can experience intermittent malfunctions and/or interference; this typically results in characteristic positive and/or negative data spikes. These aberrations are removed from the data set based on the judgement of the data analyst.
**The range of background exposure rates from EcoGamma data collected to date is approximately 9 – 34 µR/hr.
[1] A duplicate EcoGamma was operated at Big Southern Butte from 10/24/22 to 12/25/22.

Table 11. Electret ionization chamber (EIC) cumulative average exposure rates, fourth quarter, 2022.

Station Location	Exposure Rate (µR/hr)	
	Quarterly Average[1]	± 2 SD
On-Site Locations		
Base of Howe	NS[2]	NS
Big Lost River Rest Area	15.3	1.9
Experimental Field Station	14.4	1.2
Rover	NS[2]	NS
Sand Dunes	17.4	3.9
Van Buren Avenue	13.9	2.5
Boundary Locations		
Atomic City	10.7, 11.4	-
Big Southern Butte	NS[2]	NS
Howe Met. Tower	10.9, 12.6	-
Monteview	11.6	2.2
Mud Lake/ Terreton	14.7	3.9
Distant Locations		
Craters of the Moon	11.7	2.7
Ft. Hall	11.8	0.3
Idaho Falls	10.5	1.3

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.
[2] NS – No sample. Impassable road. Could not pick up electrets in fourth quarter.

Water Monitoring Results

DEQ-INL OP collects groundwater samples from wells and springs located within, upgradient of, and downgradient of the INL to evaluate the effects of INL contaminants on water quality in the eastern Snake River Plain (ESRP) aquifer and verify the results of DOE and USGS monitoring. Each year, DEQ-INL OP samples approximately 85-90 locations concurrently with a DOE contractor or the USGS and 15-20 locations independently. Co-sampled locations are primarily on or near the INL Site and are usually sampled during the second and fourth calendar quarters. DEQ-INL OP publishes a comparison of its own analytical results with those obtained by co-samplers in the DEQ-INL Oversight Program Annual Report. Locations sampled independently by DEQ-INL OP are mostly in the Magic Valley and are typically sampled during the third calendar quarter.

Most water samples are collected from wells drilled into the aquifer or springs formed by the intersection of the aquifer water table with the surface. Each aquifer well or spring is categorized as upgradient, facility, boundary, or distant based on its location (**Figure 2** and **Figure 3**):

- *Upgradient* sites are situated north or northeast of INL facilities in areas that have not been affected by INL operations. They are used to monitor background concentrations in the aquifer.

- *Facility* sites are located near facility complexes within the INL, including the Advanced Test Reactor complex (ATR), the Central Facilities Area (CFA), the Idaho Nuclear Technology and Engineering Center (INTEC), the Materials and Fuels Complex (MFC), the Naval Reactors Facility (NRF), the Radioactive Waste Management Complex (RWMC), and Test Area North (TAN). Facility sites are located within or immediately downgradient of known areas of contamination and are sampled to monitor the concentrations and migration of specific contaminants.

- *Boundary* sites are located near the southern boundary of the INL, downgradient of potential sources of INL contamination. These include several wells equipped with Westbay Multilevel Groundwater Monitoring Systems ("Westbay wells"), which offer a look at the vertical distribution of constituents in the aquifer.

- *Distant* sites are located farther downgradient of the INL, primarily in the Magic Valley, and include wells and springs used for agricultural, municipal, domestic, and industrial purposes.

A small number of samples are also collected each year from streams, waste-pond effluent, and wells drilled into perched groundwater (groundwater that sits above the aquifer).

Samples collected from water-monitoring sites are analyzed for radiological and non-radiological constituents, many of which are present in the aquifer both naturally and as a result of INL operations. All locations are sampled for gross alpha and gross beta radioactivity, manmade gamma-emitting nuclides, tritium, chloride, chromium, and nitrate-plus-nitrite.[1] Samples from locations at which tritium concentrations are too low to be detected by the standard method are re-analyzed for tritium using an electrolytic enrichment method (referred to as the low-level method), which has a minimum detectable concentration (MDC) about ten times lower than the standard method. Selected sites are also sampled for specific radionuclides—including uranium isotopes (^{234}U, ^{235}U, and ^{238}U), plutonium isotopes (^{238}Pu, $^{239/240}$Pu), americium-241 (^{241}Am), strontium-90 (^{90}Sr), iodine-129 (^{129}I), and technetium-99 (^{99}Tc)—selected trace metals, common ions, total phosphorous, and/or volatile organic compounds (VOCs)

[1] Distant locations Alpheus Spring, Bill Jones Hatchery, Clear Spring, Minidoka Water Supply, and Shoshone Water Supply and upgradient location Mud Lake Water Supply are sampled for gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium during the second quarter. In the fourth quarter, samples are collected for common ions, metals, nitrate-plus-nitrate, and other constituents along with gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium.

based on past and present INL operations or a history of elevated concentrations. If unexpected levels of radioactivity are detected in gross measurements, additional samples will be collected and analyzed for specific radionuclides.

During the fourth quarter of 2022, DEQ-INL OP sampled groundwater from the aquifer at 12 facility locations, 3 boundary locations, 5 distant locations, and 1 upgradient. DEQ-INL OP also sampled water from 4 perched water locations, 2 surface water locations, and 2 wastewater locations. **Table 12** lists the sample date, co-sampler, well depth, and analyses requested for the locations sampled this quarter. Analytical results are reported in **Tables 14** through **24** and summarized below. The results of low-level tritium analyses for 13 samples collected in 2022 are reported in **Table 13** and discussed below.

Table 13 shows the range of background concentrations for each constituent in the ESRP aquifer and the EPA drinking water maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL). Background concentrations depend on local geology, and the concentrations of constituents at sites not influenced by INL activities may on occasion be higher than the given background ranges due to local factors and natural variability.

Gross alpha and gross beta radioactivity

Gross alpha and gross beta analyses are used to screen for unexpectedly high levels of radioactivity in samples. DEQ-INL OP has determined from past sampling that background concentration ranges for gross alpha and gross beta radioactivity in the ESRP aquifer are approximately 0-5.6 pCi/L and 0-8.6 pCi/L, respectively. Occasional measurements of concentrations above these background ranges in uncontaminated samples are statistically probable due to uncertainties inherent in measuring low levels of radioactivity. Additionally, some samples will have levels of radioactivity slightly higher than background ranges due to higher-than-average concentrations of naturally occurring uranium, thorium, or potassium-40.

Gross alpha and beta radioactivity were detected at low levels in most samples (**Table 14**). Gross alpha radioactivity was measured at concentrations within the known background range at all locations. Samples from TAN-2336 resulted in the highest gross beta concentrations at 1523.7 ± 51.3 pCi/L, MDC = 36.1 pCi/L. Gross beta concentrations elevated above background were also observed in INTEC wells USGS-112 at 14.4 ± 1.1 pCi/L, MDC = 1.2 pCi/L and USGS-115 at 9.4 ± 1.0 pCi/L, MDC = 1.3 pCi/L, along with ATR well PW-12 at 50.1 ± 1.8 pCi/L, MDC = 1.3 pCi/L. All values were consistent with historical trends.

Manmade gamma-emitting radionuclides

No manmade gamma-emitting radionuclides were detected at any location sampled this quarter. Results for cesium-137 (^{137}Cs), the manmade gamma-emitter most likely to be detected in groundwater, are reported in **Table 14**.

Tritium

Tritium was analyzed for all locations sampled this quarter **(Table 15)**, with the exception of TAN-37A. Only the chemical analyte samples from TAN-37A were able to be collected before the pump failed. (**Table 12**). Elevated tritium concentrations were observed in aquifer wells at or near ATR, INTEC, RWMC, TAN, CFA, and near the southern INL boundary at USGS-104 and they ranged from 297 ± 110 pCi/L, MDC = 160 pCi/L at USGS-112 (INTEC) to 2008 ± 170 pCi/L, MDC = 170 pCi/L at CFA 2.

In perched groundwater, elevated tritium concentrations ranged from 446 ± 120 pCi/L, MDC = 160 pCi/L at USGS-073 (ATR) to 1561 ±160 pCi/L at PW-12 (ATR).There was an increase in concentration at ATR perched water well PW-12 (1561 pCi/L ± 160 pCi/L, MDC = 160 pCi/L) above the

concentration in 2021 (258 ± 100 pCi/L, MDC = 150 pCi/L). The reason for the increase is not clear, however, results from IEC (INL contractor) this quarter were comparable to ours at 1620 ± 432 pCi/L, MDC = 312 pCi/L.

Three samples from third quarter and 10 samples from this quarter were analyzed for low-level tritium, with results reported in **Table 16**. The samples consisted of three facility wells, one boundary well, eight distant wells, and one upgradient well. All concentrations from distant sites were within the background range (0-33 pCi/L). Results from one facility well and one boundary well were above background levels: USGS-120 at 87 ± 10 pCi/L, MDC = 11 pCi/L and Highway 3 at 43 ± 9 pCi/L, MDC = 12 pCi/L. Results from both wells were consistent with historical trends. No backlog for low-level tritium remains.

All tritium concentrations reported in this quarter were well below the drinking water MCL of 20,000 pCi/L.

Strontium-90

Eight aquifer facility wells and four ATR perched groundwater wells were sampled for ^{90}Sr this quarter (**Table 17**)**.** TAN-2336 had the highest ^{90}Sr concentration at 554.0 ± 46.5 pCi/L, MDC = 1.55 pCi/L. Of the two INTEC wells that were sampled, USGS-112 had the highest ^{90}Sr concentration at 4.70 ± 0.80 pCi/L, MDC = 0.66 pCi/L. Detectable results were found in CFA 2 at 0.475 ± 0.268 pCi/L, MDC = 0.398 pCi/L and RWMC Production well at 0.890 ± 0.387 pCi/L, MDC = 0.557 pCi/L. Of the perched ATR groundwater wells, PW-12, had the highest ^{90}Sr value at 19.8 ± 2.11 pCi/L, MDC = 0.747 pCi/L. This elevated ^{90}Sr value is consistent with the elevated gross beta concentration in PW-12. The next highest concentration was measured at USGS-073 (2.18 ± 0.585 pCi/L, MDC = 0.664 pCi/L), which was consistent with past observations. The concentration of ^{90}Sr in PW-9 (1.53 ± 0.47 pCi/L, MDC = 0.586 pCi/L) was elevated above historical values, with the 2020 concentration at 0.13 ± 0.32 pCi/L, MDC = 0.7 pCi/L. Although higher than historical values, this quarter's result was comparable to the concentration measured in 2021 by the USGS at 1.3 ± 0.7 pCi/L. PW-9 is scheduled for sampling in the Fall of 2023.

Technicium-99

Seven aquifer locations (i.e., five facility and two boundary) were sampled for ^{99}Tc (**Table 18**). There were two low level detections consistent with previous values, well below the MCL of 900 pCi/L for ^{99}Tc: INTEC well USGS-115 at 3.24 ± 0.806 pCi/L (MDC = 1.12 pCi/L) and CFA 2 at 4.17 ± 0.866 pCi/L (MDC = 1.12 pCi/L). All other samples analyzed this quarter for ^{99}Tc resulted in non-detections.

Actinides

Uranium isotopes were analyzed in one aquifer well: TAN-2336 (**Table 19**). Samples produced results slightly above background levels for ^{234}U, ^{235}U, and ^{238}U, but no concentration values were greater than their MDCs.

Iodine-129

Two aquifer locations located at INTEC (USGS-112 and USGS-115) and two aquifer locations located at RWMC (RWMC Production and USGS-120) were sampled and analyzed for ^{129}I (**Table 20**). Three of the four samples resulted in detections with the highest concentration found in INTEC well USGS-112 at 0.217 ± 0.12 pCi/L, MDC = 0.002 pCi/L. This result is consistent with 2017-18 USGS ^{129}I results (0.239 ± 0.008 pCi/L, uncertainty = 1 standard deviation) in a publication written by Maimer and Bartholomay and titled, "Iodine-129 in the Eastern Snake River Plain Aquifer at and near the Idaho National Laboratory, Idaho, 2017-18". The publication included ^{129}I results from various wells in 1990-91, 2003. 2007, 2011-12, and 2017-18. Initial concentrations at USGS-112 in 1990 were 2.40 ± 0.25 pCi/L, with

each consecutive result showing a decrease in ^{129}I concentration. There are tentative plans for DEQ to continue ^{129}I sampling; however, the specific wells to be sampled and the sampling frequency have yet to be determined.

Common ions, trace metals, and nutrients

All locations were sampled for chloride, chromium, sulfate, alkalinity, and dissolved nutrients (nitrate-plus-nitrite). Six locations (Alpheus Spring, Clear Spring, Bill Jones Hatchery, Minidoka Water Supply, Mud Lake Water Supply and Shoshone Water Supply) were sampled for other common ions. Four locations (TAN-37A, TAN-2336, TRA Cold Waste Pond, and MFC–Industrial Waste Pipe) were sampled for other common ions, trace metals, and phosphorus during the quarter (**Tables 21, 22, and 23**).

Most analyses were within the historical range. CFA-2, USGS-073, and PW-9 exceeded background concentrations of chloride, which were similar to prior years' results. PW-11 displayed a sulfate concentration well above background (144 mg/L, SMCL 250 mg/L), but this value was within the expected range. TAN wells also showed elevated concentrations of common ions, sodium, and alkalinity. Bioremediation injections at the TAN facility likely influence these analyte concentrations to fluctuate beyond background ranges.

Chromium concentrations were elevated above natural levels at USGS-073 (37 µg/L, MCL 100 µg/L), PW-9 (71 µg/L), PW-11 (16 µg/L), TAN-37A (37 µg/L), and TAN-2336 (180 µg/L). TAN-2336 also exhibited elevated concentrations of iron (3700 µg/L, SMCL 300), manganese (670 µg/L, SMCL 50 µg/L), barium (1500 µg/L, MCL 2000 µg/L) and magnesium (61 mg/L). TAN-2336 is an active bioremediation injection well, which likely impacts the elevated metal concentrations. TAN-37A also displayed elevated concentrations of iron, manganese, and barium, which is also likely influenced by remediation efforts at the TAN facility.

