Jordan Creek Mercury Total Maximum Daily Load



State of Idaho

Department of Environmental Quality

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Prepared by
Idaho Department of Environmental Quality
Boise Regional Office
1445 N Orchard St
Boise, ID 83706

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Abbreviations, Acronyms, and Symbols

ρ	ratio between the wet season and dry season concentration targets
§	section (usually a section of federal or state rules or statutes)
§ 303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
ACPF	Agricultural Conservation Planning Framework
Ag Plan	Idaho Agricultural Pollution Abatement Plan
AU	assessment unit
BAF	bioaccumulation factor
BMP	best management practice
BW	body weight
C	cover and management factor
CCC	criterion continuous concentration
C_D	concentration targets assigned to the dry season
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
CGP	construction general permit
CMAQ	Community Multiscale Air Quality (model)
CMC	criterion maximum concentration
COOP	Cooperative Observer Program
C_W	concentration targets assigned to the wet season
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
DMR	Discharge Monitoring Report
DO	dissolved oxygen
ID	Idaho
EIS	Environmental Impact Study
EPA	United States Environmental Protection Agency
°F	Fahrenheit
g	gram
g/d	gram per day
g/mo	gram per month
g/yr	gram per year
GIS	geographic information system
Hg	mercury
HUC	hydrologic unit code
IDAPA	Idaho Administrative Procedures Act

IDFG	Idaho Department of Fish and Game
IGS	Idaho Geological Survey
IPDES	Idaho Pollutant Discharge Elimination System
JC	Jordan Creek
K	soil erodibility factor
KDMC	Kinross DeLamar Mining Company, a former wholly-owned subsidiary of Kinross Gold Corporation
kg	kilograms
km	kilometer
LA	load allocation
LC	load capacity
LS	slope length and steepness factor
µ	micro, one-one thousandth
µg/g	microgram per gram
µg/L	microgram per liter
MeHg	methylmercury
MeHg/l	methylmercury per liter
mg/day	milligram per day
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mL	milliliter
MOS	margin of safety
MS4	municipal separate storm sewer systems
MSGP	multi-sector general permit
NA	not assessed
NB	natural background
ND	no data
ng	nanogram
ng/l	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
OR	Oregon
P	support practice factor
PEL	probable effects level
PPTM	Particle and Precursor Tagging Methodology
PRISM	Parameter-elevation Relationships on Independent Slopes Model
QAPP	Quality Assurance Project Plan
R	rainfall erosivity factor
REMSAD	Regional Modeling System for Aerosols and Deposition

RfD	Reference dose
RSC	relative source contribution
RUSLE	Revised Universal Soil Loss Equation
SDR	sediment delivery ratio
SEL	severe effects level
SPARROW	SPAtially Referenced Regression On Watershed attributes
START	Superfund Technical Assessment and Response Team
SWPPP	Stormwater Pollution Prevention Plan
TEL	threshold effects level
THg	total mercury
TL	trophic level
TMDL	total maximum daily load
TRC	tissue residue criterion
U.S.	United States
USC	United States Code
USGS	United States Geological Survey
WAG	watershed advisory group
WLA	wasteload allocation
WNAM	Western North American Mercury study

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to the CWA § 303, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. The CWA § 303(d) establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards).

States and tribes must publish a priority list (a "§ 303(d) list") of impaired waters every 2 years. Currently, the priority list ("§ 303(d)") is published as the list of Category 5 water bodies in Idaho's Integrated Report, which summarizes water quality throughout the state. For waters identified on the § 303(d) list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses two water bodies (five assessment units) in the Jordan Creek subbasin that have been placed in Category 5 of Idaho's most recent federally approved Integrated Report (DEQ 2024).

This document describes the key physical and biological characteristics of the subbasin; water quality concerns and status; pollutant sources; and recent pollution control actions in the Jordan Creek subbasin, located in southwestern Idaho and southeastern Oregon. For detailed information about the subbasin and previous TMDLs, see the *Jordan Creek Subbasin Assessment and Total Maximum Daily Load* (DEQ 2010).

The TMDL analysis establishes water quality targets and load capacities, estimates existing pollutant loads, and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards. It also identifies implementation strategies—including reasonable time frames, approach, responsible parties, and monitoring strategies—necessary to achieve load reductions and meet water quality standards.

Subbasin at a Glance

The Jordan Creek subbasin, hydrologic unit code 17050108, is located in southwest Idaho and southeast Oregon (Figure A). The headwaters of Jordan Creek originate in the western section of the Owyhee Mountains, in southwest Idaho, flowing mostly west into Oregon, entering near Jordan Valley. The watershed size is approximately 740,000 acres with just under 50% located within Idaho. It is a rural watershed consisting of irrigated agriculture, rangeland, forest, and mining.

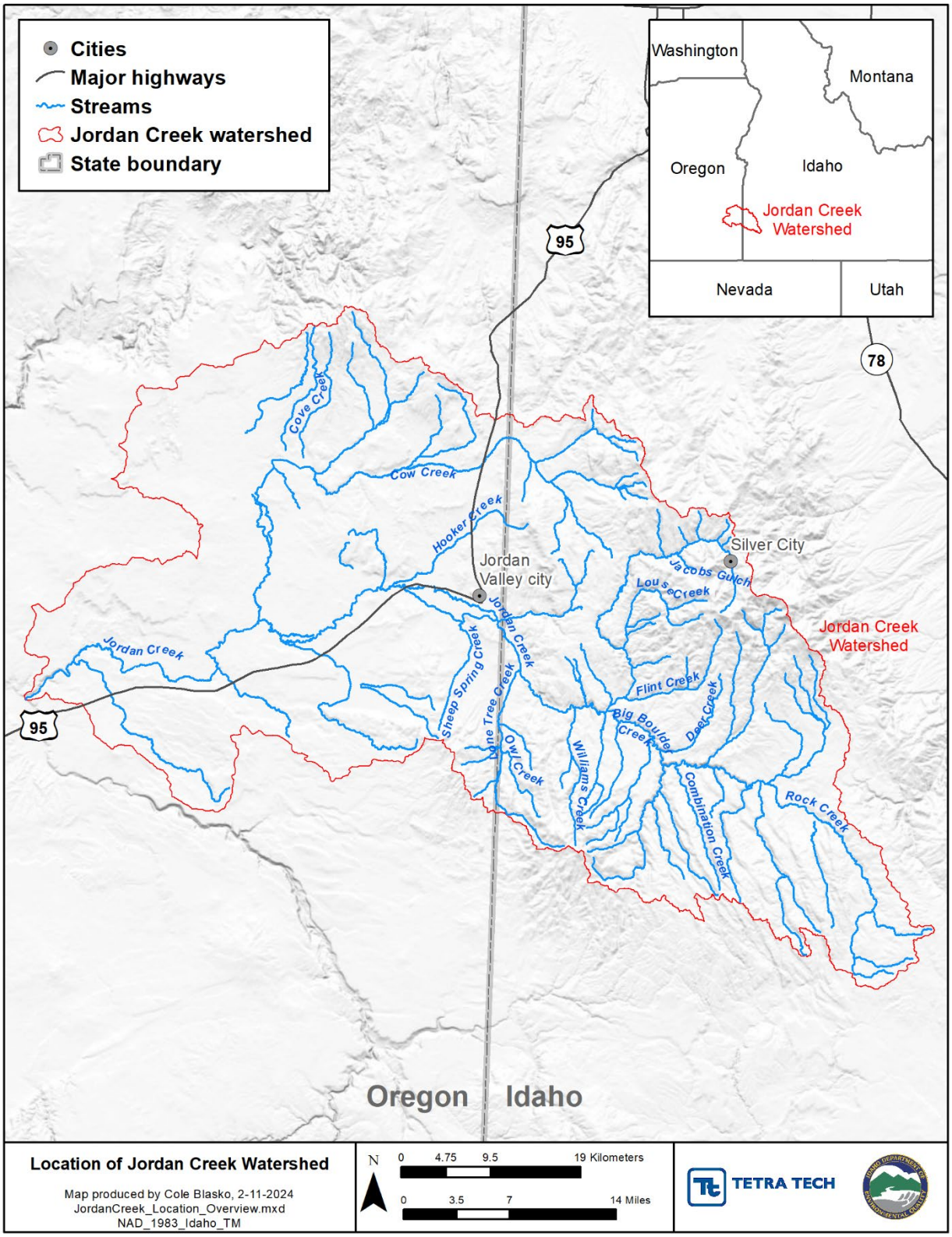


Figure A. Jordan Creek subbasin.

Key Findings

Five assessment units (AUs) in the Jordan Creek subbasin are listed as impaired (Category 5) for mercury in Idaho's most recent Integrated Report (DEQ 2024). These mercury impaired AUs were initially listed as impaired in Idaho's 1998 303(d) list. There is no explicit documentation on the basis for the original Jordan Creek mercury listings, but ample data extending back to the early 1970s documents high concentrations of mercury in fish from Jordan Creek due to legacy mining sources (DEQ 2010). Fish tissue collected in 2005 in upper Jordan Creek exceeded the fish tissue criterion of 0.3 milligrams per kilogram (mg/kg; DEQ 2005). DEQ was unable to collect adequate samples of fish from the lower portion of Jordan Creek during the 2005 study, but a predictive model used to estimate mercury levels in fish for lower Jordan Creek indicated an exceedance of the fish tissue criterion in that area as well (DEQ 2010).

Jordan Creek's designated beneficial uses include cold water aquatic life, salmonid spawning, and primary contact recreation. Beneficial uses affected by mercury pollution include recreation (in the form of fishing) and cold water aquatic life. Recreational fishing use is affected because elevated fish mercury levels may impact human health and reduce the amount of fish that can be safely consumed. Fish and other aquatic species can also be adversely affected by exposure to mercury in the food chain, thus affecting cold water aquatic life beneficial uses. Table A notes each assessment unit addressed in this document, and Table B summarizes the assessment outcomes.

Table A. Water bodies and pollutants for which TMDLs were developed.

Water Body	Assessment Unit (AU) Number	Pollutant(s)
Jordan Creek—Williams Creek to State Line	ID17050108 SW001_05	Mercury
Jordan Creek, Upper—1st and 2nd order tributaries	ID17050108 SW004_02	Mercury
Jordan Creek—Jacobs Gulch to Louse Creek	ID17050108 SW004_03	Mercury
Jordan Creek—Louse Creek to Big Boulder Creek	ID17050108 SW004_04	Mercury
Jordan Creek—Big Boulder Creek to Williams Creek	ID17050108 SW004_05	Mercury

Table B. Summary of assessment outcomes for § 303(d)-listed assessment units.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL(s) Completed	Recommended Changes to Next Integrated Report	Justification
Jordan Creek—Williams Creek to State Line	SW001_05	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek, Upper—1st and 2nd order tributaries	SW004_02	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek—Jacobs Gulch to Louse Creek	SW004_03	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek— Louse Creek to Big Boulder Creek	SW004_04	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek—Big Boulder Creek to Williams Creek	SW004_05	Mercury	Yes	Move to Category 4a	Hg TMDL completed

Note: All Assessment Unit Numbers begin with ID17050108.

TMDL Target Summary

Based on the discussion in Appendix C summarized in Section 2.3.3, this TMDL focuses on two core targets. It focuses on (1) the site-specific target of 2.4 nanograms per liter (ng/L) total mercury (THg) as an annual average exposure concentration, derived using a bioaccumulation factor approach relative to THg exposure concentrations. This is to be consistent with the Oregon fish tissue concentration target for MeHg of 0.040 mg/kg wet weight (see Appendix C). Second (2), the TMDL focuses on the chronic exposure concentration of 2.1 ng/L THg in water, as proposed by the United States Environmental Protection Agency (EPA; EPA 2024a, 2024b), which is described as most applicable to baseflow conditions. The methylmercury (MeHg) target in fish tissue is conservatively assumed to be equivalent to a THg target because MeHg generally represents over 95% of THg in fish tissue. Both Idaho and Oregon also currently have existing continuous (chronic) concentration criteria for the protection of aquatic life of 0.012 micrograms per liter (12 ng/L) total recoverable mercury; however, the Idaho criterion is expected to be revised in the near future based on the EPA-proposed chronic criterion.

To maintain consistency with both the fish tissue based annual average target of 2.4 ng/L and the proposed baseflow chronic criterion of 2.1 ng/L, **the target of 2.1 ng/L THg is applied to the dry season (75% of the year) and a target of 3.3 ng/L to the wet season (25% of the year), creating an annual average 2.4 ng/L target as explained in Section 5.2**.

Public Participation

The general public had the opportunity to comment on this document during the public comment period, March 27 to June 11, 2025. Public comments and response to public comments can be found in Appendix E. Additionally, members of the Jordan Creek Watershed

Advisory Group were consulted on this TMDL on February 14, 2023; February 18, 2025; and via electronic communication between spring 2022 and spring 2025.

Introduction

This document addresses five water body assessment units (AUs) in the Jordan Creek subbasin that have been placed in Category 5 of Idaho's Integrated Report (DEQ 2024) due to mercury impairment. This document also addresses one additional water body in the Jordan Creek subbasin that is unlisted but impaired. The purpose of this total maximum daily load (TMDL) is to characterize and document pollutant loads within the Jordan Creek subbasin. The first portion of this document presents key characteristics or updated information for the subbasin assessment, which is divided into four major sections: subbasin characterization (section 1), water quality concerns and status (section 2), pollutant source inventory (section 3), and a summary of past and present pollution control efforts (section 4). While the subbasin assessment is not a requirement of the TMDL, the Idaho Department of Environmental Quality (DEQ) performs the assessment to ensure impairment listings are up to date and accurate.

The subbasin assessment is used to develop a TMDL for mercury in the Jordan Creek subbasin. The TMDL (section 5) is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR [Code of Federal Regulations] Section 130). Consequently, TMDLs are water body- and pollutant-specific. They also allocate allowable discharges of pollutants among the various sources discharging the pollutant.

Regulatory Requirements

This document was prepared following both federal and state regulatory requirements. DEQ implements the Clean Water Act (CWA) in Idaho, while the United States Environmental Protection Agency (EPA) oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Congress passed the Federal Water Pollution Control Act, or CWA, in 1972. It aimed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USC § 1251). The act and programs it generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to ensure "swimmable and fishable" conditions. These goals relate water quality to more than just chemistry.

The CWA requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to CWA § 303(d), are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. DEQ must review those standards every 3 years, and EPA must approve Idaho's water quality standards. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, and

protect biological integrity. Water quality standards define the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The CWA § 303(d) establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). Every 2 years, states and tribes must publish a priority list (a "§ 303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 waters in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

DEQ monitors waters, and, for those not meeting water quality standards, DEQ must establish a TMDL for each pollutant impairing the waters. However, some conditions that impair water quality do not require TMDLs. EPA considers certain unnatural conditions—such as flow alteration, human-caused lack of flow, or habitat alteration—that are not the result of discharging a specific pollutant as "pollution." TMDLs are not required for water bodies impaired by pollution, rather than a specific pollutant. A TMDL is only required when a pollutant can be identified and in some way quantified.

Prior TMDLs in the Subbasin

DEQ submitted the *Jordan Creek Subbasin Assessment and TMDL* to EPA for review on June 4, 2010 (DEQ 2010). The 2010 Jordan Creek TMDL contained TMDLs addressing waters impaired for temperature, sediment, and mercury. On April 13, 2011, EPA approved the temperature and sediment TMDLs but disapproved the mercury TMDLs for Jordan Creek because they failed to demonstrate they would meet the aquatic life water quality criterion for chronic exposure to mercury in effect at that time (i.e., 0.012 micrograms per liter [µg/l]).

In October 2011, new water quality standards in Oregon went into effect, including a more stringent fish tissue criterion for mercury (0.04 milligrams per kilogram [mg/kg]). EPA developed a revised mercury TMDL for Jordan Creek that accounted for the new Oregon mercury standards and put the draft TMDL on public notice in August 2011. EPA received many comments and conducted additional technical work to address them, resulting in an updated draft TMDL that received public notice in September 2014. EPA did not finalize the 2014 mercury TMDL.

DEQ's 2010 TMDL and EPA's 2011 and 2014 TMDLs noted data limitations including lack of fish tissue data from lower Jordan Creek and water column samples collected under various flow regimes. To address the data deficiencies, Idaho Department of Fish and Game (IDFG) collected fish tissue data in 2021. Additionally, EPA's Site Assessment Program partnered with DEQ and the Oregon Department of Environmental Quality to collect water column and sediment samples in Jordan Creek to help better understand mercury sources and dynamics in the Owyhee Basin, including Jordan Creek. In addition, sampling conducted by Trout Unlimited (Willis et al. 2022) revealed further information about mercury contamination in the Silver City,

Idaho (ID) legacy mining area. With a more robust dataset, DEQ, with support from EPA Region 10, is revising the mercury TMDL for Jordan Creek.

1 Subbasin Characterization

The Jordan Creek subbasin, hydrologic unit code (HUC) 17050108, is in southwest Idaho and southeast Oregon (Figure 1). The headwaters of Jordan Creek originate in the western section of the Owyhee Mountains in southwest Idaho. Jordan Creek flows west and crosses into the city of Jordan Valley in Oregon. The creek continues to flow west until its confluence with the Owyhee River near the unincorporated community of Rome, Oregon, along U.S. Route 95. The Jordan Creek subbasin is 1,275 square miles in area, with a population just around 510 people in 2020. The only incorporated municipality in the subbasin is Jordan Valley (population 130 as of the 2020 Census), located within the Oregon portion of the subbasin. There are no Native American reservations within the subbasin.

Complete details of the Jordan Creek subbasin characterization are contained within the approved sediment and temperature TMDLs (DEQ 2010) and are summarized briefly here.

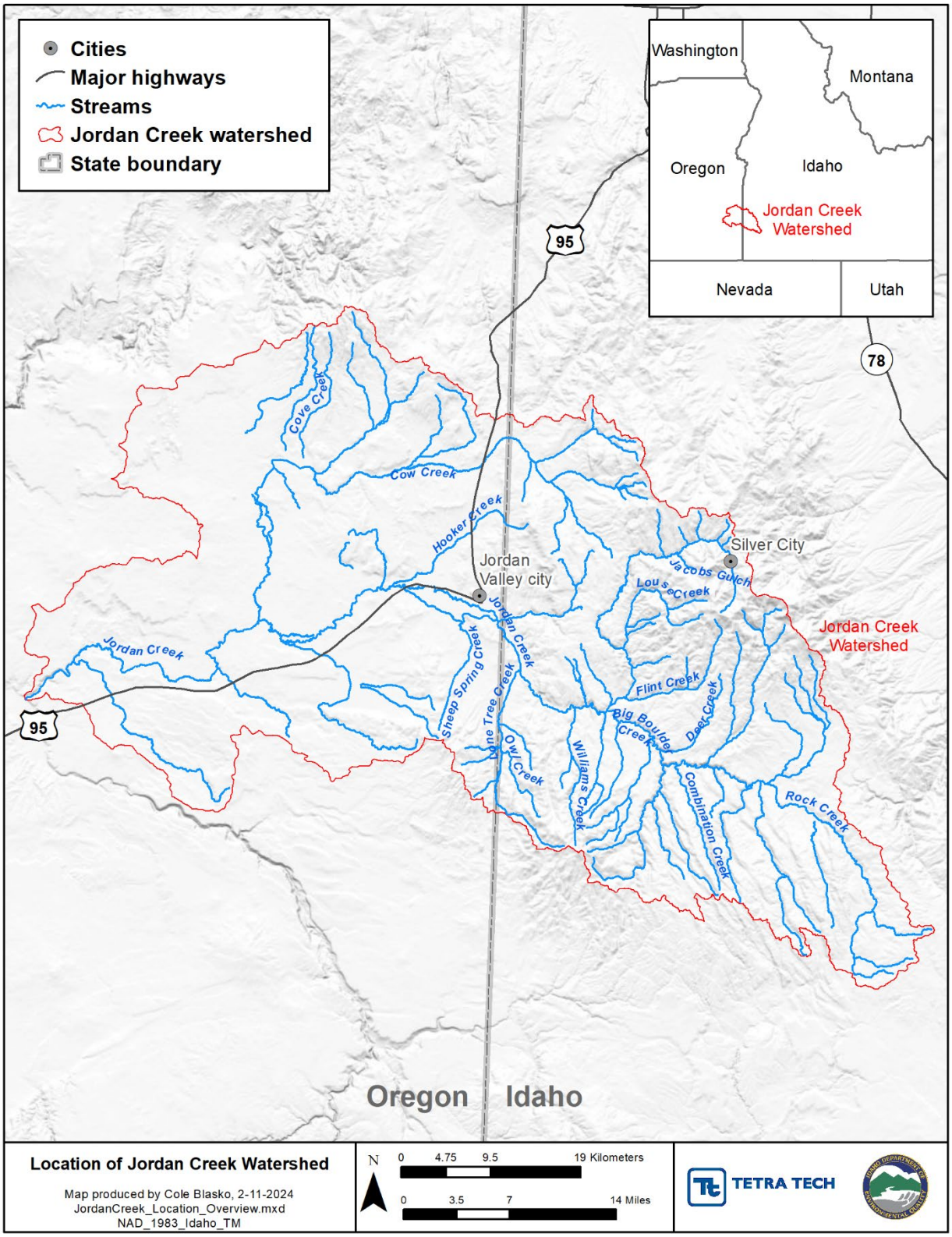


Figure 1. Location of Jordan Creek subbasin.

1.1 Physical and Biological Characteristics

Jordan Creek (Figure 1) has a diverse watershed that ranges in elevation from 8,000 feet near Silver City, Idaho to 3,500 feet near Rome, Oregon. Land uses include irrigated pasture, hayland, rangeland, and forested areas. Average precipitation ranges from a little under 21 inches in the higher elevations, to a little over 11 inches in the plateaus of eastern Oregon.

The hydrology for the watershed has been modified by human activities. Large irrigation water storage reservoirs can be found within Oregon, while in-stream diversions compose the largest type of modifications in Idaho.

The present economy is mostly agricultural, with large tracts of land under some form of irrigation in the lower elevations. Open range on federally and state managed lands is the dominant land use in the upper elevations. Although there is also evidence of legacy mining and ore milling in the subbasin, there is currently no active mining. However, the DeLamar Mine is in the planning phases of additional exploration and extraction.

The biological characteristics, geology, and history of the subbasin will be discussed in the following sections.

1.1.1 Climate

Five National Weather Service (NWS) Cooperative Observer Program (COOP) climate monitoring stations were formerly in the Jordan Creek subbasin (Table 1), but only one station was in the Idaho-portion of the subbasin: Silver City 5W (108412). Additional inactive NWS COOP climate monitoring stations were located throughout the region.

Table 1. NWS COOP climate stations in the Jordan Creek subbasin.

Station Name	Station Number	Period of Record	Elevation (feet)
Danner, OR	352135	10/1/1931 – 6/10/2016	4,330
Sheaville 1 SE, OR	357736	3/1/1952 – 9/30/2004	4,580
Silver City 5 W, ID	108412	11/1/1978 – 5/31/2014	6,160
Rocksville 5 N, OR	357277	11/1/1963 – 12/31/2012	3,760

Source: Western Regional Climate Center, https://wrcc.dri.edu/summary/Climsmor.html, accessed 8/1/2023

The Silver City, Oregon (OR) station is most representative of the Jordan Creek headwaters and reports average an annual precipitation of 22.1 inches/year, average maximum monthly temperatures of 20.3–56.0 degrees Fahrenheit (°F), and average minimum monthly temperatures of 16.5–49.4°F. No climate stations are available near the remote area where Jordan Creek crosses the ID-OR state line. Given the sparse coverage of climate stations in the subbasin, gridded data products supported by remote sensing are used to assess rainfall and runoff in the subbasin, as described in Appendix D.

One key climate resource is gridded precipitation data from the Parameter-elevation Relationships on Independent Slopes Model (PRISM; http://prism.oregonstate.edu), which combines the effects of slope and aspect with local and remote-sensed data to estimate

precipitation on a seamless grid. Figure 2 shows PRISM-estimated annual rainfall patterns for the Jordan Creek subbasin.

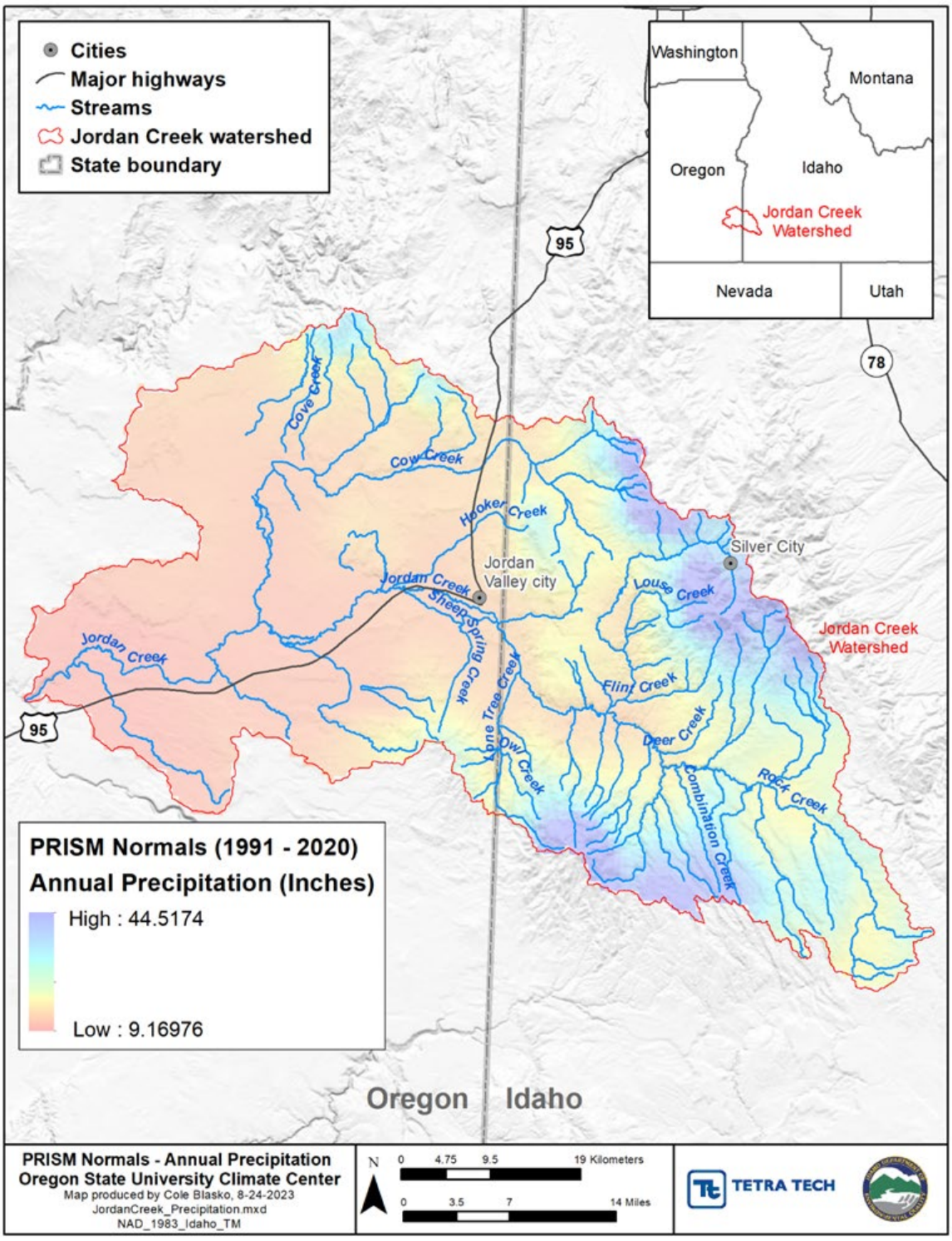


Figure 2. Precipitation ranges in inches/year for the Jordan Creek subbasin (data from PRISM, Normals: Annual Precipitation, 1991–2020, Oregon State University Climate Center).

Figure 2 contrasts the precipitation levels in the lower and higher elevations of the subbasin. Silver City, located at 6,100 feet (1,900 meters), receives almost double the annual average precipitation of the stations located below 5,000 feet. Sharp changes in precipitation patterns affect vegetation patterns. For example, isolated stands of Douglas fir (*Pseudotsuga menziesii*), which have higher water requirements, dominate the landscape near Silver City (elevation 6,100 feet), while low sagebrush (*Artemisia arbuscula*) communities, which have lower water requirements, dominate the landscape near the Oregon state line and Jordan Valley (elevation 4,390 feet).

1.1.2 Hydrography

The general flow characteristics of the Jordan Creek subbasin are from east to west, with most of the headwaters within Idaho (Figure 3). The major topographic features include the Silver City Range to the north, South Mountain to the south, and the Combination and Antelope Ridges to the east. The lava beds of eastern Oregon are the most notable characteristic to the west. Jordan Creek joins the Owyhee River downstream from Rome, OR.

The United States Geological Survey (USGS) formerly operated two gages in the Jordan Creek subbasin (17050108):

- Jordan Creek at DeLamar Mine near Jordan Valley, OR (gage 13177985): 1993–1996
- Jordan Creek above Lone Tree Creek near Jordan Valley, OR (gage 13178000; physical location is in Idaho near the Oregon state line): 1945–1971, 2002–2003

Flow characteristics for the gage above Lone Tree Creek are summarized in Table 2.

Table 2. Monthly average flow reported for USGS gage 13178000, Jordan Creek above Lone Tree Creek near Jordan, Oregon, 1945–1971, 2002–2003 (cfs [cubic feet per second]).

January	135	May	585	September	4.7
February	184	June	185	October	11
March	307	July	26	November	26
April	736	August	5.1	December	77

Analysis of historic data from the Lone Tree gage demonstrates the flow dynamics in Jordan Creek. Daily average flow for water years 1946–1952 and 1956–1971 are plotted in Figure 3 (data for water years 1953–1955 are incomplete). Flows are typically very low from mid-July through mid-November, with higher flow conditions in April and May. This trend is consistent with flow data collected at the gage from late 2002 to mid-2004 (Figure 4). More current and comprehensive Jordan Creek runoff estimates are available from the USGS Water Balance Model (Wieczorek et al. 2022) and the USGS SPARROW (SPAtially Referenced Regression On Watershed attributes) model (Wise 2020, as discussed in Appendix D)).

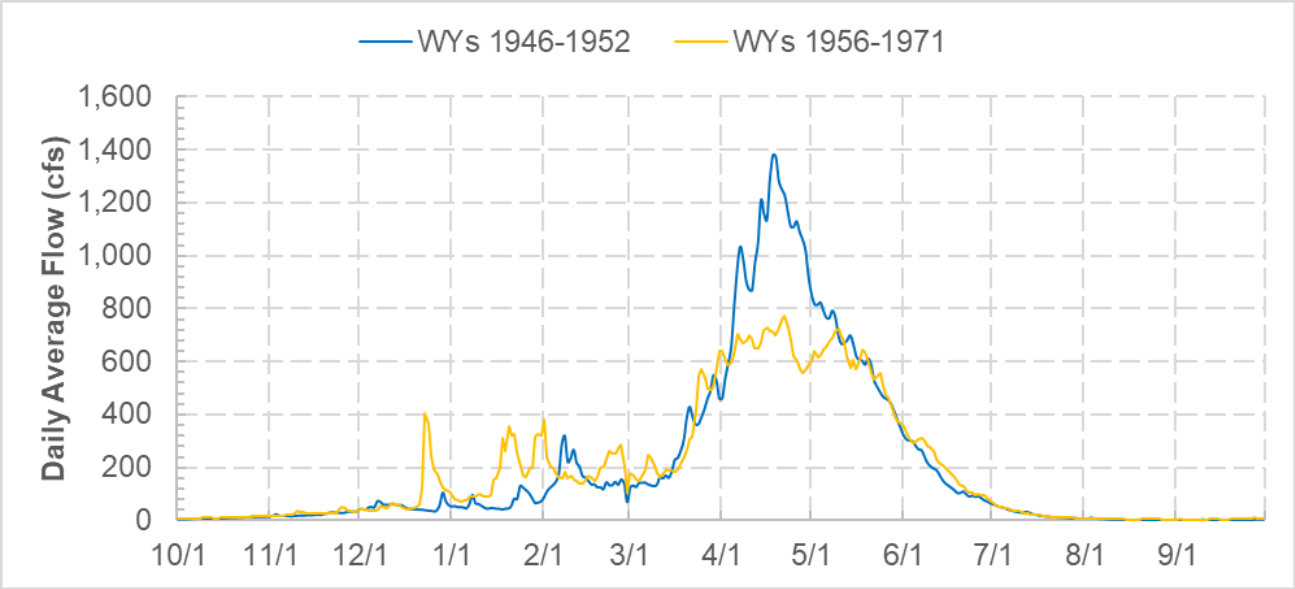


Figure 3. Daily average flow in Jordan Creek above Lone Tree Creek (USGS gage 13178000) in water years 1946–1952 and 1956–1971.

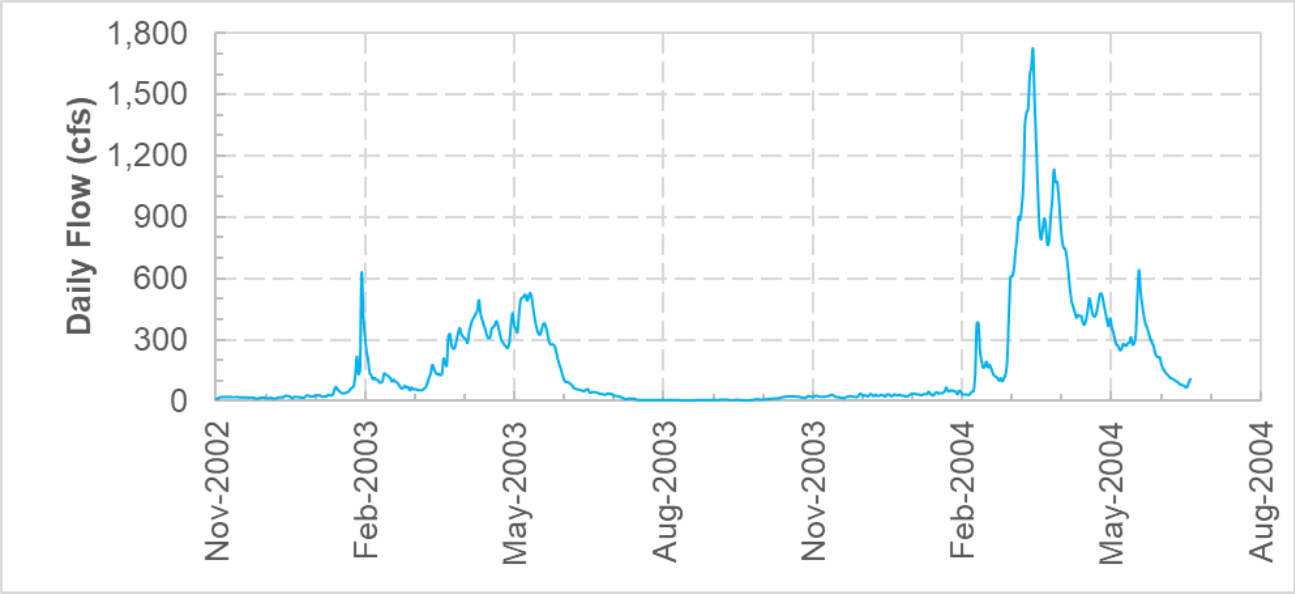


Figure 4. Daily flow in Jordan Creek above Lone Tree Creek (USGS gage 13178000) from late 2002 to mid-2004.

Most of the lower Jordan Creek subbasin has some sort of hydrologic modification. These modifications are either direct diversions from the stream, small earthen structures in headwaters for stock watering, stream channel modifications, or disturbances to the terrain and vegetation.

1.2 Biological Information

Detailed biological information for the Jordan Creek subbasin was provided in the 2010 *Jordan Creek Subbasin Assessment and Total Maximum Daily Load* and is briefly summarized here.

Rangeland makes up the largest portion of land use in the Jordan Creek subbasin. The majority of these areas are the sagebrush steppe ecosystem, with low sagebrush (*Artemisia arbuscula*) communities dominating most of the lower elevations of the watershed (Bedell et al. 1993). Mountain big sagebrush (*Artemisia tridentata*) communities can be found in higher, wetter elevations and north slopes, while isolated stands of Douglas fir (*Pseudotsuga menziesii*) dominate the woody plant community at higher elevations.

Anadromous fish are not present in the watershed due to impassable barriers downstream on the Owyhee River in Oregon and other barriers on the Snake River. No endangered fish species currently inhabit water bodies in the Jordan Creek watershed. Columbia River Redband Trout (*Oncorhynchus mykiss gairdneri*), a species of concern as listed by IDFG, are present and can be found in most of the water bodies in the watershed.

1.3 Cultural Characteristics

1.3.1 Past and Current Land Use

Evidence shows the Owyhees have a long history of use by prehistoric Native Americans (Plew 1985). It was not until 1863 that a permanent presence of Anglo-Europeans was documented in the subbasin (Adams 1986), when mineral deposits of gold and silver were discovered in the Jordan Creek area of the Silver City Range. The first documented settlement (mining camp) was Ruby City, located on Jordan Creek. Other mining camps and new discoveries of deposits of gold and silver soon followed. This area supported numerous towns and camps throughout the late 1800s and through the early 1900s (Adams 1986). As the gold and silver deposits were mined out, many of these towns were abandoned. Silver City is the only permanent settlement remaining in the Idaho portion of Jordan Creek. The only other incorporated township in the watershed is Jordan Valley, Oregon.

Additional information on mining in the Jordan Creek subbasin is in the Section 2.2.1 discussions of the § 303(d)-listed segments and the Section 3.2.3 discussion of mercury loading from legacy mining activities.

In the late 1800s, as the mining towns and camps flourished, some who could not find their riches in mining turned to supporting the mining population. Farms, along with livestock operations, began to operate soon after ore deposits were discovered. These agricultural operations provided much needed food for miners, feed for horses, and, to some extent, material for clothing.

Today, land use in the Jordan Creek watershed is primarily “cow-calf” grazing in the uplands and hay production in the irrigated lowlands. Within Idaho, irrigated areas make up a small percentage of the overall land use (estimated to cover 12,345 acres or 3.2% of the area within

Idaho as of 2009) and has probably not expanded much since the late 1800s. Within Oregon, the irrigated land use has greatly increased since the late 1800s due to the addition of large reservoirs and instream water diversion.

1.3.2 Land Ownership/Management

A little more than 57% (52% Idaho, 62% Oregon) of lands in the Jordan Creek watershed are managed by the U.S. Bureau of Land Management, and most of this land is devoted to rangeland (grazing) use. Private holdings are found mostly in the riparian and irrigated areas and make up about 32% of all land ownership. These areas are usually the more productive areas and may or may not be irrigated.

Table 3 shows the breakdown of land ownership and management. Figure 5 shows the spatial distribution of land ownership and management.

Table 3. Land ownership and management, acres, and percent of total in the Jordan Creek watershed.

Ownership/ Management	Total		Total Oregon		Total Idaho	
	Total Acres	%	Total Acres	%	Total Acres	%
Federal	447,415	57.4%	245,316	62.3%	202,099	52.4%
Private	247,598	31.8%	132,619	33.7%	114,979	29.8%
State Lands	79,008	10.1%	10,230	2.6%	68,778	17.8%
Water	5,472	0.7%	5,290	1.3%	183	0.0%
Total	779,494	100%	393,454	100%	386,040	100%

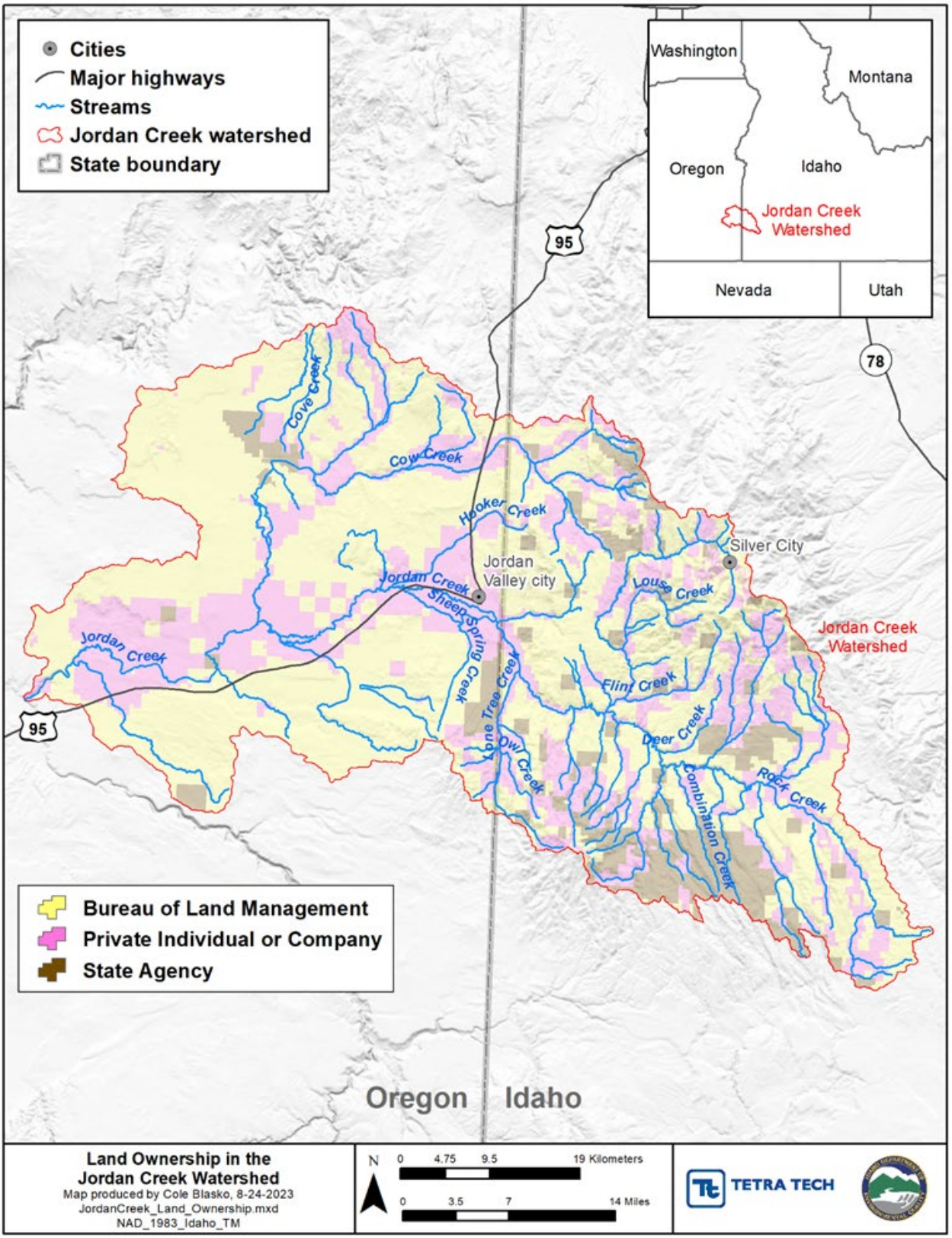


Figure 5. Land ownership in Jordan Creek subbasin.