USGS-073 had the highest nitrate + nitrite concentration above background at 14 mg/L. This result is within the expected range and down from the peak detection of 32 mg/L in October of 2020. TAN-2336 displayed the highest phosphorous concentration above background at 12 mg/L. Phosphorus concentrations at TAN-2336 are within the expected range this quarter.

Volatile organic compounds (VOCs)

VOCs were measured in aquifer wells RWMC Production, USGS-120, and TAN-2336 (**Table 24**). Carbon tetrachloride, trichloroethene (TCE), and chloroform continue to be detected at the RWMC Production well at levels consistent with previous observations. Notable MCL exceedances and/or changes from previous measurements include those below at TAN-2336, where active bioremediation is on-going:

- TAN-2336: TCE = 4.20 µg/L (estimate), up from a non-detect in 3rd quarter of 2022 (MCL is 5 µg/L).
- TAN-2336: Chloroform = 6.00 µg/L (estimate), up from a non-detect in 3rd quarter of 2022 (MCL is 80 µg/L).
- TAN-2336: 2-Butanone (MEK) = 1650 µg/L up from 335 µg/L in 3rd quarter of 2022 (EPA does not have an MCL for MEK). MEK is frequently associated with bioremediation activities as a short-term intermediary biproduct that is hypothesized to be a result of ketone producing microbes during the fermentation process. MEK is known to be highly degradable in the bioremediation process and may be reduced by more than half over a 128-day period. The INL OP will continue to closely monitor MEK concentrations.

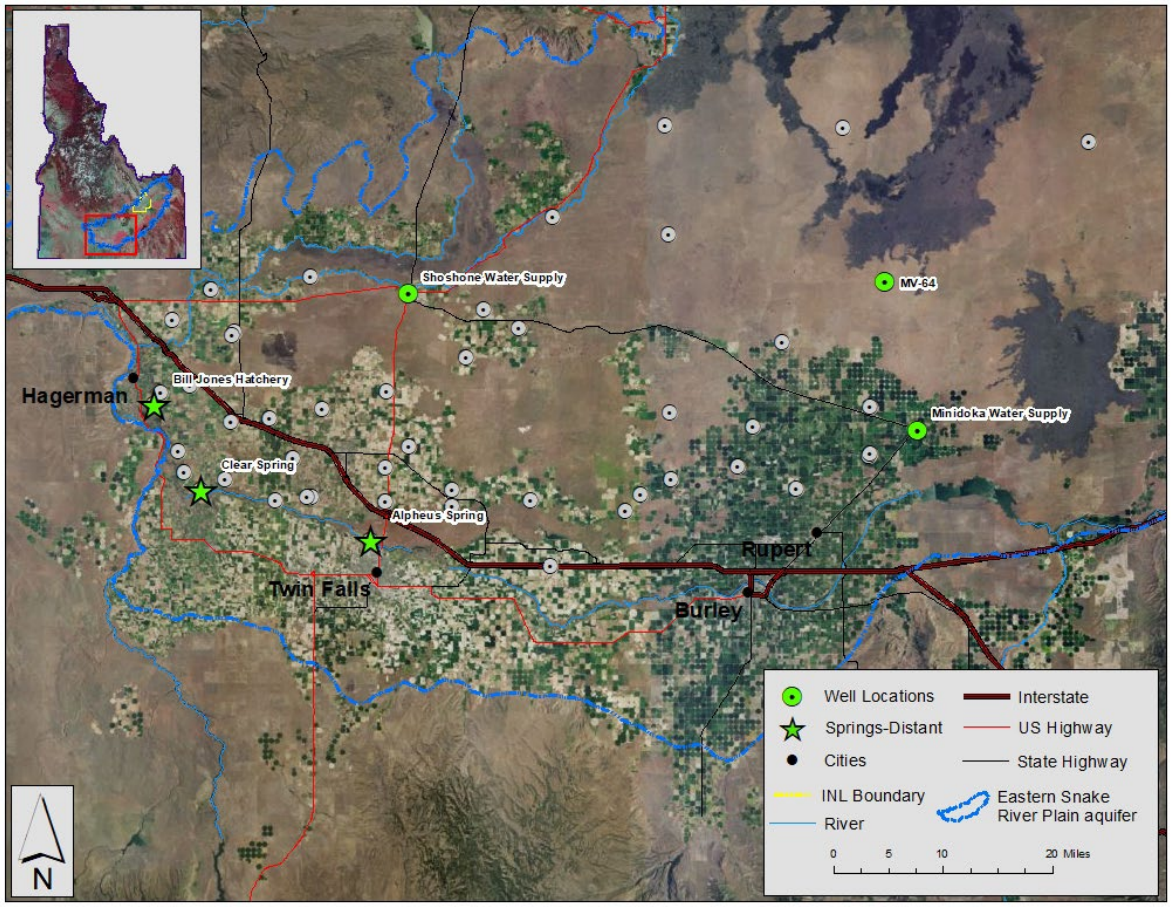

Figure 2. Distant water monitoring locations.

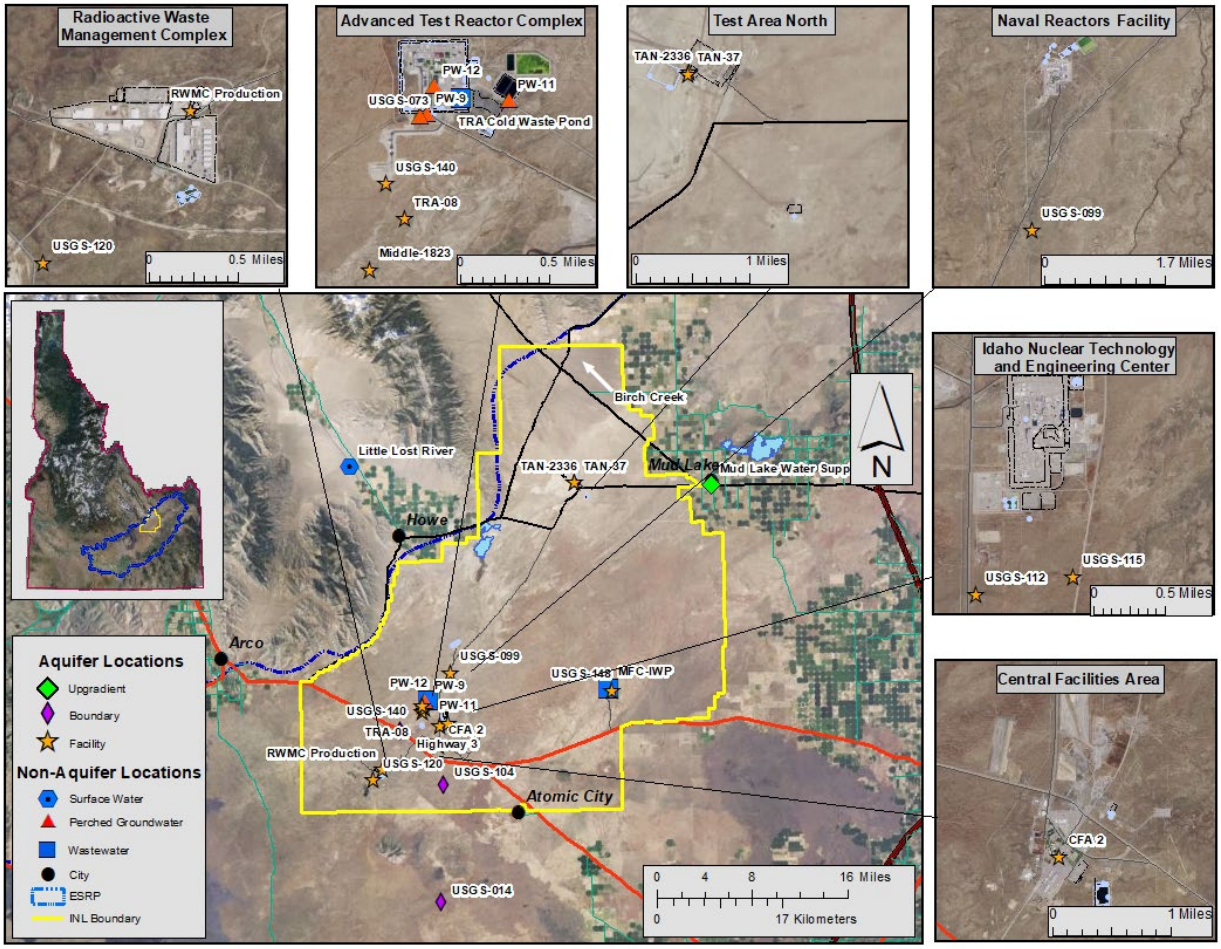

Figure 3. Up-gradient, facility, boundary, perched groundwater (GW), surface water, and wastewater monitoring locations.

Table 12. Locations sampled for water, fourth quarter, 2022.

Sample Location	Date Sampled	Co-sampler	Well Depth (ft bgs)	Analyses*
Aquifer Samples				
Upgradient				
Mud Lake Water Supply	11/15/2022	None	330	α, β, γ, ^{3}H, com. ions, Cr, As, NO_3+NO_2
Facility				
Advanced Test Reactor Complex:				
Middle-1823	10/04/2022	IEC	729.7	α, β, γ, ^{3}H, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
TRA-08	10/04/2022	IEC	501.5	α, β, γ, ^{3}H, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
USGS-140	10/24/2022	USGS	546	α, β, γ, ^{3}H, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Idaho Nuclear Technology and Engineering Center:				
USGS-112	10/03/2022	USGS	507	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, ^{129}I, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
USGS-115	10/03/2022	USGS	581	α, β, γ, ^{3}H, ^{90}Sr, ^{99}Tc, ^{129}I, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Radioactive Waste Management Complex:				
RWMC Production	10/18/2022	USGS	685	α, β, γ, ^{3}H, ^{90}Sr, ^{129}I, ^{99}Tc, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2, VOCs
USGS-120	10/18/2022	USGS	705	α, β, γ, ^{3}H, ^{90}Sr, ^{129}I, ^{99}Tc, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2, VOCs
Test Area North:				
TAN-37A	10/12/2022	IEC	240	com. ions, trace metals, NO_3+NO_2, P
TAN-2336	10/12/2022	IEC	255	α, β, γ, ^{3}H, ^{90}Sr, U iso., com. ions, trace metals, NO_3+NO_2, VOCs, P
Central Facilities Area:				
CFA 2	10/24/2022	USGS	507	α, β, γ, ^{3}H, ^{99}Tc, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Materials and Fuels Complex:				
USGS-148	10/19/2022	USGS	680	α, β, γ, ^{3}H, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Naval Reactors Facility:				
USGS-099	10/06/2022	USGS	426	α, β, γ, ^{3}H, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Boundary				
Highway 3	10/17/2022	USGS	750	α, β, γ, ^{3}H, Cl^-, ^{99}Tc, SO_4^{2-}, Cr, NO_3+NO_2
USGS-014	10/18/2022	USGS	751	α, β, γ, ^{3}H, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
USGS-104	10/19/2022	USGS	700	α, β, γ, ^{3}H, ^{99}Tc, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Distant				
Alpheus Spring	11/14/2022	None	0	α, β, γ, ^{3}H, com. ions, Cr, NO_3+NO_2
Bill Jones Hatchery	11/14/2022	None	0	α, β, γ, ^{3}H, com. ions, Cr, NO_3+NO_2
Clear Spring	11/14/2022	None	0	α, β, γ, ^{3}H, com. ions, Cr, NO_3+NO_2
Minidoka Water Supply	11/14/2022	None	282	α, β, γ, ^{3}H, com. ions, Cr, NO_3+NO_2
Shoshone Water Supply	11/14/2022	None	n/a	α, β, γ, ^{3}H, com. ions, Cr, NO_3+NO_2
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex:				
PW-9	10/06/2022	USGS	200	α, β, γ, ^{3}H, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
PW-11	10/05/2022	IEC	134.5	α, β, γ, ^{3}H, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
PW-12	10/05/2022	IEC	128	α, β, γ, ^{3}H, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
USGS-073	10/06/2022	USGS	127	α, β, γ, ^{3}H, ^{90}Sr, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Surface Water				
Birch Creek	10/25/2022	USGS	0	α, β, γ, ^{3}H, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Little Lost River	10/25/2022	USGS	0	α, β, γ, ^{3}H, Cl^-, SO_4^{2-}, Cr, NO_3+NO_2
Wastewater				
TRA Cold Waste Pond	10/04/2022	BEA	0	α, β, γ, ^{3}H, com. ions, trace metals, NO_3+NO_2, P
MFC-Industrial Waste Pipeline	10/11/2022	BEA	0	α, β, γ, ^{3}H, com. ions, trace metals, NO_3+NO_2, P

ft bgs = feet below ground surface.

*α = gross alpha radioactivity; β = gross beta radioactivity; γ = manmade gamma-emitting radionuclides; ^{3}H = tritium; ^{90}Sr = Strontium-90; ^{99}Tc = Technetium-99; ^{241}Am = Americium-241; P iso. = ^{238}Pu, $^{239/240}Pu$; ^{129}I = Iodine-129; U iso. = ^{234}U, ^{235}U, ^{238}U; Cl^- = chloride; Cr = chromium; com. ions = calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), chloride (Cl^-), sulfate (SO_4^{2-}), alkalinity; trace metals = arsenic (As), barium (Ba), chromium (Cr), iron (Fe), manganese (Mn), lead (Pb); selenium (Se); NO_3+NO_2 = nitrate plus nitrite; P = phosphorus, and VOCs = volatile organic compounds.

Table 13. Constituent background concentration ranges and EPA drinking water standards.