2 Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

The CWA § 303(d) states that waters that are unable to support their beneficial uses and do not meet water quality standards must be listed as water quality limited. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards. Five water body AUs in the Idaho portion of the Jordan Creek subbasin are listed as impaired for mercury. These AUs are identified below in Section 2.2.1.

2.2 Assessment Units

AUs are groups of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs. Even if ownership and land use change significantly, the AU usually remains the same for the same stream order.

Using AUs to describe water bodies offers many benefits, primarily that all waters of the state are defined consistently. AUs are a subset of water body identification numbers, which allows them to relate directly to the water quality standards.

2.2.1 Listed Waters

Table 4 and Figure 6 show the AUs identified as impaired for mercury on the Idaho 2024 § 303(d)-list (i.e., AUs in Category 5 of the Integrated Report). Some of these and other AUs in the Jordan Creek subbasin are also listed under other Integrated Report categories for different pollutants that have either already been addressed in previous TMDL documents or will be addressed separately from this document.

Table 4. Jordan Creek subbasin § 303(d)-listed assessment units impaired for mercury.

Assessment Unit Name	Assessment Unit Number	Length (miles)	Listing Basis
Jordan Creek—Williams Creek to State Line	ID17050108SW001_05	13.35	Listed in 2018 based on the DEQ report "Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites" (Dai and Ingham, 2009).
Jordan Creek, Upper—1st and 2nd order tributaries	ID17050108SW004_02	102.35	Water body carry over from the 1998 303(d) list
Jordan Creek—Jacobs Gulch to Louse Creek	ID17050108SW004_03	13.41	Water body carry over from the 1998 303(d) list
Jordan Creek—Louse Creek to Big Boulder Creek	ID17050108SW004_04	5.64	Listed in 2024. This AU was a carry-over from the 1998 § 303(d) list that was inadvertently omitted during the translation of Water Quality Limited Segments into Assessment units in Idaho's 2002 listing cycle
Jordan Creek—Big Boulder Creek to Williams Creek	ID17050108SW004_05	3.37	Water body carry over from the 1998 303(d) list

The original listing for mercury impairment on Idaho's 1998 § 303(d) list was for the main stem of Jordan Creek from Williams Creek upstream to the headwaters. There is no explicit explanation for the original Jordan Creek mercury listing's creation, but there are ample data extending back to the early 1970s documenting high mercury concentrations in fish from Jordan Creek.

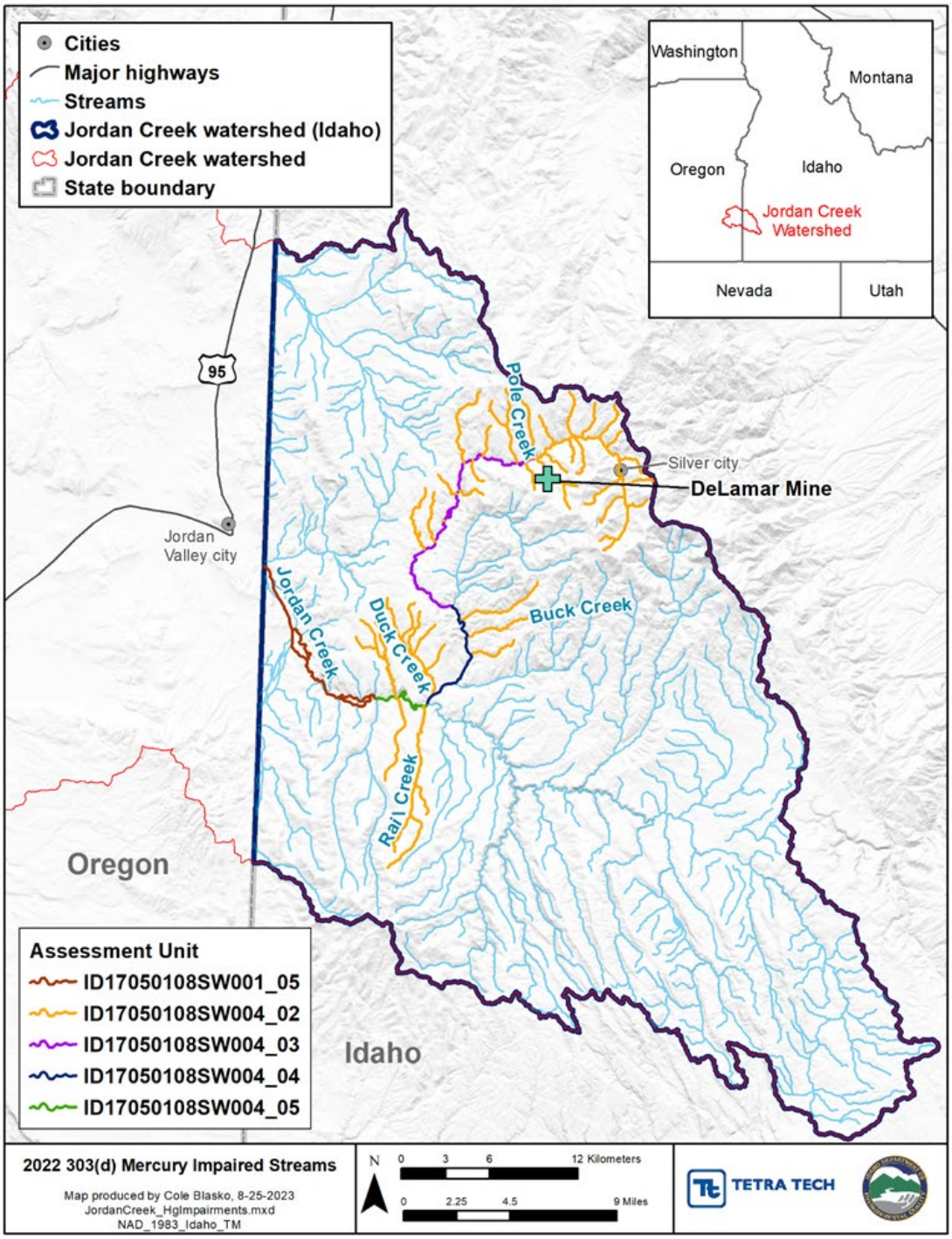


Figure 6. Waters listed as impaired for mercury in Jordan Creek Subbasin, Idaho (Idaho 2022 § 303(d) list).

The Oregon methylmercury impairment listings include Jordan Creek from the Idaho border to its confluence with the Owyhee River and Antelope Reservoir (OR_SR_1705010805_05_102720; Oregon DEQ 2022). DEQ is not responsible for addressing

impairments within the state of Oregon; however, DEQ is required to meet Oregon water quality standards at the point where Jordan Creek crosses the state line.

2.3 Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. They require that surface waters be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as described briefly in Appendix A. The *Water Body Assessment Guidance* (DEQ 2016a) provides a more detailed description of beneficial use identification for use assessment purposes.

Beneficial uses include the following:

- Aquatic life support—cold water, seasonal cold water, warm water, salmonid spawning, and modified
- Contact recreation—primary (e.g., swimming) or secondary (e.g., boating)
- Water supply—domestic, agricultural, and industrial
- Wildlife habitats
- Aesthetics

2.3.1 Beneficial Uses in the Subbasin

A list of the beneficial uses for § 303(d)-listed streams in the Jordan Creek subbasin in Idaho is provided in Table 5. Beneficial uses potentially affected by mercury pollution include recreation (in the form of fishing), cold water and salmonid spawning aquatic life, and wildlife. The recreational fishing use is affected because elevated levels of mercury in fish may impact human health and reduce the amount of fish which can be safely consumed. Fish and other aquatic species can also be adversely affected by exposure to mercury in the food chain, thus affecting cold water aquatic life (including salmonid spawning) beneficial uses. Idaho Department of Health and Welfare issued a fish consumption advisory for Columbia River Redband Trout, a subspecies of Rainbow Trout, from Jordan Creek in 2007 (Figure 7). There are also fish consumption advisories for downstream waters in Oregon. Wildlife—such as mink or osprey, which consume aquatic species—can also be affected from biomagnification, as they are reliant on prey that is exposed to mercury contamination in the water column.

Table 5. Jordan Creek subbasin beneficial uses of § 303(d)-listed streams.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses	IDAPA Section
Jordan Creek—Source to Williams Creek	ID17050108SW004_02	Cold Water Aquatic Life Salmonid Spawning Primary Contact Recreation Wildlife Habitats	58.01.02.1 40.08. SW-4
Jordan Creek, Upper—1st and 2nd order tributaries	ID17050108SW004_03		
Jordan Creek—Louse Creek to Big Boulder Creek	ID17050108SW004_05		
Jordan Creek—Big Boulder Creek to Williams Creek	ID17050108SW004_04		
Jordan Creek—Williams Creek to Idaho/Oregon State Line	ID17050108SW001_05	Cold Water Aquatic Life Salmonid Spawning Primary Contact Recreation Wildlife Habitats	58.01.02.1 40.08. SW-1

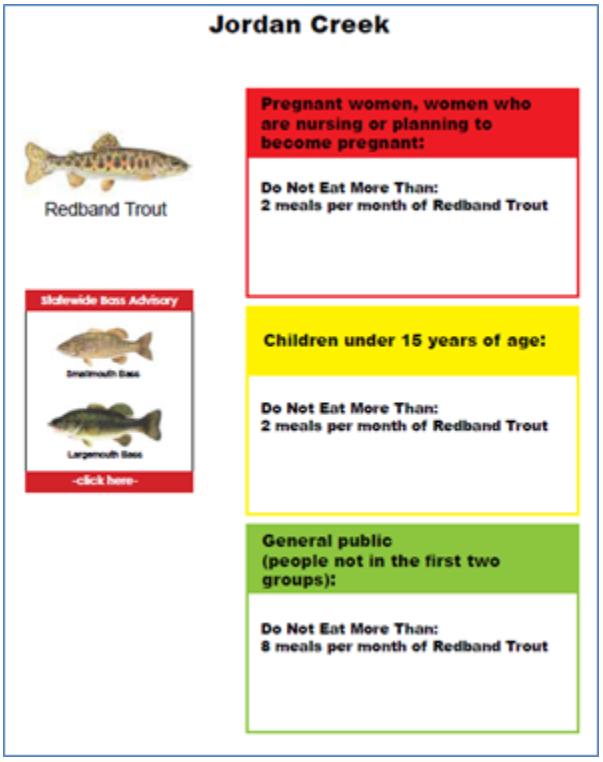


Figure 7. Idaho Department of Health fish consumption advisory for fish from Jordan Creek issued in 2007 (Idaho Department of Health and Welfare 2007). A meal is equivalent to 1 ounce of fish per 20 pounds of body weight. An average adult meal is 8 ounces of fish. An average child's meal is 2.25 ounces of fish.

2.3.2 Protection of Downstream Uses

Idaho's water quality standards require that all waters "shall maintain a level of water quality at their pour point into downstream waters that provides for the attainment and maintenance of the water quality standards of those downstream waters, including waters of another state or

tribe" (IDAPA 58.01.02.070.08). Jordan Creek flows from Idaho into Oregon and thus must meet Oregon water quality standards at the state line.

Oregon specifies the following beneficial uses and beneficial fish uses for Owyhee River and tributaries upstream from Owyhee Reservoir, including Jordan Creek: public domestic water supply, private domestic water supply, industrial water supply, irrigation, livestock watering, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, aesthetic quality, and Columbia River Redband or Lahontan Cutthroat Trout (beneficial fish use). Oregon standards specify that water quality in the Owyhee Basin (including Jordan Creek) must be managed to protect the designated beneficial uses and beneficial fish uses (November 2003, Tables 250A and 250B in Oregon Administrative Rules 340-041-250). The beneficial uses in Oregon potentially impacted by mercury are similar to those in Idaho, and include fish and aquatic life, fishing, and wildlife and hunting. Human health, fish, other aquatic life, and wildlife species which consume aquatic species all could be affected by mercury contamination in Jordan Creek.

The Oregon Health Authority has issued the following fish consumption advisories for mercury applicable to Jordan Creek from Antelope Reservoir to the creek's confluence at the Owyhee River:

- Vulnerable population: Limit of two meals per month of fish caught in these waters.
- Everyone else: Limit of six meals per month of fish caught in these waters.

Oregon defines the vulnerable population as children under 6, people who are or may become pregnant, and people who are nursing. A meal is equal to "about 1 ounce uncooked fish per 20 pounds of body weight."

This TMDL is designed to achieve Oregon fish tissue targets for methylmercury and Oregon ambient water quality criteria for total mercury at the Idaho-Oregon state line (see Section 2.3.3). This TMDL is therefore protective of downstream uses in Oregon.

2.3.3 Water Quality Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of water quality criteria, which include *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (Appendix B) and *narrative* criteria for pollutants, such as sediment and nutrients (IDAPA 58.01.02.250–251).

Methylmercury is a potent neurotoxin to which the developing human brain is especially vulnerable. Even very low levels of inorganic mercury (Hg) in water can, through the processes of methylation, bioaccumulation, and then biomagnification, produce unhealthful levels of methylmercury in fish tissue. Bioaccumulation, in which living organisms take up contaminants more rapidly than they eliminate them, magnifies mercury contamination greatly. Biomagnification then occurs at each step or trophic level in the food chain— from water to algae, algae to aquatic insects, insects to fish, fish to other fish, and fish to humans. Mercury concentrations in tissue increase, reaching multiples that can be a million times the original

concentration of mercury in the water column. Higher trophic level fish tissue consists almost entirely of methylmercury from biomagnification in mercury impaired waters.

Idaho adopted a numeric fish tissue criterion for methylmercury in April 2005 (IDAPA 58.01.02.210) rather than direct measurement of mercury in water. The EPA approved the criterion in September 2005. The criterion is 0.3 mg methylmercury per kg wet weight of tissue (Table 6). According to the *Implementation Guidance for the Idaho Mercury Water Quality Criteria* (DEQ 2005), the criterion applies to all waters in Idaho. Fish tissue samples are used to report total mercury concentrations, which provides a conservative methylmercury concentration approximation. Methylmercury generally composes about 95% of the total mercury concentration in fish tissue (Eagles-Smith et al. 2016). IDAPA 58.01.02.210 (03)(c)(iv)(2) also states "The implementation of a fish tissue criterion in National Pollution Discharge Elimination System (NPDES) program permits and TMDLs requires a nontraditional approach, as the basic criterion is not a concentration in water. In applying the methylmercury fish tissue criterion in the context of NPDES effluent limits and TMDL load reductions, the Department will assume change in fish tissue concentrations of methylmercury are proportional to change in water body loading of total mercury."

During its revision of mercury water quality standards in 2005, Idaho removed both the acute and chronic water column aquatic life criteria under the assumption that the fish tissue mercury criteria would be sufficiently protective of aquatic life (DEQ 2005). In 2008, EPA disapproved the removal of the aquatic life criteria, finding that there was insufficient evidence that the fish tissue criteria for protection of human health would protect aquatic species (EPA 2008). Since EPA's 2008 disapproval, Idaho has not updated its aquatic life criteria for mercury. Therefore, the previously adopted acute (2.1 micrograms per liter [µg/L]) and chronic (0.012 µg/L) mercury aquatic life criteria that EPA approved in 1996 have remained in effect for CWA purposes (Table 6).

Table 6. Idaho water quality criteria for mercury in Jordan Creek

Parameter	Aquatic Life		Human Health for the Consumption of Aquatic Organisms
	CMC[a] Acute Criterion	CCC[b] Chronic Criterion	
Mercury	2.1 µg/l[c, d]	0.012 µg/l [d, e]	—
Methylmercury	—	—	0.3 mg/kg[f]

a. IDAPA 58.01.02.010.03 (2022) Acute Criteria. Unless otherwise specified in these rules, the maximum instantaneous or one (1) hour average concentration of a toxic substance or effluent which ensures adequate protection of sensitive species of aquatic organisms from acute toxicity due to exposure to the toxic substance or effluent. Acute criteria are expected to adequately protect the designated aquatic life use if not exceeded more than once every three (3) years. This is also known as the Criterion Maximum Concentration (CMC). There are no specific acute criteria for human health; however, the human health criteria are based on chronic health effects and are expected to adequately protect against acute effects.
b. IDAPA 58.01.02.010.15 (2022) Chronic Criteria. Unless otherwise specified in these rules, the four (4) day average concentration of a toxic substance or effluent which ensures adequate protection of sensitive species of aquatic organisms from chronic toxicity due to exposure to the toxic substance or effluent. Chronic criteria are expected to adequately protect the designated aquatic life use if not exceeded more than once every three (3) years. This is also known as the Criterion Continuous Concentration (CCC). Human health chronic criteria are based on lifetime exposure.
c. IDAPA 58.01.02.210.01 (IAC2004); Criteria for these metals are expressed as a function of the water effect ratio WER, as defined in subsection IDAPA 58.01.10.210.03.c.iii
d. IDAPA 58.01.02.210.01 (IAC2004); Criterion expressed as total recoverable (unfiltered) concentrations.
e. If the chronic criterion for mercury is exceeded more than once in a three-year period in ambient water, the edible portion of aquatic species of concern must be analyzed to determine whether the concentration of mercury exceeds the Food and Drug Administration action level (one (1.0) mg/kg. If the Food and Drug Administration action level is exceeded, the director of DEQ must notify the EPA regional administrator, initiate a review and as appropriate, revision of its mercury criterion in these water quality standards, and take other appropriate action such as the issuance of fish consumption advisory for the affected area.
f. IDAPA 58.01.02.210.01.b Table 2 (2022); This fish tissue residue criterion (TRC) for methylmercury is based on a human health reference dose (RfD) of 0.0001 mg/kg body weight-day; a relative source contribution (RSC) estimated to be 27% of the RfD; a human body weight (BW) of 70 kg (for adults); and a total fish consumption rate of 0.0175 kg/day for the general population, summed from trophic level (TL) breakdown of TL2 = 0.0038 kg fish/day + TL3 = 0.0080 kg fish/day + TL4 = 0.0057 kg fish/day. This is a criterion that is protective of the general population. A site-specific criterion or a criterion for a particular subpopulation may be calculated by using local or regional data, rather than the above default values, in the formula: TRC = [BW x {RfD – (RSCxRfD)}] / TL. In waters inhabited by species listed as threatened or endangered under the Endangered Species Act or designated as their critical habitat, the Department will apply the human health fish tissue residue criterion for methylmercury to the highest trophic level available for sampling and analysis.

However, the biological opinions completed by the National Marine Fisheries Service (NMFS) and U.S Fish and Wildlife Service (FWS) in 2014 and 2015, respectively, resulting from formal consultation under Section 7 of the Endangered Species Act on water quality standards for toxics in Idaho, concluded that the mercury chronic aquatic life criterion is not protective of salmonids and does not correspond to Idaho's human health fish tissue-based criterion of 0.3 mg/kg. As a reasonable and prudent alternative that would protect Endangered Species Act (ESA) listed salmon, steelhead, and trout until revision of Idaho's chronic aquatic life criterion, the NMFS (2014) and FWS (2015) biological opinions identified a water column total mercury concentration geometric mean of 2 nanograms per liter (ng/L) for water bodies without sufficient fish tissue data as a target value for water quality-based effluent limits and reasonable potential to exceed water quality criteria, corresponding to the fish tissue value of 0.3 mg/kg wet weight criterion. It was noted that if water samples exceeded the 2 ng/L total mercury water column concentration, fish tissue samples shall be taken. As a result of litigation, the court concluded that EPA's 2008 disapproval created a mandatory duty for EPA to

promulgate federal mercury criteria to protect aquatic life for Idaho, regardless of what was already in effect for CWA purposes.

Following the court's direction, on April 3, 2024, EPA issued a pre-publication draft of the proposed rule "Mercury Criterion to Protect Aquatic Life in Idaho" for publication in the Federal Register under 40 CFR Part 131 along with an accompanying technical support document (EPA 2024a, 2024b).

In this rule, EPA developed a proposed chronic criterion that is based on dietary exposures. The EPA did not develop a separate acute or chronic criterion from the results of toxicity tests with only water-based exposure. Because the most harmful effects of mercury on aquatic organisms are due to its bioaccumulative properties and because the resulting chronic effects are observed at lower mercury concentrations than acute effects, this chronic criterion based on dietary exposure is expected to additionally protect aquatic communities from any potential acute effects of mercury. The proposed criterion is shown in Table 7.

Table 7. EPA Proposed Chronic Mercury Ambient Water Quality Criterion (EPA 2024a)

Table 1 to Paragraph (b). Proposed Chronic Mercury Ambient Water Quality Criterion for the Protection of Aquatic Life in Idaho.

Media Type	Fish Muscle Tissue [1, 2, 3] Total Mercury (ng THg/g wet weight)	Fish Whole Body Tissue [1, 2] Total Mercury (ng THg/g wet weight)	Water Column [1,4] Total Mercury (ng/L) in whole water
Magnitude	225	162	2.1
Duration	Instantaneous measurement [5]		30-day average
Frequency	The average tissue concentration must not be exceeded		Not more than once in three years on average

1 The proposed criterion elements are hierarchical, with both tissue elements superseding the water column element. The fish muscle tissue and fish whole body tissue criterion elements are independently applicable.
2 Tissue sample measurements must be based on measurement(s) of the total mercury concentration (in a composited tissue sample from each fish species or a central tendency estimate of individual tissue samples from each fish species) collected from a given site or waterbody in a discrete sampling period. These criterion elements support Idaho's aquatic life uses. Only samples of adult life stage trophic level (TL) 4 fish can be directly compared to the muscle or whole-body criterion elements.
3 If adult life stage TL2 or TL3 fish are sampled, a Bioaccumulation Trophic Adjustment Factor (BTAF) must be applied to the muscle concentrations of those fish. If whole-body tissue from TL2 or TL3 fish is sampled, the fish whole body – muscle conversion factor of 0.72 must be applied to generate a translated muscle value before a BTAF is applied to the sample concentration. A TL2 sampled fish concentration must be multiplied by the TL2 BTAF of 5.6 and the resultant value compared to the muscle tissue criterion element. A TL3 sampled fish concentration must be multiplied by the TL3 BTAF of 3.5 and the resultant value compared to the muscle tissue criterion element. If multiple adults of different TLs are sampled, the TL4 fish result would supersede TL3 BTAF-applied or TL2 BTAF-applied value outcomes. If TL3 and TL2 fish are sampled, the TL3 BTAF-applied values supersede the TL2 BTAF-applied values.
4 Water column values are based on total mercury in unfiltered or "whole water" samples. Total mercury includes all inorganic and organic species of mercury in the water column. Water samples collected during baseflow conditions would be most representative of the data used to derive this criterion element. This criterion element supports Idaho's aquatic life uses.
5 Fish tissue data provide integrative measurements that reflect accumulation of mercury over time and space in aquatic organisms from a given site or waterbody in a discrete sampling period.

This TMDL must also meet Oregon water quality standards at the point where Jordan Creek crosses the state line from Idaho to Oregon. The relevant Oregon criteria for mercury are

summarized in Table 8. As discussed in detail in Appendix C, Oregon's tissue-based criterion for methylmercury was translated to a water column concentration of 2.4 ng/L THg using a bioaccumulation factor approach. 2.4 ng/L is the THg chronic exposure target and is the water quality target for this TMDL. Given that 2.4 ng/L is close to the 2.1 ng/L THg concentration identified in the NMFS and FWS biological opinions as being protective within Idaho, this TMDL uses the 2.4 ng/L THg target to address the impairments based on elevated fish tissue mercury concentrations identified by DEQ within the Jordan Creek watershed.

Table 8. Oregon water quality criteria for mercury in Jordan Creek applicable at the ID-OR state line.

Designated Use	Criterion	Parameter	Numeric Limit
Aquatic Life (Freshwater)	Criterion Maximum Concentration (acute)	Mercury (Total)	2.4 µg/l
	Criterion Continuous Concentration (chronic)	Mercury (Total)	0.012 µg/l
Human Health	Organism (fish tissue)	Methylmercury	0.040 mg/kg
Domestic Water Supply	Maximum Contaminant Level/Action Level	Mercury	0.002 mg/l (2 µg/l)

Source: Oregon Administrative Rules 340.041.0033 Table 30 (aquatic life) and Table 40 (human health); Oregon Administrative Rules 333.061.0030 Table 1 (drinking water).

2.4 Summary and Analysis of Existing Water Quality Data

There have been several investigations of mercury pollution in Jordan Creek. For the 2009–2014 TMDL drafts, DEQ used earlier studies by Gebhards et al. (1971), Hill et al. (1973; referred to as "U. of I. study"), DEQ (1980), the 1988 Stone Cabin Mine Environmental Impact Study (EIS; CH2M Hill 1994), EPA (1998), and Dai and Ingham (2009). All found high mercury concentrations in various media in the area and concluded that mercury was a concern for water quality and public health. They also noted data gaps, including lack of fish tissue data from lower Jordan Creek and water column samples collected under various flow regimes.

To address these data gaps, IDFG collected fish at three locations in Jordan Creek in September 2021 to support development of this TMDL. In conjunction with IDFG, EPA funded DEQ and the Oregon Department of Environmental Quality to collect and analyze water column and sediment mercury samples at multiple stations during both high and low flow periods in 2021 (DEQ 2021).

In an effort that was independent of the TMDL development but completed under an acceptable quality assurance/quality control program, Willis et al. (2022), also referred to as the Trout Unlimited report, conducted a study of mercury in the Jordan Creek watershed in October 2021. This study targeted data gaps from previous studies. In addition to soil and water chemistry, this study assessed aquatic organism passage, stream health, and stream temperature. Trout Unlimited collected water column and sediment samples from 15 sites in and near the Silver City legacy mining area.

The following sub-sections discuss available monitoring data to support the TMDL. The discussion is divided by sample medium and applies across all the Jordan Creek AUs where beneficial uses are impaired.

2.4.1 Monitoring Data

2.4.1.1 Mercury and Fish Tissue

Fish tissue sampling was performed during the 1973 U. of I. study, the 1988 EIS, the 2005 DEQ study (Dai and Ingham 2009), and the 2021 IDFG study (Figure 8). Trout Unlimited (Willis et al. 2022) did not collect fish tissue samples. Due to concerns that the 1973 and 1988 fish samples are unrepresentative of present-day conditions, only fish tissue data collected in 2005 and later are used in the TMDL analyses of mercury bioaccumulation documented in Appendix C; however, earlier fish data are summarized here for context.

The 2021 IDFG study conducted fish tissue sampling at three sites along Jordan Creek. IDFG collected 29 fish: 28 Rainbow Trout and 1 Northern Pikeminnow. They reported 31 fish tissue analyses, including two tissue duplicates). All of these samples exceeded Idaho's fish tissue mercury criterion of 0.3 mg/kg.

The 2005 DEQ study conducted fish tissue sampling at eight sites in the Jordan Creek watershed—five sites on Jordan Creek and three sites on tributaries. Samples were collected at four sites in upper Jordan Creek: Jordan Creek below Silver City (JC-2005-11), Jordan Creek at De Lamar (JC-2005-09), Jordan Creek at end of tailings (JC-2005-08), and Jordan Creek below Boulder Creek (JC-2005-02). All of these samples exceed Idaho's fish tissue mercury criterion of 0.3 mg/kg (Table 9). DEQ found no desirable, catchable, or edible game fish in the lower segment of Jordan Creek near the state line (JC-2005-01). DEQ conducted further tributary sampling in Flint Creek, East Creek, and Louse Creek.

The specifics of collection methods, targeted species, fish preparation, and analytical methods used in the 2005 study are discussed in *Quality Assurance Project Plan, Jordan Creek Watershed HUC 1705108 Mercury Monitoring Project July-September 2005* (Jordan Creek QAPP; Ingham 2005). Data results and initial statistical analysis for all study sites are outlined in *Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites* (Dai and Ingham 2009).

The 1973 University of Idaho study also collected fish samples at a site above Jordan Valley in Idaho and at Triangle Bridge for Rainbow Trout and other species. All of the fish sampled at these locations exceeded Idaho's mercury criterion (Table 9 and Table 10).

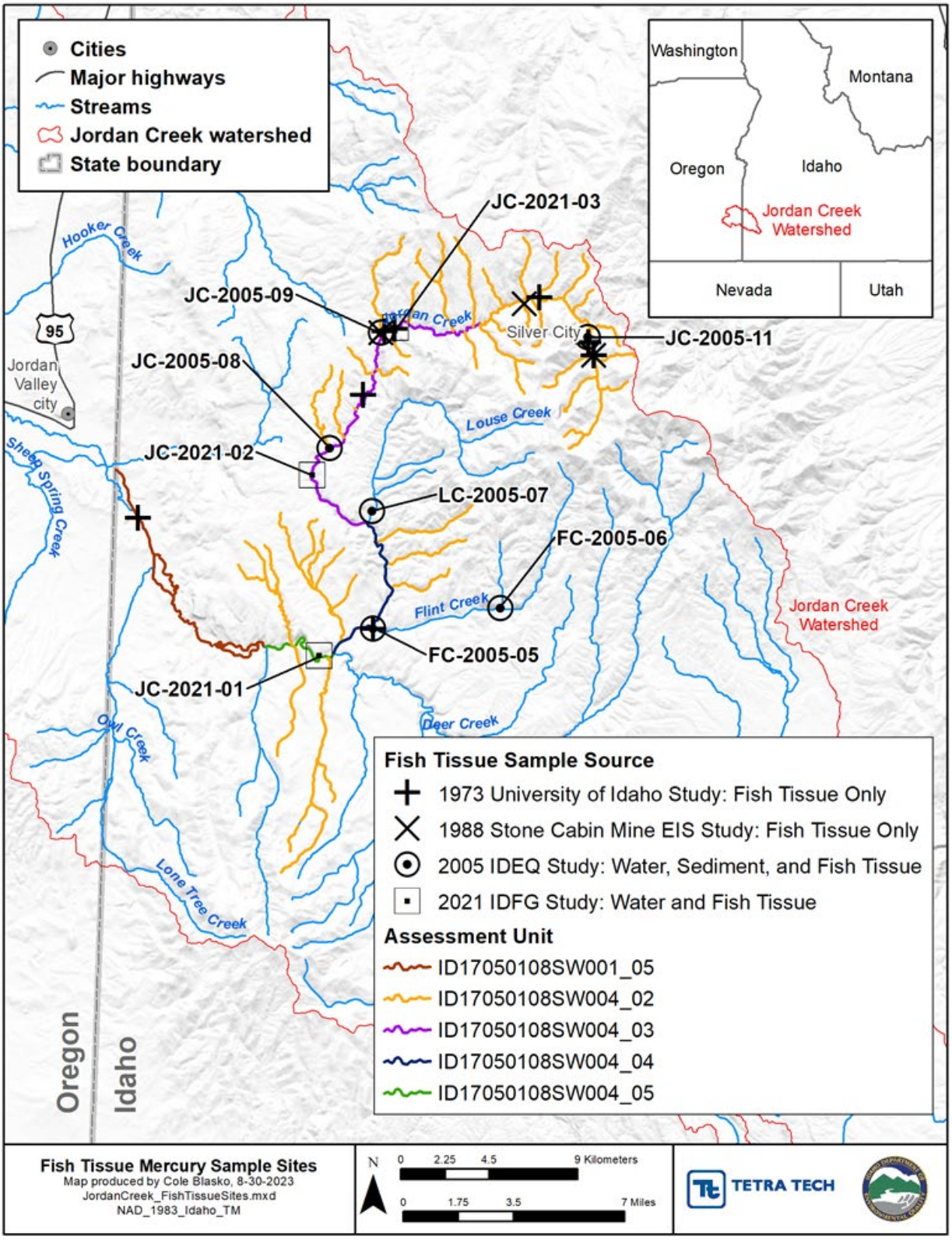


Figure 8. Jordan Creek fish tissue sampling locations.

Table 9. Fish tissue mercury sample data collected in Jordan Creek between Williams Creek and the state line; AU ID17050108SW001_05.

Species	Wholebody Composite Fish Samples from Jordan Creek at State Line (Dai and Ingham 2009) Mercury (mg/kg)	Fish Mercury Samples from Jordan Creek above Jordan Valley (Hill et al. 1973)		
		Number of Samples	Average Length (inch)	Average Mercury (mg/kg)
Dace	0.77	—	—	—
Northern Pikeminnow	0.70	2	7.5	0.86
Red-sided Shiner	0.63	4	2.3	0.66
Sucker	0.74	7	9.9	0.82
Chiselmouth Sucker	0.75	—	—	—
Rainbow Trout	—	3	11.3	0.38

Table 10. Fish tissue mercury sample data collected in Jordan Creek between Louse Creek and Big Boulder Creek; AU ID17050108SW004_04.

Fish Tissue Mercury Samples from Jordan Creek at Triangle Bridge (Hill et al. 1973)			
Species	Number of Samples	Average Length (inch)	Average Mercury (mg/kg)
Peamouth	1	6.5	0.62
Rainbow Trout	6	6.8	0.38
Red-Sided Shiner	3	3.5	0.7
Sculpin	2	2.0	0.6
Northern Pikeminnow	3	6.5	0.8
Sucker	12	5.8	0.7

Game fish were not found during the 2005 sampling in the lower segment of Jordan Creek at station JC-2005-01. Fish that were collected weighed only a few grams, and none were classified as a game fish to be caught and consumed within Idaho. This does not rule out the possibility that larger fish are present in lower Jordan Creek. At the Pleasant Valley Bridge, numerous large suckers and trout were observed in an area impounded by an instream diversion (personal observation, Mike Ingham 2005, cited in DEQ 2010).

Fish tissue results for the new sampling conducted in 2021 by EPA and IDFG are shown in Table 11. That sampling campaign focused on Rainbow Trout, but one Northern Pikeminnow was also analyzed. Note that the lengths of the Rainbow Trout collected in 2021 are consistently greater than those from the 2005 samples.

Table 11. Fish tissue mercury data from EPA/IDFG 2021 sampling.

Site	Latitude	Longitude	Species	Length (inches)	Mercury (mg/kg wet weight)
2021-JC1: Jordan Creek downstream of DeLamar Mine Entrance	42.87278	-116.89564	Rainbow Trout	13.8	2.02
			Rainbow Trout	11.1	1.40
			Rainbow Trout	12.0	1.68
			Rainbow Trout	9.0	1.06
			Rainbow Trout	13.8	2.37
			Rainbow Trout	12.4	2.11
			Rainbow Trout	14.0	1.56
			Rainbow Trout	10.0	1.59
2021-JC2: Jordan Creek above Flint Road	42.95507	-116.90397	Rainbow Trout	13.6	1.56
			Rainbow Trout	11.6	1.43
			Rainbow Trout	11.2	1.07
			Rainbow Trout	10.8	1.11
			Rainbow Trout	12.0	0.89
			Rainbow Trout	10.7	0.79
			Rainbow Trout	10.9	0.63
			Rainbow Trout	11.4	1.24
			Rainbow Trout	10.2	0.71
			Rainbow Trout	10.3	1.12
			Northern Pikeminnow	10.5	1.93
2021-JC3: Jordan Creek at DeLamar Mine (USGS gage station 13177985)	43.02384	-116.85523	Rainbow Trout	8.3	1.00
			Rainbow Trout	11.1	0.71
			Rainbow Trout	12.2	1.11
			Rainbow Trout	11.7	0.36
			Rainbow Trout	12.0	0.80
			Rainbow Trout	10.1	0.94
			Rainbow Trout	10.4	1.68
			Rainbow Trout	12.6	0.66
			Rainbow Trout	12.7	0.92
			Rainbow Trout	14.1	0.84

Note: Results for two tissue duplicate analyses are omitted.

The majority of the available fish tissue data are from Rainbow or Columbia River Redband Trout, which served as the basis of the TMDL analysis for the fish tissue criterion.

For the 2014 draft TMDL, EPA conducted statistical analyses on the available water column, sediment, and Rainbow and Columbia River Redband Trout tissue data from Jordan Creek. The 2005 DEQ study (Dai and Ingham 2009) provided the primary data for the 2014 analysis. EPA used additional fish tissue data from the 1973 U of I study and 1988 EIS throughout the analysis to complement the 2005 study's limited data. The update of the analysis (Appendix C) does not

use the 1973 and 1988 samples but instead incorporates the new 2021 samples with the 2005 samples. The resulting data set is summarized in Table 12.

Table 12. 2005 and 2021 Rainbow and Columbia River Redband Trout fish tissue results for Jordan Creek subbasin sites.

Sample Site	Sample Site Description	Latitude	Longitude	Sample Type	Length (in)	Mercury (mg/kg wet weight)
FC-2005-05	Flint Creek at Bridge	42.88584	-116.86287	Fillet, comp	8.9	0.37
				Fillet, comp	6.4	0.12
				Fillet, comp	6.7	0.07
				Whole body, comp	4.4	0.10
FC-2005-06	East Creek	42.89736	-116.78382	Whole body, comp	4.3	0.02
				Whole body, comp	4.3	0.01
				Fillet, comp	6.5	0.02
				Fillet, comp	6.2	0.02
				Fillet, comp	6.5	0.02
JC2-2021	Jordan Creek above Flint Road	42.95507	-116.90397	Fillet	13.6	1.56
				Fillet	11.6	1.43
				Fillet	11.2	1.07
				Fillet	10.8	1.11
				Fillet	12.0	0.89
				Fillet	10.7	0.79
				Fillet	10.9	0.63
				Fillet	11.4	1.24
				Fillet	10.2	0.71
				Fillet	10.3	1.12
JC-2005-08	Jordan Creek End of Tailings	42.96772	-116.89365	Fillet, comp	8.6	0.36
				Fillet, comp	8.8	0.42
JC-2005-09	Jordan Creek at De Lamar-USGS Gage	43.02133	-116.86394	Fillet, comp	5.3	0.25
				Fillet, comp	9.5	0.58
				Fillet, comp	9.5	0.57
				Fillet, comp	6.0	0.45
JC1-2021	Jordan Creek below DeLamar Entrance	42.87278	-116.89564	Fillet	13.8	2.02
				Fillet	11.1	1.40
				Fillet	12.0	1.68
				Fillet	9.0	1.06
				Fillet	13.8	2.37
				Fillet	12.4	2.11
				Fillet	14.0	1.56
				Fillet	10.0	1.59
JC3-2021	Jordan Creek at DeLamar Mine	43.02384	-116.85523	Fillet	8.3	1.00
				Fillet	11.1	0.71
				Fillet	12.2	1.11

Sample Site	Sample Site Description	Latitude	Longitude	Sample Type	Length (in)	Mercury (mg/kg wet weight)
				Fillet	11.7	0.36
				Fillet	12.0	0.80
				Fillet	10.1	0.94
				Fillet	10.4	1.68
				Fillet	12.6	0.66
				Fillet	12.7	0.92
				Fillet	14.1	0.84
JC-2005-11	Jordan Creek below Silver City	43.02247	-116.73499	Whole body, comp	3.9	0.49
				Fillet, comp	6.9	0.55
				Fillet, comp	7.9	0.69
				Fillet, comp	6.6	0.48
LC-2005-07	Louse Creek	42.93968	-116.86592	Fillet, comp	7.3	0.13
				Fillet, comp	9.1	0.12
				Fillet, comp	7.4	0.12
				Fillet, comp	7.4	0.12
				Whole body	—	0.13
				Whole body	—	0.04
				Whole body	—	0.05

DEQ used Rainbow Trout fillets to establish the average fish tissue mercury concentrations used to calculate reductions needed to meet the fish tissue human health criterion. A small number of whole-body tissue analyses were converted to equivalent fillet concentrations as described in Appendix C.

The final analyses for water column targets relative to fish tissue criteria used the more recent (2005 and 2021) Rainbow and Columbia River Redband Trout results after adjusting to a standardized length equal to the geometric mean of the samples (6.55 inches), as described in Appendix C and summarized in Table 13. This is done to eliminate bias associated with samples at different sites having different length and age distributions. DEQ combined results for the 2021 samples from JC-1 and JC-3, both within AU ID17050108SW004_03, due to their proximity and similarity in fish tissue concentrations.

Table 13. Summary statistics for 2005 and 2021 rainbow trout tissue samples standardized to length of 6.55 Inches.

Station	Count	Geometric Mean Hg (mg/kg wet weight)	Average Hg (mg/kg wet weight)	Standard Deviation Hg (mg/kg wet weight)
FC-2005-05 (tributary)	4	0.147	0.165	0.082
FC-2005-06 (tributary)	5	0.025	0.025	0.007
JC-2005-08	2	0.249	0.250	0.021
JC-2005-09	4	0.355	0.362	0.092
JC-2005-11	4	0.666	0.761	0.514
JC1 and JC3 (2021)	18	0.400	0.453	0.211
JC2 (2021)	10	0.391	0.401	0.093
LC-2005-07 (tributary)	4	0.094	0.096	0.017

Note: Table excludes 1973 samples that were used in the 2014 TMDL draft to supplement 2005 observations.

2.4.1.2 Mercury and Water Quality

DEQ analyzed historic water quality data for mercury in upper Jordan Creek prior to 2005 using detection limits of 0.1 µg/l or greater, well above Idaho's chronic aquatic life criterion of 0.012 µg/L and the TMDL water column target, which made it difficult to evaluate the data relative to applicable criteria. There were occasional results reported above the detection limits. Most water quality data presented in the 1973 U of I study showed that water column concentrations were below detectable levels of 0.2 µg/l. The *Study of Mercury and Heavy Metals in Jordan Creek Drainage, Silver City Project* (Hill et al. 1973) provides only a general description of sampling locations.

Other available water quality data include a 1998 Superfund Technical Assessment and Response Team (START) study (Ecology & Environment 1999), which showed only one station with mercury concentrations above the detectable level, and the 1988 EIS (CH2M Hill 1994), which documented surface water monitoring for various years from 1984–1992. Results reported in the 1988 EIS ranged from <0.7 µg/l to a maximum of 7 µg/l for dissolved mercury. More recent water quality data provided by the Kinross DeLamar Mining Company, former owners of the DeLamar Mine and a wholly owned subsidiary of Kinross Gold Corporation, for samples collected between 2004 and 2008 below the mine site showed that 5 samples out of 113 exceeded the detection limit, which was typically 0.1µg/l (KDMC 2003, 2004a, 2005a, 2005b, 2006, 2007 and 2008).

Both DEQ in 2005 and IDFG and Trout Unlimited in 2021 collected water column samples with low detection limits (Figure 9). Table 14 and Table 15 show the results for the water column sampling (in downstream to upstream order) for the Jordan Creek mainstem and Jordan Creek tributaries, respectively.

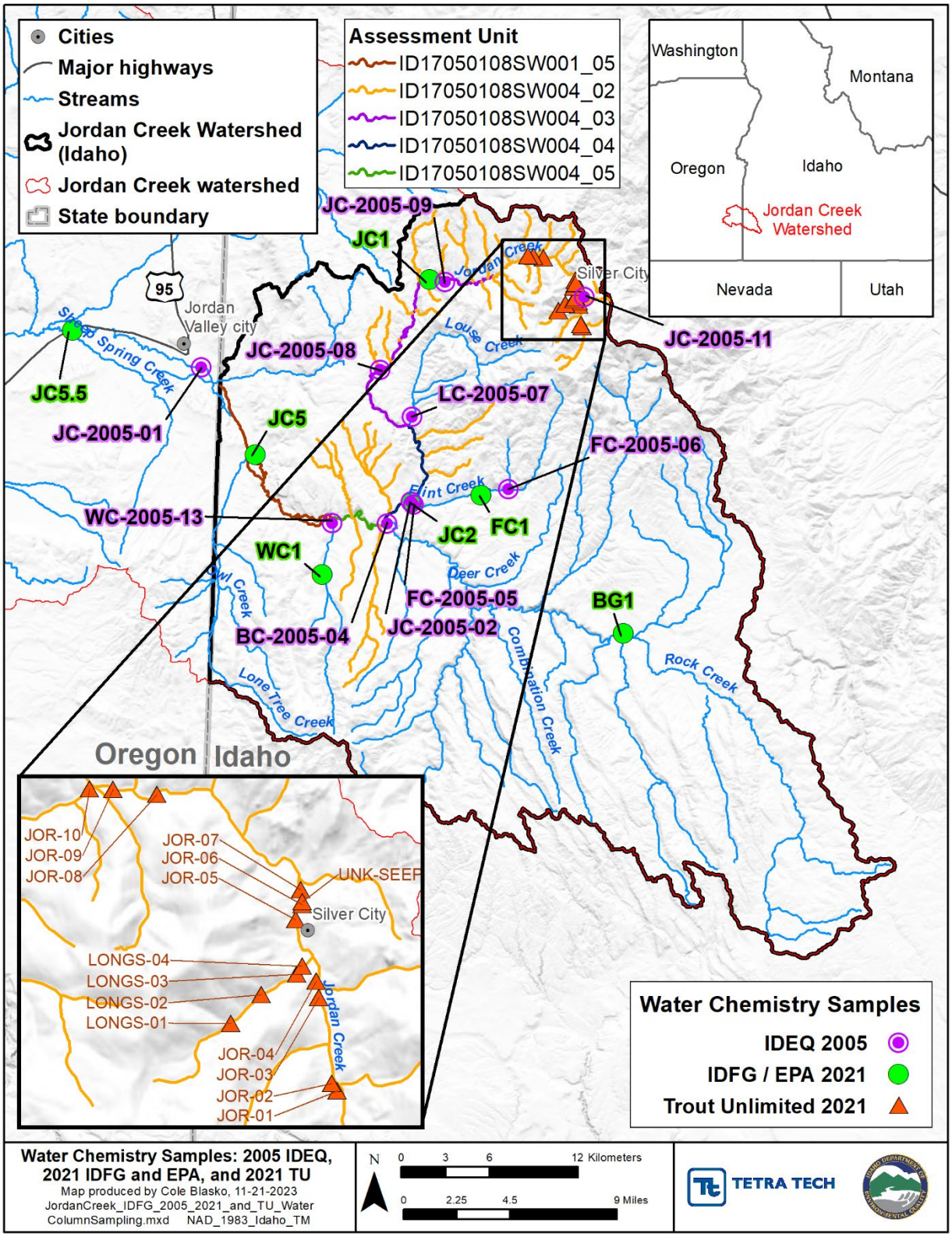


Figure 9. 2005 and 2021 Water Column Mercury Sample Sites, Jordan Creek.

Table 14. 2005 and 2021 water column mercury data for Jordan Creek mainstem in downstream to upstream order.

Source	Station	Description	Date	Unfiltered Total Mercury (ng/L)	Filtered Total Mercury (ng/L)	Unfiltered Methylmercury (MeHg) (ng/L)	Filtered MeHg (ng/L)
2	JC 5.5	Jordan Creek at US Route 95 (OR)	4/28/2021	67.7	21.8	3.81	3.44
			10/12/2021	120	31.5	1.23	0.825
1	JC 2005-01	Jordan near Stateline	8/8/2005	20	9	2.7	2.1
2	JC5	Jordan Creek at Pleasant Valley Road Bridge	4/7/2021	380	14.1	—	—
			4/28/2021	208	21.3	0.933	0.585
			5/19/2021	193	55.2	1.93	1.62
			10/13/2021	43.8	16.5	1.09	0.829
			10/13/2021	44.9	16.9	1.07	0.791
2	JC2	Jordan Creek above Flint Road	4/28/2021	307	27.5	0.446	0.24
			10/13/2021	195	57	1.13	0.751
1	JC 2005-02	Jordan below Boulder Cr.	8/10/2005	31	13	2.5	1.9
1	JC 2005-08	Jordan Below Placer Tailings	8/9/2005	13	5	0.98	0.7
2	JC1	Jordan Creek below DeLamar Entrance	4/7/2021	235	37.5	—	—
			4/7/2021	235	36.7	—	—
			4/28/2021	158	38.2	0.234	0.116
			5/19/2021	156	42.5	0.343	0.183
			10/13/2021	20.5	14.8	0.472	0.395
1	JC 2005-09	Jordan Below DeLamar Mine	8/8/2005	35	20	1.6	1.2
1	JC 2005-10	Jordan Below Blue Gulch	8/8/2005	58	8	0.85	0.6
3	JOR-10	Downstream of Blue/Cunningham Confluences	10/12/2021	45.1	1.44	—	—
3	JOR-09	Downstream of Dewey Mine/Mill	10/12/2021	138	2.5	—	—
3	JOR-08	Upstream of Dewey Mine/Mill at Culvert	10/12/2021	197	3.4	—	—
3	JOR-07	Downstream of zone two of Fluvial Tailings	10/12/2021	194	3.1	—	—
3	JOR-06	Downstream of Fluvial Tailings Zone 1	10/12/2021	156	2.6	—	—
3	JOR-05	Jordan Below Silver City	10/12/2021	165	2.8	—	v
1	JC-2005-11	Jordan Below Silver City	8/9/2005	93	90	2.8	2.1

Source	Station	Description	Date	Unfiltered Total Mercury (ng/L)	Filtered Total Mercury (ng/L)	Unfiltered Methylmercury (MeHg) (ng/L)	Filtered MeHg (ng/L)
3	JOR-04	Jordan Downstream of Cosmos Mill	10/12/2021	159	2	—	—
3	JOR-03	Downstream of Poorman and Shoenbar Mills	10/12/2021	298	1.7	—	—
3	JOR-02	Downstream of Silver Chord Inflow	10/12/2021	1.21	0.81	—	—
3	JOR-01	Headwaters of Jordan Creek upstream of Silver Chord Gulch	10/12/2021	1.02	0.87	—	—

Sources: 1: DEQ 2005 sampling (Dai and Ingham 2009); 2: IDFG and EPA sampling, 2021; 3: Trout Unlimited sampling, 2021 (Willis et al., 2022).

Table 15. 2005 and 2021 water column mercury data for Jordan Creek tributaries in downstream to upstream order.

Source	Station	Description	Date	Unfiltered Total Mercury (ng/L)	Filtered Total Mercury (ng/L)	Unfiltered Methylmercury (ng/L)	Filtered MeHg (ng/L)
2	WC1	Williams Creek along South Mountain Road	4/28/2021	2.9	1.41	0.11	0.0758
			10/13/2021	0.573	0.5	0.052	0.053
1	WC 2005-13	Williams Creek	8/8/2005	1.804	1.065	0.214	—
2	BG1	Rock Creek (background)	4/28/2021	3.95	1.67	0.0841	0.0557
			10/13/2021	1.68	1.51	0.0996	0.105
1	BC-2005-04	Boulder Creek	8/9/2005	1.24	1.979	0.236	—
2	FC1	Flint Creek at Flint Road	4/28/2021	4.16	1.94	0.0864	0.0572
			4/28/2021	4.18	2	0.0845	0.0612
			10/13/2021	1.68	1.2	0.15	0.106
1	FC-2005-06	Flint Creek	8/9/2005	1.219	0.839	0.277	—
1	FC 2005-06	East Fork	8/9/2005	0.763	0.5	0.052	—
1	LC-2005-07	Louse Creek	8/8/2005	1.397	0.779	0.103	—
3	UNK SEEP	Seep	10/12/2021	276	—	0.68	—
3	Longs-04	Long Gulch	10/13/2021	56.6	—	0.94	—
3	Longs-03	Long Gulch	10/13/2021	45.4	—	0.42	—
3	Longs-02	Long Gulch	10/13/2021	25	—	0.12	—
3	Longs-01	Long Gulch	10/13/2021	14.7	—	0.17	—

Sources: 1: DEQ 2005 sampling (Dai and Ingham 2009); 2: IDFG and EPA sampling, 2021; 3: Trout Unlimited sampling, 2021 (Willis et al., 2022).

For the 2005 DEQ study (Dai and Ingham, 2009), 11 sites in the subbasin were selected for monitoring, including six on Jordan Creek. Information on all monitoring sites, sampling methods, parameters, quality assurance/quality control, detection levels, and analytical methods can be found in the *Jordan Creek QAPP* (Ingham 2005). The six Jordan Creek sites selected for water quality and sediment sampling included all the 2005 fish tissue collection sites in Table 12. The 2005 study had a reporting limit for mercury of 0.5 ng/l (0.0005 µg/l). This represents a significant improvement over the 1973 detection limits. Figure 10 and Figure 11 present total and dissolved mercury, and methylmercury concentrations, respectively, from the 2005 DEQ study in Jordan Creek. The mercury water column data from the 2005 DEQ study show an exceedance of both Idaho and Oregon's mercury criteria for protection of aquatic life (0.012 µg/l = 12 ng/L total recoverable mercury) as well as the 2.4 ng/L target developed for this TMDL in Jordan Creek.

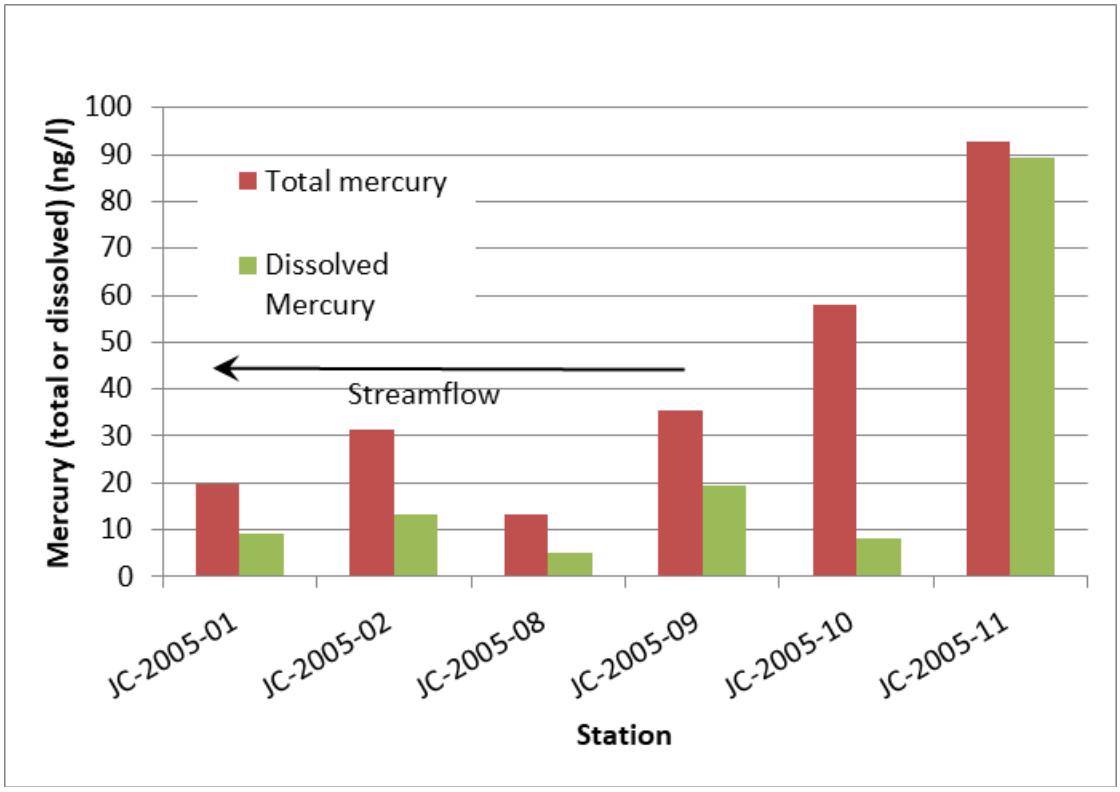


Figure 10. DEQ 2005 total and dissolved mercury concentration, Jordan Creek subbasin.

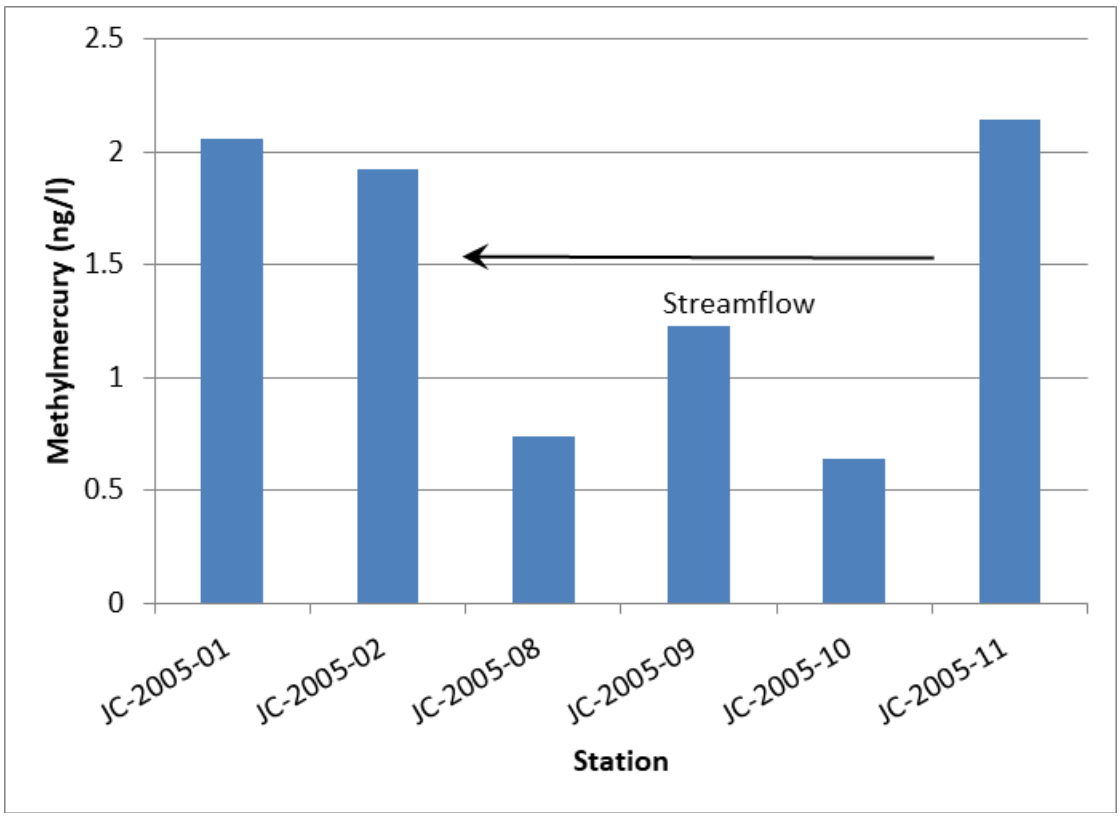


Figure 11. DEQ 2005 methylmercury concentrations in water, Jordan Creek subbasin.

Water column samples were collected from Jordan Creek and tributaries by DEQ three times in spring 2021 to target higher runoff conditions and one time in October 2021 to target low flow conditions (Table 14, Table 15, and Figure 9). These samples confirmed the elevated mercury concentrations observed during summer low flow conditions in 2005 along with even higher concentrations present in the mainstem during high flow conditions.

The 2021 Trout Unlimited study (Willis et al. 2022) evaluated water column samples for metals (total and dissolved), nutrients, THg, and MeHg at ten upstream sites in the mining area of Jordan Creek, four sites on Long Gulch, and one unknown seep to Jordan Creek downstream of Silver City (Figure 9, Table 14, and Table 15). Willis et al. discuss several major changes in THg and MeHg concentrations in the water column between sites along Jordan Creek:

- JOR-02 to JOR-03: The increase in concentrations may be due to the historic Poorman and Shoenbar Mills that were located between these sites.
- JOR-04 to JOR-05: The increase may be due to Long Gulch, which discharges to Jordan Creek between these sites. THg concentrations increase along Long Gulch from headwaters to mouth (4.7 to 56.6 ng/L). The MeHg trend is not identical but generally increases from headwaters to mouth (0.17 to 0.94 ng/L).
- JOR-06 to JOR-07: The increase may be due to a sampled seep of unknown origin (276 ng/L THg; 0.68 ng/L MeHg) and the second fluvial tailings area that occur between these sites.

- JOR-09 to JOR-10: The decrease may be due to perennial flow from Cunningham Creek or the series of beaver dams on Jordan Creek. The beaver dams result in ponding where sediment with attached mercury may settle.
- On both Jordan Creek and Long Gulch, locations of instream increases in THg are associated with historic ore processing mills that also exhibit high soil THg concentrations.

2.4.1.3 Mercury and Stream Sediment

Sediment samples were collected in 1998 by EPA's START and in 2005 by DEQ (Dai and Ingham 2009). The EPA START study (Figure 12) found high concentrations of mercury in sediments in the low gradient areas between Williams Creek confluence and the Oregon border and immediately downstream in the vicinity of Silver City. Table 16, Figure 13, and Figure 14 present longitudinal trends in mercury concentrations in sediment from Jordan Creek sites from the 2005 DEQ study. The total mercury concentrations are compared to sediment effect screening levels published by Buchman (2008) and frequently exceed the probable effects level (PEL) of 0.486 mg/kg.

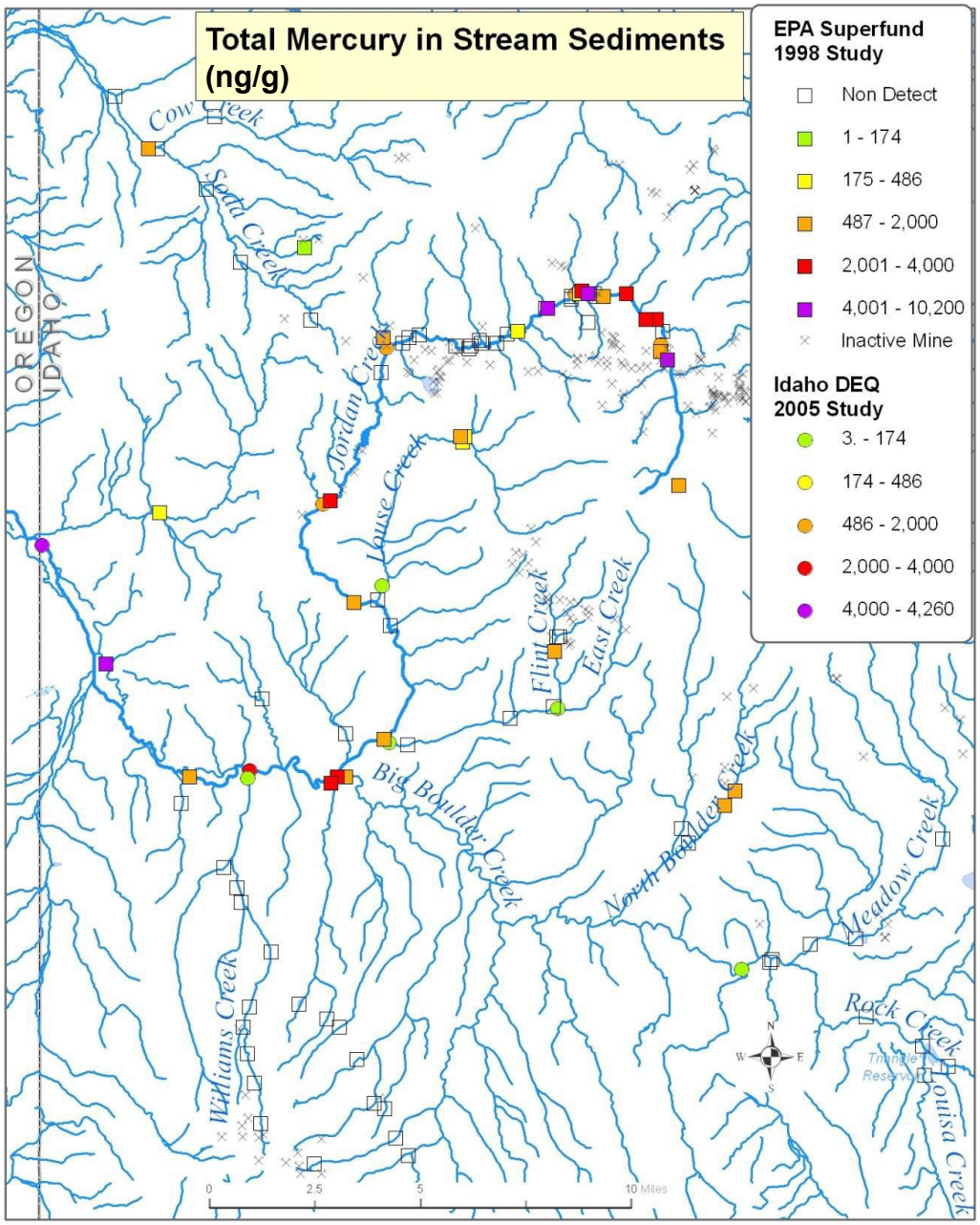


Figure 12. Locations and results of mercury sampling in stream sediment, 1998 and 2005 studies.

Table 16. DEQ 2005 total mercury and methylmercury results for stream sediments in Jordan Creek.

Station	Description	Total Hg (µg/g=mg/kg)	Total MeHg (µg/g=mg/kg)
JC-2005-01	Jordan Cr. near State Line	4.260	0.0115
JC-2005-02	Jordan Cr. below Boulder Cr.	2.046	0.0048
JC-2005-08	Jordan Cr. below Placer Tailings	1.292	0.0004
JC-2005-09	Jordan Cr. below DeLamar Mine	1.385	0.0319
JC-2005-10	Jordan Cr. below Blue Gulch	1.235	0.0067
JC-2005-11	Jordan Cr. below Silver City	0.948	0.0014
FC-2005-05	Flint Cr. upstream of Jordan Cr.	0.014	0.0010
FC-2005-06	East Cr. upstream of Flint Cr.	0.003	0.0003
LC-2005-07	Louse Cr upstream of Jordan Cr.	0.016	0.0002

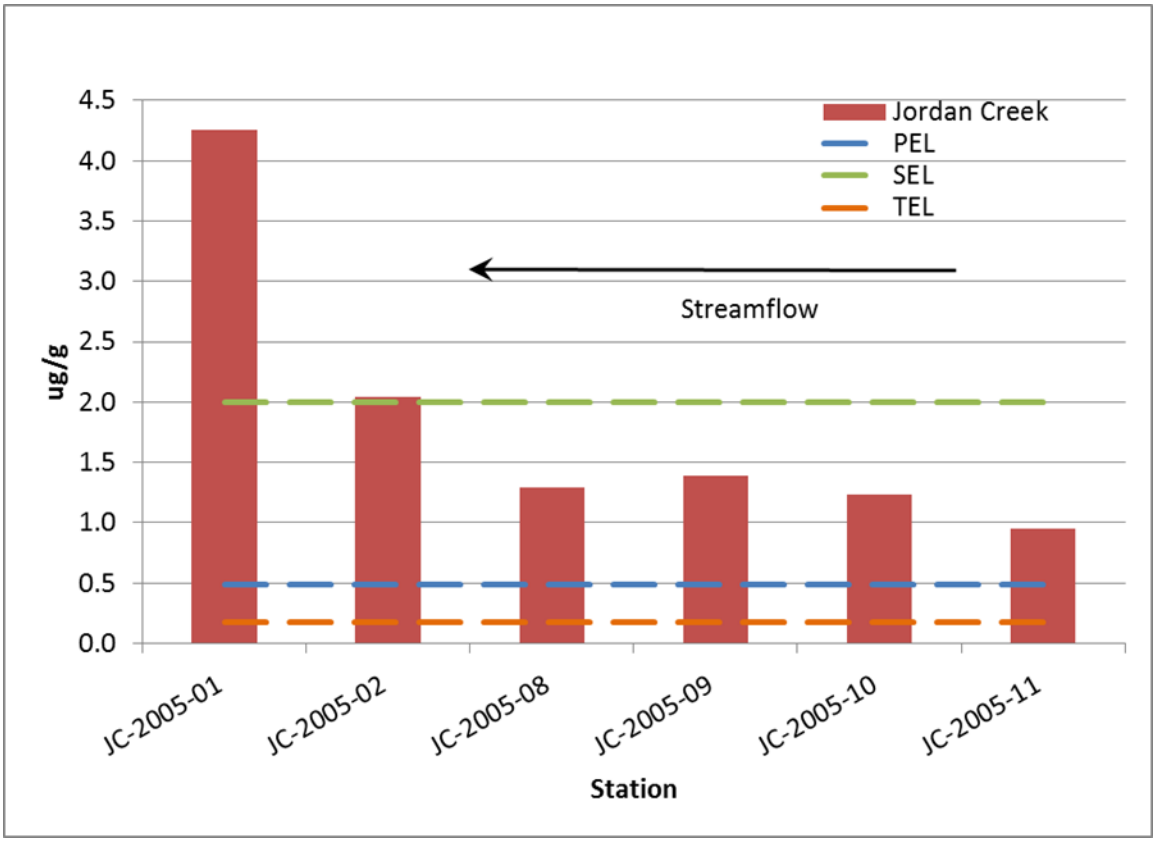


Figure 13. DEQ 2005 total mercury concentrations in stream sediments from 2005 Jordan Creek sites. Note: PEL = Probable Effects Level, SEL = Severe Effects Level, and TEL = Threshold Effects Level for toxic effects of sediment concentrations on benthic organisms (Buchman 2008).

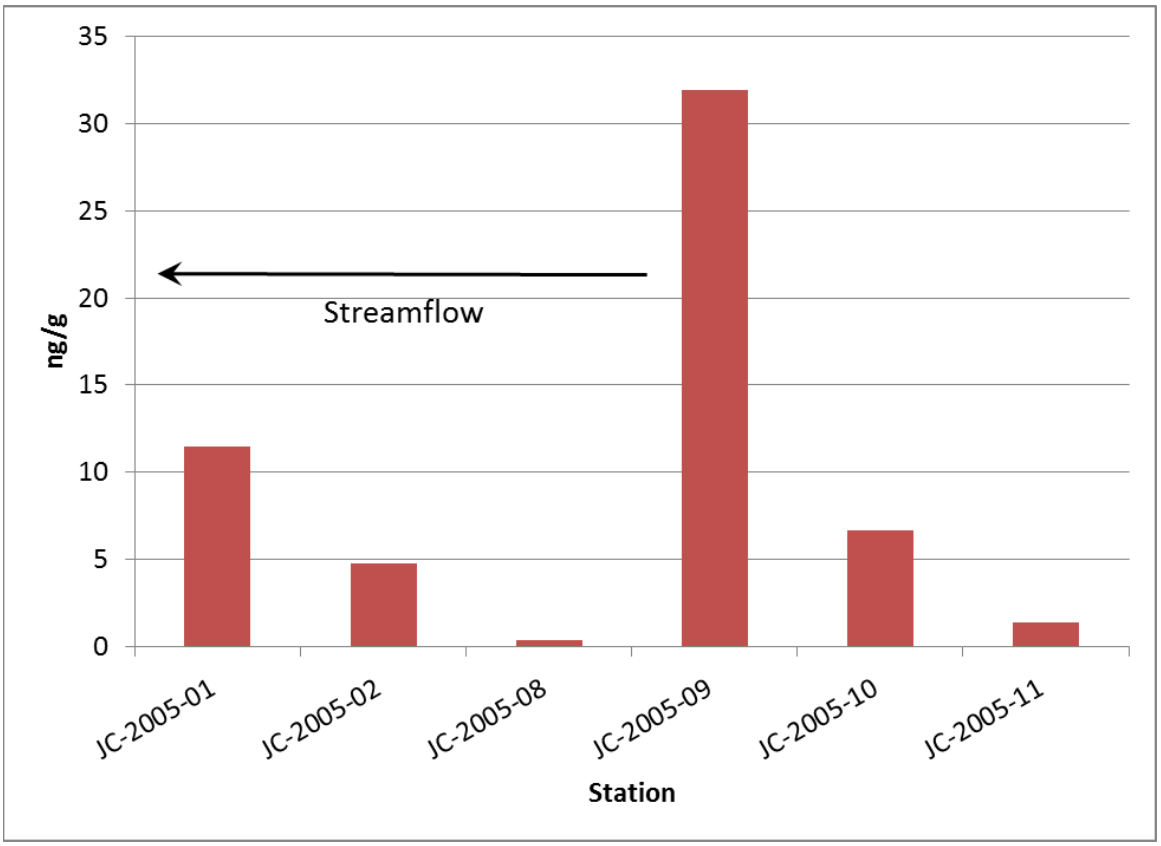


Figure 14. DEQ 2005 methylmercury concentrations in stream sediments from 2005 Jordan Creek sites.

In 2021 EPA collected sediment samples at the same sites used for water column sampling (Table 17). Trout Unlimited (Willis et al. 2022) collected sediment and soil samples from 15 sites in the upper Jordan Creek watershed in October 2021, focusing on the historic Silver City mining area. The 2021 Trout Unlimited study evaluated stream sediment samples for mercury[1] at two sites on Jordan Creek, one site on Webfoot Gulch, and one site on Silver Chord Gulch (Table 18). Trout Unlimited found the sediment samples from Webfoot Gulch and Silver Chord Gulch to be at or below background conditions, while the mainstem sediment samples were elevated.

Idaho does not have numeric quality criteria for pollutants in stream sediments although narrative criteria apply. Jordan Creek sediment mercury concentrations are greater than the PEL, the concentration of mercury above which adverse effects to benthic organisms are likely per the National Oceanic and Atmospheric Administration's Screening Quick Reference Tables (Buchman 2008).

[1] Sediment samples were also evaluated for total metals, metals, major cations, acid-producing characteristics, past pH, lime buffer, pyritic sulfur, organic content, agronomic properties, and physical properties.

The data show that mercury concentrations in Jordan Creek sediment downstream of the mining areas are much higher than the mercury concentration in sediments not influenced by historic mining. DEQ's 2005 and 2021 results (Table 16 and Table 17) also suggest that the mercury concentrations in sediment in the lower portion of Jordan Creek in Idaho are higher than those found in the segments of Jordan Creek between De Lamar and Flint Creek. This might be due to the downstream migration of mercury from the Silver City mines; alternatively, it may suggest additional mercury sources in the Flint Creek watershed.

Table 17. Total mercury results for stream sediments, EPA sampling (July 20, 2021).

Station	Description	Total Mercury (mg/kg)
BG1	Rock Creek (background)	0.44
FC1	Flint Creek at Flint Road	1.60
JC1	Jordan Creek below DeLamar Entrance	0.73
JC2	Jordan Creek above Flint Road	0.73
JC5	Jordan Creek at Pleasant Valley Road Bridge (Idaho)	0.40
JC5.5	Jordan Creek at Pleasant Valley Road Bridge (Oregon)	1.50
WC1	Williams Creek along South Mountain Road	0.13

Table 18. Trout Unlimited total mercury results for stream sediments (October 2021).

Station	Description	Total Mercury (mg/kg)
JOR-S5.5	Upstream of Dewey Mill, fluvial sediments in the stream banks	3.77
JOR-S10	Downstream of Blue and Cunningham inflows	4.22
SC-SED	Silver Chord Gulch stream sediment	0.0161
WF-01	Webfoot Gulch stream sediment	0.113

2.4.1.4 Mercury and Fluvial Soil Deposits

Trout Unlimited (Willis et al. 2022) also collected near-stream soil samples in the historic Silver City mining area. Soil samples were composites of 30 subsites. Soil samples at former mill sites and waste rock piles exhibited the highest mercury concentrations, while background and tributaries to Jordan Creek headwaters exhibited the lowest mercury concentrations. The highest soil concentrations were found at sites JOR-02 (65.7 mg/kg) and LS-01 (49.8 mg/kg); these sites are at the historic Cosmos Mill and Blaine Mill (respectively). For both sites, Trout Unlimited reported observing a "migration of material to adjacent stream corridors" (Willis et al. 2022, p. 35). As discussed in Section 3.2.3, historical processing at mill sites to extract gold and silver from ore used large quantities of imported mercury, resulting in extensive contamination.

Trout Unlimited sampled floodplain fluvial deposits at three locations along Jordan Creek (Table 19). The high mercury concentrations in the Trout Unlimited fluvial soil and sediment samples from Jordan Creek and its active floodplain in the Silver City mining area suggest that high flow conditions could mobilize mercury and transport it downstream.

Table 19. Trout Unlimited total mercury results for fluvial deposits along Jordan Creek (October 2021).

Station	Description	Total Mercury (mg/kg)
JOR-S3	Fluvial tails upstream zone 1	2.08
JOR-S4	Fluvial tails downstream zone 2	20.0
JOR-S7	Blue/Cunningham waste rock pile and barren area along alluvial fan upslope of Jordan Creek on Blue Gulch side	16.1

2.4.2 Status of Beneficial Uses

Five AUs in the Jordan Creek subbasin have been identified as having fish tissue concentrations that exceed the Idaho fish tissue criterion for mercury in the 2024 *Integrated Report*. In addition, fish tissue concentrations at the Idaho-Oregon state line exceed the Oregon fish tissue criterion. Water column samples show total mercury concentrations in excess of the chronic water quality criterion for the protection of aquatic life. These conditions result in impairment of beneficial uses, including recreation (in the form of fishing), cold water and salmonid spawning aquatic life, and wildlife habitat.

2.4.3 Assessment Unit Summary

A summary of the data analysis, literature review, and field investigations and a list of conclusions for AUs included in Category 5 for mercury in the 2024 Integrated Report follows. This section includes changes that will be documented in the next Integrated Report once the TMDLs in this document have been approved by EPA. The proposed changes in this section are not considered official until reviewed and approved by EPA during the next Integrated Report submittal process.

2.4.3.1 Assessment Units Addressed in TMDLs

ID17050108 SW001_05, Jordan Creek—Williams Creek to State Line

- Listed for mercury in fish tissue.
- Mercury listing based on the DEQ report, *Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites* (Dai and Ingham 2009). A mercury level of 0.717 mg/kg, which exceeds the human health criterion of 0.3 mg/kg, was reported.

ID17050108 SW004_02, Jordan Creek, Upper—1st and 2nd order tributaries

- Listed for mercury in fish tissue.
- Mercury listing based on the DEQ report, *Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites* (Dai and Ingham 2009). A mercury level of 0.551 mg/kg, which exceeds the human health criterion of 0.3 mg/kg, was reported.

ID17050108 SW004_03, Jordan Creek—Jacobs Gulch to Louse Creek

- Listed for mercury in fish tissue.

- Mercury listing based on the DEQ report, *Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites* (Dai and Ingham 2009). A mercury level of 0.511 mg/kg, which exceeds the human health criterion of 0.3 mg/kg, was reported.

ID17050108 SW004_04, Jordan Creek—Louse Creek to Big Boulder Creek

- Listed for mercury in fish tissue.
- Mercury should have been listed based on the DEQ report, *Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites* (Dai and Ingham 2009). A mercury level of 0.511 mg/kg, which exceeds the human health criterion of 0.3 mg/kg, was reported. EPA and IDFG confirmed fish tissue impairment in their 2021 sampling.

ID17050108 SW004_05, Jordan Creek—Big Boulder Creek to Williams Creek

- Listed for mercury in fish tissue.
- Mercury listing based on the DEQ report, *Analysis of Total Mercury Concentrations in Fish Samples from Jordan Creek and Non-Jordan Creek Sites* (Dai and Ingham 2009). A mercury level of 0.590 mg/kg, which exceeds the human health criterion of 0.3 mg/kg, was reported. EPA and IDFG confirmed fish tissue impairment in their 2021 sampling.

2.4.3.2 Assessment Units Proposed for Delisting

No AUs are being proposed for delisting in the next Integrated Report.

3 Pollutant Source Inventory

Pollutant sources fall into two broad classes: point sources and nonpoint sources. The CWA defines point sources as discernable, confide, and discrete conveyances, including but not limited to pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operations, or vessel or other floating craft, from which pollutants are or may be discharged (CWA § 502[14]). Some examples of common point sources include discharges from municipal wastewater treatment facilities, mines, and industrial operations. Nonpoint source is defined to mean any source of water pollution that does not meet the legal definition of point source as defined by the CWA. Nonpoint sources of pollution generally result from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification. Nonpoint source pollution, unlike point sources, comes from many diffuse sources (EPA 2024c).

Pollution within the Jordan Creek subbasin is primarily diffuse nonpoint sources of mercury loading.

3.1 Point Sources

There is currently one facility in the watershed that holds two permits through the Idaho Pollutant Discharge Elimination System (IPDES) program: DeLamar Mine. No unpermitted point sources of mercury are known to exist in the TMDL area. Several earlier studies in the Jordan Creek watershed looked for but did not find discrete or concentrated point sources of mercury discharge (Hill et al. 1973; Seronko 1995; E&E 2012; Willis et al. 2022), but they did identify several seeps associated with mine features.

The DeLamar Mine is an inactive, open pit silver and gold mine, located on a ridge between Jordan Creek and Louse Creek. The facility ceased mining operations in 1999 and is currently undergoing reclamation. Integra Resources Corporation acquired the DeLamar Mine in 2017. This facility has two existing IPDES permits: a stormwater permit and a groundwater remediation permit.

3.1.1 Permitted Stormwater

Direct discharges of stormwater to Jordan Creek are permitted under Idaho's 2021 IPDES Stormwater Multi-Sector General Permit (MSGP; *https://www2.deq.idaho.gov/admin/LEIA/index.html?view=folder&id=3001*). The facility's notice of intent application (permit number IDR050000) classifies the operation as an active discharger and applies to 2,135 acres within the DeLamar Mine area of operation. Stormwater from the permitted area is discharged to Jordan Creek and several of its tributaries through multiple outfalls. Under the MSGP, active operations are required to conduct chemical monitoring of stormwater and visual assessments of stormwater discharges. Chemical monitoring results are reported to EPA within 30 days of receiving complete laboratory results. Additionally, MSGP requirements address the general application of best management practices (BMPs) for controlling stormwater runoff and erosion. The MSGP does not specify a load limit for mercury for the DeLamar Mine or the reclamation activity associated with the closure of the facility.

In 2004, Kinross DeLamar Mining Company (KDMC) initiated a voluntary monitoring plan to evaluate and to confirm the effectiveness of implemented BMPs. The *Reclamation Performance Evaluation Monitoring Plan* (KDMC 2004b) is designed to assist mine personnel, along with federal and state agencies, to evaluate BMPs for managing stormwater runoff and erosion control efforts during reclamation of disturbed areas. The areas evaluated included reclaimed land, as outlined in the *Kinross DeLamar Mine Closure Plan* (KDMC 2003), as well as areas of historic mining activity, road system, plant operation, mine and mill tailings, and water impoundments.