Constituent	Background[1]	MCL or SMCL[2]
Radiological Constituents (pCi/L)		
Gross alpha	0-5.6[a]	15
Gross beta	0-8.6[a]	4 mrem/yr
Cesium-137	0	200
Tritium	0-33[a]	20,000
Strontium-90	0	8
Technetium-99	0	900
Iodine-129	0.0000054[e]	1
Uranium-234	0.043-1.9[b]	30 µg/L (total U)
Uranium-235	0-0.048[b]	
Uranium-238	0.021-0.719[b]	
Plutonium-238	0	---
Plutonium-239/240	0	---
Americium-241	0	---
Non-radiological Constituents		
Common Ions (mg/L)		
Alkalinity (as $CaCO_3$)	91-261[a]	---
Calcium	23 – 71[a]	---
Chloride	4.9 – 66.6[a]	250*
Fluoride	0.1 – 1.50[a]	4
Magnesium	10.1 – 27.4[a]	---
Potassium	1.2 – 5.8[a]	---
Sodium	2.6 – 27.0[a]	---
Sulfate	9.6 – 40.4[a]	250*
Trace Metals (µg/L)		
Arsenic	2 – 3[c]	10
Barium	50 – 70[c]	2000
Chromium	<1.0 – 5.2[a]	100
Iron	4 – 16[d]	300*
Lead	<5[c]	15
Manganese	<1 – 4[a]	50*
Selenium	<1[c]	50
Zinc	<3 – 10.5[d]	5000*
Nutrients (mg/L)		
Nitrate plus nitrite	<0.04 – 3.59[b]	10 for NO_3^-, 1 for NO_2^-
Phosphorus	<0.01 – 0.02[d]	---
Volatile Organic Compounds (µg/L)		
Tetrachloroethene (PCE)	0	5
Trichloroethene (TCE)	0	5
1,1-Dichloroethene	0	7
cis-1,2-dichloroethene	0	70
trans-1,2-dichloroethene	0	100
Vinyl chloride	0	2
Carbon tetrachloride	0	5
Chloroform	0	80[f]
Chloromethane	0	---
Methylene Chloride	0	5
Methyl Ethyl Ketone	0	---
1,1-Dichloroethane	0	---

[1] Sources for background ranges are: [a] DEQ data compiled from distant, boundary, and surface water sites from 1993-2018.
[b] Bartholomay and Hall, 2016 (DOE/ID-22237); [c] Knobel and others, 1992; [d] Knobel and others, 1999 (DOE/ID-22164). [e] Cecil and others, 2003 (DOE/ID-22186).
[2] Maximum Contaminant Levels (MCLs) are the highest levels of contaminants legally allowed in public drinking water systems in Idaho. Most wells sampled by DEQ-INL OP are not used for drinking water. A * designates a Secondary MCL (SMCL), which is a guideline recommended by the EPA for constituents that may affect the taste, color, or odor of drinking water. [f] MCL is for total trihalomethanes.

Table 14. Gross alpha, gross beta, and man-made gamma-emitting radionuclide concentrations (pCi/L) for water samples, fourth quarter, 2022.

Sample Location	Sample Date	Gross Alpha			Gross Beta			Cesium-137*		
		Concentration		2 SD	Concentration		2 SD	Concentration		2 SD
Aquifer Samples										
Upgradient										
Mud Lake Water Supply	11/15/2022	0.3	U	0.5	3.0	-	0.7	0.1	U	1.0
Facility										
Advanced Test Reactor Complex										
Middle-1823	10/04/2022	1.9	-	0.9	1.6	-	0.8	0.5	U	1.5
TRA-08	10/04/2022	1.0	-	0.7	1.7	-	0.8	-1.8	U	1.6
USGS-140	10/24/2022	0.8	U	0.7	2.4	-	0.8	0.6	U	1.4
Idaho Nuclear Technology and Engineering Center										
USGS-112	10/03/2022	1.3	-	0.7	14.4	-	1.1	-0.2	U	1.7
USGS-115	10/03/2022	0.7	U	0.8	9.4	-	1.0	0.2	U	1.2
Radioactive Waste Management Complex										
RWMC Production	10/18/2022	2.7	-	0.9	2.6	-	0.8	0.9	U	1.8
USGS-120	10/18/2022	2.0	-	0.8	3.3	-	0.8	1.2	U	1.3
Test Area North										
TAN-2336	10/12/2022	10	U	20.1	1523.7	-	51.3	1.6	U	1.5
Central Facilities Area										
CFA 2	10/24/2022	1.3	-	0.9	8.2	-	1.1	1.9	U	2.2
Materials and Fuels Complex										
USGS-148	10/19/2022	1.9	-	0.9	2.5	-	0.8	0.5	U	1.7
Naval Reactors Facility										
USGS-099	10/06/2022	0.7	U	0.7	1.8	-	0.8	0.7	U	1.9
Boundary										
Highway 3	10/17/2022	1.5	-	0.7	4.2	-	0.8	0.6	U	1.5
USGS-014	10/18/2022	2.4	-	0.9	2.0	-	0.8	1.3	U	1.7
USGS-104	10/19/2022	1.6	-	0.7	1.5	-	0.8	2.4	U	1.8
Distant										
Alpheus Spring	11/14/2022	1.9	-	1.1	6.9	-	1.1	2.3	U	1.6
Bill Jones Hatchery	11/14/2022	2.2	-	0.9	3.3	-	0.9	0.0	U	1.0
Clear Spring	11/14/2022	1.2	U	0.9	5.1	-	1.0	0.0	U	1.0
Minidoka Water Supply	11/14/2022	1.1	U	0.8	1.8	-	0.8	0.5	U	1.5
Shoshone Water Supply	11/14/2022	1.5	-	0.9	5.5	-	1.0	1.1	U	1.0
Other Samples										
Perched Groundwater										
Advanced Test Reactor Complex										
PW-9	10/06/2022	2.3	-	1.0	4.0	-	1.0	0.8	U	1.3
PW-11	10/05/2022	2.2	-	1.1	7.5	-	1.0	0.9	U	1.3
PW-12	10/05/2022	3.4	J	1.1	50.1	-	1.8	0.4	U	1.1
USGS-073	10/06/2022	1.9	-	1.1	7.0	-	1.1	0.0	U	1.4
Surface Water										
Birch Creek	10/25/2022	3.2	-	0.9	0.8	U	0.7	1.0	U	1.2
Little Lost River (LLR)	10/25/2022	1.0	-	0.6	1.1	U	0.7	1.1	U	1.6
Wastewater										
TRA Cold Waste Pond	10/04/2022	1.2	-	0.7	1.4	-	0.7	0.8	U	1.6
MFC-Industrial Waste Pipeline	10/11/2022	1.9	-	0.9	3.5	-	0.9	0.8	U	1.5

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
*ISU-EML analyzes water samples for all common manmade gamma-emitting radionuclides. If none are detected, only the results for ^{137}Cs, the manmade gamma-emitter most likely to be detected in groundwater, are reported in this table. MDC for TAN-2336 (gross alpha 34.7 pCi/L) and (gross beta 36.1 pCi/L) were larger due to high dissolved/suspended solids requiring a smaller aliquot for analysis. MDC range (gross alpha) 0.3 – 1.5 pCi/L. MDC range (gross beta) 1.0 – 1.5 pCi/L. MDC range (cesium) 1.6 – 3.5 pCi/L.

Table 15. Tritium concentrations (pCi/L) for water samples, fourth quarter, 2022.

Sample Location	Sample Date	Tritium		
		Concentration		2 SD
Aquifer Samples				
Upgradient				
Mud Lake Water Supply	11/15/2022	-3	U	100
Facility				
Advanced Test Reactor Complex				
Middle-1823	10/04/2021	391	-	110
TRA-08	10/04/2022	640	-	120
USGS-140	10/24/2022	873	-	130
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/03/2022	297	-	110
USGS-115	10/03/2022	598	-	120
Radioactive Waste Management Complex				
RWMC Production	10/18/2022	461	-	120
USGS-120	10/18/2022	91	U	100
Test Area North				
TAN-2336	10/12/2022	397	-	110
Central Facilities Area				
CFA 2	10/24/2022	2008	-	170
Materials and Fuels Complex				
USGS-148	10/19/2022	-13	U	100
Naval Reactors Facility				
USGS-099	10/06/2022	-13	U	90
Boundary				
Highway 3	10/17/2022	-29	U	90
USGS-014	10/18/2022	19	U	100
USGS-104	10/19/2022	474	-	120
Distant				
Alpheus Spring	11/14/2022	63	U	100
Bill Jones Hatchery	11/14/2022	27	U	100
Clear Spring	11/14/2022	17	U	100
Minidoka Water Supply	11/14/2022	-70	U	90
Shoshone Water Supply	11/14/2022	-40	U	90
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex				
PW-9	10/06/2022	967	-	140
PW-11	10/05/2022	494	-	120
PW-12	10/05/2022	1561	-	160
USGS-073	10/06/2022	446	-	120
Surface Water				
Birch Creek	10/25/2022	6	U	100
Little Lost River (LLR)	10/25/2022	-23	U	100
Wastewater				
TRA Cold Waste Pond	10/04/2022	-16	U	90
MFC-Industrial Waste Pipeline	10/11/2022	-68	U	90

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
MDC range 160 – 170 pCi/L.

Table 16. Low-level tritium concentrations (pCi/L) in water samples collected during 2022 and 2022 analyzed using the electrolytic enrichment method, fourth quarter of 2022.

Sample Location	Sample Date	Tritium		
		Concentration		2 SD
Aquifer Samples				
Facility				
Materials and Fuels Complex				
USGS-148	10/19/2022	6	U	7
Naval Reactors Facility				
USGS-099	10/06/2022	2	U	7
Radioactive Waste Management Complex				
USGS-120	10/18/2022	87	-	10
Upgradient				
Mud Lake Water Supply	11/15/2022	1	U	7
Boundary				
Highway 3	10/17/2022	43	-	9
Distant				
MV-27	9/06/2022	3	U	8
MV-53	8/15/2022	9	U	8
MV-65	8/15/2022	1	U	7
Alpheus Spring	11/14/2022	17	-	8
Bill Jones Hatchery	11/14/2022	5	U	6
Clear Spring	11/14/2022	2	U	8
Minidoka Water Supply	11/14/2022	6	U	7
Shoshone Water Supply	11/14/2022	2	U	8

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively. ft bgs = feet below ground surface.
MDC range 11 - 13 pCi/L.

Table 17. Strontium-90 concentrations (pCi/L) for water samples, fourth quarter, 2022.

Sample Location	Sample Date	Strontium-90		
		Concentration		2 SD
Aquifer Samples				
Facility				
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/04/2021	4.70	-	0.800
USGS-115	10/04/2021	0.359	U	0.405
Central Facilities Area				
CFA 2	10/24/2022	0.475	-	0.268
Test Area North				
TAN-2336	10/12/2022	554.0	-	46.5
Advanced Test Reactor Complex				
TRA-08	10/04/2022	0.093	U	0.242
USGS-140	10/24/2022	0.236	U	0.245
Radioactive Waste Management Complex				
RWMC Production	10/18/2022	0.890	-	0.387
USGS-120	10/18/2022	0.141	U	0.246
Other Samples				
Perched Groundwater				
Advanced Test Reactor Complex				
PW-9	10/06/2022	1.53	-	0.470
PW-11	10/05/2022	0.582	-	0.307
PW-12	10/05/2022	19.8	-	2.11
USGS-073	10/06/2022	2.18	-	0.585

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively. MDC for TAN-2336 (1.55 pCi/L) was larger due to high dissolved/suspended solids requiring a smaller aliquot for analysis.
MDC range 0.398 – 0.747 pCi/L.

Table 18. Technetium-99 concentrations (pCi/L) for water samples, fourth quarter, 2022.

Sample Location	Sample Date	Technetium-99		
		Concentration		2 SD
Aquifer Samples				
Facility				
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/03/2022	0.187	U	0.698
USGS-115	10/03/2022	3.24	-	0.806
Central Facilities Area				
CFA-2	10/24/2022	4.17	-	0.866
Radioactive Waste Materials Complex				
RWMC Production	10/18/2022	-0.189	U	0.659
USGS-120	10/18/2022	-0.605	U	0.651
Boundary				
USGS-104	10/19/2022	0.210	U	0.709
Highway 3	10/17/2022	-0.639	U	0.637

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
MDC range 1.11 – 1.21 pCi/L.

Table 19. Uranium isotope concentrations (pCi/L) for water samples, fourth quarter, 2022.

Sample Location	Sample Date	Uranium-234		Uranium-235		Uranium-238			
		Concentration	2 SD	Concentration	2 SD	Concentration	2 SD		
Aquifer Samples									
Facility									
Test Area North									
TAN-2336	10/12/2022	2.07	U	2.34	0.155	U	0.973	2.03	U	2.01

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
MDC (U-234) 3.69 pCi/L. MDC (U-235) 2.61 pCi/L. MDC (U-238) 2.89 pCi/L.

Table 20. Iodine-129 concentrations (pCi/L) for water samples, fourth quarter, 2022.

Sample Location	Sample Date	Iodine-129		
		Concentration		2 SD
Aquifer Samples				
Facility				
Idaho Nuclear Technology and Engineering Center				
USGS-112	10/03/2022	0.217	-	0.012
USGS-115	10/03/2022	0.033	-	0.004
Radioactive Waste Materials Complex				
RWMC Production	10/18/2022	0.015	-	0.003
USGS-120	10/18/2022	0.002	U*	0.002

Data qualifiers: U = undetected, J = estimate, R = rejected, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
Reported MDC is 0.002 pCi/L.
* Result is equal to MDC but ≤ 2SD and is therefore considered a non-detection and U-flagged.

Table 21. Common ion concentrations (mg/L) in water samples, fourth quarter, 2022.