Data collected between 2004 and 2008 showed that 5 out of 113 "Reclamation Trigger" water quality samples were above the detection limit. Mercury detections occurred at four sample sites. Detection limits ranged from 0.1 µg/l to 0.3 µg/l (KDMC 2003, 2004a, 2005b, 2006, 2007 and 2008), which all exceeded the aquatic life criterion then in place, 0.012 µg/l. The exact

locations of the sample sites are not known because there is no map or coordinates included in Kinross' reports.

DeLamar Mining Company began analyzing low-level mercury samples in the third quarter of 2021. The *Delamar Mine 2021 Annual Water Quality Monitoring Report* contains results of seven low-level Hg samples (Delamar Mining Company 2022). Four of these are from Jordan Creek near the DeLamar Mine site (with reported THg concentrations of 22.8–77.4 ng/L) and are thus not informative as to stormwater concentrations in runoff from the site. Two samples are from Louse Creek, reporting 1.26 ng/L dissolved THg at MP-6A (Louse Creek below Cabin Gulch) and 0.632 ng/l dissolved THg at MP-11 (Louse Creek above mine) on September 14, 2021. The groundwater discharge was active on that date and affected results at MP-6A but not MP-11; however, these samples are for dissolved, not total Hg. The only actual DeLamar site stormwater low level sample is from MP-7 (Henrietta Gulch at Jordan Creek), which reported 1.5 ng/L THg.

For the 2014 draft TMDL, EPA used the Simple Method (Schueler 1987) to estimate the volume of stormwater runoff from the DeLamar Mine site. This method uses literature-based runoff ratios for pervious and impervious land to approximate surface runoff on an annual basis. The resulting estimate of 11.9 inches per year surface runoff was at best a rough approximation. The 2014 draft then multiplied the flow estimate times the chronic aquatic life criterion for total mercury (0.012 µg/l or 12 ng/l) to estimate the portion of the existing load contributed by regulated stormwater on an annual basis. The actual concentration of stormwater runoff is not known. The 2014 draft TMDL assumption that the average concentration in stormwater runoff was equivalent to the chronic aquatic life criterion was consistent with the reported samples. It resulted in an estimated annual load of 31.3 g/yr total mercury.

The EPA used the USGS SPARROW model (Wise 2020; see description in Appendix D) to develop a revised estimate of both annual runoff and mercury loading near the DeLamar Mine site. The area to which the stormwater permit discharges to Jordan Creek lies between SPARROW segments (COMID) 2360695, 2360697 and 2360699, which surround the JC1 2021 sampling station. The incremental drainage area between 2360697 and 2360695 is 785 acres. Between 2360699 and 2360695, it is 4,814 acres, compared to the permitted site area of 2,135 acres. Incremental flow between 2360699 and 2360695 is therefore used to estimate site runoff conditions. SPARROW estimates the average annual incremental local surface runoff inflow between these segments as 3.81 cubic feet per second (cfs) or 6.89 inches per year (in/yr). This is considerably less than the Simple Method runoff estimate. The SPARROW estimate of the average annual runoff rate for the entire area upstream of JC1 is 9.3 in/yr but is expected to be higher than the runoff in the vicinity of the DeLamar Mine because it includes more high elevation area.

In addition to flow, SPARROW also provides estimates of sediment load with separate accounting for upland and in-channel or riparian sediment sources. This information is used in Appendix D to estimate mercury loads from the contributing pathways. Over the drainage area upstream of JC1, the average annual total mercury load derived from upland soil erosion and runoff of atmospheric deposition (i.e., excluding the load from highly contaminated stream and

riparian sediment near the ore processing mills) is 139.7 gram per year (g/yr) in a flow of 24.6 cfs, which yields a concentration of 6.36 ng/L. A similar calculation for the area upstream of station JC2 yields an estimate of 5.82 ng/L. These concentrations are higher than the background load concentration of 3.37 ng/L for the whole watershed because sediment concentrations of Hg are higher in the mineralized area around the mining district. Atmospheric deposition rates are higher than the watershed average due to higher elevations. It is therefore assumed that the total mercury concentration in stormwater runoff at the DeLamar Mine site that would occur under standard conditions can be approximated as 6 ng/L (as a flow-weighted average), which is consistent with the median being below the most common detection limit in site monitoring of 60 ng/L.

Combining the average annual runoff estimate of 6.89 in/yr and a THg concentration of 6 ng/L yields a THg loading rate of 8.86 g/yr or 0.0242 grams per day (g/day). The actual rate of mercury load generation from the DeLamar site is uncertain although substantial site remedial efforts, such as capping and closure of the waste lagoon, have likely reduced loads toward the estimated background concentration. The limited low-level THg monitoring in Jordan Creek reported by the DeLamar Mining Company for 2021 (DeLamar Mining Company, 2022) does not show any clear pattern of increasing stream THg concentrations from the upstream to downstream end of the site subject to the stormwater discharge permit. Two samples were reported from the Stone Cabin mine area upstream of the main DeLamar Mine (SW-2, Jordan Creek below Blue Gulch, and SW-15, Jordan Creek below Jacobs Gulch) and two samples downstream of the DeLamar mine (MP-4, Jordan Creek above Slaughterhouse Gulch, and MP-14a, Jordan Creek at Meadow Gulch). The two upstream samples had THg concentrations of 41.9 and 77.4 ng/L, while the two downstream samples had THg concentrations of 39.2 and 22.8 ng/L. The upstream samples are consistent with the Trout Unlimited sample at JOR-10 of 45.1 ng/L, while the two downstream samples are consistent with the DEQ 2005–2009 sample of 35 ng/L and the October 2021 IDFG sample from JC1 of 20.5 ng/L. However, three high flow samples at JC1 had THg concentrations ranging from 156 to 235 ng/L. The DEQ 2005–2009 and JC1 sample locations are located on Jordan Creek between DeLamar sampling sites MP-4 and MP14a.

At this time, there is not clear evidence that THg concentrations in Jordan Creek increase during transit through the DeLamar mine site. However, there is also not clear evidence on the potential load that may be generated in runoff from the site under current conditions. For this analysis, the existing load from the site (including both dry and wet season loads) is assumed to have a flow-weighted average concentration of 12 ng/L, consistent with the assumptions made in the 2014 draft TMDL. This equates to a THg load of 18.13 g/yr (50 mg/day). The SPARROW model water balance indicates this load is reduced by about 15% due to small water diversions near the state line, resulting in a predicted delivered THg load of 15.43 g/yr at the Oregon border.

The estimated stormwater load is assumed to be distributed over the course of the year according to the fraction of annual flow by month observed for water years 1945–1971 and Nov. 2002–June 2004 at USGS gage 13178000, which is located Jordan Creek above Lone Tree Creek near Jordan Valley, Oregon (Table 20).

Table 20. Annual distribution of existing permitted stormwater loads from the DeLamar Mine

Month	Fraction of Annual Flow	Total Hg Load to Jordan Creek (mg/day)
January	0.060	35.33
February	0.075	48.08
March	0.137	80.31
April	0.319	192.68
May	0.262	152.99
June	0.080	48.54
July	0.012	6.74
August	0.002	1.35
September	0.002	1.22
October	0.005	2.95
November	0.011	6.93
December	0.034	20.15

A portion of this stormwater load is expected to derive from atmospheric deposition. Therefore, this portion of the wasteload in DeLamar Mine stormwater is subtracted from the upland dissolved total mercury load (Section 3.2.2) in the final load tabulations (Section 5.3).

3.1.2 Groundwater Remediation Discharge to Louse Creek

The second permitted discharge from the DeLamar Mine site is covered under a general permit for groundwater remediation. Previously contaminated groundwater from the mine is remediated through a treatment system that removes metals and fine sediment, balances pH to permitted levels, and then discharges into Louse Creek, which is a tributary of Jordan Creek. The permit (number ID-G91-0007) was issued on October 13, 2010, and is currently administratively continued.

Discharge monitoring reports (DMRs) for the DeLamar Mine site groundwater remediation discharge to Louse Creek (permit IDG910007) were obtained for January 2015 through July 2023 and provided to Tetra Tech by EPA. 97% of samples were flagged as non-detect against varying detection limits from 0.01 to 3 µg/l with a median detection limit of 0.06 µg/l. 55% of the samples were reported as below the detection limit of 0.06 µg/l.

In the application for the groundwater remediation discharge permit, KDMC submitted an estimate of the potential mercury load associated with the discharge (KDMC and K.C. Harvey, Inc. 2010). Their analysis made the following assumptions:

- The discharge would contain mercury concentrations that would achieve the aquatic life criterion of 0.012 µg/l at the edge of the mixing zone.
- The mixing zone is designed to achieve a 5:1 dilution factor based on 25% of the flow in Louse Creek at the Sullivan Gulch Outfall 001 discharge point; thus, the end-of-pipe THg concentration limit is 0.060 µg/l (60 ng/l).
- Flows in Louse Creek at Sullivan Gulch "were estimated by adjusting the flow data collected at the Cabin Gulch gauging station located approximately 0.8 miles

downstream. The flow data for the Cabin Gulch location was reduced by 13% to reflect the reduced drainage area contributing to the Sullivan Gulch location."

The discharge rate estimates in the permit application are higher than those reported in the DMRs. At a discharge concentration of 60 ng/L, the permit application discharge rates would result in a THg load of 42 mg/day (15,340 mg/yr). Table 21 summarizes average monthly discharge rates from the 2015–2023 DMRs combined with the 60 ng/L discharge concentration. This estimate is an upper bound on actual loads as a majority of samples were reported as non-detect at a reporting limit of 0.06 µg/l.

Table 21. Existing estimated daily total mercury load from groundwater remediation to Louse Creek (permit IDG910007) based on end of pipe concentration of 60 ng/L.

Month	Average monthly discharge (cfs)	Estimated THg Load to Louse Creek (mg/day)*
January	0.063	9
February	0.117	17
March	0.173	25
April	0.223	33
May	0.191	28
June	0.082	12
July	0.018	3
August	0	0
September	0	0
October	0.055	8
November	0.035	5
December	0.042	6
AVERAGE	0.083	12

*Estimated load based on 0.06 µg/L (60 ng/L) total mercury concentration.

The estimated loads from groundwater remediation in Table 21 amount to 4.45 g/yr THg. As with the stormwater discharge (Section 3.1.1), a reduction of approximately 15% in this load is expected to occur due to diversions, resulting in a load of 3.78 g/yr at the Oregon border.

3.1.3 Small Suction Dredge Mining

Idaho's small suction dredge mining general permit covers recreational suction dredging for waters open to mining. Entities that wish to initiate this type of mining activity must submit a notice of intent (NOI) to DEQ's IPDES program, which will authorize the activity under the general permit upon DEQ approval.

This activity happens intermittently in the Jordan Creek subbasin, but suction dredge activity is not allowed in mercury or sediment-impaired streams unless there is a wasteload allocation for suction dredging.

3.2 Nonpoint Sources

The following subsections summarize estimates of mercury loads by pathway with emphasis on the total load at the Oregon state line. Refer to Appendix D for detailed information on the calculations.

3.2.1 Atmospheric Deposition

For the 2014 TMDL draft, EPA estimated atmospheric deposition of mercury using the Regional Modeling System for Aerosols and Deposition (REMSAD) system. More detailed and recent summaries of mercury deposition are now available from the Western North American Mercury (WNAM) project (Domagalski et al. 2016). The deposition grids developed by the WNAM project provide annual total mercury wet deposition estimates in micrograms per square meter from 2000–2013. The Mercury Deposition Network (*http://nadp.sws.uiuc.edu/mdn*) developed the wet deposition grids from monitoring data collected . This revised TMDL uses the WNAM results for wet deposition because they are based on measured data, cover a longer time period than REMSAD, and are available at a finer spatial scale. Average wet deposition rates for THg across the Jordan Creek basin range from 3.7 to 14.8 micrograms per square meter per year (see Figure 1 in Appendix D).

Precipitation falling on the watershed infiltrates into the ground, returns to the atmosphere via evapotranspiration, or runs off into streams via surface and subsurface pathways. As a first approximation, only a fraction of wet deposition of mercury that is associated with precipitation that becomes runoff is available to be transported to the stream network. The Water Balance Model is used to calculate this fraction (i.e., the runoff ratio). The total mercury delivery ratio is much less than the runoff ratio because much of the mercury is retained within vegetation and soils. Based on the survey of Domagalski et al. (2016), it is expected that the net mercury delivery ratio relative to atmospheric deposition is about 3% for a semi-arid forested landscape, so the delivery of mercury derived from wet atmospheric deposition is further adjusted to achieve a net delivery of 3%. This approach preserves the spatial variability of wet deposition and runoff rates across the watershed. Atmospheric dry deposition of mercury is assumed to primarily influence the mercury concentration associated with soil erosion and the delivery of soil-associated mercury is calculated separately as described below. The overall ratio of upland mercury delivery to the sum of wet and dry atmospheric deposition is 4.3%, which is consistent with Domagalski et al. (2016). Details of the calculations are described in Appendix D.

Not all of the runoff entering the stream network reaches the Oregon border. Jordan Creek emerges from the mountains into the alluvial Pleasant Valley before reaching the border, and there are some small diversions and losses from the stream channel to groundwater in this area. These losses are estimated from the SPARROW analysis, which suggests that an average of 85% of the flow and associated upland dissolved mercury entering the stream network reaches the Oregon border. This is estimated to amount to 261.9 g/yr of total mercury.

Atmospheric dry deposition of mercury to upland land surfaces is represented implicitly via soil concentrations that reflect the net deposition and re-emission of mercury (and thereby becomes part of the soil erosion load estimated in Section 3.2.2). Dry deposition loads of mercury are estimated separately for direct deposition to waterbody surfaces for the TMDL. These dry deposition fluxes are provided by Domagalski et al. (2016), estimated from the Community Multiscale Air Quality (CMAQ; Bullock et al. 2008, 2009) model run for 2009 conditions at a 40-kilometer (km) spatial resolution. The contributions from direct-to-water dry deposition of mercury are minimal (0.000033 g/yr) because of the small water surface area present in the watershed.

Atmospheric deposition includes both natural and anthropogenic components. Natural background atmospheric loading is associated with pre-industrial atmospheric deposition levels.

"The North American Mercury Model Intercomparison Study" reported efforts to use atmospheric modeling to quantify contributions of specific sources and groups of sources to mercury deposition within each of the lower 48 states for 2001 emissions (Bullock et al. 2008). In this study, EPA primarily used the REMSAD modeling system which is a three-dimensional atmospheric transport model designed to calculate concentrations of inert and chemically reactive pollutants through simulation of the physical and chemical processes in the atmosphere that may affect pollutant concentrations. The model simulates both wet and dry deposition of mercury at a scale of 12-square kilometers grid cells. It also includes algorithms for the re-emission of previously deposited mercury into the atmosphere from water and land surfaces, from both anthropogenic and natural sources.

The Particle and Precursor Tagging Methodology (PPTM) feature of REMSAD allows the tagging or tracking of emissions from selected sources or groups of sources to quantify their contribution to mercury deposited throughout the modeling domain and simulation period. EPA also used CMAQ to analyze the effects of global background concentrations of mercury. CMAQ is a state-of-the-science regional air quality modeling system that simulates emissions, chemical transformations, transport, and both wet and dry deposition of all three airborne (elemental, divalent, and particulate) forms of mercury. Further review of the results of this wide-scale analysis can be found as part of the "North American Mercury Model Intercomparison Study" (Bullock et al. 2008).

EPA provided source analysis via REMSAD's PPTM feature for the Idaho portion of the Jordan Creek watershed (Dwight Atkinson, April 2013). Results indicated that global atmospheric sources deposited approximately 85% of the atmospheric mercury deposited on the landscape at that time, which includes natural background and anthropogenic sources. The remaining atmospheric sources were regional sources. Nevada gold mines and the Ash Grove Cement Plant represented approximately 13% of atmospheric mercury deposition, and other regional North American sources filled the remaining 2% ("Other US Sources" in Figure 15).

DEQ completed a literature review to support distributing the global atmospheric sources between anthropogenic and natural sources (Appendix D). Approximately 23–29% of the total

atmospheric load (including global and regional sources) is considered to be natural, and 56–62% is considered to be global anthropogenic sources (see discussion in Section 2.1.1 of Appendix D).

Since the REMSAD PPTM modeling was conducted, Nevada established and began implementing regulations to control mercury air emissions from gold mines. In addition, EPA established in 2010 national regulations controlling emissions from the gold ore mining and processing industry (EPA 2010). Oregon negotiated an agreement with Ash Grove Cement's Durkee, Oregon facility to reduce their mercury emissions by 85% by 2012. EPA's Toxic Release Inventory's data show an approximately 90% reduction in the combined emissions from these sources by 2013 (Figure 16).

Atmospheric deposition of mercury to the land surface is primarily stored in soils, but a portion of the wet deposition may be transported directly to streams via surface runoff. Atmospheric deposition that falls on water surfaces is also a direct contribution, but the area occupied by open water in the Jordan Creek watershed is small. Erosion of upland soils contributes mercury loads that are in part derived from atmospheric deposition. The reductions in air emissions that result from the regulatory processes will decrease the amount of mercury added to Jordan Creek. However, mercury that has already been deposited in elevated quantities in the watershed will continue to be mobilized into Jordan Creek, and global mercury sources outside of U.S. regulatory controls will likely continue to deposit in the watershed for many years to come.

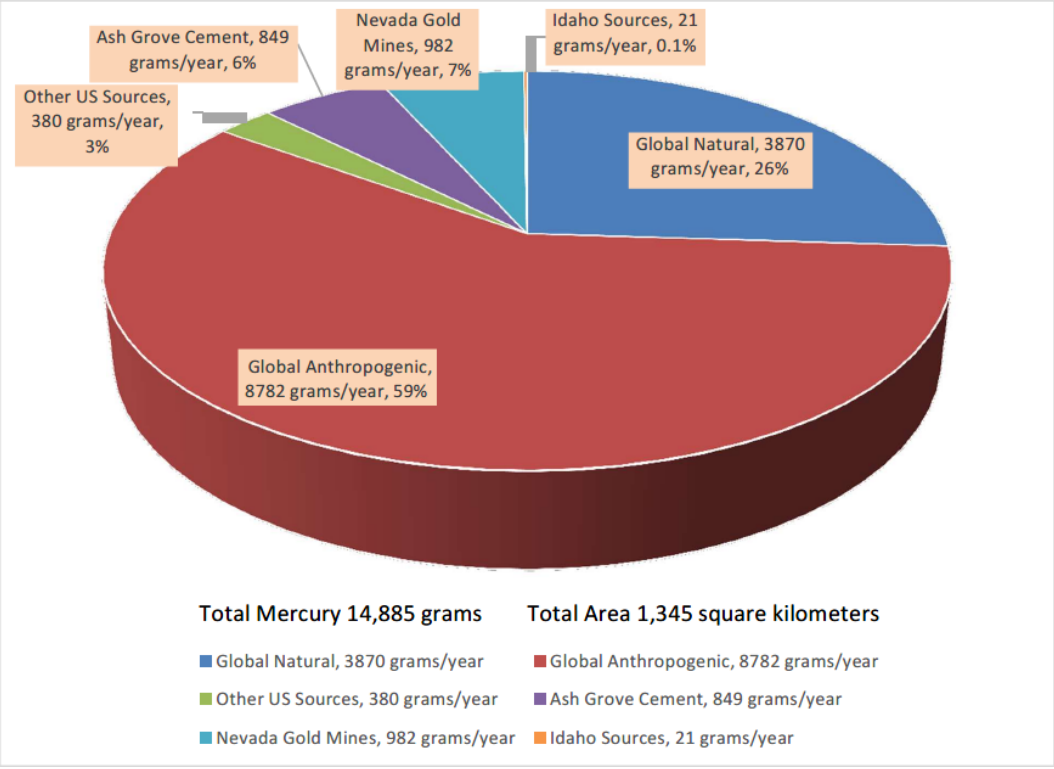


Figure 15. REMSAD atmospheric source analysis of total mercury loads to the Jordan Creek Watershed, Idaho portion as of 2001.

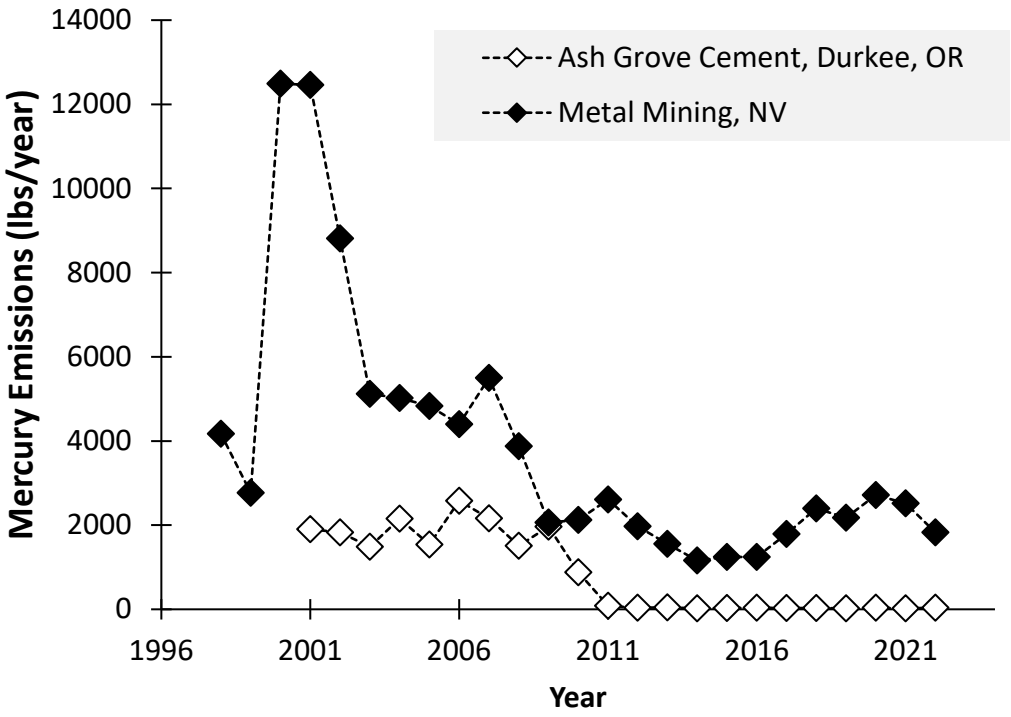


Figure 16. Reductions in mercury air emissions from major regional sources (EPA's Toxic Resource Inventory Data, queried 11/27/2023).

Notes: Graph shows the change in mercury emission to the air from the Ash Grove Cement facility in Durkee, OR (2000–2022) and the combined emissions from active mining operations in NV (1998–2022). The Nevada mining emissions are mostly associated with gold mines. Emissions of mercury include point source emissions and fugitive (non-point source) emission to the air. Between 1998 and 2022, there may have been differences in reporting requirements for the Toxic Release Inventory program. The temporal trends reflected in the graph capture both changes in reporting requirements and actual changes in releases of mercury to the air.

3.2.2 Upland Soil Erosion

Mercury concentrations in surface soils are expected to vary by geology, soil properties, and land use due to the varying retention and re-emission rates associated with different land use and cover types (Eckley et al. 2016). USGS (Smith et al. 2019) developed a gridded map of soil mercury concentrations throughout the conterminous U.S. based on relatively sparse soil samples, with inverse distance weighting between measured points. Obrist et al. (2016) reanalyzed the USGS data and confirmed that soil mercury concentrations differ significantly among land cover types, with the highest concentrations (but lowest erosion rates) in forest soils and the lowest concentrations (but highest erosion rates) in barren soils. In Obrist's analysis by ecoregion, southwestern Idaho (including the Jordan Creek watershed) is within the North American desert ecoregion where the median mercury concentration was 18.7 micrograms per kilogram (µg/kg) and the average 23.5 µg/kg. Maps of mercury distribution in soils of the conterminous United States generated through interpolation of earlier USGS soil samples collected during the Shacklette and Boerngren (1984) study show mercury soil concentrations between 33 and 50 µg/kg for the Jordan Creek watershed area (Gustavsson et al. 2001).

In 2013, EPA requested information from the Idaho Geological Survey (IGS) on mercury in soils and geologic features. While IGS confirmed that the general estimated range of 33 to 50 µg/kg for the Jordan Creek watershed as a reasonable average for unmineralized background soil concentrations in the watershed, IGS also referred to the existence of hydrothermal mineralized areas that may contain higher than average mercury concentrations in this area of southwest Idaho. IGS recommended that an upper bound mercury concentration of 1.0 mg/kg (or, 1,000 µg/kg) of soil would be more suitable for estimating the mineralized areas' relative contribution of mercury to the Jordan Creek system upstream of the Oregon state line. This includes only the mercury derived from native rock that is likely to be found in mineralized areas; it does not include the input of mercury (primarily imported) that was used in the amalgamation process at ore mills discussed in Section 3.2.3. Based on the weight of evidence discussed above, DEQ assumed all other areas within the Idaho portion of the Jordan Creek watershed (i.e., unmineralized areas) to have a native mercury soil concentration of 40 µg/kg of soil.

To estimate the spatial extents of mineralized areas, DEQ identified locations where gold and silver were found and extracted. These ores tend to occur together in hydrothermal areas where mercury is also present although mercury concentrations in the Jordan Creek mining prospects appear to have been relatively low. Mineralized areas were assumed to extend 0.25 miles around each mine site in all directions. These areas were located in clusters, with the largest cluster located around Silver City in the upper Jordan Creek watershed (Figure 17).

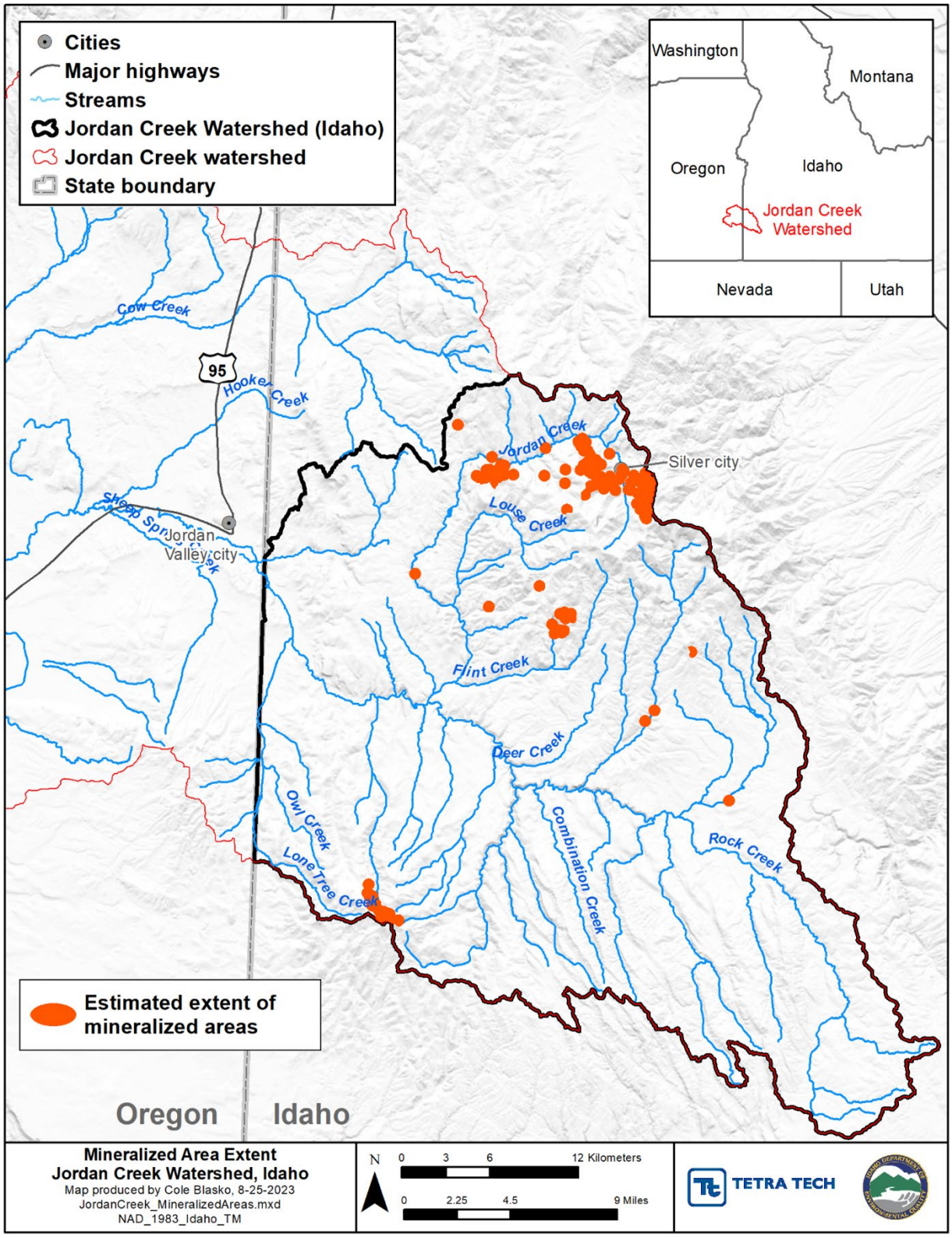


Figure 17. Estimated extents of mineralized areas within the Jordan Creek watershed, Idaho.

Soil erosion rates were needed to estimate the amount of native mercury that may be transported via surficial soil erosion processes into Oregon from Idaho via Jordan Creek and other smaller tributaries (e.g., Hooker Creek). A geographic information system (GIS)-based approach was developed to estimate the amount of soil transported from the landscape on an annual basis. The approach used spatially explicit (grid-based) parameter inputs built on equations and recommendations found in the Revised Universal Soil Loss Equation (RUSLE) user's guide (Renard et al. 1997). RUSLE estimates soil erosion from sheet and rill erosion from rainfall and its associated runoff through the development of five factors:

1. R = rainfall erosivity factor
2. K = soil erodibility factor
3. LS = slope length and steepness factor
4. C = cover and management factor
5. P = support practice factor

These five factors multiplied together result in an annual estimate of soil loss over the landscape:

$A = R * K * LS * C * P$

where A = annual soil loss from sheet and rill erosion in tons/acre

A quasi-steady-state, grid-based approach was used to estimate average annual soil loss. To maximize accuracy this approach developed R-factor and C-factor inputs for every half-month (1st through 15th, and 16th through end of month) using available literature findings and observed data. All of the 24 half-month grid-based soil loss estimates were summed to derive the estimated annual soil loss from sheet and rill erosion from each grid cell. The Cow Creek watershed (which drains to Jordan Creek after entering Oregon) was not modeled.

RUSLE estimates soil loss at the field scale but much of this sediment loss is redeposited either during transit to streams or during overbank flow episodes within streams. For the 2014 TMDL draft, a uniform sediment delivery ratio (SDR) of 0.049, based on empirical relationships between SDR and contributing area, was applied to all gridded RUSLE soil loss estimates to derive estimates of sediment load delivered to the stream network and then to the Oregon border. The sediment load was multiplied by the mercury soil concentrations to estimate a total delivered mercury load of 490 g/yr from the Idaho portion of the Jordan Creek watershed associated with erosion soil (exclusive of legacy mining loads).

The RUSLE analysis conducted for the 2014 TMDL draft is still valid for local-scale sediment loss and is described in detail in Appendix D; however, the area-based SDR was only a rough approximation. Additional evidence was used to refine the estimates of delivered soil and delivered mercury. The analysis first applied the delivery calculator from the Agricultural Conservation Planning Framework (ACPF) Toolbox. This method computes spatially varied sediment delivery from land to waterbody using an equation based on the distance (in feet; x) to the nearest stream (Delivery = x-0.2069) (Porter et al. 2018). A gridded, spatially varied coverage was created using the ACPF equation and a 10-meter digital elevation model.

The ACPF delivery calculator is useful in identifying specific geographic areas that are most likely to deliver larger amounts of sediment and sediment-associated mercury to the stream network (see figures in Appendix D). The method does not, however, account for the additional losses that occur during transport through the stream network to the Oregon border. That portion of the SDR can be estimated from the SPARROW output. SPARROW estimates the average annual accumulated sediment load at the Oregon border as 22,692,081 kg/yr; however, SPARROW also estimates that 58% of this load is derived from channel erosion processes. The portion of the load that represents upland erosion is 9,425,397 kg/yr, equivalent to 6.65 megatons per square kilometer per year or 0.065 megagrams per hectare per year. The ratio of the SPARROW average annual load derived from upland erosion to the ACPF-adjusted RUSLE sediment load is (in kg/yr) 9,425,397/44,737,815 = 0.21068. This factor is applied to the estimated output from the ACPF analysis to adjust the final upland sediment load at the Oregon border for transit losses due to retention in streams and export to the floodplain. The resulting effective SDR (ACPF and SPARROW) averages around 0.1, which is greater than that assumed in the 2014 TMDL draft, but much lower than that obtained from the ACPF analysis alone.

The delivered sediment load from upland sources is converted to a delivered total mercury load by multiplying the background mercury concentrations for mineralized and nonmineralized areas, resulting in estimated annual average loads to the Oregon state line of 321.2 grams of Hg per year from nonmineralized soils and 13.3 grams of Hg per year from mineralized soils for a total load of 334.5 grams of Hg per year.

3.2.3 Legacy Mining Activities

From the 1860s until the early 20th century, extensive mining for precious metals occurred in the Jordan Creek watershed, primarily in the area around Silver City. Some mercury load is expected to be generated from mine tailings in hydrothermal mineralized areas; however, the mercury content of the ore bodies around Silver City is relatively low. To understand how the legacy mining contributed to high levels of mercury in the mainstem of Jordan Creek, it is important to understand how the ore was processed.

The gold and silver content of the ore bodies is relatively low. Miners extracted the precious metals from the waste rock using the mercury amalgamation process. In this process, stamp mills initially crushed the mined ore to a fine powder. Romans widely used the stamp mill process. It was subsequently refined in 16th century Europe. Lynch and Rowland (2005) note that “early dry-stamp mills were essentially mechanized mortars and pestles” designed to “crush abrasive ores to small sizes at higher rates using a renewable power source.” Generally powered via water wheels, stamp mills consisted of “iron-shod” stamps to accomplish this (Lynch and Rowland 2005).

The stamp mills used in Silver City were similar to those in use since the 1560s. In remote areas such as Silver City, water powered stamp mills, so they tended to be located on the edge of streams and adjacent to mine adits.

Once crushed, operators combined ore with elemental mercury in a drum whereupon the gold and silver content amalgamated with the mercury. This amalgam is denser than the waste rock

facilitating separation of the gold-containing amalgam from the tailings. Once the mercury was bound to the gold or silver, it was separated from the barren soil to a retorting vessel where the mercury was vaporized and condensed off the amalgam. Often, some attempted to distill and recover the vaporized mercury for reuse, but this was rarely an efficient process and usually resulted in high levels of atmospheric deposition in the immediate vicinity of the furnace (Esdaile and Chalker 2018). As mercury was inexpensive compared to gold and silver, the mills focused on extracting the precious metals, not on conserving mercury.

In 2005, DEQ commissioned Jim Hyslip, a member of the Owyhee County Historic Society and part- time Silver City resident, to compile a narrative report on the historic use of mercury in the mining and milling operations of the Jordan Creek watershed. The completed report, *Mercury Use in Mining in the Area near Silver City, Idaho* (Hyslip 2006), reviewed historic newspaper accounts, reference materials, and personal interviews that account the gold extraction, milling operations and production, and other related mining and milling activity in the Jordan Creek watershed.

The report summarized concisely mercury's importance in the Jordan Creek watershed:

> If gold and silver are the precious metals, then quicksilver-mercury is the essential metal. Without mercury, 19th century precious metal mining would not have been possible in most districts. Nearly all of the gold mining districts relied on amalgamation in arrastras, stamps, and pans for recovery of the values. (Hyslip 2006)

Anecdotal accounts in Hyslip's report—e.g., "hundreds of pounds of mercury wasted/spilled daily," "using a ladle to dip quicksilver from the stream to sell back to the mills," "a bathtub full of mercury as a collection vessel," and "empty mercury flasks used as part of the Silver City Hotel's foundation"— indicate there was an abundance of mercury used in the area, and most of it, according to Hyslip, found its way to Jordan Creek. Silver City mills imported most of their mercury from California (Hyslip 2006).

Although the wide use of mercury in Jordan Creek mining is well documented, its fate is not. For Silver City mines and mills, losing mercury to the environment was simply an overhead cost. The high yielding ore produced millions of dollars in gold and silver bullion for the owners.

The additional sampling by Trout Unlimited in the Silver City area (Willis et al. 2022) corroborates the anecdotal accounts from Hyslip. As described in Section 2.4.1.4, sediment samples at former mill sites and waste rock piles exhibited the highest mercury concentrations, with a concentration of 65.7 mg/kg in a composite sample at the historic Cosmos Mill site and 49.8 mg/kg at the historic Blaine Mill site. The concentrations at the mill sites are approximately an order of magnitude greater than samples from tailings not immediately adjacent to a stamp mill. High mercury concentrations in tailings close to stamp mills are likely due in part to retorting vessels vaporizing mercury, creating localized atmospheric deposition.

The productive mines and associated stamp mills were located on War Eagle Mountain (on the east side of Jordan Creek), Florida Mountain (on the west side of Jordan Creek), and De Lamar Mountain (Figure 18). The IGS published a thorough history of the Florida Mountain Mines,

which detailed how the Dewey Mill used 20 flasks of quicksilver (i.e., mercury) a month to process ore (Mitchell 2010). A flask is equal to 34 kg–680 kg of mercury per month.

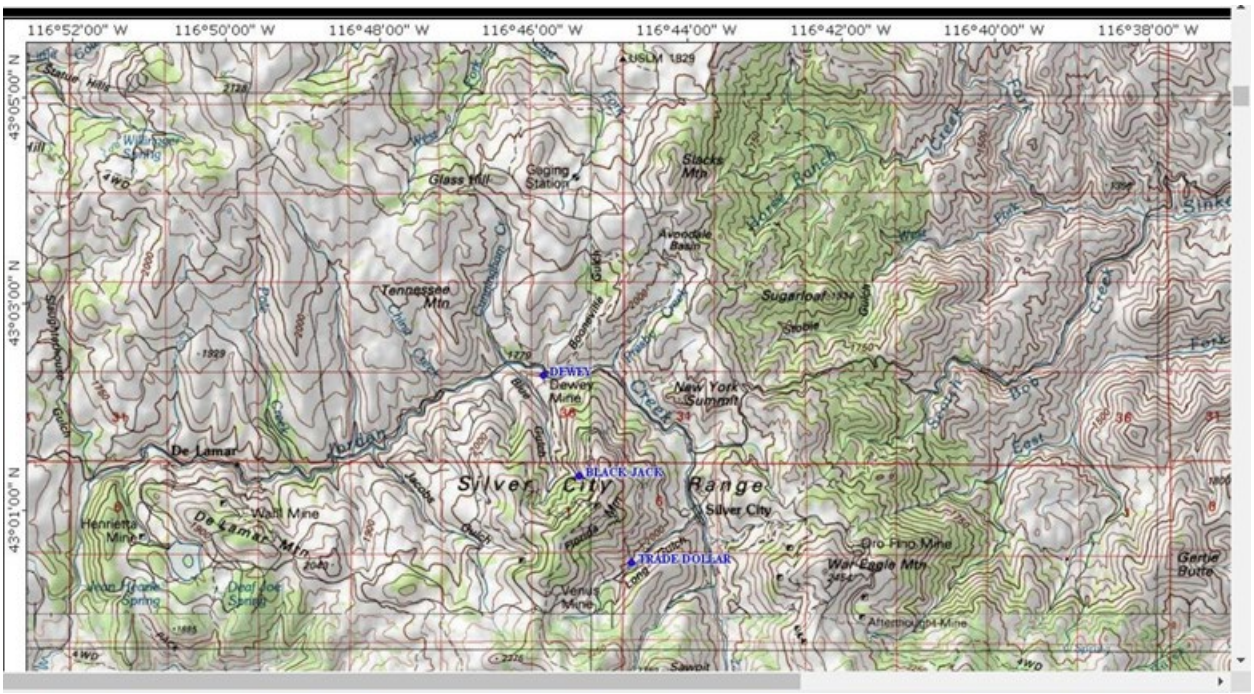


Figure 18. Florida Mountain mines (Gebhards et al. 1971).

Based on this information, stamp mills and their associated furnaces likely acted as the primary source of the elevated mercury load to Jordan Creek, which is consistent with the Trout Unlimited findings. One of the most striking observations from the Trout Unlimited data from Silver City is that the total mercury concentration in water jumps from 1.21 ng/L at JOR-02 (upstream of all the mines) to 298 ng/L at JOR-03 after passing the Poorman and Shoenbar stamp mill sites and remains above 100 ng/L through most of the other Silver City sampling stations.

Mostly elemental mercury composed the mercury loaded from stamp mills' spills and volatilization. Because the ore was ground to a powder as part of the milling process, the resulting material was likely to be readily erodible and transportable. A 1971 report for Idaho Fish and Game noted "The Idaho Historical Society reported that one mill at Silver City…" lost "2 ½ tons of mercury during 1866-1868. An abandoned mill in the same area at De Lamar has been the site of recent commercial reclamation of quicksilver from the mill tailings. Free mercury can be seen as small beads in the rock crevices and in the soil at the mill site" (Gebhards et al. 1971). This quote referred to the old mine that operated in De Lamar, Idaho in the late 19th century, not the later open pit mine, DeLamar Mine. Trout Unlimited did not sample at the old De Lamar mine sites.

While the exact amount of mercury mass loss from the Silver City ore mills is unknown, it was likely quite large. Stream scour and deposition processes over the last 150 years have distributed this mercury throughout downstream reaches and onto floodplain sediments.

Elemental mercury may not be confined to the current stream channel but could also be deposited in the flood plain, buried deep in old meanders, and spread out on irrigated land in the valleys. Today, substantial stores of elemental mercury are likely buried in deposits of sediments that can be exposed and moved during high flow events in Jordan Creek.

Hard rock mining in the Silver City area largely ceased in the early 20th century. A later potential source of mercury loading may be due to placer mining conducted to recover gold from stream deposits within Jordan Creek. Placer mining operations started by 1931 (Gerry and Miller 1934), and various mines filed claims in subsequent years. The majority of placer mining within the watershed occurred on Jordan Creek mainstem downstream of the DeLamar Mine. It is visible on Google Earth as a series of scars normal to the direction of flow (Figure 19). DEQ sampled near this area in 2005 at station JC-2005-08, referred to as “Jordan Below Placer Tailings” (refer to Figure 9 for location).



Figure 19. Placer mining scars on Jordan Creek above Station 2055-08.

Placer mines used mercury amalgamation as the primary method of extracting gold until the 1940s and continued to widely use it until the 1960s (Alpers et al. 2005). Thus, placer mining activity is another source of mining-related mercury load to Jordan Creek, but little is known about the placer tailings above station JC-2005-08.

Some of the mercury from legacy mining in the upper reaches of Jordan Creek is transformed to methylmercury in downstream waters of Jordan Creek and the Owyhee River. Mercury is highly persistent, and its organic form (methylmercury) bioaccumulates in the food web. Studies

conducted on mercury contamination downstream of other historic gold or mercury mining areas—such as San Francisco Bay in central California (Guadalupe River TMDL Project), Walker Lake in eastern Nevada (Seiler et al. 2004), Cache Creek in Central California (Domagalski et al. 2004), and Steamboat Creek in eastern Nevada (Stamenkovic et al. 2004)—all demonstrate that mercury contamination and elevated mercury in fish tissue are associated with redistributed mercury from mining sources. These studies underscore that the introduction of elemental mercury to the environment has had both far-reaching and long-lasting impacts. The transported mercury accumulates in low-gradient depositional areas as it attaches to particulates. These low gradient areas also have physical conditions that are conducive to the methylation of mercury, leading to biomagnification in the food chain.

The SPARROW model and EPA's 2021 monitoring effort provide a basis for approximating the ongoing mercury load contributions to Jordan Creek associated with legacy mining activity. The SPARROW model output estimates the incremental and accumulated average annual flow and sediment load for the given NHD v2 stream segment and identifies the portion of the sediment-associated load that is due to estimated channel erosion.

In EPA's 2021 sampling at three stations on the Jordan Creek mainstem within Idaho (JC1, JC2, and JC5; see Section 2.4.1.2), they found that a median of 84% of the mercury present in the water column during the high flow period (which transports the majority of the load) is sediment-associated (with lower fractions during the fall low-flow sampling event). The median ratio of particulate total mercury to total suspended solids was 12.45 mg/kg (also referred to as the potency factor). In contrast, the median potency factor in uncontaminated background sites is 0.05 mg/kg. Because the background potency factor is so low, applying the mainstem potency factor to the SPARROW-estimated annual sediment load (derived from the Jordan Creek mainstem channel between the most upstream mine site in Silver City and a downstream monitoring station) provides a reasonable approximation of the mercury load. The load is calculated from the mainstem channel's erosion and associated floodplain areas. This estimate can then be corrected for the background mercury concentration expected for streams not affected by ore processing to attribute loads to the legacy mining operations.

The potency factors used in this analysis are the particulate Hg to total suspended solids ratio medians from the EPA sampling. These samples include one dry weather event and two to three wet weather events. Bias toward wet weather conditions is appropriate for mass loading estimation because most of the sediment-associated load moves during higher flow events. Example calculations—based on SPARROW average annual flows and sediment loads combined with 2021 EPA mercury monitoring data—are shown in detail in Table 12 of Appendix D and summarized in Section 5.3. The resulting concentration estimates (Figure 20) are in reasonable agreement at monitoring stations JC1 and JC2. JC5 observed concentrations are higher than the SPARROW-based predictions, reflecting uncertainty in the SPARROW-based estimates and a potential additional load source in this area. EPA did not obtain observations at the Oregon state line in 2021.

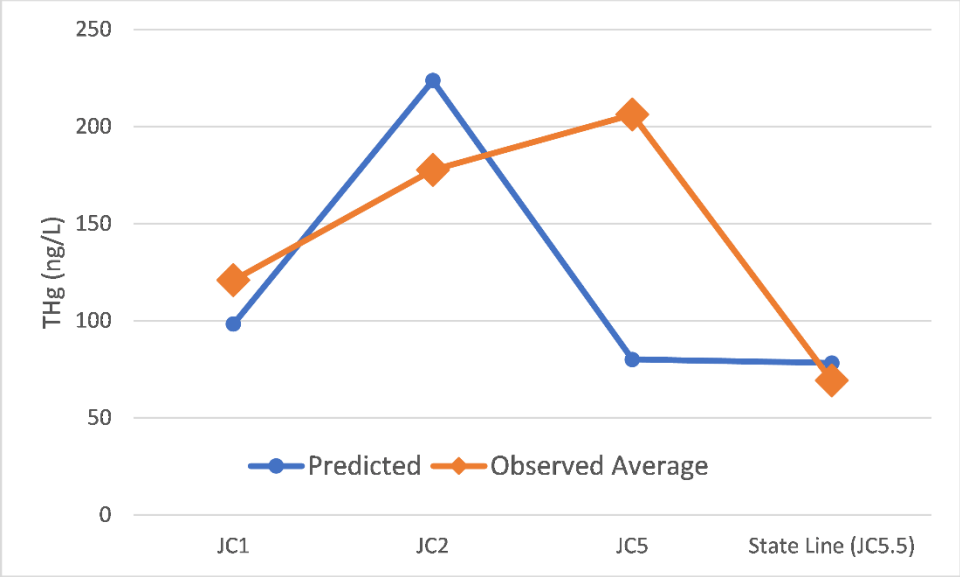


Figure 20. Comparison of 2021 total mercury concentrations in the Jordan Creek mainstem to estimates based on flow and accumulated mainstem channel-derived sediment loads that was calculated via SPARROW and observed sediment potency for mercury.

3.2.4 Background versus Natural Sources of Mercury

Mercury loads derived from atmospheric deposition or from watershed soils and sediment erosion are considered background sources. Note that DEQ distinguishes between "background" and "natural" sources. Background sources are defined as diffuse load sources that are already present in the environment which includes ongoing and past anthropogenic activity as well as natural mercury of geogenic origin. Background is not equivalent to "natural" sources, which are only of geogenic origin. The global pool of atmospheric mercury has significantly increased over the last century from industrial and mining emissions, creating increased mercury deposition onto the landscape (Schuster et al. 2002). The United Nations Environment Programme estimated that human activities have increased atmospheric mercury concentrations by 450% above natural levels (UNEP 2019). The mercury currently stored in western stream and riparian sediment is affected by the worldwide increases in anthropogenic atmospheric loads and by inputs from mining activity and ore processing that occurred in the western U.S primarily between the 1860s and 1920s.

In the 2014 TMDL draft, EPA estimated the background total mercury concentration as 1.28 ng/L. EPA used the average total mercury concentration in the DEQ 2005 samples from water bodies in watersheds that are not downstream of the Silver City historic mining sites, and which meet the Idaho human health and aquatic life criteria (Dai and Ingham 2009). An estimate of the background mercury load at the Oregon border was generated by multiplying this concentration times estimated flows in Jordan Creek at the Oregon border.

EPA's background load estimation method in the 2014 draft was affected by uncertainties in estimating mercury concentration from limited samples and by uncertainties in estimating long-term average flow. DEQ obtained all the 2005 samples during August low flow conditions;

during high flow events, it is common to observe that concentrations of pollutants (e.g., mercury) increase when the majority of the total load is transported. The occurrence of higher total mercury concentrations during spring runoff is confirmed by the EPA 2021 water column sampling (see Section 2.4.1.2). As a result, estimates of mercury load based on the 2005 samples were biased low. Additional samples aimed at evaluating background concentrations were collected in 2021. DEQ collected two samples in Rock Creek (station BG1) at 3.95 and 1.68 ng/L. Trout Unlimited collected another background sample in Jordan Creek, upstream of the Silver City mining area, with a concentration of 1.02 ng/L. The three samples averaged 2.22 ng/L.

Mercury concentrations in the water column are higher during conditions where more stream sediment is entrained into the water column, which occurs usually at higher flows during spring runoff. As shown in Table 2, higher flows (average daily flow greater than 200 cfs in Jordan Creek near the state line) occur during three months (March through May), or 25% of the year. Therefore, DEQ assigned a higher background concentration to these months while maintaining the temporal average concentration of total mercury on an annual basis at 2.4 ng/L, which is consistent with attaining fish tissue criteria.

DEQ used the following logic to estimate the mercury that is considered “background” in the sense that it is derived from native geology and the global atmospheric mercury cycle (which includes centuries of worldwide anthropogenic input) and not from local anthropogenic activities in the Jordan Creek watershed.

Background concentrations of mercury in streams in the vicinity of Jordan Creek were sampled in Rock Creek (station BG1) during low flow (10/13/2021) and high flow (4/28/2021) conditions. Rock Creek is approximately 25 km from Silver City, where most of the mercury was used in the mercury amalgamation process (Figure 9). During the period of mining activity in Silver City, there would have been large releases of Hg to the atmosphere. Other studies have shown that the impact of elevated Hg emissions to the air can result in elevated Hg concentrations in soil between 50 and 85 km from the source (Eckley et al., 2015).

Most Hg deposited from the atmosphere is accumulated in soils (Domagalski et al. 2016; Eckley et al. 2015; Obrist et al. 2009; Obrist et al. 2011; Obrist et al. 2016). The extent to which the background water samples were impacted by historical releases of Hg to the air can be estimated based on sediment concentration measured in Rock Creek in 2021 by DEQ, which was 0.44 mg/kg. For context, background stream sediment concentrations in unmined basins throughout the U.S are 0.089 mg/kg (Scudder et al. 2009). Also, for context, the commonly applied sediment risk-based criteria concentrations for mercury in sediment is 0.2 mg/kg (MacDonald et al., 2000). Thus, Rock Creek appears to have highly elevated sediment Hg despite being outside of the immediate mining district.

Based on several estimates from the literature, it is assumed that 20% of the sediment from the national USGS streams study is Hg from geogenic sources and 80% is from accumulation of anthropogenic associated Hg (Fiorentino et al. 2011; Obrist et al. 2016; Peña-Rodríguez et al. 2012; Reimann et al. 2009).

Subtracting the national average concentrations from the sediment concentration of 0.44 mg/kg from Rock Creek yields an estimate of 0.35 mg/kg from enhanced deposition from Silver City mining (80% of total). The remaining Hg would be from geogenic sources (0.02 mg/kg—or 4%) and from a century of global atmospheric pool enhanced deposition (0.07 mg/kg—or 16%).

Assuming that the contribution of historical air emissions from Silver City primarily affected particulate-bound Hg, and not the dissolved phase concentrations, allows adjustment of the background concentrations as shown in Table 22. The estimated background concentrations that are not influenced by historical mining activity are 1.54 ng/L during baseflow and 2.13 ng/L during high flow.

Table 22. Adjustment of background concentrations of particulate Hg to account for non-point source emissions of Hg from Silver City on Rock Creek water samples

Measurement	Dissolved THg (ng/L)	Particulate THg (ng/L)	Sum THg (ng/L)
	Observed		
Rock Creek—Spring	1.67	2.28	3.95
Rock Creek—Fall	1.51	0.17	1.68
	Estimated Background		
Estimated. background Spring (high flow)	1.67	**0.46**	**2.13**
Estimated background Fall (baseflow)	1.51	**0.03**	**1.54**

3.3 Pollutant Transport

Mercury is an environmentally active element, which is pervasive in abiotic and biotic media. As it cycles through the atmosphere, land, and water, mercury undergoes a series of chemical and physical transformations. Mercury's cycle in the environment is a result of mostly anthropogenic activities, but there are also contributions from natural sources.

Inorganic mercury exists in several oxidation states. Elemental mercury is a heavy, mobile, liquid metal at ambient temperatures. Virtually insoluble in water, elemental mercury is volatile.

In terrestrial and aquatic environments, most mercury is in an inorganic, oxidized form. Inorganic mercury does not bioaccumulate in the food chain to any significant degree; however, inorganic mercury can be methylated by microorganisms under low oxygen conditions in soil, sediment, and water to form methylmercury. Methylmercury is an organic mercury compound that is somewhat soluble in water and accumulates in the aquatic food web.

Fish accumulate the majority of their methylmercury burden through their diet, with direct uptake from the water being a minor exposure pathway. The elimination of methylmercury by fish is very slow relative to the rate of uptake, which allows the pollutant to accumulate in fish tissue (Laarman et al. 1976; McKim et al. 1976). In contrast, inorganic mercury is eliminated much more rapidly and does not accumulate in fish tissue (Hildebrand et al. 1980a and 1980b).

Therefore, almost all of the mercury found in fish tissues (generally more than 95% in higher trophic level fish; Eagles-Smith et al. 2016) is in the form of methylmercury (EPA 1997); thus, measurements of THg in fish tissue is generally assumed to be a conservative estimate of the MeHg content of the tissue.

The linkage between mercury exposure concentrations and bioaccumulation in fish is explored in detail in Appendix C, which evaluates relationships between fish tissue concentrations and THg and MeHg concentrations in water in both filtered and unfiltered samples. While it is primarily MeHg that drives accumulation in the food web, the analysis approach used in this TMDL is based on THg concentrations per IDAPA 58.01.02.210 (03)(c)(iv)(2), which states "In applying the methylmercury fish tissue criterion in the context of NPDES effluent limits and TMDL load reductions, the Department will assume change in fish tissue concentrations of methylmercury are proportional to change in water body loading of total mercury." Use of a THg target is also consistent with modern scientific practices because MeHg is continuously created and destroyed in the environment by a series of complex, largely bacterially mediated processes that are still not fully understood (Zhu et al. 2018; Peterson et al. 2023). Further, the mercury that is loaded from the atmosphere and watershed to the impaired waterbodies is mostly in the form of inorganic mercury. MeHg is also present in Jordan Creek at much lower levels than THg (often near the analytical reporting limit) and more data are available for THg.

3.4 Pollutant Source Inventory Summary

Sections 3.1 and 3.2 describe the point and nonpoint sources of THg in the Jordan Creek subbasin. These sources are transported to the impaired waterbody segments via the following mechanisms:

- Point source loads: The two small, permitted point sources of mercury discharge to upper Jordan Creek and its tributary Louse Creek. Mercury loads to upper Jordan Creek are transported by flow to the other downstream impaired AUs.
- Atmospheric deposition: Mercury is loaded to the watershed via both wet and dry atmospheric deposition. Some of this atmospheric deposition falls directly on flowing stream segments; however, the vast majority of this load is deposited on the upland watershed. From there it may be stored in vegetation, litter, soil, and snow and eventually be transported in dissolved form with runoff or in particulate form with soil erosion. Only a small fraction of the total atmospheric deposition of mercury is transported to the basin outlet. The time between deposition and mobilization in runoff can be decades (Harris et al 2007; Domagalski et al. 2016).
- Upland soils: Mercury associated with particulate matter in upland soils is derived in large part from atmospheric deposition (both current and historic) along with native geology. This sorbed mercury is transported to the impaired waterbody segments through soil erosion and transport. A substantial portion of soil mercury moved by soil erosion is re-incorporated into the soil matrix prior to reaching flowing waters.
- Legacy mining: Mercury derived from legacy mining activities is currently stored in stream sediment and in near-stream riparian soils of the Jordan Creek mainstem. This mercury is subject to mobilization and transport by high flow events and other

processes that disturb stream banks, stream sediment, and riparian soils. Legacy mining activities also likely resulted in enhanced local atmospheric deposition and accumulation in surrounding soils

- Transport losses: Mercury loads that enter Jordan Creek are subject to losses during transport that reduce the total mercury load delivered to the Idaho-Oregon border. Loss mechanisms include:
    - Storage of mercury in stream depositional areas and by export back onto the riparian floodplain during high flow events.
    - Loss of stream mercury due to agricultural diversions or infiltration to groundwater.
    - Loss of total mercury load through conversion to elemental mercury that can volatilize to the atmosphere.

Appendix D provides a best estimate of the full mercury mass balance in the Jordan Creek subbasin and is summarized in Section 5.3.

4 Pollution Control Efforts and Monitoring

To address the Jordan Creek subbasin temperature and sediment TMDLs developed in 2008, the Idaho State Soil and Water Conservation Commission, Idaho Association of Soil Conservation Districts, and the Owyhee Conservation District developed the *Jordan Creek Subbasin TMDL Implementation Plan for Agriculture* (ISWCC 2013). This implementation plan focused on adaptive management and best management practices (BMPs). Reducing sediment erosion is one way to mitigate inorganic mercury levels released into the water column and therefore reduce methylation by microorganisms.

The historic DeLamar Mine operated between 1880 and 1940, followed by more recent production from 1977 to 1998 (KDMC 2004c). Early mine reclamation efforts began in 1994, which included wetlands mitigation, regrading and seeding several areas with suitable plant growth media, and rock dump stabilization and remediation.

Mine closure in the early 2000s initiated additional reclamation efforts to mitigate sedimentation and stabilize historic rock dumps and previously mined land (KDMC 2004c). These efforts also included regrading and re-vegetation. Kinross developed these closure earthworks and activities using *Best Management Practices for Mining in Idaho* (Idaho Department of Lands 1992). Water Quality Monitoring

Trout Unlimited recently completed monitoring and a report regarding water quality in the Jordan Creek subbasin, much of which was used to inform the development of this TMDL (Willis et al., 2022). Additionally, Integra completes ongoing water quality monitoring for its various permits associated with DeLamar Mine.

5 Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on loading of a pollutant from all sources to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation, and nonpoint sources which receive load allocations. Wasteload allocations may be composited for certain types of point sources, such as general permits, but typically each point source is given a wasteload allocation. Each nonpoint source load may receive a load allocation, or the sources may be aggregated with a single load allocation for all nonpoint source loads. Natural background contributions, when present, are considered part of the load allocation but may be treated separately because they represent a part of the load not subject to control. Because of uncertainties about quantifying loads and the relation of specific loads to attaining water quality standards, the rules regarding TMDLs (40 CFR 130) require a margin of safety be included in the TMDL. Practically, the margin of safety and natural background are both reductions in the load capacity available for allocation to anthropogenic pollutant sources.

Load capacity can be summarized by the following equation:

LC = MOS + NB + LA + WLA = TMDL

Where:

- LC = load capacity
- MOS = margin of safety
- NB = natural background
- LA = load allocation
- WLA = wasteload allocation

The equation is written in this order because it represents the logical order in which a load analysis is conducted. First, the load capacity is determined. Then the load capacity is broken down into its components. If the MOS is explicit (i.e., a specific amount or proportion of the load capacity) and the natural background is separated from other nonpoint sources, those loads are subtracted from the overall load capacity, and the remaining load is allocated among pollutant sources (i.e., the load allocation and WLA). When the breakdown and allocation are complete, the result is a TMDL, which must equal the load capacity.

The load capacity must consider critical conditions—the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determining critical conditions can be more complicated than it may initially appear.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows for the specification of load reductions as percentages from current conditions and considers equities in load reduction responsibility. A load is fundamentally a quantity of pollutant

discharged over some period of time and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary (40 CFR 130.2). These other measures must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads when consistent with applicable water quality standards.

5.1 Instream Water Quality Targets

TMDL water quality targets are a translation of the applicable numeric or narrative water quality standard(s) for each pollutant. For pollutants with established numeric water quality standards, the numeric value(s) are used as the TMDL targets. For pollutants with narrative water quality standard(s), the targets provide a water body-specific interpretation of the narrative standard(s). Water quality targets are typically developed for multiple parameters that link directly to the impaired beneficial use(s) and applicable water quality standard(s). Therefore, the targets provide a benchmark by which to evaluate attainment of water quality standards. Furthermore, comparing existing stream conditions to target values allows for a better understanding of the extent and severity of the problem.

5.1.1 Critical Conditions, Seasonal Variation, and Other Design Conditions

The process of bioaccumulation in the food chain integrates chronic environmental exposure over space and time as fish and other biota eat, meaning critical conditions are not limited to a certain flow or season. As described above in Section 3, the majority of mercury in the Jordan Creek subbasin derives from diffuse sources, including mercury from legacy mining activities that has been redistributed throughout the Jordan Creek mainstem and its floodplain, atmospheric deposition, and the transport of mercury in sediment erosion from the landscape. Due to the influence of nonpoint sources, mercury concentrations and loading tend to increase during higher flow periods (as was confirmed by the 2021 sampling described in Section 2.4.1). Former mill sites and other areas driving increased loading during high flows will be important to address to meet the TMDL. This document acknowledges the variability in background concentrations that is estimated to occur across a range of flow conditions and demonstrates how that variability is accounted for to meet the water column target, applicable criteria, and the TMDL.

5.1.2 Target Selection

Idaho water quality standards for mercury in the Jordan Creek subbasin are discussed above in Section 2.3 and Table 6. For the purposes of the TMDL, the fish tissue concentration targets need to be translated into instream total mercury concentration and load targets. Development of a process-based simulation model of mercury in higher trophic level fish requires detailed

information on food chain pathways, mercury concentrations in lower trophic level organisms, and fish population dynamics and energetics. Such information is not available for Jordan Creek. Therefore, this TMDL uses an empirical, bioaccumulation factor approach to translate the fish tissue target to an instream mercury concentration target as recommended in EPA's (2010) guidance for implementing the 2001 methylmercury criteria recommendations. Appendix C provides details of the bioaccumulation analysis.

Based on the discussion in Appendix C— which is summarized in Section 2.3.3— this TMDL focuses on (1) the chronic exposure concentration of 2.1 ng/L THg in water proposed by EPA (2024a, 2024b), which is described as most applicable to baseflow conditions, and (2) the site-specific target of 2.4 ng/L THg as an annual average exposure concentration. DEQ derived the site specific target using a bioaccumulation factor (BAF) approach relative to THg exposure concentrations to be consistent with the Oregon fish tissue concentration target for MeHg of 0.040 mg/kg wet weight (see Appendix C). The MeHg target in fish tissue is conservatively assumed to be equivalent to a THg target as MeHg generally represents over 95% of THg in fish tissue. Both Idaho and Oregon also currently have an existing criterion continuous (chronic) concentration for the protection of aquatic life of 0.012 µg/L (12 ng/L) total recoverable mercury; however, the Idaho criterion is expected to be revised in the near future based on the EPA-proposed chronic criterion.

To maintain consistency with both the fish tissue based annual average target of 2.4 ng/L and the proposed baseflow chronic criterion of 2.1 ng/L, the target of 2.1 ng/L is applied to the dry season (75% of the year) and a target of 3.3 ng/L to the wet season (25% of the year), creating an annual average target of 2.4 ng/L, as explained in Section 5.2.

Concentration reductions needed to achieve the applicable criteria in Jordan Creek are calculated using recent fish and water column data from DEQ's 2005 study and EPA's 2021 study (see Section 2.4.1). Data prior to 2005 are not used in the target analysis based on concerns that they may not be representative of current conditions and also that they used analytical methods with detection limits that are higher than the TMDL concentration target for total mercury. The 2021 data represent the most recent mercury study in Jordan Creek, while the 2005 data provides additional spatial coverage.

The procedure for estimating exposure concentrations consistent with achieving the fish tissue criteria has changed since the 2014 TMDL draft. The 2014 draft used log-log regression equations to estimate the exposure concentration associated with achieving a fish tissue target, which required extrapolation beyond the support of the data and is subject to influence by outliers in small data sets. EPA (2010) instead recommended using a BAF approach and developing an ambient water quality criterion (i.e., a TMDL target) by dividing the target tissue concentration by the BAF. For extrapolation across multiple sites, EPA recommended using the geometric mean of BAFs from individual sites as the best indicator of central tendency that is not unduly influenced by anomalous outliers. These BAFs are derived as the ratio of average fish tissue concentration to average water column mercury concentrations.

Appendix C provides recalculation of the regression equations used in the previous iterations of the TMDL along with BAF calculations. Several variants on the BAF calculations are also reported, examining relationships between fish tissue concentrations, total mercury concentrations, dissolved total mercury concentration, and methylmercury concentration. Another complicating factor is that the IDFG 2021 sampling obtained three high flow season mercury samples and one dry season sample. DEQ obtained all the 2005 samples during dry season conditions. The IDFG sampling demonstrated that mercury concentrations are consistently higher during spring wet weather conditions as opposed to dry season conditions. Mercury, however, is a chronic pollutant that biomagnifies through the food chain and is thus more susceptible to the time averaged exposure concentration than to the flow-weighted concentration (total mass per year divided by total flow).

Historic gage records for Jordan Creek suggest that higher flow conditions observed from March–May (i.e., greater than 200 cfs at USGS gage 13178000, Jordan Creek above Lone Tree Creek near Jordan Valley, OR) occur during approximately 25% of the year (Table 2). A simple average of mercury concentrations in multiple high flow samples and a single low flow sample, as is present in the 2021 samples, is likely to be biased high. Therefore, sample averages of water column mercury samples at the 2021 monitoring points were time-weighted, with 25% of the weight applied to the high flow samples and 75% applied to the low flow samples. This reweighting is only possible for the 2021 water column samples (JC1, JC2, and JC5). The 2005 samples are used without adjustment. The 2005 samples included paired fish and water column mercury data. For the 2021 samples, there are paired fish and water column data at JC1, while fish tissue concentrations at JC3 are evaluated relative to the water column concentrations at nearby station JC2. No fish tissue samples were collected at JC5 during 2021 (see summary in Section 2.4.1).

DEQ developed BAFs for each sample location with paired fish and water column data as the ratio of the average Rainbow and Columbia River Redband Trout standardized length wet weight tissue concentration to the average water column concentration (using the time-weighted concentrations for stations JC1 and JC2). The BAFs and associated instream targets are based on total mercury concentrations in water, not methylmercury. It is consistent with IDAPA 58.01.02.210 (03)(c)(iv)(2), which states

> The implementation of a fish tissue criterion in NPDES permits and TMDLs requires a nontraditional approach, as the basic criterion is not a concentration in water. In applying the methylmercury fish tissue criterion in the context of NPDES effluent limits and TMDL load reductions, the Department will assume change in fish tissue concentrations of methylmercury are proportional to change in water body loading of total mercury..

This approach is conservative (as total mercury will by definition be greater than methylmercury concentration), avoids problems due to the limited data available for methylmercury concentrations, and is most convenient for implementation. An overall BAF is then estimated as the geometric mean of the calculated BAFs at each station, as recommended by EPA (2010). The recommended approach uses BAFs calculated from the 2005 and 2021 data, with the 2021 data discharge-weighted to adjust for bias toward higher flow samples. The BAF calculations for both total and methylmercury are presented in Appendix C.

The analysis of the 2005 and 2021 data resulted in a total mercury BAF of 1.685 x 104 liters per kilogram (L/kg; mg/kg fish tissue total Hg divided by total mercury water column concentration in mg/L), which is the geometric mean of the BAFs calculated for each individual sampling location. The water column THg target concentration (mg/L) needed to achieve the TMDL is equivalent to the fish tissue target (mg/kg) divided by the BAF (L/kg). For THg, this results in a water column THg target concentration to meet the Oregon fish tissue target of 0.04 mg/kg of 2.4 ng/L (0.0024 µg/L), which also ensures meeting the less stringent Idaho fish tissue target of 0.3 mg/kg. A target can also be specified in terms of total MeHg concentration. For total MeHg, the geometric mean BAF is 5.057 x 105 L/kg. The corresponding water column MeHg target to achieve the Oregon fish tissue criterion is 0.079 ng/L; the MeHg water column target to achieve the Idaho fish tissue criterion is 0.59 ng/L.

Idaho and Oregon also have ambient water quality chronic criteria for the protection of aquatic life of 0.012 µg/L (12 ng/L) THg.

To calculate initial empirical estimates of needed reductions in mercury concentrations and loads, DEQ compared the total mercury targets needed to achieve the fish tissue target against the station averages of all 2005 DEQ and 2021 IDFG total mercury samples (where the 2021 samples are time-weighted as described above). Both the fish tissue and ambient water quality chronic criteria are assumed to apply over the whole year. Fish tissue concentrations are due to chronic bioaccumulation of mercury through the food chain. The aquatic life target is a chronic or criterion continuous concentration that is specified in the Idaho rules as a 4-day average.

The resulting empirical load reduction estimates are shown in Table 23. Across all stations, the maximum concentration empirical reduction estimate is 99%. This maximum reduction is needed to meet the Idaho aquatic life criterion continuous concentration at Jordan Creek above Flint Road based on the 2021 sampling at JC2. Two samples were obtained at this station, one on April 28, 2021 (wet season) of 307 ng/L and one on October 13,2021 (dry season) of 195 ng/L. The JC2 station captures all upstream sources in the Silver City mining district but has a total drainage area of 218 square kilometers, which constitutes only 15.4% of the total drainage area of Jordan Creek at the Oregon state line.

Table 23. Empirical estimates of total mercury reductions to achieve fish tissue and water column targets for total mercury relative to observed average concentrations.

Station	Assessment Unit	Average Fish Tissue Concentration (mg/kg)	Total Mercury Water Column Conc. (ng/l)	Oregon Human Health-based Target (ng/L)	Percent Reduction to Meet Oregon Human Health Target	Idaho Human Health-based Target (ng/L)	Percent Reduction to meet the Idaho Human Health Target	Maximum Reduction
Jordan near State line (JC-2005-01; in OR)	-	ND	19.9	**2.4**	**88%**	17.8	11%	**88%**
Jordan at Pleasant Valley Rd. (JC5, 2021)	SW001_05	ND	97.9	**2.4**	**98%**	17.8	82%	**98%**
Jordan above Flint Road (JC2, 2021)	SW004_04	0.401	223.0	**2.4**	**99%**	17.8	92%	**99%**
Jordan End of Tailings (JC-2005-08)	SW004_03	0.250	13.3	**2.4**	**82%**	17.8	0%	**82%**
Jordan below DeLamar Entrance (JC1, 2021)	SW004_03	0.453	61.1	**2.4**	**96%**	17.8	71%	**96%**
Jordan below DeLamar Mine (JC-2005-09)	SW004_02	0.362	35.3	**2.4**	**93%**	17.8	50%	**93%**
Jordan below Blue Gulch (JC-2005-10)	SW004_02	ND	57.9	**2.4**	**96%**	17.8	69%	**96%**
Jordan below Silver City (JC-2005-11)	SW004_02	0.761	92.68	**2.4**	**97%**	24.8	81%	**97%**

Notes: See Table 13 for fish tissue data and Appendix C for BAF calculations. ND: No data. Water column concentrations for 2021 stations are time-weighted between wet and dry seasons. Water column concentrations for 2005 samples are single observations. Reduction estimates based solely on 2005 samples are likely to be biased low as they represent only August low flow conditions. All assessment units begin with ID17050108.

The empirical estimates of reduction needs in Table 23 suggest that large reductions of up to 99% may be needed to achieve the Oregon fish tissue target, which is estimated to require a total mercury concentration average of 2.4 ng/L or less. The 2021 IDFG sampling did not obtain water column data at the state line, while neither the 2005 nor 2021 sampling obtained game fish samples at the state line. The nearest station to the state line within Idaho, sampled in 2021, was JC5 (Jordan Creek at Pleasant Valley Road), located approximately 3.5 miles upstream of the border where the discharge-weighted total mercury concentration was 97.93 ng/L. Applying the revised BAF analysis at this site would result in an estimated 98% reduction in total mercury concentrations needed to meet the Oregon fish tissue criterion.

The 2021 station JC5.5 (Jordan Creek at I-95) is within Oregon and several miles downstream of the state border. Two water column samples were obtained at this station in 2021 (one at high flow and one at low flow), with a discharge weighted concentration total mercury concentration of 106.92 ng/L. Attaining the Oregon fish tissue criterion is also estimated to require a reduction of 98% in total mercury concentrations. However, this station has only two water column samples and the concentration may be affected by other sources within Oregon.

Because only limited sampling data are available for mercury in Jordan Creek, the empirical estimates in Table 23 are imprecise indicators of the actual required load reductions to achieve water quality standards. In addition, Table 23 estimates reductions in relation to total mercury loads including both background and anthropogenic sources and does not account for the seasonal differences in concentrations. Section 5.2 provides a more detailed estimate of the loading capacity, incorporating seasonal differences, and Section 5.3 provides a detailed analysis of existing loads by source. Reductions in loads are then applied only to local, non-background sources resulting in the TMDL allocations presented in Section 5.4.

5.1.3 Water Quality Monitoring Points

Achieving this TMDL will require meeting the target of 2.4 ng/L total recoverable mercury at the Idaho-Oregon border and in Idaho waters. Monitoring is needed both at or near the Oregon border and in the upper reaches of Jordan Creek where the highest instream concentrations have been observed.

High levels of mercury in the Jordan Creek subbasin appear to be primarily associated with the Jordan Creek mainstem and are likely derived from legacy mining and ore processing activity in the Silver City mining district near the Jordan Creek headwaters. Mercury derived from this area has been redistributed throughout the Jordan Creek mainstem. Various investigations summarized in Section 2.4 have not located significant sources of mercury on tributaries to Jordan Creek with the exception of small tributaries associated with ore processing mills in Silver City.

The 2021 water column sampling indicates that increased water column total mercury concentrations occur during the higher flow associated with spring runoff. Therefore, it will be important to continue to sample spring runoff. Sampling sites should be consistent with several

of the historic sampling sites where accessibility is known to allow progress tracking. The following sites are of primary interest for continued water column sampling:

- JC1 (2021)—Jordan Creek below DeLamar Entrance: monitors the Silver City area
- JC2 (2021)—Jordan Creek above Flint Road: site with highest observed total recoverable mercury concentrations
- JC-2005-01—Jordan Creek at State Line: for compliance with Oregon standards. If access to this site is not feasible, DEQ could instead use JC5 (2021)—Jordan Creek at Pleasant Valley Road.

Future monitoring should also continue to focus on evaluating mercury concentrations in fish tissue to track achievement of the TMDL goal. Tissue concentrations in fish represent the net result of exposure concentrations to the food chain over time and exposure during migration. Thus, fish samples tend to integrate over space and time, making them a good indicator of progress in achieving the TMDL goal.

Fish sampling should be attempted at sites with water chemistry monitoring to support further refinement of the BAF analysis but should also be done at a broader array of sites throughout the subbasin. Fish movement can be affected by many factors, including water temperature, water availability and spawning preference. With this in mind, fish tissue collection should include both water bodies assessed as unimpaired as well as those impaired by mercury sources in the subbasin. The evaluation of non-impaired water bodies will assist in tracking changes not associated with historic use of mercury for gold and silver extraction, the primary source in the watershed, or impacts from airborne deposition.

5.2 Load Capacity

The load capacity was calculated using the annual average water quality target of 2.4 ng/L total recoverable mercury, the proposed chronic criterion for baseflow conditions of 2.1 ng/L (Section 5.1.2), and monthly average flows. DEQ expects that mercury concentrations in Jordan Creek will be higher during high flow conditions, as demonstrated by recent sampling (Table 14), and that estimated background concentration will also be higher during high flow conditions, when bottom sediment is entrained into the water column (Table 24). Therefore, separate load capacities are assigned to the dry season (C_D;75% of the year) and the wet season (C_W; 25% of the year) such that a temporal average concentration of 2.4 ng/L is achieved. This is expressed as

$$2.4 = 75\% \, C_D + 25\% \, \rho \, C_D \qquad \textbf{Equation 1}$$

where ρ is the ratio between the wet season and dry season concentration targets.

Equation (1) can be satisfied by many different combinations of C_D and ρ. To calculate the load capacity on a seasonal basis, DEQ first ensured that C_D was consistent with the proposed chronic criterion of 2.1 ng/L THg. Rounding to a tenth of a nanogram, DEQ assigned a target concentration of 3.3 ng/L THg during the wet season (25% of the year) and 2.1 ng/L during the dry season (75% of the year), resulting in a temporal average across the year of 2.4 ng/L THg.

The TMDL's goal is to protect aquatic organisms and human health by reducing mercury levels sufficient to attain the fish tissue criteria. To achieve this goal, the load capacity for each AU was calculated by multiplying the water quality target for each month by the pattern of average monthly flows at the USGS gage site 13178000, Jordan Creek below Lone Tree Creek near the Idaho-Oregon state line. Each AU was scaled by the SPARROW-estimated average annual flow at their respective downstream end (Table 24). The SPARROW-estimated annual flow at the USGS gage (186.1 cfs; see Appendix D and Section 5.3) provided a close match to the average annual flow recorded at the USGS gage (190 cfs), with a ratio of 0.978626. The resulting loading capacity at the Idaho-Oregon border with the assigned seasonal targets is equal to 491 g/yr THg.

Table 24. Total mercury load capacity to achieve annual average total mercury target concentration of 2.4 ng/L.

Assessment Unit Name	Assessment Unit Number	Annual Average Flow (cfs)	Load Capacity (g/day)
Jordan Creek - Williams Creek to State Line	SW001_05	190	1.34
Jordan Creek - Big Boulder Creek to Williams Creek	SW004_05	161	1.17
Jordan Creek – Louse Creek to Big Boulder Creek	SW004_04	49	0.36
Jordan Creek - Jacobs Gulch to Louse Creek	SW004_03	28	0.20
Jordan Creek, Upper - 1st and 2nd order tributaries	SW004_02	20	0.15

Notes: All assessment units begin with ID17050108. Flow estimates are annual averages from the SPARROW model distributed to months according to summary statistics for USGS gage 13178000, Jordan Creek above Lone Tree Creek near Jordan, Oregon, 1945-1971, and 2002-2003. Load Capacity shows daily load on an average annual basis. Estimated load capacities are cumulative from SW004_02 (upstream) to SW001_05 (downstream). Target concentrations are 3.3 ng/L for March through May and 2.1 ng/L for April through February.

The flows and associated load capacity vary markedly by month and season. For the higher flow months of March–May, the load capacity is 4.29 g/d. For June–February, the load capacity is 0.37 g/d.

The empirical analysis comparing the observed concentrations relative to the target concentrations (Table 23) suggested that larger reductions in existing load may be needed to achieve standards at sampling point JC2 (Jordan Creek at Flint Road). This station is situated between the terminus of AU SW004_03 and that of SW004_04. Averaging the load capacity for the two AUs yielded an intermediate estimated load capacity of 0.28 g/d.

5.3 Estimates of Existing Pollutant Loads

The mercury sources loading the impaired waterbody segments of the Jordan Creek subbasin are documented above in Section 3. A detailed discussion of the mass balance of mercury in Jordan Creek including estimates of loading and transport rates of mercury through the stream network based on currently available data is provided in Appendix D. Data limitations result in uncertainty in these load estimates; however, regulations allow that loading estimates "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (40 CFR 130.2(g)).

Results of the mass balance analysis in Appendix D are summarized below. After accounting for losses in transit, existing mercury loads are summarized in terms of source loads (i.e., mercury loads entering the Jordan Creek stream network) and delivered loads reaching the point where Jordan Creek crosses the Idaho-Oregon border. Table 25 and Table 26 show the estimated point source and nonpoint source loads by assessment unit, respectively, under current conditions. Based on a 365.25 day year (accounting for leap years), the combined daily load to the stream network from point and nonpoint sources is 35.3 g/day or 13,007 g/yr.

Table 25. Current mercury point source loads in subbasin (loads at point of discharge).

Facility/Source	Permit Number[a]	Assessment Unit[b]	Assessment Unit Name	Current Mercury Load (g)		
				Daily	Monthly	Yearly
DeLamar Mine Stormwater	IDR050000	SW004_02	Jordan Creek, Upper—1st and 2nd order tributaries	0.05	1.51	18.13
Groundwater Remediation, Louse Creek[c]	ID-G91-0007	SW004_04	Jordan Creek—Louse Creek to Big Boulder Creek	0.01	0.37	4.45

a. IPDES permit
b. All assessment unit numbers begin with ID17050108.
c. Load estimated using DMR discharges and THg concentration of 60 ng/L (Table 21).

Table 26. Current mercury loads from nonpoint sources in subbasin (loads delivered to streams).

Assessment Unit	Assessment Unit Name	Current Mercury Load (g)		
		Daily	Monthly	Yearly
SW001_05	Jordan Creek—Williams Creek to State Line	8	241	2,892
SW004_05	Jordan Creek—Big Boulder Creek to Williams Creek	5	142	1,710
SW004_04	Jordan Creek—Louse Creek to Big Boulder Creek	6	189	2,263
SW004_03	Jordan Creek—Jacobs Gulch to Louse Creek	12	372	4,461
SW004_02	Jordan Creek, Upper—1st and 2nd order tributaries	5	138	1,661
Total		36	1,082	12,987

Note: All assessment unit numbers begin with ID17050108. Loads are calculated via the SPARROW analysis described in Appendix D. Calculated loads are loads direct to the AU and do not include aggregated load from upstream AUs. Table 26 accounts for the assignment of minor first and second-order tributaries draining to SW004_05 through SW004_03 to SW004_02 (see Figure 6).