Sample Location	Sample Date	Calcium*	Magnesium*	Sodium*	Potassium*	Fluoride	Chloride	Sulfate	Alkalinity†
Aquifer Samples									
Facility									
Advanced Test Reactor Complex									
Middle-1823	10/04/22	-	-	-	-	-	11.0	32.2	169
TRA-08	10/04/22	-	-	-	-	-	11.4	43.9	156
USGS-140	10/24/22	-	-	-	-	-	14.5	34.8	167
Idaho Nuclear Technology and Engineering Center									
USGS-112	10/03/22	-	-	-	-	-	13.7	26.7	147
USGS-115	10/03/22	-	-	-	-	-	52.4[1]	26.6	100
Radioactive Waste Management Complex									
RWMC Production	10/18/22	-	-	-	-	-	27.2	30.5	139
USGS-120	10/18/22	-	-	-	-	-	15.2	31.3	148
Test Area North									
TAN-37A	10/12/22	21[5]	27[5]	590[5]	14[5]	-	103[4]	3.35[4] UJ	2900
TAN-2336	10/12/22	53[5]	61[5]	2000[5]	9.7[5]	-	137[4]	<16[4] U	8580
Central Facilities Area									
CFA 2	10/24/22	-	-	-	-	-	108[3]	36.2	166
Materials and Fuels Complex									
USGS-148	10/19/22	-	-	-	-	-	15.7	17.8	133
Naval Reactors Facility									
USGS-099	10/06/22	-	-	-	-	-	20.0	26.9	197
Boundary									
Highway 3	10/17/2022	-	-	-	-	-	6.25	21.1	145
USGS-014	10/18/2022	-	-	-	-	-	21.2	22.1	141
USGS-104	10/19/2022	-	-	-	-	-	15.1	21.5	123
Distant									
Alpheus Spring	11/14/2022	52	19	32	6.2	-	42.0[1]	58.5	183
Clear Spring	11/14/2022	42	18	24	4.0	-	34.1	49.6	153
Bill Jones Hatchery	11/14/2022	30	15	16	3.4	-	12.6	28.9	138
Shoshone Water Supply	11/14/2022	46	16	20	3.5	-	38.3[1]	48.0	143
Minidoka Water Supply	11/14/2022	38	13	13	2.8	-	6.50	18.2	164
Other Samples									
Perched Groundwater									
Advanced Test Reactor Complex									
PW-09	10/06/2022	-	-	-	-	-	83.0[2]	45.7	119
PW-11	10/05/2022	-	-	-	-	-	17.1	144[2]	156
PW-12	10/05/2022	-	-	-	-	-	32.2	21.8	177
USGS-073	10/06/2022	-	-	-	-	-	133[3]	40.3	162
Surface Water									
Birch Creek	10/25/2022	-	-	-	-	-	4.65	25.6	147
Little Lost River	10/25/2022	-	-	-	-	-	8.16	19.2	176
Wastewater									
TRA Cold Waste Pond	10/04/2022	44	16	8.6	1.6	-	10.0	21.4	168
MFC-Industrial Waste Pipeline	10/11/2022	38	12	20	3.3	-	20.4	18.9	138
Upgradient									
Mud Lake Water Supply	11/15/2022	8.2	2.6	29	4.7	-	4.93	8.66	91.0

Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
"-" = not analyzed.
Note 1. Lab indicated that a 2:1 dilution of this sample was required for this analyte.
Note 2. Lab indicated that a 5:1 dilution of this sample was required for this analyte.
Note 3. Lab indicated that a 10:1 dilution of this sample was required for this analyte.
Note 4. Lab indicated that a 20:1 dilution of this sample was required for this analyte.
Note 5. Lab indicated that a 6.25:1 dilution of this sample was required for this analyte.

Table 22. Dissolved metals concentrations (µg/L) in water samples, fourth quarter, 2022.

Sample Location	Sample Date	Arsenic		Barium		Chromium		Iron		Lead		Manganese		Selenium		Zinc	
Aquifer Samples																	
Facility																	
Advanced Test Reactor Complex																	
Middle-1823	10/04/22	-	-	-	-	9.9	-	-	-	-	-	-	-	-	-	-	-
TRA-08	10/04/22	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-
USGS-140	10/24/22	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-
Idaho Nuclear Technology and Engineering Center																	
USGS-112	10/03/22	-	-	-	-	9.6	-	-	-	-	-	-	-	-	-	-	-
USGS-115	10/03/22	-	-	-	-	5.4	-	-	-	-	-	-	-	-	-	-	-
Radioactive Waste Management Complex																	
RWMC Production	10/18/22	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-
USGS-120	10/18/22	-	-	-	-	8.4	-	-	-	-	-	-	-	-	-	-	-
Test Area North																	
TAN-37A	10/12/22	6.2[2]	UJ	780[2]	-	37[2]	-	4500[1]	-	<12[2]	U	780[2]	-	-	-	-	-
TAN-2336	10/12/22	20[2]	UJ	1500[2]	-	180[2]	-	3700[1]	-	<12[2]	U	670[2]	-	-	-	-	-
Central Facilities Area																	
CFA 2	10/24/22	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-
Materials and Fuels Complex																	
USGS-148	10/19/22	-	-	-	-	1.6	-	-	-	-	-	-	-	-	-	-	-
Naval Reactors Facility																	
USGS-099	10/06/22	-	-	-	-	6.0	-	-	-	-	-	-	-	-	-	-	-
Boundary																	
Highway 3	10/17/2022	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-	-
USGS-014	10/18/2022	-	-	-	-	4.3	-	-	-	-	-	-	-	-	-	-	-
USGS-104	10/19/2022	-	-	-	-	7.7	-	-	-	-	-	-	-	-	-	-	-
Distant																	
Alpheus Spring	11/14/2022	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-	-
Clear Spring	11/14/2022	-	-	-	-	2.6	-	-	-	-	-	-	-	-	-	-	-
Bill Jones Hatchery	11/14/2022	-	-	-	-	3.8	-	-	-	-	-	-	-	-	-	-	-
Shoshone Water Supply	11/14/2022	-	-	-	-	1.9	-	-	-	-	-	-	-	-	-	-	-
Minidoka Water Supply	11/14/2022	-	-	-	-	2.5	-	-	-	-	-	-	-	-	-	-	-
Other Samples																	
Perched Groundwater																	
Advanced Test Reactor Complex																	
PW-09	10/06/2022	-	-	-	-	71	-	-	-	-	-	-	-	-	-	-	-
PW-11	10/05/2022	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-
PW-12	10/05/2022	-	-	-	-	7.9	-	-	-	-	-	-	-	-	-	-	-
USGS-073	10/06/2022	-	-	-	-	37	-	-	-	-	-	-	-	-	-	-	-
Surface Water																	
Birch Creek	10/25/2022	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	-	-
Little Lost River	10/25/2022	-	-	-	-	1.2	-	-	-	-	-	-	-	-	-	-	-
Wastewater																	
TRA Cold Waste Pond	10/04/2022	1.5	UJ	46	-	3.3	-	<10	UJ	<1	U	<1	U	1.1	UJ	-	-
MFC-Industrial Waste Pipeline	10/11/2022	2.1	-	36	-	1.7	-	25	-	<1	U	<1	UJ	-	-	-	-
Upgradient																	
Mud Lake Water Supply	11/15/2022	9.0	-	-	-	<1.0	U	-	-	-	-	-	-	-	-	-	-

Samples were filtered in the field unless otherwise noted.
Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
"-" = not analyzed.
Note 1. Lab indicated that a 6.25:1 dilution of this sample was required for this analyte.
Note 2. Lab indicated that a 12.5:1 dilution of this sample was required for this analyte.

Table 23. Dissolved nutrient concentrations (mg/L) in water samples, fourth quarter, 2022.

Sample Location	Sample Date	Nitrate + Nitrite*		Total Phosphorus	
Aquifer Samples					
Facility					
Advanced Test Reactor Complex					
Middle-1823	10/04/22	1.0	-	-	-
TRA-08	10/04/22	1.0	-	-	-
USGS-140	10/24/22	1.1	-	-	-
Idaho Nuclear Technology and Engineering Center					
USGS-112	10/03/22	0.89[1]	-	-	-
USGS-115	10/03/22	1.7	-	-	-
Radioactive Waste Management Complex					
RWMC Production	10/18/22	1.0	-	-	-
USGS-120	10/18/22	0.84	-	-	-
Test Area North					
TAN-37A	10/12/22	0.051	-	5.0[3]	-
TAN-2336	10/12/22	0.22	-	12[4]	-
Central Facilities Area					
CFA-2	10/24/22	2.8[1]	-	-	-
Materials and Fuels Complex					
USGS-148	10/19/22	2.5[1]	-	-	-
Naval Reactors Facility					
USGS-099	10/06/22	1.8	-	-	-
Boundary					
Highway 3	10/17/22	0.54	-	-	-
USGS-014	10/18/22	1.3	-	-	-
USGS-104	10/19/22	0.87	-	-	-
Distant					
Alpheus Spring	11/14/22	2.2[1]	-	-	-
Clear Spring	11/14/22	2.3[1]	-	-	-
Bill Jones Hatchery	11/14/22	1.8	-	-	-
Shoshone Water Supply	11/14/22	1.4	-	-	-
Minidoka Water Supply	11/14/22	1.3	-	-	-
Other Samples					
Perched Groundwater					
Advanced Test Reactor Complex					
PW-9	10/06/22	3.9[1]	-	-	-
PW-11	10/05/22	1.5	-	-	-
PW-12	10/05/22	1.5	-	-	-
USGS-073	10/06/22	14[2]	-	-	-
Surface Water					
Birch Creek	10/25/22	0.23	-	-	-
Little Lost River (LLR)	10/25/22	0.44	-	-	-
Wastewater					
TRA Cold Waste Pond	10/04/22	0.92	-	0.023	-
MFC-Industrial Waste Pipeline	10/11/22	2.6[1]	-	0.098	-
Upgradient					
Mud Lake	11/15/22	<0.01	U	-	-
Samples were filtered in the field unless otherwise noted.					

Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
* As N.
"-" = not analyzed.
Note 1. Lab indicated that a 2:1 dilution of this sample was required for this analyte.
Note 2. Lab indicated that a 10:1 dilution of this sample was required for this analyte.
Note 3. Lab indicated that a 20:1 dilution of this sample was required for this analyte.
Note 4. Lab indicated that a 50:1 dilution of this sample was required for this analyte.

Table 24. Volatile organic compound concentrations (µg/L) in water samples, fourth quarter, 2022. Only VOCs detected this quarter or in the recent past are shown.

Sample Location	Sample Date	PCE		TCE		1,1-DCE		cis-1,2-DCE		trans-1,2-DCE		Vinyl chloride		Carbon tetrachloride		Chloroform		Chloro-methane		2-Butanone	
Aquifer Samples																					
Facility																					
Radioactive Waste Management Complex:																					
RWMC Production	10/18/2022	<0.50	U	2.58	-	<0.50	U	<0.50	U	<0.50	U	<0.50	U	5.20	-	1.52	-	<0.50	U	<10.0	U
USGS-120	10/18/2022	<0.50	U	<0.50	-	<0.50	U	<0.50	U	<0.50	U	<0.50	U	1.12	-	<0.50	U	<0.50	U	<10.0	U
Test Area North:																					
TAN-2336	10/12/2022	<10.0[1]	U	4.20	J+	<10.0[1]	U	<10.0[1]	U	<10.0[1]	U	<10.0[1]	U	<10.0[1]	U	6.00[1]	J	<10.0[1]	U	1650[1]	-

Abbreviations: PCE = tetrachloroethene; TCE = trichloroethene; 1,1-DCE = 1,1-dichloroethene; cis-1,2-DCE = cis-1,2-dichloroethene; trans-1,2-DCE = trans-1,2-dichloroethene; 1,1-DCA = 1,1-dichloroethane.
Data qualifiers: U = undetected, J = estimate, R = rejected, "<" = less than detection limit, "+" or "-" after a J means that the estimated result is biased high or low, respectively.
Note 1. Lab indicated that a 20:1 dilution of this sample was required for this analyte. This raised the detection limits by a factor of 20.

Terrestrial Monitoring Results

The DEQ-INL OP conducts terrestrial (soil and milk) monitoring to characterize deposition and migration of contaminants and provide independent verification of DOE's terrestrial monitoring programs. Physical soil sampling and *in-situ* gamma spectrometry are used to characterize actual deposition and accumulation of radioactive contaminants in soils. *In-situ* gamma spectroscopic measurements of soil were performed at 19 locations during the fourth calendar quarter of 2022. No physical soil samples were collected during the quarter. Milk samples are collected to evaluate the potential for ingestion of radioactivity by the population around the INL. Ten milk samples were analyzed during the quarter.

Milk

DEQ-INL OP monitors milk for the naturally occurring radionuclide potassium-40 (^{40}K) and man-made iodine-131 (^{131}I). Milk samples are collected on a monthly basis. Results for analyses of milk samples are presented in **Table 25**. ^{40}K was detected in all samples within the expected range of concentration. ^{131}I was not detected. Based on measurements of radionuclides in milk, there were no discernable impacts to the off-site environment from INL operations.

Table 25. Gamma spectroscopy analysis data for milk samples, fourth quarter, 2022.

Sample Location/Dairy	Sample Date	Naturally occurring Potassium-40		Man-made Iodine-131		
		Concentration[2]	± 2 SD	Concentration[2]	± 2 SD	MDC
Monitoring Samples						
Gooding	10/19/22	1372	117	1.3	2.3	3.8
Gooding	11/16/22	1126	107	0.8	1.5	2.5
Gooding	12/14/22	1436	104	-0.2	1.0	1.8
Monteview	10/31/22	1388	110	-0.1	2.6	4.4
Monteview	12/13/22	1288	105	-0.2	2.5	4.3
Verification Samples[1]						
Rigby	10/04/22	1463	106	0.4	1.1	1.8
Terreton	11/01/22	1384	112	-0.7	1.7	2.9
Minidoka	12/06/22	1391	110	0.1	0.9	1.6
Tetonia	11/12/22	1481	106	0.3	1.5	2.0
Tetonia	12/08/22	1294	103	1.2	2.2	3.7

Soil

DEQ-INL OP monitors long-term radiological conditions via physical soil sampling as well as field instrumentation capable of identifying and measuring *in-situ* concentrations of gamma-emitting radionuclides in soil. Monitoring concentrations of gamma-emitting radionuclides in surface soil provides some insight to transport, deposition, and accumulation of radioactive material in the environment as a result of INL operations as well as historical above ground testing of nuclear weapons. *In-Situ* gamma spectroscopic measurements were performed at 19 locations (see **Figure 4**) during the fourth calendar quarter of 2022. The gamma spectra were analyzed using a uniform homogeneous distribution of nuclides with depth as recommended by

NCRP (NCRP report 129). ^{137}Cs was the only man made gamma emitting radionuclide detected. Analysis results for ^{137}Cs concentrations for *in-situ* soil monitoring are shown in **Table 26**.