A summary of the total existing point and nonpoint source loads delivered to the Idaho-Oregon border from the Jordan Creek subbasin is provided in Table 27 and Figure 21. Estimated loads are average annual loads in g/yr, where the averages implicitly account for year-to-year variability. Legacy mining is the largest source of mercury from the Jordan Creek watershed, representing nearly 90% of the existing load. The calculated total mercury load is greater than that estimated for the 2014 draft TMDL. Comparing the point and nonpoint delivered load of 13,007 g/yr (35.61 g/d) to the loading capacity of 491 g/yr (1.34 g/d) suggests the need for a 96.2% reduction in total mercury loads at the Oregon border.

Table 27. Estimated existing loads of mercury delivered from Jordan Creek to the Oregon border.

Category of Delivered Mercury	Delivered Load (g/yr)	Percent of Delivered Load
Background Soil Erosion and Transport	**334**	**2.6%**
Non-mineralized Area	321	2.5%
Mineralized Area	13	0.1%
Channel and Floodplain Erosion	**12,391**	**95.3%**
Legacy Mining Sources to Jordan Creek Mainstem	11,686	89.8%
Background Channel Erosion (non-mining sources)	705	5.4%
Upland Dissolved Mercury in Runoff*	**262**	**2.0%**
Dry Atmospheric Deposition Direct to Waterbodies	**< 0.01**	**~0%**
Point Sources	**19**	**0.1%**
Watershed Total	***13,007***	***100%***

Note: * The upland dissolved mercury load is discounted for the atmospheric wet deposition load tabulated as part of the DeLamar Mine point source.

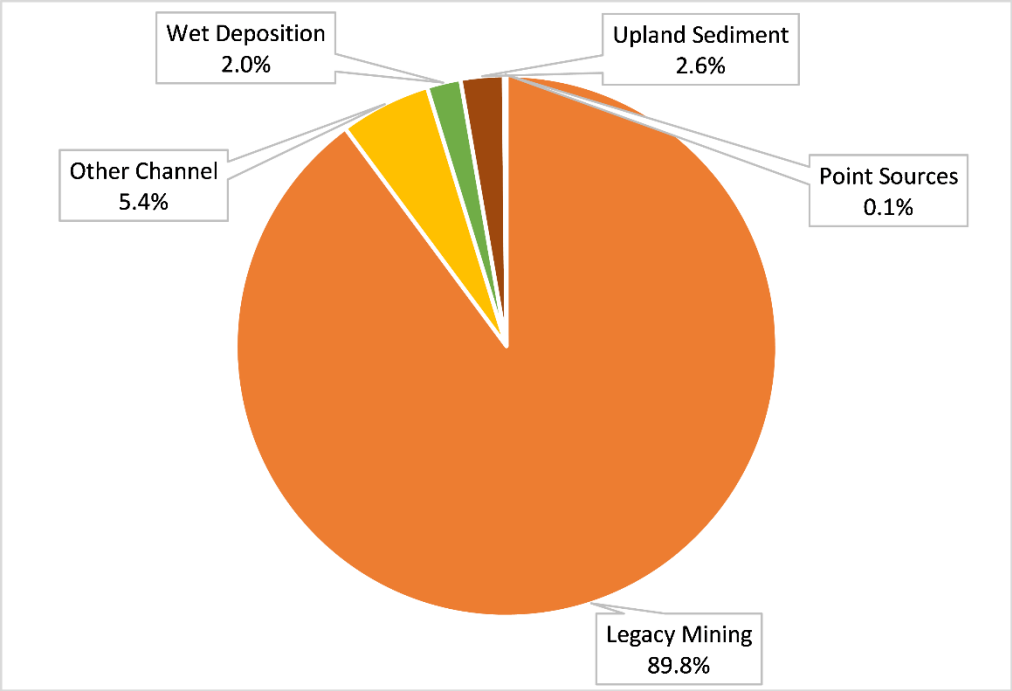


Figure 21. Estimated sources of existing loads of mercury delivered from Jordan Creek to the Oregon border.

Similar calculations were carried out for station JC2 (Jordan Creek at Flint Road, located in AU ID17050108_SW004_04), as shown in Table 28. At this location, the estimated existing load of total mercury is 7,857 g/yr (21.5 g/d). As noted in Section 5.2, the load capacity at this station is 0.26 g/d, suggesting the need for a 98.8% reduction at this station downstream of the legacy mining areas.

Table 28. Estimated existing loads of total mercury delivered from Jordan Creek to Station JC2.

Category of Delivered Mercury	Delivered Load (g/yr)	Percent of Delivered Load
Background Soil Erosion and Transport	**142**	**1.8%**
Non-mineralized Area	132	1.7%
Mineralized Area	10	0.1%
Channel and Floodplain Erosion	**7,618**	**97.0%**
Legacy Mining Sources to Jordan Creek Mainstem	7,570	96.4%
Background Channel Erosion (non-mining sources)	48	0.6%
Wet Atmospheric Deposition in Runoff	**63**	**0.8%**
Dry Atmospheric Deposition Direct to Waterbodies	**< 0.01**	**~0%**
Point Sources	**33**	**0.4%**
Watershed Total	**7,857**	**100%**

5.4 TMDL Allocations

The load capacity calculation for total mercury in Jordan Creek (Section 5.2) indicates that large reductions in existing mercury loads are needed to attain the annual average water quality target of 2.4 ng/L total mercury. Most of this reduction will need to come from load allocations to legacy mining sources as these constitute the majority of the existing load. The two small, permitted point sources contribute only 0.2% of the total load.

The TMDL cannot require reductions in the natural background loading of mercury that is not attributable to anthropogenic sources. However, as described in Section 3.2.4, “natural” and “background” loads are not the same thing for mercury. The present-day diffuse background load is elevated due to centuries of atmospheric deposition of mostly anthropogenic mercury. Therefore, reductions are evaluated relative to the current background loads rather than to the natural concentrations that may have existed prior to human interference in the global mercury cycle.

Emissions of mercury to the atmosphere in the U.S. have declined substantially since the late 1990s, including large decreases in mercury emissions from major sources in Oregon and Nevada, which even during peak emissions were considered to be minor sources to Jordan Creek relative to the legacy mining inputs(see Figure 16). There has been less success in reducing global emissions (UNEP 2019), but future progress may occur if there are global reductions in coal burning and artisanal mining operations. Reductions in atmospheric loading will eventually result in reductions in surface soil and water concentrations although the response to lower emissions may take centuries due to the large amounts of anthropogenically derived mercury stored in soils and the oceans (Seigneur et al. 2004). No reductions in mercury load in Jordan Creek due to future changes in atmospheric deposition are assumed, but such reductions may be considered as part of an implicit margin of safety.

The time required and ability to achieve the TMDL is uncertain because less than 1% of the load derives from anthropogenic sources that are subject to discharge permits. This issue is discussed further in Sections 5.4.7 and 5.5.

5.4.1 Load Allocations

Load allocations represent the portion of the load capacity allocated to nonpoint sources. Load allocations may be presented by source type (e.g., load allocations for agriculture, silviculture, or roads), or a single load allocation may include all sources lumped together. In some TMDLs, a natural background allocation may be split from the load allocation.

The overall load allocation sum is calculated based on the needed reduction in total load, estimated from observations, to achieve the concentration target. Because the load from point sources is not precisely known but appears to constitute well less than 1% of the total load, and because the point source discharges will be directly assigned the concentration targets in their permits, the load allocations are not adjusted for the small load reductions to be obtained from the point sources.

As was discussed for the load capacity (Section 5.2), significantly higher total mercury concentrations are expected in the wet season than in the dry season. Therefore, separate load allocation concentration targets of 3.3 and 2.1 ng/L are assigned to the wet and dry season via Equation (1) in Section 5.2 such that a temporal average annual concentration of 2.4 ng/L is achieved. These targets are compared to observed average dry and wet weather concentrations at the three Jordan Creek mainstem stations in Idaho with sufficient data (JC1, JC2, JC5). The reductions are then compared to the total mercury concentration and to the non-background concentration.

The calculated reductions are shown in Table 29. The reductions are technically feasible in the sense that they are less than 100% of the estimated non-background concentration. Reductions estimated for individual stations are uncertain due to data limitations, so the overall average reduction by season relative to non-background concentrations should be applied to loads.

Table 29. Calculation of reductions for total mercury load allocations.

Station	Target concentration (ng/L)	Background concentration (ng/L)	Non-background concentration (ng/L)	Observed concentration (ng/L)	Reduction vs. total concentration	Reduction vs. non-background concentration
Dry Season						
JC1	2.20	1.54	0.66	27.8	92.07%	97.62%
JC2	2.20	1.54	0.66	113.0	98.05%	99.42%
JC5	2.20	1.54	0.66	31.9	93.10%	97.93%
Average	—	—	—	—	94.41%	98.32%
Wet Season						
JC1	3.00	2.13	0.87	183.0	98.36%	99.52%
JC2	3.00	2.13	0.87	307.0	99.02%	99.72%
JC5	3.00	2.13	0.87	260.3	98.85%	99.67%
Average	—	—	—	—	98.74%	99.64%

Note: JC1 is in AU SW004_03, JC2 is in AU SW004_04, and JC5 is in AU SW001_05. All assessment unit numbers begin with ID17050108.

Equation (1) can also be satisfied using alternative values of ρ to achieve the annual temporal average exposure concentration of 2.4 ng/L. For example, if the objective was to assign equal percent reductions for dry and wet season loads, it could be achieved through optimization by setting ρ = 2.177 (Equation 2).

$$C_D = 2.4/(0.75+0.25*\rho);\ C_W = C_D*\rho;\ \rho = 2.177 \qquad \text{Equation 2}$$

In this case the dry and wet season concentration targets round to 1.85 and 4.04 ng/L, and the average reduction in total non-background load is 99.2% for both the wet and dry seasons.

The sources of mercury load in Jordan Creek are predominantly the diffuse remnants of legacy mining with additional minor inputs from atmospheric deposition and upland runoff and erosion. A background load has been calculated (Section 3.2.4). This background load reflects the estimated conditions without local anthropogenic inputs associated with mining and other disturbances but is not entirely “natural” because it reflects centuries of anthropogenic input to the global atmospheric mercury pool.

To achieve the TMDL, the bulk of reductions will need to come from the mercury associated with legacy mining activities; however, the total reduction requirements are larger than the load directly attributed to legacy mining (Section 5.3 and Table 29). Therefore, some additional reductions may need to come from background soil erosion and transport and upland dissolved mercury delivered in runoff. The *Jordan Creek Subbasin: TMDL Implementation Plan for Agriculture* addresses potential sediment reduction BMPs for the watershed. In the Jordan Creek subbasin, both sources are elevated due to indirect effects of legacy mining (primarily through local atmospheric deposition) and regional atmospheric emissions. Substantial reductions in regional atmospheric emissions of mercury have been obtained since 2005 that

will gradually result in a decline in background mercury load sources in Jordan Creek, and the global atmospheric background of mercury may also be decreased over time through ongoing international efforts.

Given the limited data currently available, load allocations for nonpoint sources are assigned in aggregate, recognizing that the majority of the load reduction will need to come from legacy mining sources. An allocation to background sources is assigned separately. The strategy for assigning the nonpoint source load allocation is as follows:

1. Specify the load capacity on a monthly basis, as described in Section 5.2.
2. Subtract the background allocation monthly.
3. Subtract the wasteload allocations to point sources.

As there is no reserve for growth (Section 5.4.4), and the margin of safety is implicit (Section 5.4.5). The remaining fraction of the load capacity is equivalent to the aggregated nonpoint source load allocation, calculated by month, as shown in Table 30.

Table 30. Total mercury allocations for nonpoint and point sources in Jordan Creek subbasin.

Month	Days	Load Capacity (g/d)	Background (g/d)	Point Source WLAs (g/d)	Load Allocation (g/d)
January	31	0.6786	0.4977	0.0074	0.1736
February	28.25	0.9236	0.6773	0.0102	0.2361
March	31	2.4243	1.5648	0.0169	0.8426
April	30	5.8167	3.7544	0.0397	2.0226
May	31	4.6185	2.9811	0.0316	1.6059
June	30	0.9324	0.6838	0.0101	0.2385
July	31	0.1294	0.0949	0.0014	0.0331
August	31	0.0258	0.0190	0.0003	0.0066
September	30	0.0235	0.0172	0.0002	0.0060
October	31	0.0567	0.0416	0.0009	0.0142
November	30	0.1332	0.0977	0.0016	0.0340
December	31	0.3872	0.2839	0.0042	0.0990
Annual Total (g/yr)		491.20	325.69	3.78	161.73
Annual Average (g/d)		1.345	0.892	0.010	0.443

5.4.1.1 Anthropogenic Sources

The load allocations to nonpoint sources are made monthly after subtracting background concentrations. Therefore, the nonpoint source allocation is for anthropogenically derived sources.

5.4.1.2 Natural Background

A separate allocation is assigned to background sources based on the seasonal concentration estimates discussed in Section 3.2.4. The background load allocation is shown in Table 31.

Table 31. Total mercury load allocation for background sources in Jordan Creek subbasin.

Month	Days	Average flow (cfs)	Background Total Hg Concentration (ng/L)	Background Load (g/d)
January	31	135	1.54	0.498
February	28.25	184	1.54	0.677
March	31	307	2.13	1.565
April	30	736	2.13	3.754
May	31	585	2.13	2.981
June	30	185	1.54	0.684
July	31	26	1.54	0.095
August	31	5	1.54	0.019
September	30	5	1.54	0.017
October	31	11	1.54	0.042
November	30	26	1.54	0.098
December	31	77	1.54	0.284
Total Load (g/yr)				325.69
Total Load (g/day)				0.892

5.4.2 Wasteload Allocations

EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual and future point sources. The wasteload allocations may be based on a uniform percent reduction or mass-based limitation for dischargers where it can be shown that this solution meets water quality standards and does not result in impairment.

The Jordan Creek subbasin contains two permitted point sources (Section 3.1), both associated with the DeLamar Mine site. One is a conventional permit for a groundwater remediation discharge; the other is for stormwater permitted under Idaho's 2021 IPDES Stormwater MSGP. The TMDL assigns WLAs to these discharges that meet the instream water quality targets of 2.1 ng/L total mercury for dry season conditions for the groundwater remediation discharge and the annual average instream water quality target of 2.4 ng/L for the stormwater discharge.

5.4.2.1 Conventional Point Sources

The groundwater remediation point source discharge to Louse Creek is covered under a general permit for groundwater remediation (number ID-G91-0007). Previously contaminated groundwater from the DeLamar mine is remediated through a treatment system to remove metals and fine sediment, to balance pH to permitted levels, and to then discharge it into Louse Creek, which is a tributary of Jordan Creek, as discussed in Section 3.1.2.

The THg load associated with this discharge is not precisely known because the majority of monitoring samples have been below a detection limit of 60 ng/L. The current load from this discharge was estimated based on DMR-reported average monthly discharges coupled with a concentration of 60 ng/L (see Table 21).

The TMDL WLA for this industrial permit is based on the discharge achieving the proposed chronic criterion of 2.1 ng/L total mercury, representing a 96.5% reduction from the current limit of 60 ng/L. The revised WLA is combined with the monthly average flows to estimate the daily WLA, as shown in Table 32.

Table 32. Wasteload Allocation for Louse Creek groundwater discharge at total mercury concentration of 2.1 ng/L.

Month	Days	Average flow (cfs)	WLA (mg/day)
January	31	0.063	0.33
February	28.25	0.117	0.60
March	31	0.173	0.89
April	30	0.223	1.15
May	31	0.191	0.98
June	30	0.082	0.42
July	31	0.018	0.09
August	31	0	0.00
September	30	0	0.00
October	31	0.055	0.28
November	30	0.035	0.18
December	31	0.042	0.22

The daily load allocations sum to a total of 0.16 g/yr total mercury, or an average monthly wasteload of 0.013 g.

5.4.2.2 Stormwater Point Sources

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural, man-made storage, or conveyance systems. Certain types of stormwater runoff are considered point source discharges for CWA purposes, including stormwater that is associated with municipal separate storm sewer systems (MS4s), industrial stormwater covered under the MSGP, and construction stormwater covered under the construction general permit (CGP).

Direct discharges of stormwater from the DeLamar Mine site to Jordan Creek and its tributaries are permitted under Idaho's 2021 IPDES Stormwater MSGP. The site has multiple outfalls, and most monitoring data for total mercury has been below analytical detection limits that were mostly above the TMDL annual average target concentration of 2.4 ng/L (see Section 3.1.1).

While information on the total mercury load in stormwater runoff from the DeLamar Mine site is limited, DEQ needed to estimate existing loads to determine the total load fraction for nonpoint sources. To do this, DEQ estimated the site average stormwater runoff at 1.691 cfs and combined it with an assumed total mercury concentration of 12 ng/L, as described in Section 3.1.1.

For this TMDL WLA, the estimated stormwater runoff from the site is left unchanged, but the average monthly load is calculated based on the TMDL annual average instream target of 2.4 ng/L total mercury. This yields an annual WLA of 3.63 g/yr (0.0099 g/d), which is an 80% reduction from estimated existing loads. This load is assumed to be distributed by month based on the fraction of flow at USGS gage 13178000, Jordan Creek above Lone Tree Creek near Jordan Valley, OR, as was done for existing conditions in Table 20, resulting in the daily WLAs shown in Table 33.

Table 33. Wasteload Allocation for DeLamar Mine stormwater discharge to Jordan Creek and tributaries at total mercury concentration of 2.4 ng/L.

Month	Fraction of annual flow	WLA (g/mo)	WLA (mg/day)
January	0.060	0.219	35.33
February	0.075	0.272	48.08
March	0.137	0.498	80.31
April	0.319	1.156	192.68
May	0.262	0.949	152.99
June	0.080	0.291	48.54
July	0.012	0.042	6.74
August	0.002	0.008	1.35
September	0.002	0.007	1.22
October	0.005	0.018	2.95
November	0.011	0.042	6.93
December	0.034	0.125	20.15

The TMDL annual average target concentration of 2.4 ng/L THg should not be interpreted as a water quality-based effluent limit relative to the stormwater permit. However, a benchmark value can be assigned to the permit as a maximum daily load calculated using the statistical techniques described in EPA (1991) for estimating an upper confidence limit on the daily concentration. This method requires an variance estimate of daily stormwater runoff concentrations, which is not currently available for this site; however, EPA 1991) suggests that a 1.5-2.0 default multiplier (for instances where the statistical distribution of the effluent concentration has not been documented) can be applied to the average monthly load (calculated from the target concentration of 2.4 ng/L) to estimate the maximum daily load (resulting in a benchmark concentration in the range of 3.6–4.8 ng/L).

Consistent with EPA guidance (EPA 2002, 2014), the stormwater WLAs in this TMDL are to be expressed as BMPs in IPDES or NPDES permits. In general, stormwater point sources regulated by the CWA and/or IDAPA 58.01.25 are consistent with the provision of this TMDL if operators obtain coverage under the appropriate MS4, MSGP, or CGP NPDES/IDPES permit and implement all BMPs necessary to meet permit conditions. The relevant conditions for each permit or permit category are discussed in Section 5.5.2.2. Due to the dynamic nature of watershed characteristics and stormwater in general, DEQ believes adaptively managing stormwater permits through an iterative process of monitoring and BMP requirements, permitting flexibility while maintaining consistency with the provisions and goals of this TMDL.

5.4.3 Small Suction Dredge General Permit

Mercury or sediment-impaired streams are not granted coverage under the small suction dredge mining general permit unless a WLA for suction dredging is provided. Due to the legacy nature of mercury impairment in the Jordan Creek subbasin, the WLA for suction dredge mining established in this TMDL is **0 mg/day**.

5.4.4 Reserve for Growth

An explicit growth reserve has not been included in this TMDL. The entire existing load capacity has been allocated to current sources within the watershed. However, new permitted discharges may be accommodated if they do not result in an increase in the overall watershed load. While the TMDL target concentration is 2.4 ng/L THg, discharges exceeding this concentration may still be permissible if the associated load—calculated based on concentration and flow—does not exceed the equivalent load at the target concentration. Offset projects may also be considered to accommodate new or expanded discharges, provided they achieve at least a 1.5:1 offset ratio, ensuring a net reduction in overall watershed loading.

5.4.5 Margin of Safety

TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. EPA guidance states an MOS can be implicit (i.e., incorporated through conservative assumptions) or explicit (i.e., a portion of the load capacity is set aside for an MOS). The Jordan Creek mercury TMDL incorporates an implicit MOS based on conservative assumptions in the TMDL analysis.

One conservative assumption is the calculation of the instream target to meet the fish tissue criterion (Appendix C) based on a BAF relationship to total mercury concentrations. The water column target calculated from the BAF analysis of total methylmercury is 0.08 ng-MeHg/L (Appendix C), and percentage reductions calculated to achieve the methylmercury target are substantially (5 to 9%) lower than those calculated to meet the total mercury target (Table 34). This difference holds for calculations based on wet season, dry season, or temporally averaged exposure concentrations.

The following additional conservative assumptions also contribute to the implicit MOS:

- Wet atmospheric deposition of mercury is based on averages for 2000 – 2013. This does not account for reductions in deposition associated with the large reduction in regional emissions from Nevada mines and the Ash Grove Cement plant that occurred between 2001 and 2010 that will gradually reduce mercury in soils and runoff in the Jordan Creek subbasin. The REMSAD modeling estimated that those regional sources contributed approximately 13% of the atmospheric mercury deposition to the Jordan Creek subbasin (Section 3.2.1).
- Point source loads are not known with certainty but are likely substantially less than estimated from permit conditions.

- BAF calculations are based on measured total mercury rather than methylmercury in fish tissue. This is conservative because approximately 5% of mercury in fish tissue consists of inorganic mercury (Eagles-Smith et al. 2016).
- The average soil mercury concentration in mineralized areas provided by IGS is an upper bound estimate that is greater than would be expected from the summary in Obrist et al. (2016).

Table 34. Comparison of load reduction estimates obtained using water column targets based on total mercury and total methylmercury targets for average conditions at 2021 Jordan Creek mainstem stations JC1, JC2, and JC5.

	Wet season	Dry season	Annual weighted
Average total mercury concentration (ng/L)	234	76	116
Average total methylmercury concentration (ng/L)	0.777	0.941	0.900
Reduction to achieve total mercury target of 2.4 ng/L	98.97%	96.84%	97.93%
Reduction to achieve total methylmercury target of 0.08 ng/L	90.59%	89.71%	91.49%
Difference	8.11%	9.28%	5.39%

Note: Annual weighted concentrations are temporal averages calculated assuming that the wet season concentrations apply for 25% of the year.

5.4.6 Summary of TMDL Allocations

This TMDL applies to five assessment units (Figure 6) that are arranged linearly along the extent of Jordan Creek within Idaho. Mercury loads to these assessment units are primarily derived from the results of legacy mining activities that have been spread throughout the mainstem, and there are no large point sources of load. Therefore, DEQ is summarizing the TMDL allocations over the five assessment units as a group rather than individually (Table 35).

Table 35. TMDL allocation summary.

Assessment Unit	Assessment Unit Name	Load Capacity (g/day)	Load Allocation (g/day)	Wasteload Allocation (g/day)	Margin of Safety (g/day)	Natural Background (g/day)	Current Load (g/day)	Required Reduction (lb/day)	Required Reduction (%)
SW001_05	Jordan Creek—Williams Creek to State Line	1.34	0.443	0.010	Implicit	0.892	35.61	34.27	96.2
SW004_05	Jordan Creek—Big Boulder Creek to Williams Creek	↓	↓	↓	↓	↓	↓	↓	↓
SW004_04	Jordan Creek—Louse Creek to Big Boulder Creek	↓	↓	↓	↓	↓	↓	↓	↓
SW004_03	Jordan Creek—Jacobs Gulch to Louse Creek	↓	↓	↓	↓	↓	↓	↓	↓
SW004_02	Jordan Creek, Upper—1st and 2nd order tributaries	↓	↓	↓	↓	↓	↓	↓	↓

Note: All assessment unit numbers begin with ID17050108. Capacities and allocations vary by month; this summary shows annual averages across all AUs.

5.4.7 Reasonable Assurance

Due to the point sources and wasteload allocations in this TMDL, a demonstration of reasonable assurance is required. DEQ has reasonable assurance that point source wasteload allocations will be implemented effectively through the IPDES permit program.

For nonpoint source controls and BMP implementation, DEQ relies on the state's § 319 program, local stakeholders, and agency partners to implement nonpoint source controls, which generally rely on voluntary implementation. A discussion of those groups is provided in this section and a more specific discussion of TMDL implementation strategies is found in Section 5.5.

The CWA § 319 requires each state to develop and submit a nonpoint source management plan. The *Idaho Nonpoint Source Management Plan* was approved by EPA in December 2020 (DEQ 2020b). The plan identifies programs to achieve implementation of nonpoint source BMPs, includes a schedule for program milestones, outlines key agencies and agency roles, is certified by the state attorney general to ensure that adequate authorities exist to implement the plan, and identifies available funding sources.

Idaho's Nonpoint Source Management Program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, including basin advisory groups and watershed advisory groups (WAGs). The Jordan Creek Watershed Advisory Group is the designated WAG for the Jordan Creek subbasin.

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 36.

Table 36. State of Idaho's regulatory authority for nonpoint pollution sources.

Authority	Water Quality Standard	Responsible Agency
Rules Pertaining to the Idaho Forest Practices Act (IDAPA 20.02.01)	58.01.02.350.03(a)	Idaho Department of Lands
Solid Waste Management Rules and Standards (IDAPA 58.01.06)	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Individual/Subsurface Sewage Disposal Rules (IDAPA 58.01.03)	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Stream Channel Alteration Rules (IDAPA 37.03.07)	58.01.02.350.03(d)	Idaho Department of Water Resources
Rathdrum Prairie Sewage Disposal Regulations (Panhandle District Health Department)	58.01.02.350.03(e)	Idaho Department of Environmental Quality/Panhandle District Health Department
Rules Governing Exploration, Surface Mining and Closure of Cyanidation Facilities (IDAPA 20.03.02)	58.01.02.350.03(f)	Idaho Department of Lands
Dredge and Placer Mining Operations in Idaho (IDAPA 20.03.01)	58.01.02.350.03(g)	Idaho Department of Lands
Rules Governing Dairy Waste (IDAPA 02.04.14)	58.01.02.350.03(h)	Idaho State Department of Agriculture

Idaho uses a voluntary approach to address agricultural nonpoint sources; however, regulatory authority is found in the water quality standards (IDAPA 58.01.02.350.01–03).

IDAPA 58.01.02.055.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan) (ISWCC 2015), which provides direction to the agricultural community regarding approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (soil conservation districts) that will take the lead if nonpoint source pollution problems need to be addressed. For agricultural activity, the Ag Plan assigns the local soil conservation districts to assist the landowner/operator with developing and implementing BMPs to abate nonpoint source pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations determined to be an imminent and substantial danger to public health or the environment (IDAPA 58.01.02.350.02(a)).

The Idaho water quality standards and wastewater treatment requirements specify that if water quality monitoring indicates that water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate or modify the BMPs to protect beneficial uses. If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity per the DEQ director's authority provided in Idaho Code § 39-108 (IDAPA 58.01.02.350). The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs: the Idaho Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities; Idaho Soil and Water Conservation Commission for grazing and agricultural activities; Idaho Transportation Department for public road construction; Idaho State Department of Agriculture for aquaculture; and DEQ for all other activities (IDAPA 58.01.02.010.24).

5.5 Implementation Strategies

Management practices that reduce surface soil erosion and runoff of air deposition can reduce mercury loads, as well as wasteload allocation implementation. Additionally, future mine reclamation/remediation efforts at the DeLamar Mine site may contribute to mercury load reductions. However, implementing TMDLs with legacy mining sources is challenging as the original contributing activity has already ceased. Implementing this Hg TMDL in tandem with the previous sediment TMDL will help work towards meeting both Idaho and Oregon's water quality standards for Hg.

Outside of targeted remediation projects, responsible parties can strive to reduce certain activities within mercury impaired areas, including suction dredge mining, recreational gold panning, recreational vehicle usage on certain trails, and excessive grazing.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. Reasonable assurance (Section 5.4.7) for the TMDL to meet water quality standards is based on the implementation strategy.

5.5.1 Time Frame

The targets established for point and nonpoint sources in this TMDL may take decades to achieve. The Jordan Creek mercury TMDL relies on a staged implementation strategy as referenced in EPA's phased TMDL clarification memo (EPA 2006a). The staged implementation strategy for the Jordan Creek subbasin acknowledges that IPDES-permitted point sources will strive to achieve the TMDL as soon as possible, consistent with IDAPA 58.01.25 and 40 CFR 122.47.

This TMDL does not define an implementation time frame for nonpoint sources; rather, implementation would begin as quickly as possible and continue until the load allocation targets are met. This acknowledges that successfully achieving the TMDL target and allocations will depend in part on voluntary measures and be influenced by available funding, cost-sharing, willing partners, and opportunities for water quality trading.

DEQ recognizes that, in spite of all reasonable efforts, attainment of restoration targets may not be possible due to the potential presence of unalterable human-caused sources and natural background sources of metals loading. Per DEQ's Implementation Guidance for Idaho Mercury Water Quality Criteria, section 5.1.2 Adaptive Management (DEQ 2005), an adaptive management approach will be considered for mercury and implemented under the implementation plan developed for this TMDL. Under this adaptive management approach, the nature of the impairment will ultimately fall into one of the three categories identified below:

- Implementation of restoration activities results in full attainment of restoration targets.
- Implementation of restoration activities fails to result in target attainment due to underperformance or ineffectiveness of restoration actions. Under this scenario the waterbody remains impaired and will require further restoration efforts associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.
- Implementation of restoration activities fails to result in target attainment, but target attainment is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards or the reclassification of the waterbody may be necessary. This would then lead to a new mercury target (and TMDL), and the new target could either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The agencies charged with developing the implementation plan for this TMDL, in coordination with DEQ and the Jordan Creek Watershed Advisory Group, will determine the appropriate management approach for the specific mine cleanup activities or any impairment condition improvement efforts associated with mining impacts. DEQ's IPDES Bureau will also be involved in all permitted point sources. DEQ will evaluate the performance of restoration activities along with available in-stream data to determine the suitability of any given target and beneficial use support. Reclamation activities and monitoring conducted by other parties should be

incorporated into the process as well. The information will also help determine any further cleanup or load reduction needs for any applicable waterbody in the Jordan Creek watershed and will ultimately measure the success of water quality restoration.

DEQ acknowledges that restoration, construction, maintenance, and future development may result in short term increase in surface water metals concentrations. For any activities that occur within the stream or floodplain, all appropriate permits should be obtained before beginning the activity. Federal and state permits necessary to conduct work within a stream or stream corridor are intended to protect the resource and reduce, if not completely eliminate, pollutant loading or degradation from the permitted activity. The permit requirements typically have mechanisms that allow for some short-term impacts to the resource, as long as all appropriate measures are taken to reduce impact to the least amount possible.

5.5.2 Approach to Meeting Allocations

Funding provided under CWA § 319 and other funds will be used to encourage voluntary projects to reduce nonpoint source pollution. Implementing the WLAs outlined in this document into IPDES permits may require additional mercury mitigation efforts to meet new permit limits.

5.5.2.1 Wasteload Allocation

While the TMDL wasteload allocations are expressed in terms of grams of mercury per day, for implementation purposes in IPDES permits, water quality-based effluent limits do not necessarily have to be expressed in terms of a daily limit. Water quality-based effluent limits should be consistent with time periods for which the assumptions of the TMDL were established (EPA 2006b).

5.5.2.2 Stormwater Wasteload Allocation

Construction General Permits

Under the conditions of the construction general permits, operators are required develop a Stormwater Pollution Prevention Plan (SWPPP) before submitting a notice of intent for permit coverage. The SWPPP must include a description of stormwater controls to meet the effluent limits of the construction general permit. Erosion controls requirements contained in the CGP are expected to meet water quality standards. The relevant conditions to control stormwater sources include but are not limited to the following:

- Maintain natural buffers when a water of the United States is within 50 feet of the earth disturbances.
- Direct stormwater to vegetated areas to maximum stormwater infiltration and filtering.
- Install sediment controls along the perimeter areas of the site that will receive pollutant discharges.
- Minimize sediment track out.
- Manage stockpiles or land clearing debris.
- Protect storm drains inlets.

- Preserve native topsoil.

In addition to the conditions listed above, an operator discharging to a water body with a TMDL must increase frequency of inspections to ensure erosion controls are functioning properly and monitor turbidity to ensure that numeric turbidity criteria are not exceeded when the construction site is discharging. If turbidity monitoring identifies the numeric turbidity criterion is exceeded, the operator must stop construction activities, take immediate actions to address the cause of exceedances, and notify a DEQ regional office within 24 hours (EPA 2017).

DEQ does not intend the wasteload allocation for CGPs in this TMDL to be implemented as load limits to permits. DEQ assumes the requirements of the CGP provided adequate controls for sediment and sediment bound nutrients to provide consistency with the intent of the TMDL. Additionally, future dischargers that require a CGP are considered consistent with the TMDL if they apply for permit coverage and implement the requirements of the CGP, including a SWPPP.

Multi-Sector General Permits

Similar to CGPs, MSGPs require the operator to develop a SWPPP before submitting a notice of intent. The SWPPP must identify pollutants that may be exposed to stormwater and identify pollution control measures that will be implemented to meet the nonnumeric technology-based limits, water quality-based effluent limits, or other limits specific to the industry type. For existing MSGP discharges to impaired waters with an EPA-approved TMDL, EPA is required to inform operators if additional measures are needed for the discharge to be consistent with the assumptions and requirements of the applicable TMDL (EPA 2015). To be consistent with the assumptions of the TMDL requirements, the operator must have stormwater permit coverage under the IPDES or NPDES permit and properly implement and maintain all BMPs required by the permit.

New MSGP dischargers to waters with EPA-approved TMDLs are ineligible for permit coverages unless the operator can do one of the following: prevent all exposure to stormwater of the pollutants for which the water body is impaired and retain documentation of procedures taken to prevent exposure onsite with a SWPPP; provide technical information or other documentation to demonstrate the pollutant(s) of concern are not present on the site, or demonstrate to EPA that the discharge is expected to meet applicable water quality standards (EPA 2015). DEQ assumes that future discharges are consistent with the intent of the TMDL if the operator can demonstrate exposure of TMDL pollutants to stormwater will not occur or pollutants of concern are not present. If the new MSGP dischargers cannot make those demonstrations, they may demonstrate the discharge from the facility will not exceed any concentration-based targets established in the TMDL.

DEQ recommends monitoring for pollutant(s) that are addressed in the TMDL. Certain industries covered by the MSGP may already be required to monitor pollutant(s) addressed in this TMDL. Renewed IPDES/NPDES permits should include monitoring to ensure MSGPs are consistent with the TMDL targets. During future permit cycles, the monitoring results should be reviewed to demonstrate MSGP sources provide consistency with the TMDL. If monitoring

results show consistency with the TMDL, additional monitoring can be reduced or eliminated. If monitoring results show inconsistency with the TMDL, additional BMP requirements should be added to future permit cycles. Additional BMP requirements should focus on reducing the pollutant loads by the necessary reductions to meet the targets established in the TMDL. DEQ recommends permit writers match additional BMP requirements with BMPs identified as effective for reducing TMDL pollutant(s) as discussed in *the Idaho Catalog of Storm Water Best Management Practices* (DEQ 2020a).

Municipal Separate Storm Sewer System

There are no MS4 permits in the Jordan Creek subbasin.

5.5.3 Responsible Parties

DEQ and the designated management agencies in Idaho have primary responsibility for overseeing implementation in cooperation with landowners and managers. In Idaho, these agencies, and their federal and state partners, are charged by the CWA to lend available technical assistance and other appropriate support to local efforts for water quality improvements. Designated state agencies are responsible for assisting with preparing specific implementation plans, particularly for those resources for which they have regulatory authority or programmatic responsibilities:

- Idaho Department of Lands for timber harvest, oil and gas exploration and development, and mining
- Idaho Soil and Water Conservation Commission for grazing and agricultural activities
- Idaho Transportation Department for public road construction
- Idaho State Department of Agriculture for aquaculture
- DEQ for all other activities

In addition to the designated management agencies, the public—through the WAG and other equivalent organizations or processes—will have opportunities to be involved in developing the implementation plan to the maximum extent practical. Public participation will significantly affect public acceptance of the document and the proposed control actions. Stakeholders (e.g., landowners, local governing authorities, taxpayers, industries, and land managers) are the most educated regarding the pollutant sources and will be called upon to help identify the most appropriate control actions for each area. Experience has shown that the best and most effective implementation plans are those developed with substantial public cooperation and involvement.

5.5.4 Implementation Monitoring Strategy

The objectives of a monitoring strategy are to demonstrate long-term recovery, better understand natural variability, track project and BMP implementation, and track the effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the reasonable assurance component of the TMDL implementation plan.

Monitoring will provide information on progress being made toward achieving TMDL allocations and water quality standards and will help in the interim evaluation of progress, including in the development of 5-year reviews and future TMDLs.

The implementation plan will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. Implementation plan monitoring will include watershed and BMP monitoring.

5.5.5 Water Quality Trading

Water quality trading (also known as pollutant trading) is a contractual agreement to exchange pollution reductions between two parties. Water quality trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Water quality trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed.

Trading is often appealing when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Water quality trading is voluntary. Parties trade only if both are better off because of the trade, and trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements.

Water quality trading is recognized in Idaho's water quality standards in IDAPA 58.01.02.055.06. DEQ allows for water quality trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ's *Water Quality Pollutant Trading Guidance* establishes the procedures for water quality trading (DEQ 2016b).

5.5.5.1 Trading Components

The major components of water quality trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Ratios are used to ensure the environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database by DEQ or its designated party.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant load beyond a level required by existing federal, state, local, and tribal regulations and TMDL implementation documents:

- Point sources create credits by reducing pollutant discharges below NPDES effluent limits set consistent with the assumptions and requirements of the TMDL wasteload allocations.
- Nonpoint sources create credits by implementing approved BMPs that reduce pollutant runoff below current loading levels. Nonpoint sources must follow the specific design,

maintenance, and monitoring requirements for that BMP, as established in relevant trading guidance and framework documents; apply discounts to credits generated, if required (i.e., attenuation or uncertainty ratios); meet trading baseline requirements (i.e., existing federal, state, tribal, and local regulations and any requirements established via TMDL implementation plans); and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit) is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL. This last step is important because it helps to demonstrate reasonable assurance toward meeting TMDL goals and not just pollutant offsetting between point and nonpoint sources.

5.5.5.2 Watershed-Specific Environmental Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL is protected. To do this, hydrologically-based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally better outcomes at the point of environmental concern. Localized adverse impacts to water quality are not allowed.

5.5.5.3 Trading Authorization

Water quality trading is authorized in the Idaho water quality standards (IDAPA 58.01.02.055). Trading should be implemented per the Clean Water Act and other existing regulations, EPA's water quality trading policy (EPA 2003), and DEQ's water quality trading guidance (DEQ 2016b).

6 Conclusions

Mercury TMDLs are provided for five AUs currently in Category 5 (Table 37). The AUs generally have high mercury loads that would require large reductions to meet both Idaho Water Quality Standards and downstream Oregon Water Quality Standards.

Table 37. Summary of assessment outcomes for § 303(d)-listed assessment units.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL(s) Completed	Recommended Changes to Next Integrated Report	Justification
Jordan Creek - Williams Creek to State Line	SW001_05	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek, Upper - 1st and 2nd order tributaries	SW004_02	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek - Jacobs Gulch to Louse Creek	SW004_03	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek – Louse Creek to Big Boulder Creek	SW004_04	Mercury	Yes	Move to Category 4a	Hg TMDL completed
Jordan Creek - Big Boulder Creek to Williams Creek	SW004_05	Mercury	Yes	Move to Category 4a	Hg TMDL completed

Note: All Assessment Unit Numbers begin with ID17050108.

This document was prepared with input from the public, as described in Appendix E. Following the public comment period, comments and DEQ responses will also be included in Appendix E.

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GIS Coverages

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Glossary

§ 303(d)

Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to United States Environmental Protection Agency approval.

Assessment Unit (AU)

A group of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs. All the waters of the state are defined using AUs, and because AUs are a subset of water body identification numbers, they tie directly to the water quality standards so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

Beneficial Use

Any of the various uses of water that are recognized in water quality standards, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics.

Exceedance

A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and existing beneficial uses as determined through the *Water Body Assessment Guidance* (DEQ 2016a).

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load

The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Load is the product of flow (discharge) and concentration.

Load Capacity (LC)

How much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and natural background contributions, it becomes a total maximum daily load.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's load capacity set aside to allow for uncertainly about the relationship between the pollutant loads and the

	quality of the receiving water body. The margin of safety is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The margin of safety is not allocated to any sources of pollution.
Nonpoint Source	A dispersed source of pollutants generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and nonirrigated lands used for grazing, crop production, and silviculture; rural roads; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing water bodies that have been studied but are missing critical information needed to complete an assessment.
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (DEQ 2016a).
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater plants.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and produce undesirable environmental and health effects. Pollution includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A 1st-order stream is an unforked or unbranched stream. Under Strahler’s (1957) system, higher-order streams result from the joining of two streams of the same order.
Total Maximum Daily Load (TMDL)	A TMDL is a water body’s load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if

	appropriate. Sediment loads, for example, are often calculated on an annual basis. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.
Wasteload Allocation (WLA)	
	The portion of receiving water's load capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.
Water Body	
	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Quality Criteria	
	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, aquatic habitat, or industrial processes.
Water Quality Standards	
	State-adopted and United States Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Appendix A. Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses.