Table 26. *In-Situ* gamma spectroscopic analysis results (^{137}Cs) for soil, fourth quarter, 2022.

Location	Date Acquired	Concentration[1]	2-sigma	MDA
Boundary Sampling Locations				
Big Southern Butte	11/15/2022	0.318	0.101	0.029
ESER Soil Site Monteview	11/17/2022	0.316	0.063	0.018
Monteview air station	11/17/2022	0.135	0.074	0.024
ESER Soil Site Mud Lake #2	11/17/2022	0.249	0.091	0.027
ESER Soil Site Frenchman's Cabin	11/15/2022	0.340	0.081	0.023
ESER Soil Site Reno Ranch	11/18/2022	0.512	0.082	0.021
ESER Soil Site FAA tower	11/18/2022	0.398	0.082	0.024
Distant Sampling Locations				
IF air station[2]	11/24/2022	0.127	0.051	0.017
IF CMS[3]	11/14/2022	0.072	0.051	0.017
St Anthony	11/14/2022	0.451	0.137	0.033
Sage Junction	11/14/2022	0.349	0.058	0.018
Roberts Met Tower	11/14/2022	0.327	0.090	0.026
ESER soil site Blackfoot	11/16/2022	0.235	0.061	0.018
Crystal Ice Caves	11/16/2022	0.366	0.105	0.026
On site Sampling Locations				
EFS[4] field air station	11/16/2022	0.507	0.093	0.029
Rover	11/18/2022	0.257	0.081	0.025
Large Grid 24-8	11/18/2022	0.500	0.067	0.018
Large Grid 30-1	11/18/2022	0.470	0.087	0.021
Sand Dunes Air station	11/17/2022	0.209	0.069	0.024

[1]Concentrations with associated uncertainties (± 2 SD), and minimum detectable concentrations (MDC) are reported in pCi/g.
[2]DEQ-INL OP HPIC air monitoring station near Idaho Falls, ID.
[3]DEQ-INL OP HPIC Community Monitoring Station (CMS) near John's Hole Bridge Idaho Falls, ID.
[4]Experimental Field Station.

The average Cesium-137 value was 0.31 picocuries per gram (pCi/g) with a minimum value of 0.07 pCi/g and a maximum of 0.51 pCi/g, well below the DEQ-INL OP action level of 6.4 pCi/g and the recommended federal screening limit for surface soil of 6.8 pCi/g (NCRP Report 129).

Based upon terrestrial radiological measurements of soil, there were no discernable impacts to the off-site environment from INL operations. Long-term accumulation of radionuclides observed by soil monitoring was consistent with historical measurements and was in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons.

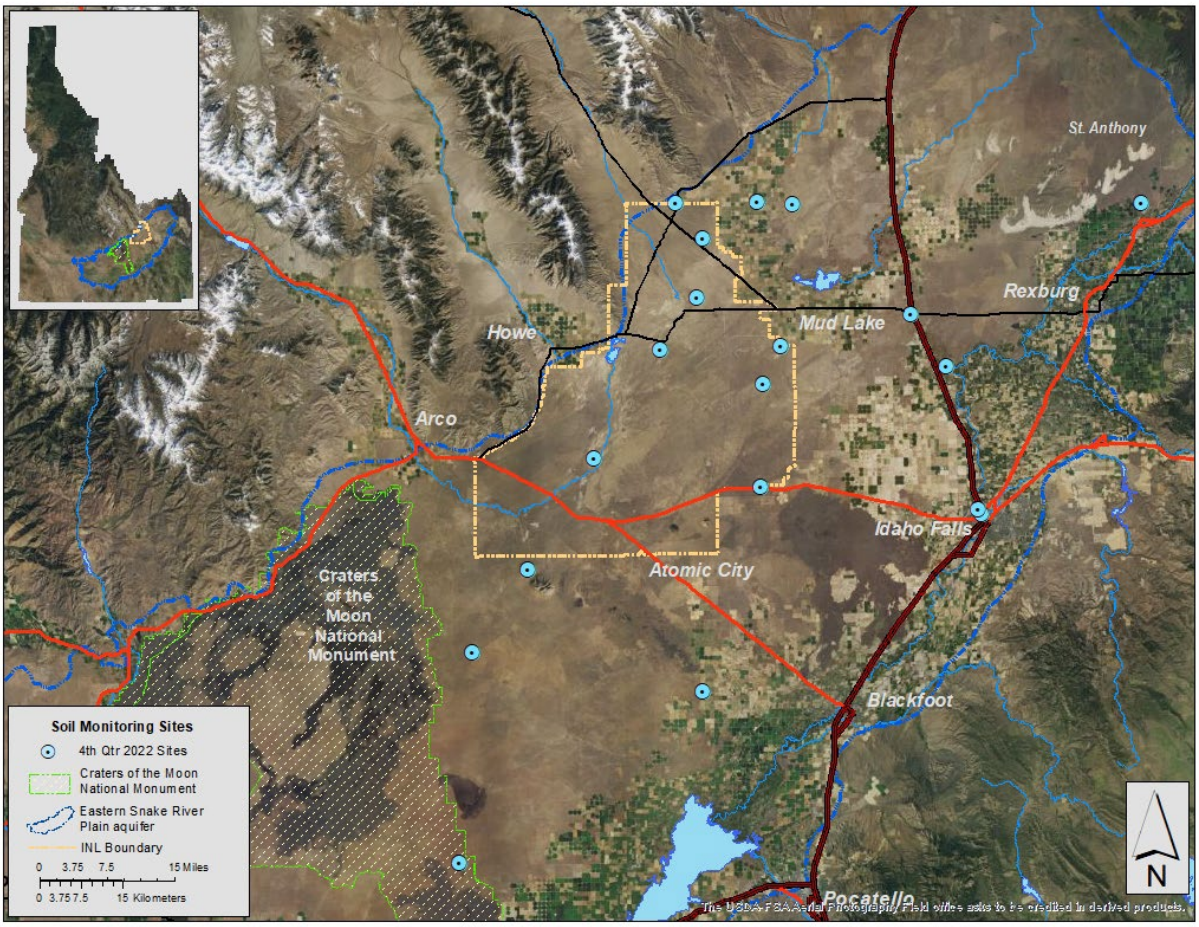

Figure 4. *In-situ* soil monitoring sites, fourth quarter 2022.

Quality Assurance

Measurements of constituent concentrations in environmental media are subject to inaccuracy from errors that may be introduced during the collection, transportation, and analysis of samples, calibration of equipment, and recording and reporting of results. While it is impossible to quantify every error that may affect a result, a quality assurance (QA) program can evaluate the overall quality of a dataset and, in many cases, identify and address errors or inaccuracies. DEQ-INL OP's QA program is designed to (1) ensure sample integrity, (2) evaluate the precision and accuracy of analytical results, and (3) ensure that the environmental data are representative and complete.

This section summarizes the quality assurance assessment of the data collected by DEQ-INL OP in the fourth quarter of 2022. Included are the results of quality control (QC) samples (blanks, duplicates, and spikes) that DEQ-INL OP submitted to Idaho State University's Environmental Monitoring Laboratory (ISU-EML) for radiological analyses and to the Idaho Bureau of Laboratories-Boise (IBL) for non-radiological analyses during the quarter. The analytical results of QC samples are used to assess the precision, accuracy, and representativeness of the environmental data presented in this report. During the fourth quarter of 2022, DEQ-INL OP submitted 100 QC samples for various radiological and non-radiological analyses (**Table 27**).

All samples referenced in this report were collected in accordance with written procedures maintained by the DEQ-INL OP. Analytical methods and QC procedures used by the laboratories were performed in accordance with approved written procedures maintained by each lab. QC samples analyzed by the labs as part of each lab's internal QA program are not discussed in this report.

Blank Samples

Blank samples consist of matrices that contain immeasurable or acceptably low concentrations of the analyte(s) of interest. They are used to monitor contamination introduced during sample collection, storage, shipment, and analysis. For water matrices, a blank sample consists of 18-megaohm deionized water from the DEQ-Idaho Falls Regional office and is categorized as a field blank, equipment blank, or trip blank depending on how the blank is handled. A field blank is used to monitor for contamination introduced from the environment during sample collection, an equipment blank is used to monitor for contamination introduced by contaminated equipment, and a trip blank is used to monitor for contamination introduced during transportation of samples (trip blanks are typically only used for VOCs). Most water blank samples submitted to laboratories by DEQ-INL OP are field blanks.

For all analyses except low-level tritium in water, a blank sample result is considered acceptable if it is less than or equal to the minimum detectable concentration (MDC). For low-level tritium analyses in water samples, a blank sample result is acceptable if it is less than or equal to 33 pCi/L.[2] If a blank result exceeds acceptance criteria, above-MDC results in other samples collected, transported, or analyzed together with the failed blank may be qualified as biased high (J+) or rejected (R), or may remain unqualified, depending on the relative sizes of the blank detection and other sample results.

Sample results for blank TSP filters submitted for gross alpha and gross beta screening in air for the fourth quarter of 2022 are presented in **Table 28**. Blank sample results for selected gamma emitters in air from 47-mm TSP filter quarterly composites and 8x10-inch monthly composites are presented in **Table 29**. Blank sample results for radiochemical analysis of 8x10-inch TSP filter quarterly composites from third quarter 2022 are presented in **Table 30.** Data for blank analyses used to assess data quality for tritium in water vapor in air are presented in **Table 31**. Blank sample results for radiological analytes in groundwater are presented in **Table 32**. Blank sample results for metals and common ions and nutrients are presented in **Tables 33** and **34.**

The third quarter 2022 8x10-inch TSP blank air filter composite Pu-239/240 value was greater than the MDC. All 8x10-inch TSP air filter composite Pu-238/239 results were qualified as non-detected estimates (UJ) for the third quarter. All other blank sample results were less than MDC.

Duplicate Samples

A duplicate sample is one that is collected at the same location and approximately the same time as another sample (referred to as the "original" sample). Duplicate sample results are compared to the original sample's results to evaluate reproducibility. Significant differences between the two could indicate poor analytical precision or a non-uniform sample matrix.

The difference between the results of an original and duplicate sample (referred to below as a "duplicate-sample pair") is evaluated differently for radiological and non-radiological analyses. For radiological analyses, the results of a duplicate-sample pair are considered to be in agreement if their absolute difference is less than or equal to three times the pooled error of the results:

[2] The water used by DEQ-INL OP to create blank samples contains measurable concentrations of tritium produced cosmogenically and by above-ground testing of nuclear weapons during the twentieth century. The highest tritium concentration that DEQ considers acceptable in a blank is calculated as the mean tritium concentration in DEQ blanks from 2013 to 2017 plus two standard deviations (33 pCi/L).

$$|R_1 - R_2| \leq 3\sqrt{S_1^2 + S_2^2}$$

R_1 = Original sample result
R_2 = Duplicate sample result
S_1 = Analytical uncertainty (1 SD) of the original result
S_2 = Analytical uncertainty (1 SD) of the duplicate result

Duplicate radiological results are also considered to be in agreement if their relative percent difference (RPD) is no more than ±20 percent. RPD is calculated as:

$$RPD = \frac{R_1 - R_2}{(R_1 + R_2)/2} \times 100$$

For non-radiological analyses, the RPD is used to evaluate duplicate sample pairs in which both results exceed five times the MDC. An RPD of up to ±20 percent is acceptable. If one or both sample results are less than five times the MDC, the results agree if their absolute difference is less than or equal to the MDC.

Duplicate results for radiological analyses in groundwater and surface water are presented in **Table 35**. Duplicate results for metals and common ions and nutrients in groundwater are presented in **Tables 36** and **37.** Duplicate results for in-situ soil sample results are presented in **Table 38**. The duplicate gross alpha result did not agree with the original sample result for perched groundwater well PW-12. The original PW-12 result was qualified as an estimate (J) in the **Water Monitoring Results** section.

Spiked Samples

Spiked samples are samples to which known concentrations of specific analytes have been added. They are used to assess a laboratory's analytical accuracy. The percent recovery (%R) of each spiked-sample analysis is calculated as the ratio of the spike concentration determined by the lab to the known spike concentration. DEQ-INL OP considers the lab's result to be in control if the percent recovery is 100 ± 25%. If the percent recovery of a spiked sample is 50-74%, above-MDC results of samples analyzed in the same batch as the spiked sample may be qualified as low-biased estimates (J-), and below-MDC results may be qualified as undetected estimates (UJ). If the percent recovery of a spiked sample is 126-150%, above-MDC results of associated samples may be qualified as high-biased estimates (J+), and below-MDC results may be qualified as undetected (U). If the percent recovery of a spiked sample is <50% or >150%, the results of all associated samples may be qualified as rejected (R), except for sample results below MDC associated with a spiked-sample analysis having a percent recovery >150%, in which case the sample result remains qualified as undetected (U).

Results from spiked water samples for metals, common ions and nutrients, and VOCs are presented in **Tables 39, 40**, and **41**. TAN-2336 required a 20:1 dilution for successful VOC analysis and the associated spiked VOC sample was also diluted 20:1. Several spiked sample VOC percent recoveries (%R) from the 20:1 diluted spiked sample were above the acceptable limit of 150%. These included carbon tetrachloride, vinyl chloride, 1,2-dichloroethane, 1,1-dichloroethene, and methylene chloride. However, these analytes were not detected in the associated diluted TAN-2336 field sample. Trichloroethene and cis-1,2-dichloroethene had percent recoveries of 126-150%, causing the greater-than-MDC result for trichloroethene in the associated diluted TAN-2336 field sample to be qualified as a biased-high estimate (J+). This spiked sample was rerun undiluted (as sample 231W090) with all percent recoveries acceptable. Therefore, the associated undiluted field sample results (from RWMC Production and USGS-120) did not require qualification flags. All other spiked sample results were within acceptable limits.

DEQ-INL OP also prepares additional "spike-like" quality control samples to assess ambient radiation measurement bias. Once per quarter, DEQ-INL OP irradiates several electret ionization chambers (EICs) at ISU to verify EIC response. Irradiations of EICs are conducted in a repeatable geometry to a known

exposure of near 30 mR and two additional higher and lower exposures, ranging from 15 to 60 mR. EIC responses are compared directly with the exposure received from the NIST traceable cesium-137 source provided by ISU-EML. EIC response is considered acceptable if each measurement has a percent recovery of 100 ± 25% when compared to the known irradiated quantity. Overall response for each control set is considered acceptable if the average of the three individual results for the set has a percent recovery of 100 ± 25%. Real-time pressure correction is used to calculate the net exposure measured by these EIC control sets. The ISU irradiation results for fourth quarter 2022 are presented in **Table 42**. All individual EIC readings and all EIC control set averages passed the DEQ-INL OP acceptance criterion.

Laboratory QC Issues

Radiochemical separation analysis results for 8x10-inch TSP particulate filter composites collected during third quarter 2022, and reported this quarter, were performed by GEL Laboratories. Strontium-90 (Sr-90) results were greater than MDC at the on-site locations Big Lost River Rest Area and Experimental Field Station, and at the distant locations Craters of the Moon and Idaho Falls. These four filter composites were recounted for Sr-90 by GEL Laboratories at the request of ISU-EML. For two of the four samples (Idaho Falls and Rest Area) the recounts were in relatively close agreement with the original analyses, so the original analyses are considered official. The recount analyses for the Experimental Field Station and Craters of the Moon did not closely agree with the original analyses, so both the original and recounted analyses are considered estimates (J-flagged). Further analyses of these filter composites were not possible. Also, the Idaho Falls positive Sr-90 result did not agree with the Idaho Falls duplicate TSP sampler less-than-MDC result. GEL Laboratories reported the following information indicating significant Quality Control issues with these Sr-90 analyses:

1. The Laboratory Control Sample (LCS) and Laboratory Control Sample Duplicate (LCSD) do not meet the duplication requirement; however, they both meet the spiked recovery requirement. The LCS and LCSD Strontium-90 relative percent difference (RPD) is 44.6% (0% - 20% is acceptable).
2. The Laboratory Control Sample (LCS) was recounted due to low recovery. The recount result is reported, with a 75.7% recovery (recovery limits are 75% - 125%).
3. The Atomic City, Howe, and Monteview samples were recounted due to a suspected false positive. The recounts are reported. All recounts are less than MDC.

DEQ-INL OP Equipment QC Issue

None.

Qualification of Low Level Sample Results

Sample results >MDC are generally considered detections, with the following exceptions[3] that apply primarily to radionuclide concentrations in water samples:

1. Results >MDC but ≤ 2SD are considered non-detections and U-flagged as undetected, where SD is the sample standard deviation.
2. Results >MDC and >2SD but <3SD are considered questionable and J-flagged as estimates.

Analytical QA/QC Assessment

Other than those discussed above, no issues involving sample chain of custody, sample holding times, and the analysis of blank, duplicate, and spiked samples were observed during the fourth quarter of 2022 which significantly affected data quality. The ratio of total QC analyses to total field sample analyses of 12.9% is acceptable and above the DEQ-INL OP minimum requirement of 10%. Methodologies and data

[3] Monitoring and Surveillance Committee, Consistency in Reporting Results Subcommittee Meeting Summary, 2/5/04 and 4/1/04.

reports issued by the contracting laboratories conformed to the requirements of DEQ-INL OP during the fourth quarter of 2022.

Data usability is the measure of field sample results that are not rejected divided by the total number of field sample results obtained. The overall data usability (non-rejected results divided by the total number of field sample results reported) of 100.0% for the fourth quarter of 2022 is well above the acceptable value of 90% for the DEQ-INL OP ESP and is summarized in **Table 27**. The overall data completeness (usable results divided by the total number of field sample results expected) of 98.3% is also well above the acceptable value of 90%.

Preventative Maintenance and Equipment Reliability

All equipment was calibrated and checked according to prescribed periodicity. Service reliability for air sampling equipment for the fourth quarter of 2022 is summarized in **Table 43**.

Conclusion

All data collected for the fourth quarter of 2022 have been assigned the applicable qualifiers to designate the appropriate use of the data. The overall data usability of 100.0% and data completeness of 98.3% are well above the acceptable value of 90% for the quarter, with the data meeting the requirements and data quality objectives established by DEQ-INL OP.

Table 27. Summary of the analyses performed in the fourth quarter, 2022.

Media Sampled	Collection Device	Analyte	Sample Analyses	Blank Analyses	Duplicate Analyses	Spike Analyses	Data Rejected[1]	Analyzing Lab[2]
Air								
Particulate	47-mm filters	Gross alpha	141	13	0	0	0	ISU-EML
		Gross beta	141	13	0	0	0	ISU-EML
	47-mm and 8x10" filters	Gamma emitters	47	4	0	0	0	ISU-EML
	8x10" filters	Radiochemical	36	1	0	0	0	ISU Sub
Water Vapor	Desiccant column	Tritium	32	4	0	0	0	ISU-EML
Gaseous	Charcoal filter	Iodine-131	13	0	0	0	0	ISU-EML
Precipitation	Poly bottle	Tritium	11	0	0	0	0	ISU-EML
		Gamma emitters	11	0	0	0	0	ISU-EML
Water								
Groundwater & Surface Water	Grab or composite	Gross alpha	28	4	2	0	0	ISU-EML
		Gross beta	28	4	2	0	0	ISU-EML
		Gamma emitters	28	4	2	0	0	ISU-EML
		Tritium	28	4	2	0	0	ISU-EML
		Low-level tritium	14	3	1	0	0	ISU-EML
		Radiochemical[6]	25	1	2	0	0	ISU Sub
		Metals	29	4	2	1	0	IBL
		Common Ions	29	4	2	1	0	IBL
		Nutrients	29	4	2	1	0	IBL
		Volatile Organics	3	0	0	2	0	IBL
Terrestrial								
Milk	Grab or composite	Gamma emitters	10	0	0	0	0	ISU-EML
Soil	*in situ*	Gamma emitters	19	0	2	0	0	DEQ-INL OP
	Grab – "puck"	Gamma emitters	0	0	0	0	0	ISU-EML
Radiation								
Ambient	EICs	Gamma Radiation	61	0	0	9	0	DEQ-INL OP
	EcoGamma	Gamma Radiation	11	NA	NA	NA	0	DEQ-INL OP
Total analyses performed			**774**	**67**	**19**	**14**	**0**	
Total QC analyses performed (blanks, duplicates, and spikes)			**100**					
Ratio of total QC analyses to total sample analyses[3]			**12.9%**					
Data usability[4], percent			**100.0%**					
Data completeness[5], percent			**98.3%**					

[1] Combined Laboratory and DEQ-INL OP rejection criteria (data was rejected for any reason).

[2] ISU-EML = Idaho State University – Environmental Monitoring Laboratory; ISU Sub = Subcontract laboratory to ISU-EML; IBL = Idaho Bureau of Laboratories, Boise; IBL Sub = Subcontract laboratory to IBL; DEQ-INL OP = Analyzed by INL Oversight Program, Idaho Department of Environmental Quality.

[3] DEQ-INL OP requires that the number of QC analyses performed be at least 10 percent of the number of sample analyses performed.

[4] Data usability is calculated as [total analyses – rejected data]/[total analyses]. DEQ-INL OP considers a data usability rate of 90 percent or higher to be acceptable.

[5] Data completeness is calculated as usable results divided by the total number of field sample results expected. DEQ-INL OP considers a data completeness rate of 90 percent or higher to be acceptable.

[6] Radiochemical includes Strontium-90, Technetium-99, Uranium 234, 235, and 238, Plutonium-238, 239/240, Americium-241, and Iodine-129.

Table 28. Blank analysis results for gross alpha and beta in 47-mm particulate air (TSP) filters, fourth quarter, 2022.

Collection Period		Corrected volume (m^3)[1]	Gross alpha			Gross beta		
Start	Stop		Value	± 2 SD	MDC	Value	±2 SD	MDC
09/28/22	10/05/22	563	-0.4	0.4	0.7	0.8	0.7	1.0
10/05/22	10/12/22	563	0.0	0.3	0.5	-0.4	0.7	1.2
10/12/22	10/19/22	563	0.0	0.3	0.6	0.4	0.7	1.1
10/19/22	10/26/22	563	-0.2	0.3	0.6	-0.2	0.7	1.2
10/26/22	11/02/22	563	-0.1	0.3	0.5	-0.5	0.7	1.2
11/02/22	11/09/22	563	-0.1	0.3	0.6	-0.1	0.7	1.2
11/09/22	11/16/22	563	-0.6	0.4	0.8	-0.7	0.7	1.2
11/16/22	11/23/22	563	-0.2	0.3	0.6	-0.3	0.6	1.1
11/23/22	11/30/22	563	-0.2	0.3	0.6	0.0	0.7	1.2
11/30/22	12/07/22	563	0.3	0.3	0.5	0.1	0.7	1.1
12/07/22	12/14/22	563	-0.5	0.3	0.6	-0.1	0.6	1.0
12/14/22	12/21/22	563	0.1	0.3	0.5	-0.6	0.5	1.0
12/21/22	12/28/22	563	0.0	0.2	0.4	-0.1	0.5	0.9

Note: Concentrations, associated uncertainties (± 2 SD), and minimum detectable concentrations (MDC) are expressed in 1 x 10^{-3} pCi/m^3.

[1] A volume equal to the average of the weekly volumes collected through each valid field filter was used to compute "concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 29. Blank analysis results for gamma spectrometry for 47-mm TSP air filters, quarterly composite samples, fourth quarter, 2022.

Analysis Date	Beryllium-7			Ruthenium-106/Rhodium-106			Antimony-125		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/17/2023	-6	65	113	13	146	240	9	15	26

Analysis Date	Cesium-134			Cesium-137		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/17/2023	4	7	12	0	7	12

Note: Concentrations are expressed in 1 x 10^{-5}pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

[1] These concentrations are from blank filters collected weekly, composited, and analyzed for the calendar quarter. A composite volume equal to the sum of the weekly average volumes collected through each valid field filter was used to compute "air concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 29 (continued). Blank analysis results for gamma spectrometry for 8x10-inch TSP air filters, monthly composite samples, fourth quarter, 2022.

Month	Beryllium-7			Ruthenium-106/Rhodium-106			Antimony-125		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
Oct 2022	9	37	62	-10	47	81	9	7	11
Nov 2022	15	31	51	-39	52	94	1	7	12
Dec 2022	5	26	44	1	60	103	4	7	12

Month	Cesium-134			Cesium-137		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC
Oct 2022	2	2	4	1	3	5
Nov 2022	-2	5	8	3	4	7
Dec 2022	0	1	6	1	3	5

Note: Concentrations are expressed in 1 x 10^{-5}pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).
[1]These concentrations are from blank filters collected weekly, composited, and analyzed for the calendar month. A composite volume equal to the sum of the weekly average volumes collected through each valid field filter was used to compute "air concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 30. Blank results for radiochemical analysis of 8x10-inch TSP air filters, quarterly composite samples, third quarter, 2022.

Sample Description	^{90}Sr			^{238}Pu			^{239}Pu/^{240}Pu			^{241}Am		
	Value[1]	± 2 SD	MDC	Value[1]	± 2 SD	MDC	Value[1]	± 2 SD	MDC	Value[1]	± 2 SD	MDC
Blank	0.71	0.89	1.46	-0.02	0.19	0.44	0.64	0.56	0.60	-0.04	0.11	0.32

Note: Concentrations are expressed in 1 x 10^{-5} pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).
[1] These concentrations are from blank filters collected weekly, composited, and analyzed for the calendar quarter. A composite volume equal to the sum of the weekly average volumes collected through each valid field filter was used to compute "air concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 31. Blank analysis results for tritium in water vapor from air samples, fourth quarter, 2022.

Sample Number	Start Date	Collection Date	Analysis Date	Tritium		
				Concentration	± 2 SD	MDC
OP224ZTR01	10/18/22	10/24/22	02/07/23	-0.04	0.05	0.09
OP224ZTR02	10/18/22	10/24/22	02/07/23	0.00	0.06	0.09
OP224 Fridge	10/21/22	01/11/23	02/11/23	-0.10	0.05	0.10
OP224 Sink	10/21/22	01/11/23	02/11/23	-0.03	0.06	0.10

Note: Concentrations are expressed in nCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 32. Blank analysis results (pCi/L) for radiological constituents in water, fourth quarter, 2022.

Sample Number	Sample Date	Blank Type	Concentration	± 2 SD	MDC	Within Blank Criteria?
Gross Alpha						
221W717	10/19/2022	Field	0.0	0.2	0.3	Yes
221W797	10/18/2022	Field	0.1	0.2	0.3	Yes
221W802	10/19/2022	Field	0.1	0.2	0.3	Yes
221W844	11/14/2022	Field	0.2	0.2	0.3	Yes
Gross Beta						
221W717	10/19/2022	Field	-1.0	0.6	1.0	Yes
221W797	10/18/2022	Field	0.0	0.6	1.0	Yes
221W802	10/19/2022	Field	-0.5	0.6	1.0	Yes
221W844	11/14/2022	Field	0.7	0.6	0.9	Yes
Cesium-137						
221W717	10/19/2022	Field	1.9	2.1	3.4	Yes
221W797	10/18/2022	Field	1.6	2.0	3.2	Yes
221W802	10/19/2022	Field	1.1	1.8	3.0	Yes
221W844	11/14/2022	Field	-0.4	1.0	1.8	Yes
Tritium (standard method)						
221W718	10/19/2022	Field	10	100	170	Yes
221W798	10/18/2022	Field	-20	100	170	Yes
221W803	10/19/2022	Field	-20	100	170	Yes
221W845	11/14/2022	Field	50	100	160	Yes
Tritium (low-level method)						
221W598	08/15/2022	Field	-2	7	13	Yes
221W718	10/19/2022	Field	-4	6	11	Yes
221W845	11/14/2022	Field	-6	7	12	Yes
Technetium-99						
221W804	10/19/2022	Field	-0.497	0.653	1.13	Yes

MDC = minimum detectable concentration.