Existing Uses

Existing uses under the Clean Water Act are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards" (40 CFR 131.3). The existing instream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.051.01). Existing uses need to be protected, whether or not the level of water quality to fully support the uses currently exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that supported salmonid spawning since November 28, 1975, but does not now due to other factors, such as blockage of migration, channelization, sedimentation, or excess heat.

Designated Uses

Designated uses under the Clean Water Act are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained" (40 CFR 131.3). Designated uses are simply uses officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Multiple uses often apply to the same water; in this case, water quality must be sufficiently maintained to meet the most sensitive use (designated or existing). Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are described in the Idaho water quality standards (IDAPA 58.01.02.100) and specifically listed by water body in sections 110–160.

Undesignated Surface Waters and Presumed Use Protection

In Idaho, due to a change in scale of cataloging waters in 2000, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations (IDAPA 58.01.02.110–160). The water quality standards have three sections that address undesignated waters. Sections 101.02 and 101.03 specifically address undesignated man-made waterways and private waters. Man-made waterways and private waters have no presumed use protections. Man-made waters are protected for the use for which they were constructed unless otherwise designated in the water quality standards. Private waters are not protected for any beneficial uses unless specifically designated in the water quality standards.

All other undesignated waters are addressed by section 101.01. Under this section, absent information on existing uses, DEQ presumes that most Idaho waters will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called presumed uses, DEQ applies the numeric cold water and recreation criteria to undesignated waters. If in addition to presumed uses, an additional existing use (e.g., salmonid spawning) exists, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect water quality for that existing use. However, if some other use that requires less stringent criteria for protection (such as seasonal cold aquatic life) is found to be an existing use, then a use designation (rulemaking) is needed before that use can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Appendix B. State and Site-Specific Water Quality Standards and Criteria

Table B1. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Parameter	Contact Recreation		Cold Water Aquatic Life	Salmonid Spawning[a]	Warm Water
Water Quality Standards: IDAPA 58.01.02.250–251					
E. Coli					
• Geometric mean	<126 *E. coli* counts/100 mL[b]		—	—	—
• Statistical Threshold Value	≤410 *E. coli* counts/100 mL for 10% or fewer samples in a 45-day period		—	—	—
Enterococci					
• Geometric mean	<35 enterococci counts/100 ml		—	—	—
• Statistical Threshold Value	<130 enterococci counts/100 ml in more than 10% of samples in 45-day period		—	—	—
pH	—	—	Between 6.5 and 9.0	Between 6.5 and 9.0	Between 6.5 and 9.0
Dissolved oxygen (DO)	—	—	DO exceeds 6.0 milligrams/liter (mg/L)	**Water Column DO**: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater. **Intergravel DO**: DO exceeds 5.0 mg/L for a 1-day minimum and exceeds 6.0 mg/L for a 7-day average	DO exceeds 5.0 mg/L
Temperature[c]	—	—	22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average **Bull Trout**: Not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October	33°C or less daily maximum 29°C or less daily average

Turbidity	—	—	Turbidity shall not exceed background by more than 50 nephelometric turbidity units instantaneously or more than 25 nephelometric turbidity units for more than 10 consecutive days.	—	—
Ammonia	—	—	Ammonia not to exceed calculated concentration based on pH and temperature.	—	Ammonia not to exceed calculated concentration based on pH and temperature
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR 131					
Temperature	—	—	—	7-day moving average of 10 °C or less maximum daily temperature for June–September	

[a] During spawning and incubation periods for inhabiting species
[b] *Escherichia coli* per 100 milliliters
[c] Temperature exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

Appendix C. Jordan Creek Mercury TMDL Development: Statistical Correlation between Fish Tissue Mercury and Water Column Mercury Concentrations

1 Introduction

The 2011 EPA draft TMDL for Jordan Creek assumed a log-linear relationship between fish tissue mercury and water column mercury concentrations and used this relationship to establish in-stream water quality targets for impaired segments in the Jordan Creek watershed. The analysis used fish tissue data from rainbow and redband trout (*Oncorhynchus mykiss*), the species for which the majority of data are available[2]. During the public review period, concerns were raised regarding the use of a direct log-linear relationship between the mercury content in fish and mercury concentrations measured in the water column. Questions arose regarding application of a relationship developed only in the Upper Jordan Creek to sites located downstream of the study area. In addition, the relationship between fish length or age and tissue concentrations of mercury was not previously addressed.

EPA revised the draft TMDL in 2014 to incorporate Oregon's recalculated fish tissue criterion of 0.040 mg/kg total mercury (THg). As part of this revision, EPA also addressed comments on the relationship between fish tissue mercury and water column mercury concentrations. That revision converted the fish tissue data to a standardized length and converted whole-body samples to fillet estimates. Regression analyses evaluated the natural log of water column THg concentration, the natural log of sediment THg concentration, and total water column methyl mercury (TMeHg) concentrations as predictors of fish tissue concentration. The best predictive equation using data available in 2014 was:

$$THg_{length} = 0.078 \ln(THg_{WC}) + 0.059$$

where:

THg_{length} = Fish tissue mercury concentration adjusted for length in mg/kg wet weight

THg_{wc} = Water column total mercury concentration in ng/L

[2] Note – Redband trout are a subspecies of rainbow trout adapted to the arid conditions of eastern Oregon and southwest Idaho There is some confusion in the record about whether the trout sampled in Jordan Creek are properly referred to as redband or rainbow trout. According to the Idaho Department of Fish and Game, rainbow trout were planted in Jordan Creek from 1968 through 1990. The 1973 University of Idaho study calls all their samples out as rainbow trout. The 1988 sampling for the Stone Cabin Mine EIS calls out all but 3 of their trout samples as redband (the three include two rainbow and one brook trout). The 2005 IDEQ sampling identified all the samples as rainbow trout on the lab sheets but the Dai and Ingham analysis (2009) and the Idaho TMDL calls them redband trout. Given that redband trout are a subspecies of rainbow trout, the TMDL refers to all the samples as rainbow trout and assumes that they are comparable in their bio-accumulation of mercury.

Application of this equation indicated that a THg_{WC} concentration of 0.00078 µg/L (0.78 ng/L) was consistent with achieving the fish tissue target of 0.040 mg/kg in a standard length rainbow trout.

The 2014 regression analyses used fish tissue data collected IDEQ by in 2005 (Dai and Ingham, 2009), the University of Idaho 1973 study (Hill *et al*., 1973), and the 1988 Stone Cabin Mine EIS (CH2M HILL, 1994) combined with water column concentration data collected in 2005. Additional data were collected by IDFG in 2021. As noted in the 2014 draft TMDL (Appendix C), "The use of fish data from 1973 and 1988 to develop a relationship with water quality data from 2005 is not ideal. However, the earlier fish data was incorporated into this analysis to allow for the assessment of the entire reach of Jordan Creek (upper and lower reaches)." New data collection of both fish tissue and water column concentrations in 2021 allows recalculation of the relationships between fish tissue and water column mercury concentrations using only contemporaneous data as is presented below.

1 Data Used in the Reanalysis

Analysis of the relationship between mercury exposure concentrations and fish tissue mercury was explored in several ways. First, a regression analysis was pursued similar to that contained in the 2014 draft TMDL. That analysis combines all the data obtained from 1973 through 2021 to provide a sufficient range of individual sites to support the regression analysis, but has the disadvantage of pairing 1973 fish samples with 2005 water column concentrations at several sites. An alternate approach, described in Section 5, uses bioaccumulation factor (BAF) analysis consistent with USEPA (2010) recommendations for mercury. The BAF analysis uses only the paired fish and water column data collected in 2005 and 2021. Table 1 lists the sampled variables used in both analyses.

Table 1. List of variables.

Water	Total Hg	ng/L
	Dissolved Hg	ng/L
	Total MeHg	ng/L
	Dissolved MeHg	ng/L
Sediment	Total Hg	ng/g (dry)
	Total MeHg	ng/g (dry)
Fish (*O. mykiss)*	Total Hg	mg/kg (wet)
	Length	inches

Data are available for 18 sites over the length of Jordan Creek down to the Oregon border and various tributaries (Table 2 and Figure 1). Data from sites JC1 and JC3 were merged due to their close proximity and to increase the number of paired water concentration and fish tissue data. Field duplicates (same day replicate samples) were removed from the analysis at the advice of EPA.

Table 2. Sampling locations.

Stream	Site ID	Latitude	Longitude
Jordan Creek	**JC1**	43.02369	-116.855
	JC2	42.88759	-116.864
	JC3	43.02384	-116.855
	JC-2005-01*	42.9653	-117.043
	JC-2005-02*	42.8877	-116.864
	JC-2005-08	42.96772	-116.89365
	JC-2005-09*	43.02243	-116.843
	JC-2005-10*	43.01937	-116.814
	JC-2005-11*	43.01619	-116.726
	JC5	42.91324	-116.995
	JC5.5	42.98537	-117.154
Boulder Creek	BC-2005-04	42.8739	-116.884
East Creek	FC-2005-06	42.89736	-116.78382
Flint Creek	**FC1**	42.89307	-116.807
	FC-2005-05*	42.886	-116.862
Louse Creek	LC-2005-07	42.93968	-116.86592
Rock Creek	**BG1**	42.81152	-116.685
Williams Creek	**WC1**	42.84136	-116.936
	WC-2005-13	See note	See note

Notes: Sites from the 2021 sampling effort are shown in bold. The 2005 sampling attempted to revisit sites from the 1973 study and are referred to by their 2005 sample designation. Sites marked * have fish tissue samples available from 1973. Latitude and longitude were not provided for site WC-2005-13; however, there are also no fish tissue samples reported for this site.

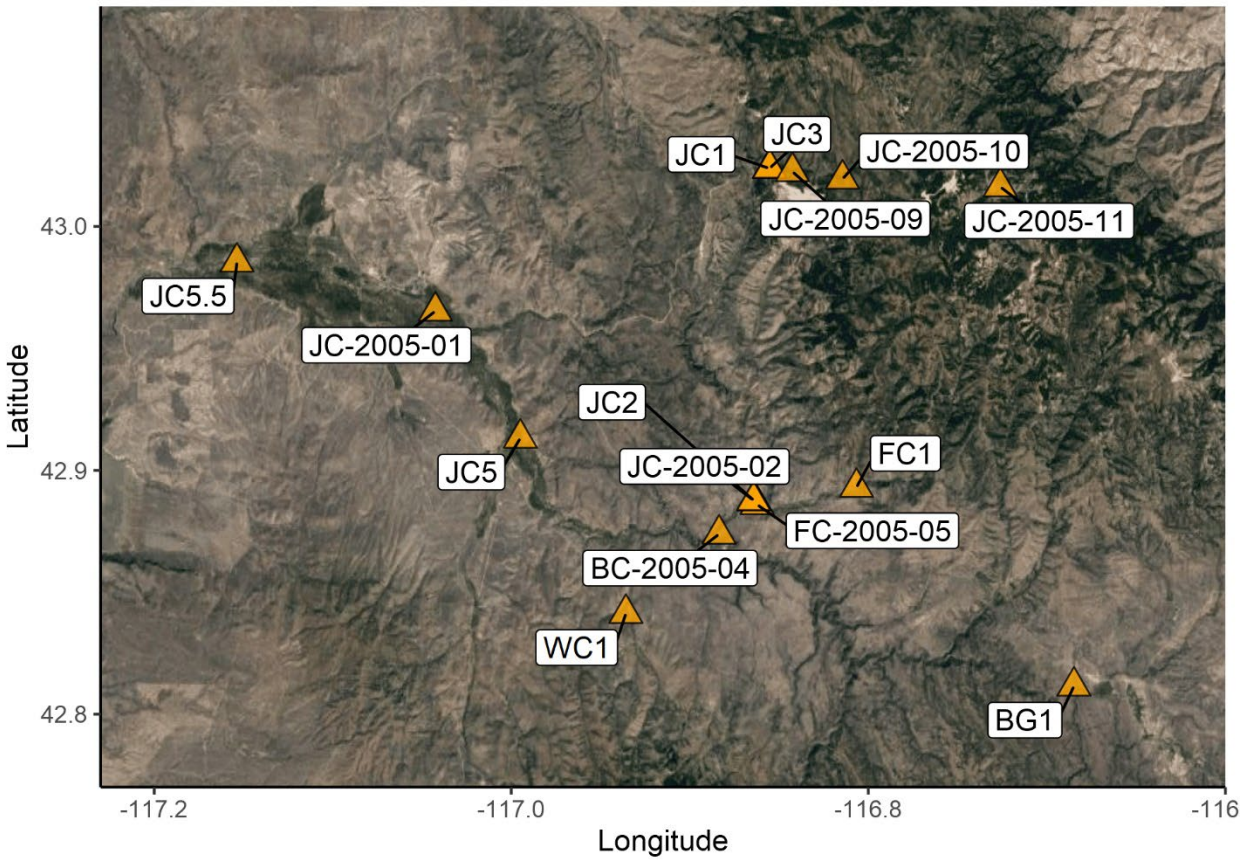


Figure 1. Map of sample locations

2 Regression Analysis Methods

The methods for the regression analysis largely follow those used in the 2014 draft TMDL but with the addition of new data from 2021. Data processing and analyses were performed in R (R Core Team 2023). Data were checked for impossible values (e.g., negative concentrations) and extreme values. No extreme values were observed.

Four out of 150 tissue measurements were from whole body samples. Fish tissue concentrations from whole body samples were translated to fillet samples using the equation developed by Peterson et al. (2005) and presented in Section 3.1 of Tetra Tech, 2022:

$$log10(Whole\ body) = -0.2712 + 0.9005 * log10(Fillet)$$

which is re-expressed to output the natural log of fillet concentration as[1]:

[1] Peterson's equation is treated as deterministic as the error term is not documented.

$$\ln(Fillet) = 0.6935 + 2.5570 * log10(Whole\ body)$$

Individual fish tissue concentrations were standardized based on fish length. The following linear regression model was used to relate the two variables:

$$\ln(TissueConcentration_i) = Intercept + B1 * Length_i + e_i$$

where *Intercept* and *B1* are parameters estimated by the model, *e* is the residual error, and *i* is the sample index. Modeling the natural log of the fish tissue guarantees a positive standardized tissue concentration when back-transforming. Data and the model results are shown in Figure 2 and Table 3, respectively.

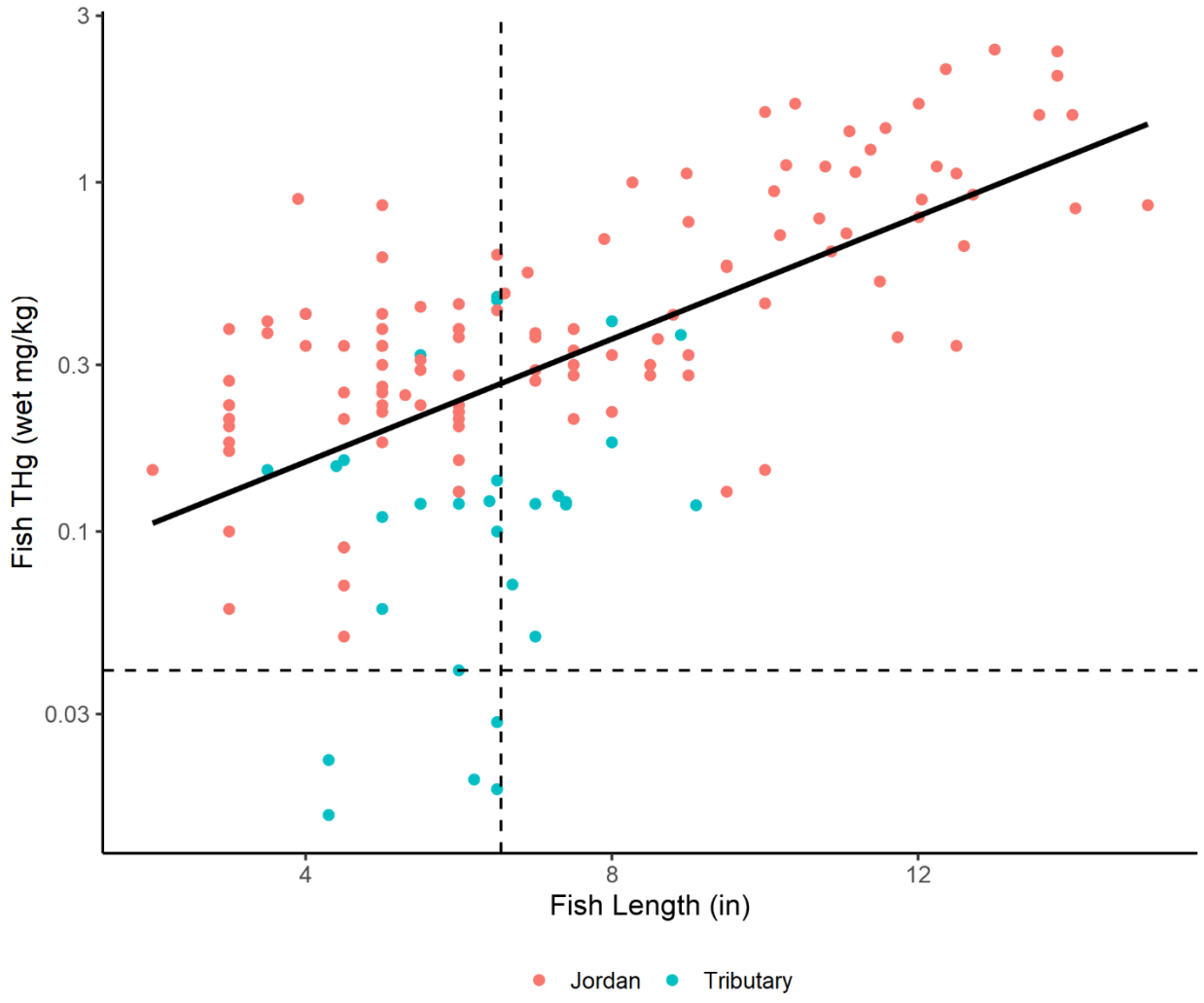


Figure 2. Scatterplot of fish tissue vs fish length data. Vertical line denotes the standard length of 6.55 inches. Horizontal line denotes the Oregon fish tissue criterion of 0.040 mg/kg wet weight, applicable at the Oregon state line.

Table 3. Regression results for the natural log of fish tissue concentration (mg/kg) vs fish length model.

Predictor	Slope	Intercept	Std Error	t value	P-value
Fish Length (in)	0.203	-2.654	0.021	9.48	<0.0001

Individual fish tissue concentrations were standardized to a length of 6.55 inches, which is the geometric mean of the lengths contained in the dataset. (The same procedure was used in the 2014 draft TMDL; however, the geometric mean of the lengths in the data used in that analysis was 6 inches.) To standardize, each point was translated to the 6.55 inches (vertical line), while remaining parallel to the line of best fit. This is equivalent to:

$$StdTissueConcentration_i = \exp(Fitted_i + residual_i)$$

where *Fitted* and *residual* are from the log-linear model of the natural log of fish tissue concentration (mg/kg) at the standard length (inches) and *i* is the sample index. The right side of the equation is back transformed to provide an arithmetic estimate of the standardized length concentration. Sediment, water, and standardized fish tissue concentration data were aggregated (using an average without weighting) to each site-year combination.

Summary statistics for the analysis data are shown in Table 4. Of the 11 stations with co-located fish tissue and water column mercury data, only one tributary station (FC-2005-06, East Creek) had an average of standardized fish tissue concentration less than the Oregon fish tissue criterion of 0.04 mg/kg. At this station, all fish samples (n=5) were below 0.04 mg/kg with a mean of 0.025. Only a single water column mercury sample is available for this station, with THg = 0.763 ng/L, dissolved THg = 0.5 ng/L, and TMeHg = 0.052 ng/L.

Table 4. Summary statistics for input data for the reanalysis.

Matrix	Variable	N	Min	10th %ile	25th %ile	Geomean	Mean	Std Dev	75th %ile	90th %ile	Max
Sediment	Total Hg (dry ng/g)	18	3.19	8.39	44.83	253.93	928.25	1,056.8	1,334.7	1,733.9	4,260.4
	Total MeHg (dry ng/g)	11	0.029	0.23	0.35	1.91	9.38	12.64	16.05	31.03	31.92
Water	Total Hg (ng/L)	29	0.57	1.24	1.80	19.08	81.24	104.62	156.00	213.40	380.00
	Dissolved Hg (ng/L)	29	0.50	0.83	1.51	7.19	18.49	21.70	27.50	45.04	89.46
	Total MeHg (ng/L)	27	0.053	0.085	0.13	0.41	0.81	0.91	1.18	1.98	3.81
	Dissolved MeHg (ng/L)	16	0.053	0.056	0.10	0.26	0.59	0.87	0.77	1.22	3.44
Fish (*O. mykiss*)	Length (in)	150	2.00	3.50	5.00	6.55	7.16	3.03	9.00	12.01	15.00
	Total Hg (wet mg/kg)	150	0.015	0.10	0.17	0.30	0.47	0.47	0.57	1.07	2.40
	Std Total Hg (wet mg/kg)	150	0.018	0.10	0.17	0.27	0.34	0.22	0.47	0.63	1.53

Note: This table includes all samples from 1973 to present within Idaho as well as 2021 IDFG samples from Jordan Creek at I-95, which is within Oregon but just downstream of the Idaho-Oregon border.

3 Regression Results

Standardized fish tissue concentrations were compared to water (THg, dissolved THg, TMeHg), and sediment (THg and TMeHg) concentrations (with and without logarithmic transformation and paired in time and space) using simple linear regression consistent with the approach used in Appendix C of the 2014 draft TMDL. The regressions with the logarithmic transformations of water and sediment concentrations perform better than those with untransformed data. As shown in Figure 3, the relationship was strongest with total Hg and dissolved Hg for water (R^2 0.87 and 0.90, respectively). Fish tissue concentrations were not well correlated with sediment Hg concentrations.

Models were developed for all sites as well as for mainstem only sites. Scatterplots show that using all available sites results in a richer gradient of predictor values, as well as increasing the sample size, while not degrading the fit to mainstem sites.

In addition to simple linear regression, multiple linear regression against both water column and sediment mercury concentrations was explored. Akaike's Information Criterion (AIC) was used to perform variable selection to attain a parsimonious model. This did not increase predictive ability and AIC by and large selected water concentration data over sediment data. Therefore, only water concentration data were considered for the final analysis.

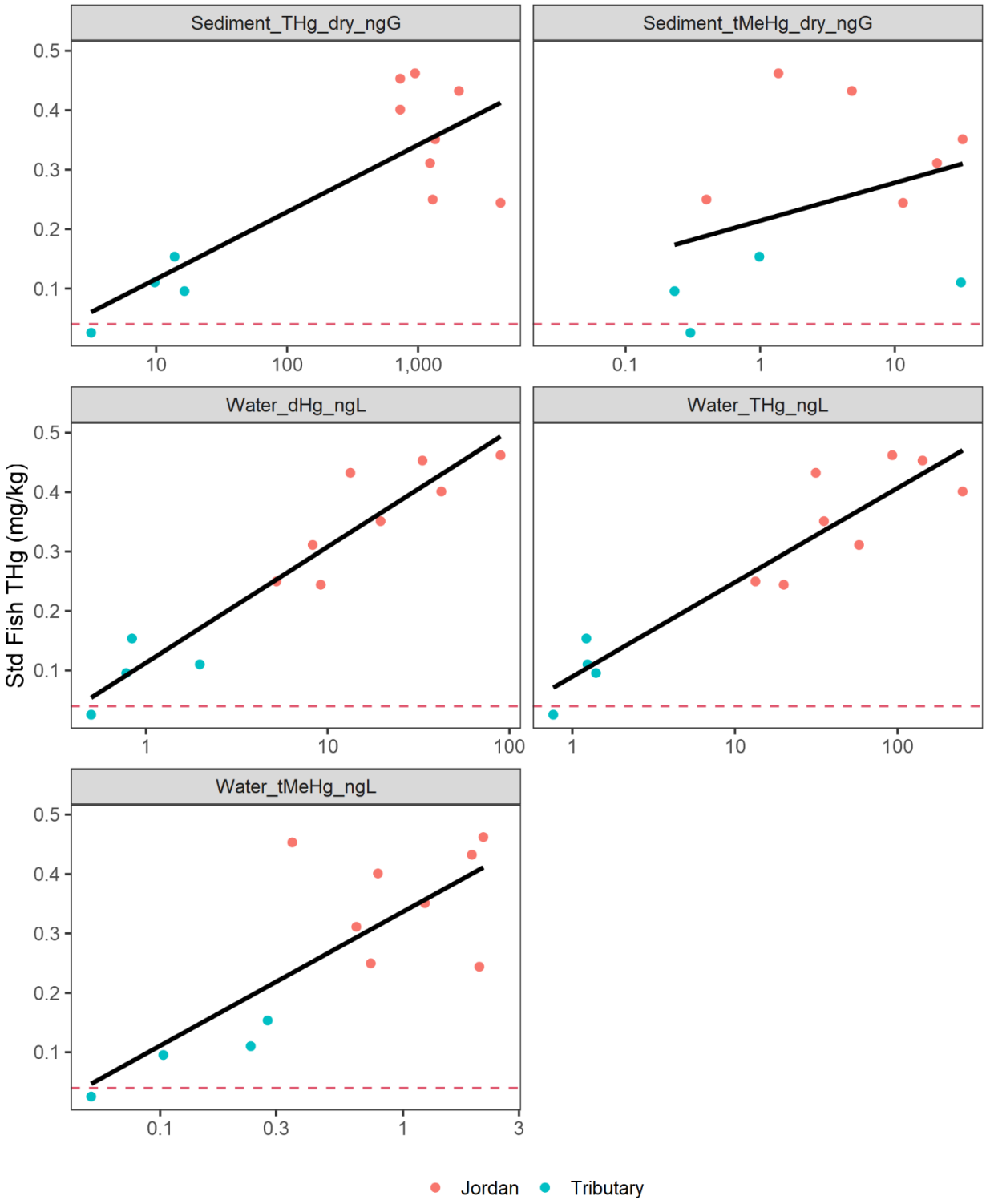


Figure 3. Scatterplot of standardized fish tissue vs various predictors.

Note: Solid black line denotes line of best fit. Horizontal red dashed line denotes Oregon fish tissue criterion of 0.04 mg/kg. Points color-coded by Jordan River mainstem or tributary.

The water column concentration required to meet the fish tissue criterion of 0.04 mg/kg was calculated for each regression as the value of the exposure concentration that results in the tissue criterion – i.e., where the line of best fit intersects the tissue criterion. Results from all the single-predictor regression models are presented in Table 5. Table 6 shows the associated estimates of mercury concentrations to achieve the fish tissue criterion of 0.040 mg/kg at the Oregon state line.

Table 5. Summary output for the regression models for rainbow trout tissue concentration (mg/kg).

Matrix	Predictor (ng/L)	N	Intercept	Slope	R^2	RMSE	P-value
Water	ln(Total Hg)	12	0.090	0.069	0.87	0.051	**<0.0001**
	ln(Dissolved Hg)	12	0.11	0.085	0.90	0.046	**<0.0001**
	ln(Total MeHg)	12	0.34	0.098	0.60	0.092	**0.0031**
	ln(Dissolved MeHg)	2	NA	NA	NA	NA	NA

Note: Bold values denote significant relationships. At least three paired samples are required for regression output.

Table 6. Regression model estimated mercury targets to achieve the tissue criterion of 0.040 mg/kg in standard length rainbow trout.

Matrix	Predictor	Target
Water	ln(Total Hg)	0.487 ng/L
	ln(Dissolved Hg)	0.424 ng/L
	ln(Total MeHg)	0.048 ng/L
	ln(Dissolved MeHg)	NA

Note: Results for Total Hg are rounded to the nearest tenth of a ng; results for MeHg are rounded to the nearest hundredth of a nanogram.

The regressions of fish tissue concentration against both the natural log of THg and the natural log of dissolved THg provide strong performance with high R^2values, low RMSE, and low probability values (*p*) values for a null hypothesis that the regression is not significantly different from basing the estimate on the average. While these equations perform well across the full data set, only one station had standardized fish tissue concentrations below 0.04 mg/kg and this station had only a single measurement of water column mercury, so extrapolation to the target concentration should be regarded with caution. These equations also have some undesirable characteristics as the intercept is greater than the target fish tissue concentration and the regressions do not constrain the predicted tissue concentration to be greater than zero. The behavior of the two candidate regressions in the vicinity of the fish tissue target is shown in Figure 4.

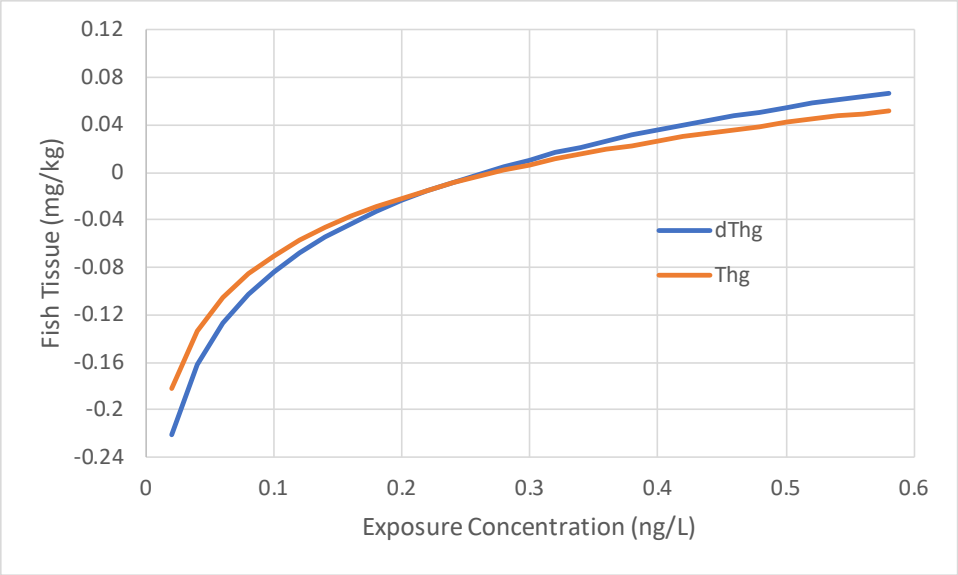


Figure 4. Behavior of log-linear regression equations in the vicinity of the fish tissue target of 0.040 mg/kg.

4 Alternate BAF Approach

USEPA guidance (2001, 2003, 2010) allows considerable flexibility in the analysis methods used to develop a mercury TMDL depending on the amount and quantity of data that are available for a given site, but does not explicitly endorse the regression approach described in previous sections of this appendix. Instead, USEPA (2010) recommends using a BAF approach and developing an ambient water quality criterion (i.e., a TMDL target) by dividing the target tissue concentration by the BAF. The document also recommends normalization to a standard length and calculating the BAF as the ratio of tissue concentration to water column exposure concentration. For extrapolation across multiple sites EPA recommends use of the geometric mean as the best indicator of central tendency. The method is specifically recommended for use with MeHg concentrations in the water column, but notes that a translator between THg and MeHg may be used when sufficient MeHg data are not available.

The Jordan Creek data, while limited, are sufficient to calculate BAFs based on average concentrations in water and fish at 8 sites. These results are summarized as geometric means along with resulting target concentrations in Table 7. The table includes calculations for BAFs relative to THg and dissolved THg as well as TMeHg. Targets derived from THg and dissolved THg calculations are equivalent to an MeHg target with a constant mercury translator.

Table 7. Bioaccumulation factor (BAF) calculations for mercury in Jordan Creek, 2005 and 2021 data, unweighted

Analyte	Geometric Mean BAF (L/kg)	Target concentration (ng/L) to achieve Oregon fish tissue target of 0.040 mg/kg
Total Hg	1.49E+04	2.7
Dissolved Total Hg	3.23E+04	1.2
Total MeHg	5.31E+05	0.08

Note: Results for Total Hg are rounded to the nearest tenth of a ng; results for MeHg are rounded to the nearest hundredth of a nanogram.

Targets derived in Table 7 are higher than those derived from the regression method and reported in Table 6. Note that the geometric mean BAF for total MeHg is similar to the national median BAF for trophic level 3 fish (which include rainbow trout) of 6.80E+05 in USEPA (2001).

Across all Jordan Creek and tributary sites, the ratio of total MeHg to THg is variable, but has a geometric mean of 0.035, a median of 0.044, and an average of 0.063. The geometric mean ratio is consistent with the ratio of the TMeHg and THg targets in Table 7.

Only two stations have paired fish and exposure concentrations in 2021. (No fish samples were obtained at JC5.) Results for these 2021 stations yield unweighted BAFs that are considerably lower than estimates for 2005 for Total Hg (3.65E+03 vs. 3.43E+04), which, if applied, would in turn result in a higher criterion concentration for Total Hg and a lower criterion concentration for Total MeHg.

Differences between the 2021 and 2005 results could in part reflect changing environmental conditions over the intervening 16 years. Another contributing factor may be that the 2021 sampling included samples from the spring high flow period (three at JC1, one at JC2) along with a low flow sample from October. In contrast, all the 2005 samples are from August low flow conditions. Based on historical 1993-1996 flow records for Jordan Creek at the JC1 station (USGS 13177985; Jordan Creek at De Lamar Mine near Jordan Valley, OR), higher flows (defined as flows greater than 50 cfs) occur only about 25 percent of the time. Dr. Chris Eckley (EPA Region 10) suggested re-weighting the average concentrations used in the BAF calculations by assigning a 25 percent weight to the higher flow samples and a 75 percent weight to the lower flow samples.

This reweighting is only feasible for the 2021 samples as there are no high flow samples from 2005. For the 2021 samples, discharge weighting results in lower Total Hg concentrations and slightly higher Dissolved Total Hg and Total MeHg concentrations (Table 8). The selected approach uses the geometric mean of the BAFs from the combined the 2021 discharge-weighted BAF estimates and the 2005 (unweighted) BAF estimates to derive the targets. 9 shows the resulting BAFs and target concentrations.

Table 8. Unweighted and discharge-weighted exposure concentrations for 2021 sampling in Jordan Creek.

Analyte	Station JC1		Station JC2	
	Unweighted	Weighted	Unweighted	Weighted
Total Hg (ng/L)	142.4	61.1	251.0	223.0
Dissolved Total Hg (ng/L)	33.2	21.0	42.2	49.6
Total MeHg (ng/L)	0.35	0.43	0.79	0.96

Table 9. BAFs and target water column concentrations to achieve fish tissue criteria for Jordan Creek based on discharge-weighted 2021 samples and unweighted 2005 low flow samples.

	Total Hg	Dissolved Total Hg	Total MeHg
Geomean BAF (L/kg)	1.685E+04	3.358E+04	5.057E+05
Target (ng/L) to Meet Oregon Fish Tissue Criterion (0.04 mg/kg)	2.4	1.2	0.08
Target (ng/L) to Meet Idaho Fish Tissue Criterion (0.30 mg/kg)	17.8	8.9	0.6

Note: Results for Total Hg are rounded to the nearest tenth of a ng; results for MeHg are rounded to the nearest hundredth of a nanogram.

Of the potential targets shown in Table 9, the targets based on the Oregon fish tissue criterion are most restrictive. Use of the 2.4 ng/L target for total Hg is consistent with IDAPA 58.01.02.210 (03)(c)(iv)(2), which states “The implementation of a fish tissue criterion in NPDES permits and TMDLs requires a nontraditional approach, as the basic criterion is not a concentration in water. In applying the methylmercury fish tissue criterion in the context of NPDES effluent limits and TMDL load reductions, the Department will assume change in fish tissue concentrations of methylmercury are proportional to change in water body loading of total mercury.”

5 Accounting for Uncertainty

Confidence limits are not currently provided for target concentrations developed with either the regression approach (Section 4) or the BAF approach (Section 5) . For the BAF approach, USEPA (2010, p. 32) says “EPA does not recommend basing an AWQS [ambient water quality standard] on BAF values associated with the extremes of the distribution (e.g., 10th or 90th percentiles), unless supported by site-specific data.” Many mercury TMDLs have relied primarily on implicit margins of safety, noting the many conservative assumptions incorporated in the development of the fish tissue criterion for the protection of human health (USEPA, 2001). Alternatively, a margin of safety could be introduced into the allocation calculations by using an upper confidence limit on the regression for the length-standardized fish tissue concentration.

6 References

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Appendix D. Jordan Creek Mercury Loading from Atmospheric Deposition, Background Soil Concentrations, and Legacy Mining Activities

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1 Introduction

In 2010 Idaho Department of Environmental Quality (IDEQ) submitted total maximum daily loads (TMDLs) for waterbody segments impaired for water temperature, sediment, and mercury in the Jordan Creek watershed. In 2011, the U.S. Environmental Protection Agency (EPA) approved the water temperature and sediment TMDLs but disapproved the mercury TMDLs and the disapproval cited that the submitted mercury TMDLs were not shown to be protective of aquatic life based on Idaho's fish tissue criterion. EPA drafted a revision to the TMDL in 2011. Shortly thereafter a more stringent fish tissue standard went into effect for Oregon. The TMDL for Jordan Creek needs to meet water quality standards for Idaho and be protective of downstream waters in Oregon, thus, must also consider the Oregon fish tissue mercury standard. EPA redrafted the TMDL in 2014 and released it for public comment, although it was not finalized. In 2021, work began to update and finalize the TMDL. The technical assessments have been revised to reflect newly available data, literature, and methods.

This memorandum describes analyses completed to quantify mercury loads from atmospheric deposition and soil and stream erosion within the Jordan Creek watershed. It is a thorough revision and update of Appendix D from the EPA 2014 draft TMDL. Section 2 tabulates atmospherically deposited mercury and applies spatially varied, runoff-based delivery ratios to determine the mercury loaded to the stream network from wet atmospheric deposition. Section 3 applies soil mercury concentrations and estimates of soil erosion and delivery to quantify mercury loads from soils in the watershed. Section 4 estimates mercury derived from contaminated sediment associated with historic mining activities along the Jordan Creek mainstem. Section 5 summarizes mercury loading from the nonpoint sources discussed in this memorandum. The contents of these sections have been revised to reflect new observational data from EPA's 2021 sampling effort and new secondary sources such as updated coverages of wet and dry atmospheric deposition.

The monitoring data is supplemented by the detailed results of the USGS SPARROW model analysis for the Pacific Northwest (Wise, 2019; 2020). SPARROW predicts annual flow, nitrogen loads, phosphorus loads, and sediment loads for every reach in the NHD v2 dataset, including multiple reaches for Jordan Creek and its tributaries. The SPARROW analysis for Jordan Creek is not perfect nor is it explicitly calibrated to Jordan Creek due to the lack of continuous data. However, the SPARROW analysis does provide estimates of flow and sediment transport at the high-resolution scale of the NHD v2 network. For instance, the mainstem of Jordan Creek from Silver City to the Oregon state line is represented in 47 segments, and every blueline tributary is also included in the model. The detailed output (Wise, 2020) is particularly valuable for analysis of Jordan Creek due to scant amount of flow gaging and suspended sediment observations that are available.

Information provided in this memorandum is applied in the 2023 version of the Jordan Creek Mercury TMDL.

2 Atmospheric Mercury

Elemental mercury (Hg) exists in a gaseous form and is readily transported long distances in the atmosphere. Because of its high volatility, net deposition rates of elemental Hg to the land surface are low. Significant deposition occurs when elemental Hg is converted to ionic forms by chemical reactions in the atmosphere and also through the uptake of elemental mercury by plant leaves. In areas without local geologic or industrial sources of Hg, atmospheric deposition is the primary source of Hg to waterbodies (e.g., Watras et al., 1994).

2.1 Atmospheric Mercury Deposition Rate Estimates

Atmospheric deposition of Hg occurs in both wet and dry forms, corresponding to fluxes dissolved in rainfall and fluxes associated with dust and foliar uptake. For the 2014 draft of the TMDL, rates of mercury atmospheric deposition to the watershed were extracted from the Regional Modeling System for Aerosols and Deposition (REMSAD; Bullock et al., 2008) application for 2001 conditions, a three-dimensional atmospheric transport model designed to calculate concentrations of inert and chemically reactive pollutants through simulation of the physical and chemical processes in the atmosphere and land surface at a spatial resolution of 12 km.

The REMSAD application is now out of date. More recent and detailed summaries of mercury deposition are available from the Western North American Mercury (WNAM) project (Domagalski et al. 2016). The deposition grids developed through that project provide annual total mercury wet deposition estimates in µg/m^2 for the period 2000 to 2013. The WNAM project estimated mercury wet deposition (in µg/m^2) from grids at a resolution of 800 m developed from monitoring data collected by the Mercury Deposition Network (MDN; *http://nadp.sws.uiuc.edu/mdn*) coupled with estimates of dry deposition at a resolution of 40 km. The MDN point estimates of total mercury concentration were converted to loads and interpolated based on gridded precipitation data from PRISM (Parameter-elevation Relationships on Independent Slopes Model; *http://prism.oregonstate.edu*). Atmospheric deposition fluxes were estimated across the watershed and summarized for each land use/cover in the drainage area. Land uses/covers were based on the 2006 National Land Cover Database (NLCD); more recent versions of NLCD were not applied because there has been little land use change in the watershed and because NLCD 2006 was applied in the upland erosion analysis (Section 3.2). Wet deposition fluxes were extracted for the watershed and applied for load estimation purposes. Figure 1 displays the resulting average annual WNAM wet mercury deposition grids. Estimated loading rates of mercury wet deposition grouped by land use are shown in Table 1. The annual average load of mercury in wet deposition to the Idaho portion of the Jordan Creek watershed is 9,081 g/yr, only a fraction of which is delivered to the stream network.