Table 33. Blank analysis results (µg/L) for metals in water, fourth quarter, 2022.

Sample Number	Sample Date	Blank Type	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
221W720	10/19/2022	Field	-	-	<1.0	-	-	-	-	-
221W800	10/18/2022	Field	-	-	<1.0	-	-	-	-	-
221W806	10/19/2022	Field	-	-	<1.0	-	-	-	-	-
221W847	11/14/2022	Field	-	-	<1.0	-	-	-	-	-

Table 34. Blank analysis results (mg/L) for common ions and nutrients in water, fourth quarter, 2022.

Sample Number	Sample Date	Blank Type	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Alkalinity†	NO_3+NO_2*	Total Phosphorus
221W719, 721	10/19/2022	Field	-	-	-	-	-	<0.4	<0.8	<1.0	<0.01	-
221W799, 801	10/18/2022	Field	-	-	-	-	-	<0.4	<0.8	<1.0	<0.01	-
221W805, 807	10/19/2022	Field	-	-	-	-	-	<0.4	<0.8	<1.0	<0.01	-
221W846, 847, 848	11/14/2022	Field	<0.1	<0.1	<0.1	<0.1	-	<0.4	<0.8	<1.0	<0.01	-

† As $CaCO_3$.

* As N.

Table 35. Duplicate sample results (pCi/L) for radiological constituents in groundwater and/or surface water, fourth quarter, 2022

Analysis/Sample Location	Original Sample Number	Concentration	± 2 SD	Duplicate Sample Number	Concentration	± 2 SD	RPD (%)	$\lvert R_1-R_2 \rvert$	$3(S_1^2+S_2^2)^{1/2}$	Within either criterion?
Gross Alpha										
PW-12	221W657	3.4	1.1	221W728	9.1	1.7	-91	5.7	3.0	No
Highway 3	221W756	1.5	0.7	221W808	1.3	0.6	57	0.8	1.9	Yes
Gross Beta										
PW-12	221W657	50.1	1.8	221W728	59.6	2.0	-17	9.5	4.0	Yes
Highway 3	221W756	4.2	0.8	221W808	1.6	0.8	-33	1.0	1.7	Yes
Cesium-137										
PW-12	221W657	0.4	1.1	221W728	-1.4	1.7	-360	1.8	3.0	Yes
Highway 3	221W756	0.6	1.5	221W808	1.1	1.7	-59	0.5	3.4	Yes
Tritium (standard method)										
PW-12	221W659	1561	160	221W730	1425	150	8.7	130	329	Yes
Highway 3	221W758	-29	90	221W810	36	100	-1400	70	202	Yes
Tritium (low level method)										
Highway 3	221W758	43	9	221W810	38	9	12	5	19	Yes
Strontium-90										
PW-12	221W658	19.8	2.1	221W729	19.5	2.1	2	0.3	4.4	Yes
Technetium-99										
Highway 3	221W757	-0.639	0.637	221W809	-0.670	0.607	5	0.03	1.32	Yes

Table 36. Duplicate results for metals (µg/L) in groundwater, fourth quarter, 2022.

Sample Location	Sample Number	Sample Date	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
PW-12	221W661	10/05/2022	-	-	7.9	-	-	-	-	-
PW-12	221W732	10/05/2022	-	-	7.0	-	-	-	-	-
RPD (%)			**-**	**-**	**12**	**-**	**-**	**-**	**-**	**-**
Highway 3	221W760	10/17/2022	-	-	2.0	-	-	-	-	-
Highway 3	221W812	10/17/2022	-	-	2.0	-	-	-	-	-
RPD (%)			**-**	**-**	**0.0**	**-**	**-**	**-**	**-**	**-**

RPD = relative percent difference.

Table 37. Duplicate sample results for common ions and nutrients (mg/L) in groundwater, fourth quarter, 2022.

Sample Location	Sample Number	Sample Date	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Total Alkalinity†	Total Nitrogen	Total Phosphorus
PW-12	221W660, 662	10/05/2022	-	-	-	-	-	32.2	21.8	177	1.5	-
PW-12	221W731, 733	10/05/2022	-	-	-	-	-	30.8	21.9	176	1.5	-
RPD (%)			**-**	**-**	**-**	**-**	**-**	**4.4**	**-0.5**	**0.6**	**0.0**	**-**
Highway 3	221W759, 761	10/17/2022	-	-	-	-	-	6.25	21.1	145	0.54	-
Highway 3	221W811, 813	10/17/2022	-	-	-	-	-	6.25	21.1	145	0.54	-
RPD (%)			**-**	**-**	**-**	**-**	**-**	**0.0**	**0.0**	**0.0**	**0.0**	**-**

RPD = relative percent difference.

† As $CaCO_3$.

Table 38. Duplicate *in-situ* analyses of gamma emitting radionuclides in soil, fourth quarter, 2022.

Analysis/Sample Location	Sample Date	Original Result (pCi/g)	± 2 SD	Duplicate Result (pCi/g)	± 2 SD	RPD (%)	$\lvert R_1-R_2 \rvert$	$3(S_1^2+S_2^2)^{1/2}$	Within either criterion?
Cs-137									
Idaho Falls CMS[1]	11/14/2022	0.072	0.051	0.097	0.044	-30	0.024	0.101	Yes
ESER Soil Site Blackfoot	11/16/2022	0.235	0.061	0.253	0.063	-7	0.018	0.132	Yes
K-40									
Idaho Falls CMS[1]	11/14/2022	9.82	0.59	9.91	0.58	-1	0.09	1.24	Yes
ESER Soil Site Blackfoot	11/16/2022	13.9	0.7	13.3	0.7	4.4	0.6	1.5	Yes

RPD = relative percent difference.

[1]Community Monitoring Station.

Table 39. Spiked sample results (µg/L) for metals in water, fourth quarter, 2022.

Sample Number	Sample Date	Barium	Chromium	Lead	Manganese	Zinc

		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
221W714	10/12/2022	-	-	-	9.16	9.4	103	-	-	-	-	-	-	-	-	-

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.

Table 40. Spiked sample results (mg/L) for common ions and nutrients in water, fourth quarter, 2022.

Sample Number	Sample Date	Calcium			Magnesium			Sodium			Potassium			Fluoride		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
221W713, 715	10/12/2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 40. (Continued) Spiked sample results (mg/L) for common ions and nutrients in water, fourth quarter, 2022.

Sample Number	Sample Date	Chloride			Sulfate			Total Alkalinity			$NO_3 + NO_2$*			Total Phosphorus		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
221W713, 715	10/12/2022	106	107[1]	101	16.7	17.2	97	35.5	33.3	94	3.21	3.3[2]	103	-	-	-

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.
*As N.
[1] A sample dilution factor of 5 was required for this analyte.
[2] A sample dilution factor of 2 was required for this analyte.

Table41. Spiked sample results (µg/L) for VOCs in water, fourth quarter, 2022.

Sample Number	Sample Date	Carbon Tetrachloride			Styrene			Tetrachloroethene			Trichloroethene			Vinyl Chloride		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
221W716[1]	10/12/2022	9.44	16.2	172	20.1	18.2	91	13.3	15.8	119	13.2	19.6	148	7.00	12.8	183
231W090[2]	04/05/2023	9.44	10.8	114	20.1	18.4	92	13.3	13.6	102	13.2	14.7	111	7.00	7.65	109

Table 41 (continued). Spiked sample results (µg/L) for VOCs in water, fourth quarter, 2022.

Sample Number	Sample Date	1,2-Dichloroethane			1,1-Dichloroethene			Cis-1,2-Dichloroethene			Trans-1,2-Dichloroethene			Methylene Chloride		
		Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
221W716[1]	10/12/2022	15.5	24.4	157	17.9	25.2	141	11.3	10.2	90	15.0	23.2	155	17.8	35.0	197
231W090[2]	04/05/2023	15.5	16.2	105	17.9	18.7	104	11.3	13.2	117	15.0	17.5	117	17.8	20.8	117

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.
[1] A sample dilution factor of 20 was used for all analytes.
[2] This was a re-analysis of the same spike material with no dilution.

Table42. ISU-EML electret ionization chamber (EIC) irradiation results (categorized as spiked samples), fourth quarter, 2022.

Electret #	Exposure Received	Net Measured Exposure[1]	%R	

	(mR)	Uncertainty (±1 SD, mR)	(mR)	Uncertainty (±1 SD, mR)		Within Spec?
SKR566	40.0	1.4	35.1	1.3	87.8%	Yes
SKR408	40.0	1.4	39.4	1.3	98.6%	Yes
SKR536	40.0	1.4	37.7	1.3	94.3%	Yes
				Triplicate AVG:	**93.6%**	**Yes**
SMD582	30.0	1.1	27.2	1.3	90.5%	Yes
SMD594	30.0	1.1	29.2	1.3	97.4%	Yes
SKR272	30.0	1.1	29.7	1.3	99.1%	Yes
				Triplicate AVG:	**95.7%**	**Yes**
SKR514	20.0	0.7	19.1	1.3	95.5%	Yes
SMD513	20.0	0.7	19.7	1.3	98.5%	Yes
SKR506	20.0	0.7	20.3	1.3	101.4%	Yes
				Triplicate AVG:	**98.5%**	**Yes**

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.
[1] Net measured exposure estimate includes a correction for atmospheric pressure.

Table 43. Air sampling field equipment service reliability (percent operational), fourth quarter, 2022.

Station Locations	Sample Type				
	47-mm TSP	8x10-inch TSP	Radioiodine	Atmospheric Moisture	Precipitation
Onsite Locations					
Big Lost River Rest Area	100%	100%	100%	100%	100%
Experimental Field Station	85%	92%	100%	100%	NC[1]
Sand Dunes Tower	100%	100%	100%	100%	NC[1]
Van Buren Avenue	100%	92%	100%	100%	NC[1]
Boundary Locations					
Atomic City	100%	100%	100%	100%	100%
Howe	100%	100%	100%	100%	100%
Monteview	100%	100%	100%	100%	100%
Mud Lake	100%	92%	100%	100%	100%
Distant Locations[2]					
Craters of the Moon	100%	100%	100%	100%	NC[1]
Idaho Falls	100%	100%	100%	100%	100%
Idaho Falls Duplicate[3]	NC[1]	100%	-	-	-

Note: The values in this table were calculated by dividing the number of weeks the equipment was in operation by the number of weeks in the quarter.

[1] NC = Sample not collected at this location.

[2] The Fort Hall Station, operated by the Shoshone-Bannock Tribes, is not included here.

[3] A duplicate 8x10-inch filter TSP sampler is currently installed at the Idaho Falls location.

Appendix A

Table A-1. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, fourth quarter, 2022.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
On-Site Locations						
Big Lost River Rest Area	09/28/22	10/05/22	0.8	0.5	27.3	1.5
	10/05/22	10/12/22	2.1	0.5	47.8	2.0
	10/12/22	10/19/22	1.0	0.4	23.5	1.5
	10/19/22	10/26/22	0.7	0.4	22.9	1.5
	10/26/22	11/02/22	0.3	0.3	27.6	1.5
	11/02/22	11/09/22	0.1	0.4	9.0	1.0
	11/09/22	11/16/22	-0.2	0.5	27.6	1.6
	11/16/22	11/23/22	0.7	0.4	46.8	1.9
	11/23/22	11/30/22	0.3	0.4	25.5	1.5
	11/30/22	12/07/22	0.5	0.3	19.8	1.4
	12/07/22	12/14/22	0.0	0.4	22.5	1.3
	12/14/22	12/21/22	0.7	0.4	43.3	1.8
	12/21/22	12/28/22	0.9	0.4	30.7	1.5
Experimental Field Station	09/28/22	10/05/22	NS[1]	NS	NS	NS
	10/05/22	10/12/22	NS[1]	NS	NS	NS
	10/12/22	10/19/22	2.2	0.6	27.6	1.6
	10/19/22	10/26/22[2]	1.6	0.7	27.4	1.9
	10/26/22	11/02/22[2]	0.7	0.4	36.0	1.9
	11/02/22	11/09/22	0.4	0.4	10.4	1.1
	11/09/22	11/16/22	0.5	0.5	33.5	1.7
	11/16/22	11/23/22	0.7	0.4	49.4	2.0
	11/23/22	11/30/22	0.4	0.4	28.0	1.6
	11/30/22	12/07/22	0.2	0.3	22.8	1.4
	12/07/22	12/14/22	0.3	0.4	25.9	1.4
	12/14/22	12/21/22	0.8	0.4	43.3	1.8
	12/21/22	12/28/22	0.8	0.4	29.8	1.5
Sand Dunes Tower	09/28/22	10/05/22	0.8	0.5	26.1	1.4
	10/05/22	10/12/22	2.4	0.5	48.2	1.9
	10/12/22	10/19/22	0.9	0.4	25.0	1.4
	10/19/22	10/26/22	0.5	0.4	22.1	1.4
	10/26/22	11/02/22	0.6	0.4	29.6	1.5
	11/02/22	11/09/22	0.0	0.3	11.0	1.1
	11/09/22	11/16/22	0.0	0.4	23.8	1.4
	11/16/22	11/23/22	1.7	0.5	46.7	1.8
	11/23/22	11/30/22	0.5	0.4	27.0	1.5
	11/30/22	12/07/22	0.5	0.3	21.4	1.3
	12/07/22	12/14/22	0.5	0.4	23.6	1.3
	12/14/22	12/21/22	1.0	0.4	50.7	1.8
	12/21/22	12/28/22[7]	0.7	0.3	33.9	1.6

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, fourth quarter, 2022.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Van Buren Avenue	09/28/22	10/05/22	0.6	0.5	28.2	1.5
	10/05/22	10/12/22	1.6	0.5	47.3	2.0
	10/12/22	10/19/22	1.1	0.4	25.6	1.5
	10/19/22	10/26/22	0.6	0.4	22.4	1.4
	10/26/22	11/02/22	0.7	0.4	28.2	1.5
	11/02/22	11/09/22	0.1	0.4	11.5	1.1
	11/09/22	11/16/22	-0.1	0.5	29.8	1.6
	11/16/22	11/23/22	0.8	0.4	47.0	1.9
	11/23/22	11/30/22	0.3	0.4	28.6	1.6
	11/30/22	12/07/22	0.4	0.3	20.4	1.4
	12/07/22	12/14/22	0.3	0.4	24.5	1.4
	12/14/22	12/21/22	0.3	0.3	42.1	1.7
	12/21/22	12/28/22	0.6	0.3	32.2	1.5
Boundary Locations						
Atomic City	09/28/22	10/05/22	0.7	0.5	26.8	1.5
	10/05/22	10/12/22	2.0	0.5	50.0	2.0
	10/12/22	10/19/22	1.0	0.4	24.6	1.5
	10/19/22	10/26/22	0.7	0.4	21.3	1.4
	10/26/22	11/02/22	0.6	0.4	29.2	1.6
	11/02/22	11/09/22	0.5	0.4	10.4	1.1
	11/09/22	11/16/22	0.6	0.6	36.5	1.8
	11/16/22	11/23/22	1.4	0.5	45.5	1.9
	11/23/22	11/30/22	0.6	0.3	27.2	1.5
	11/30/22	12/07/22	0.4	0.4	18.7	1.2
	12/07/22	12/14/22	0.0	0.4	25.4	1.4
	12/14/22	12/21/22	1.1	0.4	44.3	1.8
	12/21/22	12/28/22	0.8	0.4	31.6	1.5
Howe	09/28/22	10/05/22	0.3	0.4	25.6	1.4
	10/05/22	10/12/22	1.9	0.5	47.8	2.0
	10/12/22	10/19/22	1.2	0.5	25.3	1.5
	10/19/22	10/26/22	1.3	0.5	21.8	1.4
	10/26/22	11/02/22	0.8	0.4	30.9	1.5
	11/02/22	11/09/22	0.1	0.4	11.6	1.2
	11/09/22	11/16/22	-0.1	0.4	29.5	1.5
	11/16/22	11/23/22	1.0	0.4	46.0	1.9
	11/23/22	11/30/22	0.5	0.4	24.8	1.5
	11/30/22	12/07/22[5]	0.3	0.3	19.3	1.3
	12/07/22	12/14/22[5]	-0.2	0.3	21.8	1.3
	12/14/22	12/21/22	0.5	0.3	44.2	1.7
	12/21/22	12/28/22	0.8	0.4	30.5	1.5

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for 47-mm TSP filters for all locations, fourth quarter, 2022.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Monteview	09/28/22	10/05/22	0.8	0.5	28.0	1.5
	10/05/22	10/12/22	1.7	0.5	48.0	1.9
	10/12/22	10/19/22	0.9	0.4	22.4	1.4
	10/19/22	10/26/22	0.5	0.4	22.0	1.4
	10/26/22	11/02/22	0.6	0.4	28.4	1.5
	11/02/22	11/09/22	0.0	0.3	12.2	1.1
	11/09/22	11/16/22	-0.3	0.4	28.3	1.6
	11/16/22	11/23/22	1.5	0.5	42.9	1.8
	11/23/22	11/30/22	0.6	0.4	33.1	1.6
	11/30/22	12/07/22	0.7	0.4	23.4	1.4
	12/07/22	12/14/22	0.0	0.4	21.6	1.3
	12/14/22	12/21/22	1.4	0.4	63.9	2.1
	12/21/22	12/28/22	0.9	0.4	33.7	1.5
Mud Lake	09/28/22	10/05/22	0.8	0.5	28.4	1.5
	10/05/22	10/12/22[6]	2.0	0.5	49.4	2.0
	10/12/22	10/19/22[6]	1.0	0.4	25.8	1.5
	10/19/22	10/26/22	0.9	0.4	24.2	1.5
	10/26/22	11/02/22	1.1	0.4	33.1	1.6
	11/02/22	11/09/22	0.1	0.4	12.4	1.1
	11/09/22	11/16/22	-0.4	0.4	31.8	1.6
	11/16/22	11/23/22	1.2	0.5	47.0	1.9
	11/23/22	11/30/22	0.6	0.4	34.9	1.7
	11/30/22	12/07/22	0.4	0.3	21.5	1.4
	12/07/22	12/14/22	-0.1	0.3	23.1	1.3
	12/14/22	12/21/22	0.9	0.4	58.0	2.0
	12/21/22	12/28/22	1.2	0.4	33.5	1.5
Distant Locations						
Craters of the Moon	09/28/22	10/05/22	0.4	0.5	25.4	1.4
	10/05/22	10/12/22	1.7	0.5	44.8	1.9
	10/12/22	10/19/22	0.9	0.4	22.0	1.4
	10/19/22	10/26/22	0.2	0.4	17.8	1.3
	10/26/22	11/02/22	0.4	0.3	25.8	1.4
	11/02/22	11/09/22	0.2	0.4	10.4	1.1
	11/09/22	11/16/22	-0.1	0.5	28.9	1.6
	11/16/22	11/23/22	0.9	0.4	42.1	1.8
	11/23/22	11/30/22	0.0	0.4	19.1	1.3
	11/30/22	12/07/22	0.3	0.3	15.1	1.2
	12/07/22	12/14/22	0.1	0.4	17.8	1.2
	12/14/22	12/21/22	0.5	0.3	33.6	1.6
	12/21/22	12/28/22	0.7	0.3	25.4	1.4

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses of 47-mm TSP filters for all locations, fourth quarter, 2022.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Fort Hall[1]	09/28/22	10/05/22[4]	1.0	0.5	26.9	1.4
	10/05/22	10/12/22[4]	2.3	0.5	46.5	1.9
	10/12/22	10/19/22[4]	0.8	0.4	21.2	1.4
	10/19/22	10/26/22[4]	1.0	0.4	23.9	1.4
	10/26/22	11/02/22[4]	0.8	0.4	24.1	1.4
	11/02/22	11/09/22[4]	0.6	0.4	11.1	1.0
	11/09/22	11/16/22[4]	0.1	0.5	30.3	1.6
	11/16/22	11/23/22[4]	1.0	0.4	43.0	1.8
	11/23/22	11/30/22[4]	0.3	0.4	21.1	1.4
	11/30/22	12/07/22[4]	0.7	0.4	18.4	1.3
	12/07/22	12/14/22[4]	0.2	0.4	18.8	1.2
	12/14/22	12/21/22[4]	1.5	0.4	40.8	1.7
	12/21/22	12/28/22[4]	0.7	0.3	29.1	1.4
Idaho Falls	09/28/22	10/05/22	0.4	0.5	25.9	1.5
	10/05/22	10/12/22	2.1	0.5	48.5	2.0
	10/12/22	10/19/22	1.7	0.5	25.2	1.5
	10/19/22	10/26/22	1.3	0.5	23.7	1.5
	10/26/22	11/02/22	0.9	0.4	26.7	1.5
	11/02/22	11/09/22	0.0	0.4	11.2	1.1
	11/09/22	11/16/22	0.1	0.5	34.9	1.7
	11/16/22	11/23/22	1.3	0.5	43.6	1.8
	11/23/22	11/30/22	0.9	0.5	33.7	1.7
	11/30/22	12/07/22	0.3	0.3	18.1	1.3
	12/07/22	12/14/22	0.2	0.4	24.3	1.4
	12/14/22	12/21/22	0.9	0.4	54.5	1.9
	12/21/22	12/28/22	0.6	0.3	30.8	1.5

Note: MDCs typically range from (0.4 to 0.9) x 10^{-3} pCi/m^3 for gross alpha and from (0.9 to 1.3) x 10^{-3} pCi/m^3 for gross beta.

[1] NS – No sample due to planned power outage.
[2] Partial sample due to planned power outage.
[3] Operated by Shoshone-Bannock Tribes.
[4] Improper sampling orientation with the filter not fully exposed to the ambient air. Results are considered (usable) estimates.
[5] Power was out during 12/07/22 filter changeout.
[6] Total volume is an estimate. Results are considered (usable) estimates.
[7] Power was out during 12/28/22 filter changeout.

Appendix B

Table B-1. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2022.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
Arco	15.3	2.9
Craters of the Moon	11.7	2.7
Rest Area	15.3	1.9
Van Buren Avenue	13.9	2.5
Experimental Field Station	14.4	1.2
Main Gate	15.4	5.0
Atomic City	10.7, 11.4	-
Taber	14.3	1.5
Blackfoot	12.5	1.7
Ft. Hall	11.8	0.3
Idaho Falls	10.5	1.3
Mud Lake/ Terreton	14.7	3.9
Monteview	11.6	2.2
Sand Dunes	17.4	3.9
Howe Met. Tower	10.9, 12.6	-
MP282 -20	11.4	1.6
MP280 -20	13.2	3.8
MP278 -20	14.0	0.6
MP276 -20	11.3, 12.8	-
MP274 -20	12.5	2.8
MP272 -20	13.3	4.0
MP270 -20	13.0	2.5
MP268 -20	14.6	2.5
MP266 -20	15.4	0.9
MP264 -20	13.0	1.3
MP270 -20/26	14.1	3.2
MP268 -20/26	13.0	2.4
MP266 -20/26	15.6	2.9
MP263 -20/26	14.1	0.4
MP261 -20/26	11.6	1.9
MP259 -20/26	15.0	2.6
MP256 -20/26	11.7	1.6
MFC (EBR II)	12.5	1.5
EBR I	10.5, 11.5	-
RWMC	15.3	3.2
CFA	15.4	5.2
CITRC (PBF)	13.7	2.3
INTEC	15.8	4.6
ATR (TRA)	13.1	1.1
NRF	15.0, 16.1	-
TAN/SMC	11.0, 12.8	-
Mud Lake Bank of Commerce	15.0	2.1
MP43-33	14.8, 15.5	-
MP41-33	18.1	4.4
MP39-33	14.7	3.0
MP37-33	9.7, 11.8	-
MP35-33	11.0	3.6
MP33-33	13.5	4.8
MP31-33	14.9	4.2
MP29-33	16.5	4.2

Table B-1 continued. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2022.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
MP27-33	14.1, 16.2	-
MP25-33	12.9	2.1
MP23-33	NS[2]	NS
MP21-33	14.3	4.5
MP19-33	13.4	4.5
MP14-33	10.7	1.9
MP11-33	12.6	3.5
MP06-33	12.5	2.6
MP03-33	13.8	3.9
Base of Howe	NS[3]	NS
Rover	NS[3]	NS
Hamer	12.5	2.8
Sugar City	16.9	0.7
Roberts	12.5	1.3
Big Southern Butte	NS[3]	NS
T4 North	NS[3]	NS
T4 South	NS[3]	NS

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.
[2] NS – No sample. Electrets not deployed for fourth quarter. No milepost found.
[3] NS – No sample. Impassable road. Could not pick up electrets in fourth quarter.

Appendix C

Table C-1. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
Benzene	0.5
Carbon tetrachloride	0.5
Chlorobenzene	0.5
1,4-Dichlorobenzene	0.5
1,2-Dichlorobenzene	0.5
1,2-Dichloroethane	0.5
1,1-Dichloroethene	0.5
cis-1,2-Dichloroethene	0.5
trans-1,2-Dichloroethene	0.5
1,2-Dichloropropane	0.5
Ethylbenzene	0.5
Methylene Chloride	0.5
Styrene	0.5
Tetrachloroethene (PCE)	0.5
Toluene	0.5
1,2,4-Trichlorobenzene	0.5
1,1,1-Trichloroethane	0.5
1,1,2-Trichloroethane	0.5
Trichloroethene (TCE)	0.5
Vinyl chloride	0.5
Xylenes (total)	0.5
Bromodichloromethane	0.5
Dibromochloromethane	0.5
Bromoform	0.5
Chloroform	0.5
Bromobenzene	0.5
Bromochloromethane	0.5
Bromomethane	0.5
n-Butylbenzene	0.5
sec-Butylbenzene	1.0
tert-Butylbenzene	0.5
Chloroethane	0.5
Chloromethane	0.5
2-Chlorotoluene	0.5

Table C-1 continued. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
4-Chlorotoluene	0.5
1,2-Dibromo-3-chloropropane (DBCP)	0.5
1,2-Dibromoethane (EDB)	0.5
Dibromomethane	0.5
1,3-Dichlorobenzene	0.5
Dichlorodifluoromethane	0.5
1,1-Dichloroethane	0.5
1,3-Dichloropropane	0.5
2,2-Dichloropropane	0.5
1,1-Dichloropropene	0.5
cis-1,3-Dichloropropene	0.5
trans-1,3-Dichloropropene	1.0
Hexachlorobutadiene	0.5
Isopropylbenzene	0.5
p-Isopropyltoluene	0.5
Methyl Tert Butyl Ether (MTBE)	0.5
Naphthalene	0.5
n-Propylbenzene	0.5
1,1,1,2-Tetrachloroethane	0.5
1,1,2,2-Tetrachloroethane	0.5
1,2,3-Trichlorobenzene	0.5
Trichlorofluoromethane	0.5
1,2,3-Trichloropropane	0.5
1,2,4-Trimethylbenzene	1.0
1,3,5-Trimethylbenzene	0.5