It is extremely difficult to directly measure net dry deposition because there are complex bi-directional fluxes and much of the deposited mercury is re-emitted to the atmosphere. Dry deposition fluxes provided by Domagalski et al. (2016) are estimated from the Community

Multiscale Air Quality (CMAQ; *https://www.cmascenter.org/cmaq/*) model run for 2009 conditions at a 40-km spatial resolution. The 2009 results are assumed to approximate dry deposition rates for other years as well and range from 3.68 to 14.75 µg/m^2/yr. Bullock et al. (2008, 2009) demonstrated that REMSAD and CMAQ have similar levels of skill in predicting wet atmospheric deposition of mercury, but CMAQ (in the configuration used by Bullock et al.) predicted substantially higher dry deposition rates. The 2009 dry atmospheric deposition flux for the Idaho portion of the Jordan Creek watershed is 5,153 g/yr. As with wet deposition, only a small fraction of this mercury is delivered to the stream network.

Dry deposition of mercury is greatly enhanced by leaf uptake and subsequent litter fall in areas with vegetation. For the TMDL mass balance, loads to the stream network from dry deposition of mercury to upland land surfaces are represented implicitly via soil concentrations that reflect the net deposition and re-emission of mercury.

Dry deposition loads of mercury are also estimated separately for direct deposition to waterbody surfaces for the TMDL. An analysis of flux studies by Zhang et al. (2016) concluded that dry deposition to water surfaces ranged from 1.0 to 3.2 µg/m^2/yr and was about an order of magnitude less than net dry deposition to soils in forested areas. While there is substantial uncertainty in the rate of dry deposition of mercury direct to water this is expected to have minimal impact on the TMDL due to the small surface area of water within the Jordan Creek watershed. Gridded annual total mercury dry deposition (µg/m^2/yr) data were calculated over Jordan Creek watershed major streams and areas classified as Open Water land use in NLCD 2006. Zonal Statistics was used to calculate an estimated total dry mercury deposition load on waterbody surfaces within the Idaho portion of Jordan Creek watershed as 33.39 µg/yr.

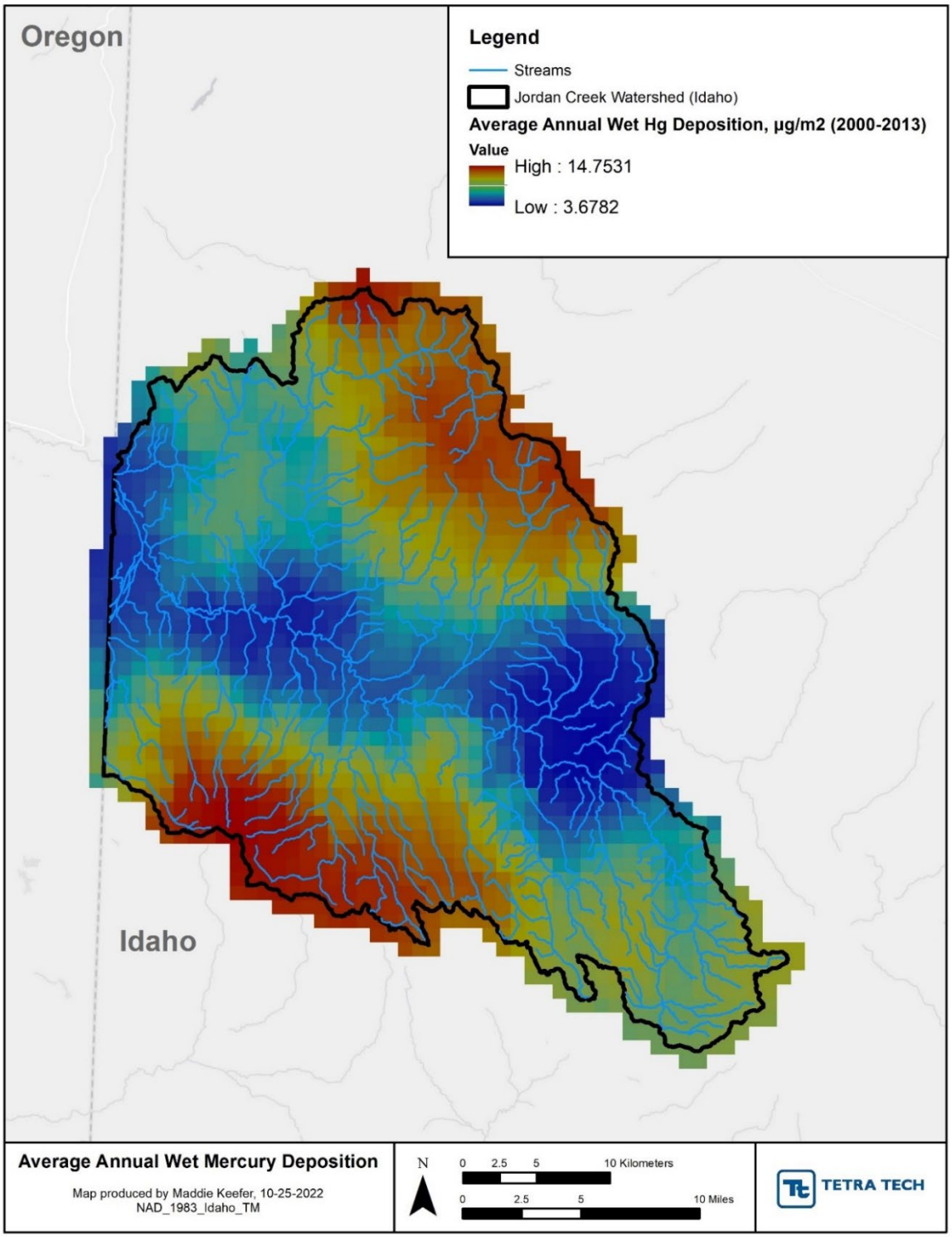


Figure 1. Average annual mercury wet deposition for the Jordan Creek subbasin, 2000-2013.

Table 1. Estimated atmospheric mercury wet deposition (g/yr) by land use categories.

Land Use Category	Mean Atm. Wet Dep. Rate (g/km^2/yr)	Total Wet Deposition (g/yr)
Rangeland	6.3	6,685.6
Forest	8.3	2,213.7
Wetlands	4.9	66.5
Grassland/Herbaceous	6.0	48.8
Agricultural Land	4.6	37.4
Barren Land	8.1	22.1
Open Water	4.9	4.5
Developed, Open Space	4.9	8.9
Watershed Total	-	9,087.5

2.1.1 Global Background Sources of Atmospheric Mercury

The Particle and Precursor Tagging Methodology (PPTM) feature of REMSAD allows the tagging or tracking of emissions from selected sources or groups of sources to quantify their contribution to mercury deposited throughout the modeling domain and simulation period. For the 2014 TMDL draft a source analysis was performed by Dwight Atkinson of EPA using the PPTM feature of REMSAD for just the Idaho portion of the Jordan Creek watershed was provided by EPA. While the REMSAD application is out of date, the results provide some insights into the relative importance of different sources. The REMSAD modeling indicated that approximately 85% of the mercury deposited on the Jordan Creek watershed under 2001 emission conditions was from global background sources, leaving 15% from U.S. sources. Nevada gold mines and Ash Grove Cement Plant were two regional sources composing approximately 12% of mercury deposited on the landscape. U.S. emissions and atmospheric concentrations of mercury have decreased since conditions in 2001 that formed the basis for the REMSAD modeling, although the most significant decreases have been in the eastern U.S. (Olson et al., 2020). Since that modeling was conducted, the State of Nevada established and began implementing regulations to control mercury emissions from gold mines. The State of Oregon negotiated an agreement with Ash Grove Cement to reduce their mercury emissions 85% by 2012. In addition to these control measures, EPA set national regulatory controls for mercury air emissions from cement plants and gold processing sources in 2010.

Global background mercury budgets from several studies were summarized in Seigneur et al. (2004), indicating that anthropogenic sources (both direct and re-emitted) likely account for 50% to 75% of background atmospheric mercury (Table 2).

Table 2. Global Atmospheric Mercury Budgets (from Seigneur et al., 2004)

Emissions	Source						Summary Statistics	
	Bergan et al. 1999	Mason and Sheu 2002	Lamborg et al. 2002	Seigneur 2004, base	Seigneur 2004, lower bound	Seigneur 2004, upper bound	Mean	Median
Direct Anthropogenic (Mg/yr)	2,160	2,400	n/a	2143	2,143	2,143	2,198	2,143
Re-emitted Anthropogenic (Mg/yr)	2,000	2,090	4,800	2134	1,067	2,670	2,460	2,112
Natural from Land (Mg/yr)	500	810	1,000	1180	1,805	878	1,029	939
Natural from Oceans (Mg/yr)	1,400	1,300	600	954	1,396	720	1,062	1,127
Total (Mg/yr)	6,060	6,600	6,400	6,411	6,411	6,411	6,382	6,411
Direct anthropogenic as % of total	36%	36%	n/a	33%	33%	33%	34%	33%
Anthropogenic % of total	**69%**	**68%**	**75%**	**67%**	**50%**	**75%**	**73%**	**66%**

Selin and Jacob (2008) studied the spatial and seasonal variations of mercury deposition in the U.S. using the 3-D GEOS-Chem chemical transport model. The model used 2004-2005 data from the national mercury deposition program (MDN) that included 57 sites across the United States. Based on model simulations, the average annual contribution of primary anthropogenic U.S. sources to total mercury deposition is approximately 25% for the Jordan Creek watershed. This is consistent with the "Direct anthropogenic as % of total" findings listed by Seigneur (2004) identified in Table 2.

EPA maintains a National Emissions Inventory [NEI] for hazardous air pollutants that is updated every three years (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei). Detailed results for mercury by state are available since 2008 and include both fixed and mobile sources. Comparison of 2008 and 2017 tabulations (Table 3) show large declines for Nevada and Oregon, while the Idaho emissions have approximately doubled.

Table 3. National Emissions Inventory estimates for mercury air emissions (lb/yr)

State	2008		2017	
	Total	**Industrial**	**Total**	**Industrial**
Idaho	761	83%	1,511	86%
Nevada	3,672	92%	1,981	89%
Oregon	1,842	85%	386	30%

2.1.2 Atmospheric Deposition and Waterbody Mercury Loads

Atmospherically deposited mercury contributes to waterbody mercury load in three main ways: by direct deposition to water surfaces, by increasing the concentration of dissolved mercury present in surface and subsurface runoff, and by contributing to mercury concentrations in soil that can subsequently erode and be delivered to streams. As noted above, direct deposition to water is a minor component of the mercury balance in the Jordan Creek watershed, primarily because the areas occupied by open water are small. Dissolved mercury transport depends on the amount of precipitation that is delivered to streams. This transport is estimated using runoff and mercury delivery ratios, discussed in Section 2.2. Atmospheric deposition contributions to soil mercury are implicitly included in the soil mercury concentrations discussed in Section 3.

Atmospheric sources are a significant portion of the mercury mass balance in the Jordan Creek watershed. The reductions in air emissions that result from ongoing regulatory processes will decrease the amount of mercury added to Jordan Creek. However, mercury that has already been deposited in elevated quantities from atmospheric deposition (as well as from past mining activities) in the subbasin will continue to erode into Jordan Creek, and global mercury sources outside U.S. regulatory controls will likely continue to deposit in the watershed for many years to come.

2.2 Delivery Ratio Estimates for Mercury Wet Deposition

2.2.1 Land Use

The amount of atmospherically deposited mercury conveyed to a waterbody has been shown to be a function of land cover (ORDEQ, 2006; Grigal, 2002; USEPA, 2001). For wet deposition, land cover is an important controlling factor on both runoff rates and retention of mercury in soils. Dry deposition of mercury is in large part due to foliar uptake of elemental mercury with subsequent conversion to ionic forms and deposition to the soil in leaf litter (Watras et al., 1994; Domagalski et al., 2016).

The Jordan Creek watershed is primarily composed of two land cover categories: scrub/shrub (occupying 78 percent of the watershed) and evergreen forest (occupying 19 percent of the watershed). The scrub/shrub land use is identified by the Natural Resources Conservation Service (NRCS) as rangelands in the Rapid Watershed Assessment for Jordan Creek (NRCS, 2007). Emergent herbaceous and woody wetlands occupy approximately one percent of the

watershed while all other land use categories occupy less than one percent of the watershed. The areal extent of these land use categories is summarized in Table 4; land use data statistics were derived from the 2006 NLCD GIS data layer (Fry et al., 2011) and includes only the portion of the Jordan Creek watershed (HUC 17050108) located within the state of Idaho but excluding the area of the HUC-8 that does not drain to Jordan Creek before entering the state of Oregon (i.e., Cow Creek watershed).

Table 4. Areal extent of land use categories in the Jordan Creek Subbasin in Idaho.

Land Use Category	Land Use Area (acres)	Land Use Area (km^2)	Percent of Watershed
Rangeland - Scrub/Shrub	264,553	1,070.6	78.5%
Forest – Evergreen	65,302	264.3	19.4%
Wetlands	3,431	13.9	1.0%
Emergent Herbaceous Wetlands	2,995	12.1	0.9%
Woody Wetlands	436	1.8	0.1%
Grassland/Herbaceous	1,375	5.6	0.4%
Agricultural Land	1,388	5.6	0.4%
Pasture/Hay	1,364	5.5	0.4%
Cultivated Crops	24	0.1	0.0%
Barren Land	436	1.8	0.1%
Open Water	301	1.2	0.1%
Developed, Open Space	189	0.8	0.1%
Total Land Area:	336,975	1,070.6	

2.2.2 Mercury Delivery Ratios

In the 2014 draft of the TMDL, delivery factors derived from literature were used to estimate the fraction of atmospheric wet deposition of mercury transported to waterbodies. These delivery ratios were taken from a study of the Willamette River Basin TMDL in Oregon (ORDEQ 2006) and were not specific to the Jordan Creek watershed location within Idaho. A different approach is taken for this study.

We first assume that the spatial pattern of wet deposition of mercury (Figure 1) and the spatial pattern of runoff generation are good indicators of the spatial pattern (although not the total mass) of dissolved mercury delivered to the stream network. For this analysis the wet deposition mercury load was first updated with estimates of the fraction of precipitation converted to runoff for the Jordan Creek drainage area from the gridded United States Geological Survey (USGS) water-balance model (WBM) (Wieczorek et al. 2022), which reflects

the land use categories in the watershed. Spatially varying runoff-to-precipitation (mm/mm) ratios were calculated using extracted annual average runoff and precipitation estimates from the WBM. Figure 2 shows the spatially varying runoff ratios across the Idaho portion of the Jordan Creek watershed.

The runoff estimated by the WBM includes both direct overland flow and shallow subsurface soil flow pathways. Mercury transmitted through the soil will likely experience variable rates of attenuation due to sorption or re-volatilization that vary with residence time and reduce the total load. Most of the mercury load derived from atmospheric deposition is not delivered directly to streams but rather is retained in the landscape. Domagalski et al. (2016) summarize ratios of mercury yield in streams relative to total mercury deposition (wet plus dry) for the western US and state that in non-Arctic regions watersheds with natural vegetation watersheds tended to have low ratios of Hg runoff (mostly < 10%) whereas urbanized watersheds had higher ratios (34 – 100%) because of runoff from impervious surfaces. There is not a perfect surrogate for the Jordan Creek hydroclimate in the Domagalski paper. Of the sites studied by Domagalski, the Sagehen Creek site in California is a potential reference for Jordan Creek because it has a generally dry forest landscape with relatively low organic material. The mercury runoff ratio/percent for this site is 3 percent. This estimated delivery ratio is possibly low relative to Jordan Creek because there is less forest/organic matter in the Jordan Creek catchment than in that of Sagehen Creek.

The delivery ratios presented by Domagalski et al. relate stream mercury yield to the sum of wet and dry atmospheric deposition on the watershed. Delivery of mercury sorbed to eroded soil, assumed to be largely derived from current and historic dry atmospheric deposition, is analyzed independently based on soil erosion analysis (Section 5.1). The ratio of sorbed mercury delivered in Jordan Creek at the Oregon border to dry atmospheric deposition on the watershed is 334/5,153 g/yr or 6.5 percent, which is in the range presented by Domagalski et al. but is likely to have a high bias due to contributions to soil mercury from native geogenic sources and wet deposition. We experimented with different Hg runoff ratios in the mass balance accounting for Jordan Creek (see Section 5 in this appendix) and found that a 3 percent net delivery ratio provided a close match to observed background concentrations calculated only from wet atmospheric deposition at stations in the Jordan Creek watershed. The overall delivery ratio for mercury from wet and dry atmospheric deposition is then 4.3 percent, consistent with being slightly greater than the reported delivery ratio for Sagehen Creek.

A summary of water column monitoring data for the Jordan Creek watershed is provided in Section 5 of the main TMDL document. The background station identified in the 2021 IDFG sampling had observed total mercury (tHg) concentrations of 3.95 (April higher flow) and 1.68 ng/L (October low flow), for an average of 2.82 ng/L. 2021 station WC1 also appears to have little impact from mining and had tHg concentrations of 2.9 (April) and 0.57 ng/L (October), while the Trout Unlimited mainstem sample upstream of the mining area (JOR-01) had a concentration of 1.02 ng/L (also from October). IDEQ samples from 2005, all collected in August, from stations WC 2005-13, BC 2005-04, and FC 2005-06, all of which appear likely to represent background concentrations, had concentrations ranging from 0.76 to 1.80 ng/L. Across all these samples, the average observed concentration was 1.74 and the median 1.46

ng/L. The estimated concentration calculated only from atmospheric deposition inputs with a net 3 percent total mercury delivery ratio for the entire Jordan Creek watershed within Idaho is 1.58 ng/L with slightly higher estimated concentrations upstream (e.g., 1.79 ng/L at station JC2 at Flint Road). The net 3 percent delivery ratio is obtained by applying an additional multiplier of 0.115964438 to the wet atmospheric deposition load reduced by the runoff to precipitation ratio (average 0.2587), thus preserving the spatial pattern of mercury wet deposition.

The estimates derived for dissolved mercury yield from wet atmospheric deposition do not account for additional losses in transit to the Oregon state line, which includes a few small diversions and losses to ground water. The SPARROW model (which also uses the WBM for hydrology) does attempt to account for such losses, which (in Idaho) occur primarily in Pleasant Valley near the Oregon line. SPARROW does not report flow losses directly, but these can be estimated from the average flow predicted at the border. USGS gage 13178000 (Jordan Creek above Lone Tree Creek near Jordan, OR), which is just upstream of the border within Idaho was operational for 1945-1971 and 2002-2003 and an average flow of 190 cfs. The annual average SPARROW flow at the border is 186.066 cfs, in close agreement with the USGS gage record, while the WBM analysis of flow into the stream network described above yields 218.72 cfs. The ratio of the SPARROW and WBM estimates is 0.8507. The estimates of wet deposition load at the Oregon border are thus further adjusted by applying this factor to account for diversions and other flow losses.

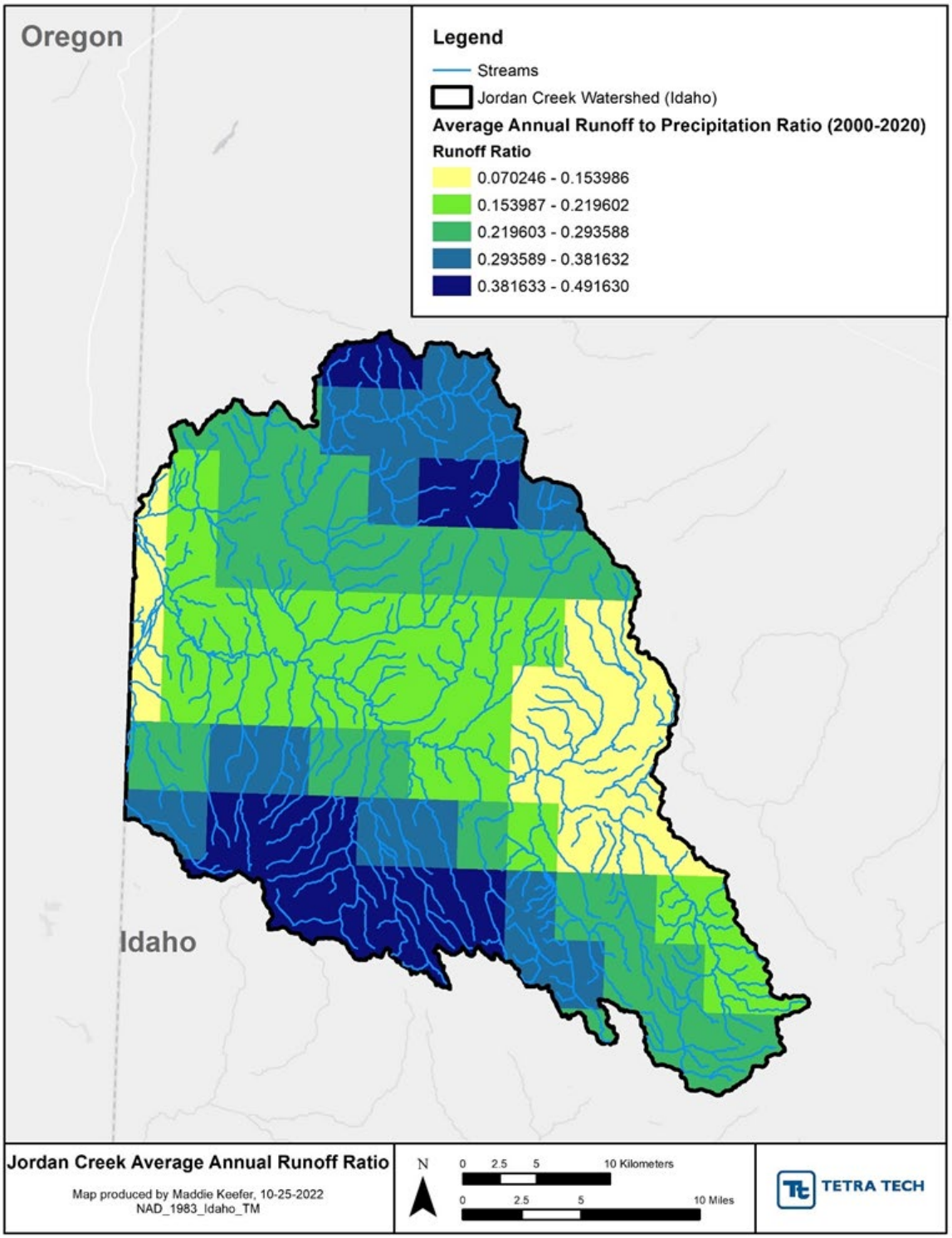


Figure 2. Jordan Creek runoff-to-precipitation ratios from the USGS Water-Balance Model.

3 Soil Mercury Contributions

A major pathway for mercury loading to waterbodies is the erosion of mercury-containing soil. Mercury concentrations in soil, excluding any areas contaminated by mining tailings or waste disposal, derive from a combination of natural geologic background and the accumulation of mercury inputs from atmospheric deposition. Mercury in wet atmospheric deposition on pervious surfaces is either transported directly to the stream network via overland flow or contributes to the soil mercury concentration if associated with precipitation that infiltrates. Accounting for dry atmospheric deposition of mercury is more challenging because the major flux pathway in vegetated areas is through leaf uptake and subsequent deposition of litter to the soil. Eckley et al. (2016) used flux chamber data to examine soil-air mercury fluxes in the Western North America region and demonstrated that most of the variability in soil-air mercury fluxes could be explained by variations in soil- mercury concentrations, solar radiation, and soil moisture.

This section estimates the background mercury load concentration associated with erosion of soil in the watershed. It does not include mercury contributions from imported mercury used in the ore amalgamation process in legacy mining, which is discussed separately in Section 4. The sources described in this section are referred to as “background” sources because they reflect diffuse loading. They should not, however, be referred as “natural” sources as the concentrations of mercury in soils reflect a long history of atmospheric deposition of anthropogenically derived mercury.

3.1 Mercury Concentrations in Soils

The average global crustal abundance of mercury has been estimated at 0.05 mg Hg/kg (UNEP, 2002). Throughout the conterminous United States, the average mercury soil concentration is about 0.06 mg Hg/kg (Holloway et al., 2009). USGS (Smith et al. 2019) developed a gridded map of soil mercury concentrations throughout the conterminous US based on relatively sparse soil samples, with inverse distance weighting between measured points. Obrist et al. (2016) reanalyzed the USGS data and confirmed that soil mercury concentrations differ significantly among land cover types, with the highest concentrations (but lowest erosion rates) in forest soils and the lowest concentrations (but highest erosion rates) in barren soils. In Obrist’s analysis by ecoregion, southeastern Idaho (including the Jordan Creek watershed) is within the North American Desert ecorgion for which the median mercury concentration was 18.7 µg/kg and the average 23.5 µg/kg. Maps of mercury distribution in soils of the conterminous United States generated through interpolation of earlier USGS soil samples collected during the Shacklette and Boerngren (1984) study show mercury soil concentrations between 33 and 50 µg/kg for the location of the Jordan Creek watershed (Gustavsson et al. 2001).

Smith et al. (2019) shows the estimated mercury concentrations in the upper 5 cm of soil, which is the layer most likely to contribute erosion to streams, as falling below the 60th percentile of the national distribution with concentrations in the range of 0.01 to 0.03 mg/kg in the Jordan Creek watershed. Low concentrations in typical Jordan Creek soils are not

unexpected because the extent of vegetative canopy is low. This reflects the importance of leaf uptake of mercury by plants in contributing to mercury concentrations in soils via litterfall (Obrist et al., 2016). The un-mineralized areas within the Jordan Creek watershed within Idaho were assumed to have a spatially varying native mercury soil concentration according to the data presented in Smith et al.

In July of 2013, EPA requested feedback and additional information on mercury in soils from Virginia Gillerman with the Idaho Geological Survey (IGS). While the general estimated range of soil concentrations shown above was confirmed by IGS as a reasonable average for un-mineralized and background soil concentrations in the watershed, IGS also identified that there exist several sizeable hydrothermal mineralized areas that may contain higher than average mercury concentrations in this area of southwest Idaho. For the 2014 TMDL draft, IGS recommended that an upper bound mercury concentration of 1.0 mg Hg/kg (or, 1,000 mg Hg/ton) of soil would be more appropriate for mineralized areas for estimating their relative contribution of mercury to the Jordan Creek system upstream of the Oregon state line.

Mineralized areas were identified in the 2014 draft TMDL assessment and retained for this update. To identify the spatial extents of mineralized areas IGS and EPA recommended using a proxy by spatially correlating mining activity where mercury, gold, and/or silver were found and extracted (these three ores tend to occur together in hydrothermal areas). To do this, active and historic mines were identified from two sources – the IGS Mines and Prospects Database (Mitchell et al., 2011) and the USGS Mineral Resources Data System, or MRDS (USGS, 2005). Both resources include data from multiple current and historic sources, and both identify that much of the information is incomplete and database fields are often poorly populated. While there is much duplication of mine data between the two sources, each has numerous unique records within the Jordan Creek watershed not included with the other. EPA indicated that mine locations in MRDS tend to be less accurate than in the IGS database.

Processing of mine database records was performed on each source, with initial steps in common. First, mine locations within the Jordan Creek watershed were selected. Next, database records were examined to determine the source of information for commodity (i.e., mercury, gold, and/or silver), type of deposit, and degree to which the mine was developed. Commodity was identified in the IGS database from the linked Commodity table, and from MRDS using the three commodity fields. All mines were excluded that did not list mercury, gold, or silver. Deposits identified as "placer" in the mine name and/or various description fields were also excluded (placer deposits are those found in riverbeds, and may not originate from the immediate upland, surrounding area). Mines identified as "occurrence" (no mine developed) or "prospect" (mine in early stages of development) were excluded based on guidance from EPA staff. MRDS and the IGS database were then compared, and duplicate mines were excluded from MRDS using the assumption that the IGS location information was more accurate. The result was unique locations from IGS and MRDS of what are assumed to be surface and/or underground mines with mercury, gold, and/or silver as commodities. It is important to note that deposit type and degree of mine development could not be determined for many records in both datasets. However, these were still included since most of the records with data represented well developed surface or underground mines.

Mineralized areas were assumed to extend 0.25 miles around each mine site in all directions. Each of the mine locations was buffered this distance using GIS, and the mineralized areas were then merged. Qualifying mines tended to be located near each other in clusters, with the largest cluster located in the areas around Silver City in the upper Jordan Creek watershed area. When a merged mineralized area crossed a major watershed divide, the portion of the 0.25-mile buffer on the far side of the divide from the mine was excluded if there were no mines in the same watershed. Final extents of mineralized areas are shown in Figure 3. The gridded data from USGS (Smith et al., 2019) was combined with the recommended value of 1.0 mg Hg/kg for mineralized areas to create a comprehensive spatially varying coverage (Figure 4).

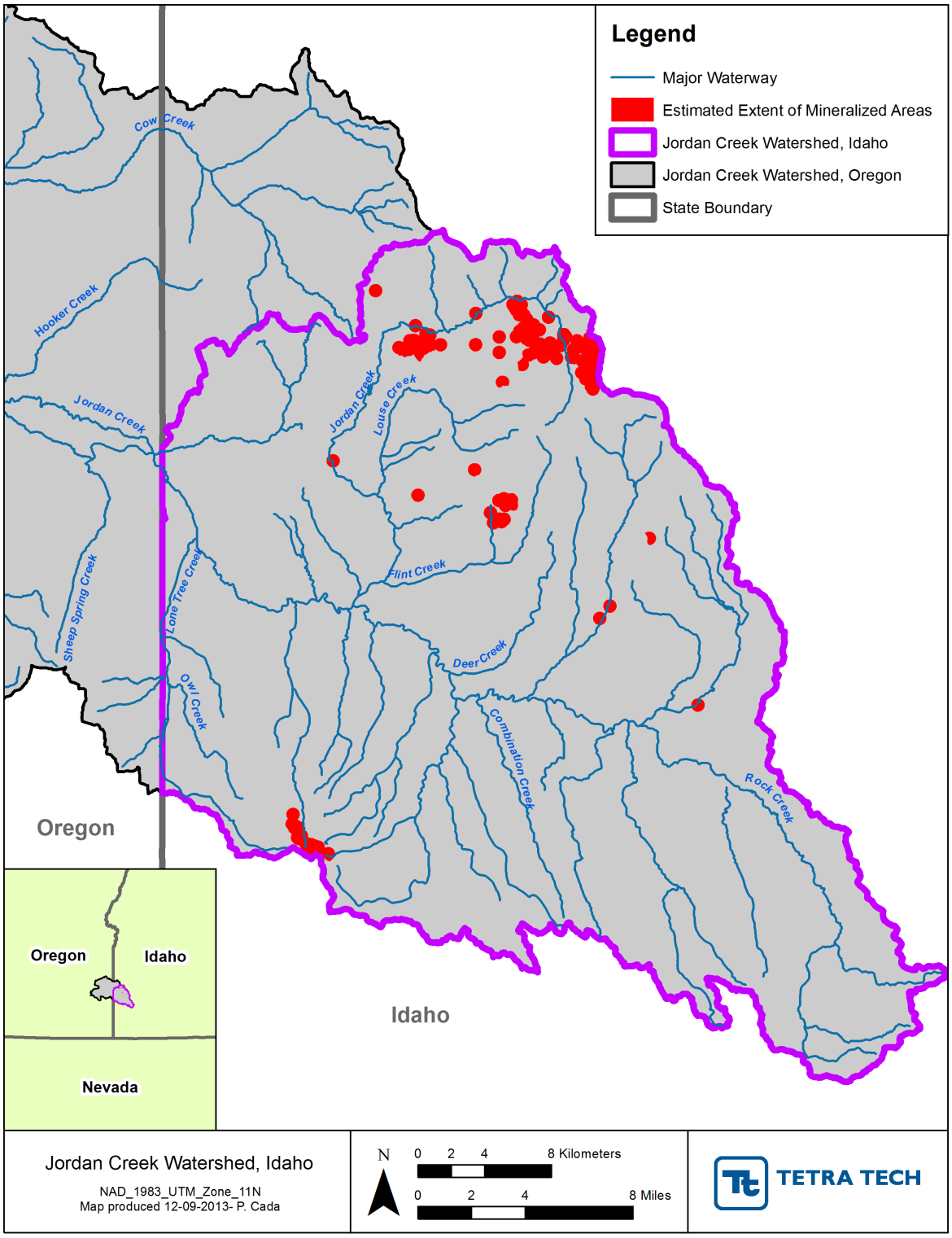


Figure 3. Estimated Extents of Mineralized Areas within the Jordan Creek Watershed

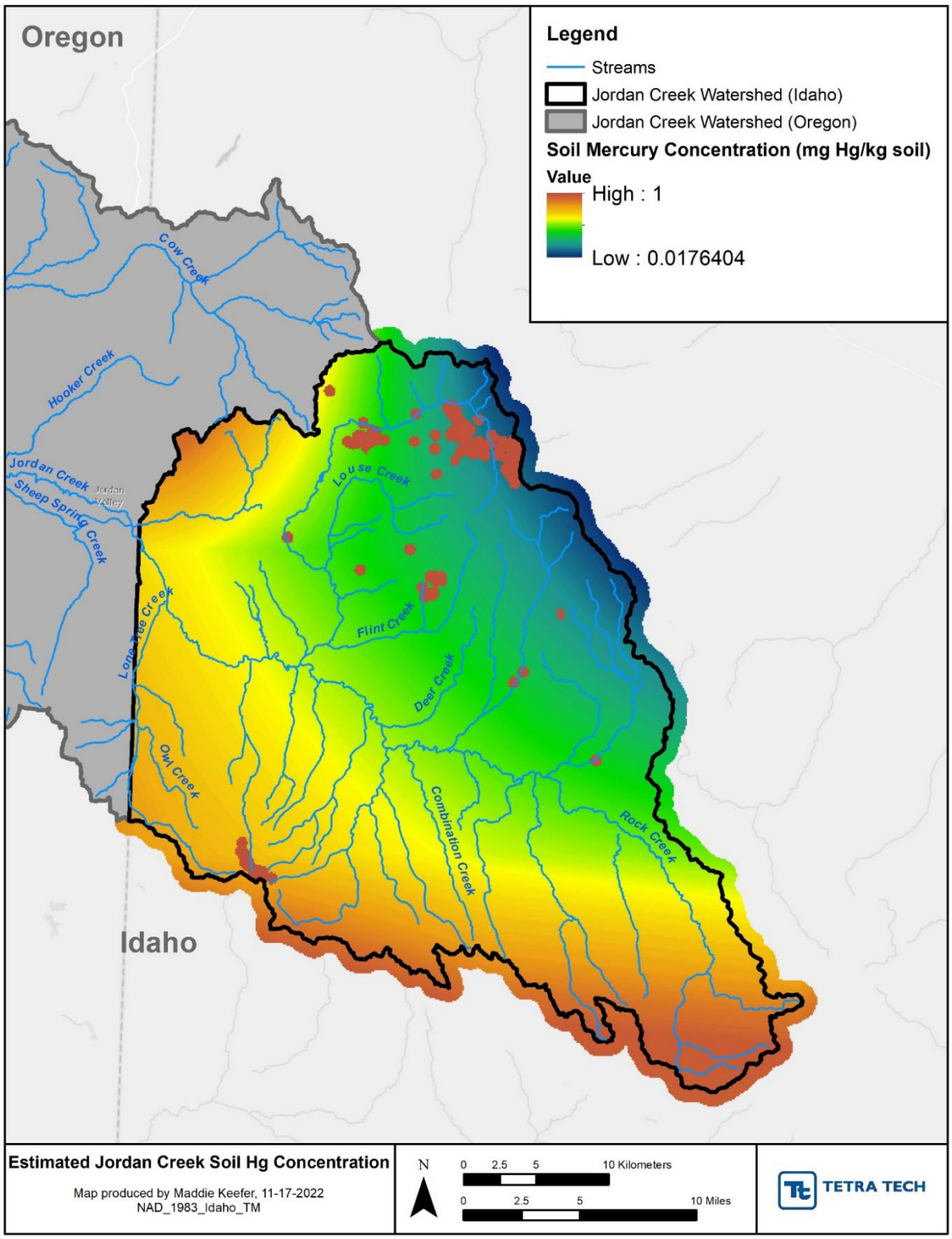


Figure 4. Estimated soil mercury concentrations for Jordan Creek Subbasin, Idaho.

Apart from mineralized areas or areas contaminated by mine waste, mercury in surface soils is largely derived from atmospheric deposition, especially dry deposition mediated by leaf uptake.

Much of this mercury is ultimately of anthropogenic origin; however, the time to reach equilibrium between surface soil and atmospheric mercury concentrations is long (on the order of centuries; see USEPA, 1997), so it would be incorrect to attribute ongoing sediment-associated loads of mercury to current day atmospheric deposition. Amos et al. (2015) provide a review of evidence on global anthropogenic enrichment of mercury based on both modeling and observations from lake sediment and peat deposits. Anthropogenic mercury emissions increased significantly with the advent of large-scale mining of gold, silver, and mercury around 1550 current era (CE) and seem to have reached a peak around 1960 CE. According to Amos et al., mercury emissions during the industrial era (ca. 1880) were about 3 to 4 times greater than during the pre-industrial era (ca. 1760), but the 18th-century emission rate was about 5 times greater than in the pre-colonial era (3000 BCE to 1550 CE). Current concentrations in surface soils thus reflect the cumulative result of many centuries of deposition of anthropogenically derived mercury emissions.

Trout Unlimited (Willis et al. 2022) collected sediment and soil samples from 15 sites in the Upper Jordan Creek watershed in October 2021, focusing on the historic Silver City mining area. As discussed in the main TMDL document (Section 6.2), historical processing at mill sites to extract gold and silver from ore used large quantities of imported mercury, resulting in extensive contamination, mostly adjacent to Jordan Creek. Therefore, the soil and sediment concentrations reported in the Trout Unlimited study should generally not be considered as representative of background in watershed soils and is analyzed separately in Section 4.

3.2 Soil Erosion Rates

Upland soil erosion estimates established for the 2014 draft TMDL were maintained and are discussed in this section.

On pervious land, precipitation energy or mechanical disturbance (e.g., from grazing, tillage, roads, or forest harvest) detaches sediment from the soil matrix. Areas with reduced vegetative cover (such as plowed fields, roads, or forest converted to shrubland) will have greater rates of sediment detachment. Overland flow carries eroded soil across the land surface. Along the way, some of the sediment is deposited back on the land surface, while the remaining fraction is transported to streams. The net capacity for transport of sediment to streams depends on the depth and velocity of overland flow, which in turn depends on precipitation, soil infiltration capacity, slope, and cover. If the concentration of mercury bound to sediment (referred to as a potency factor when expressed as mass per mass) is known, it can be combined with sediment transport rates to estimate erosion-related mercury loads delivered to the stream network. Management actions that increase cover, decrease overland flow, or otherwise trap sediment can all reduce the delivered loads.

A GIS-based approach was developed to estimate the amount of soil transported from the landscape on an annual basis. The developed approach employed spatially explicit (grid-based) parameter inputs built upon equations and recommendations found in the Revised Universal Soil Loss Equation (RUSLE) user's guide (Renard, et al., 1996). RUSLE is a revision and update to

the USLE approach; however, both still estimate soil erosion from sheet and rill erosion from rainfall and its associated runoff through the development of five "factors".

R = rainfall erosivity factor

K = soil erodibility factor

LS = slope length and steepness factor

C = cover and management factor

P = support practice factor

These five factors multiplied together result in an annual estimate of soil loss over the landscape.

A = R * K * LS * C * P

where,

A = annual soil loss from sheet and rill erosion in tons/acre

In lieu of developing a complex dynamic watershed model to estimate soil loss from sheet and rill erosion –requiring significantly more time and resources than allotted—a quasi-"steady-state", grid-based approach was employed to estimate average annual soil loss. To maximize accuracy this approach developed R-factor and C-factor inputs varying half-month (1st through 15th, and 16th through end of month) using available literature findings and/or observed data. All the 24 half-month grid-based soil loss estimates were summed to derive the estimated annual soil loss from sheet and rill erosion from each grid cell. The remainder of this section contains detailed descriptions of how each factor was derived using data from several sources and information from the RUSLE user's guide and Pierson, et al. (2001).

3.2.1 Rainfall Erosivity Factor (R-factor)

On average the watershed experiences a proportion of precipitation in the form of snow, and persistent snow cover above certain elevations, for several months of the year. Therefore, both meteorological and snow cover data were obtained and reviewed for areas within and areas surrounding the watershed. Hourly (precipitation and air temperature) and daily (snow cover) meteorological data were obtained for two stations from NOAA's National Climatic Data Center (NCDC)—one in the watershed within Idaho, the other located in the Jordan Creek HUC8 watershed (Cow Creek subwatershed) in Oregon just west of the state line (Figure 5).

To determine long-term precipitation patterns for each 24 half-month time periods all available air temperature and precipitation data were analyzed for both stations (1978-2009 for Station #108412; 1953-2003 for Station #357736). Long-term average daily precipitation amounts (inches) and the average number of days with precipitation events were determined for both monitoring locations for each 24 half-month time period. The two values for each station were multiplied together to get an estimated Precipitation value (PPT) to be used for subsequent

estimation of a spatially explicit grid-based R-factor across the Idaho portion of the watershed for each half-month time period.

Because the R-factor portion of the USLE-based approaches to estimate annual soil erosion rates are based only for the surface impacts of raindrops it is essential to account for precipitation as snowfall (where snowfall would not have the erosive power of raindrops striking the land surface). To do this, hourly air temperature and precipitation data were used to determine which precipitation events could be expected to fall as snow, and not rain. If precipitation was reported for a given hour and the air temperature for that hour was below 32 degrees Fahrenheit, the precipitation was considered to fall as snow. The long-term average proportion of reported precipitation as rain was determined from this hourly dataset for each half-month time period for both stations. These long-term average proportions were used in subsequent creation of the R-factor grids for the Idaho portion of the watershed.

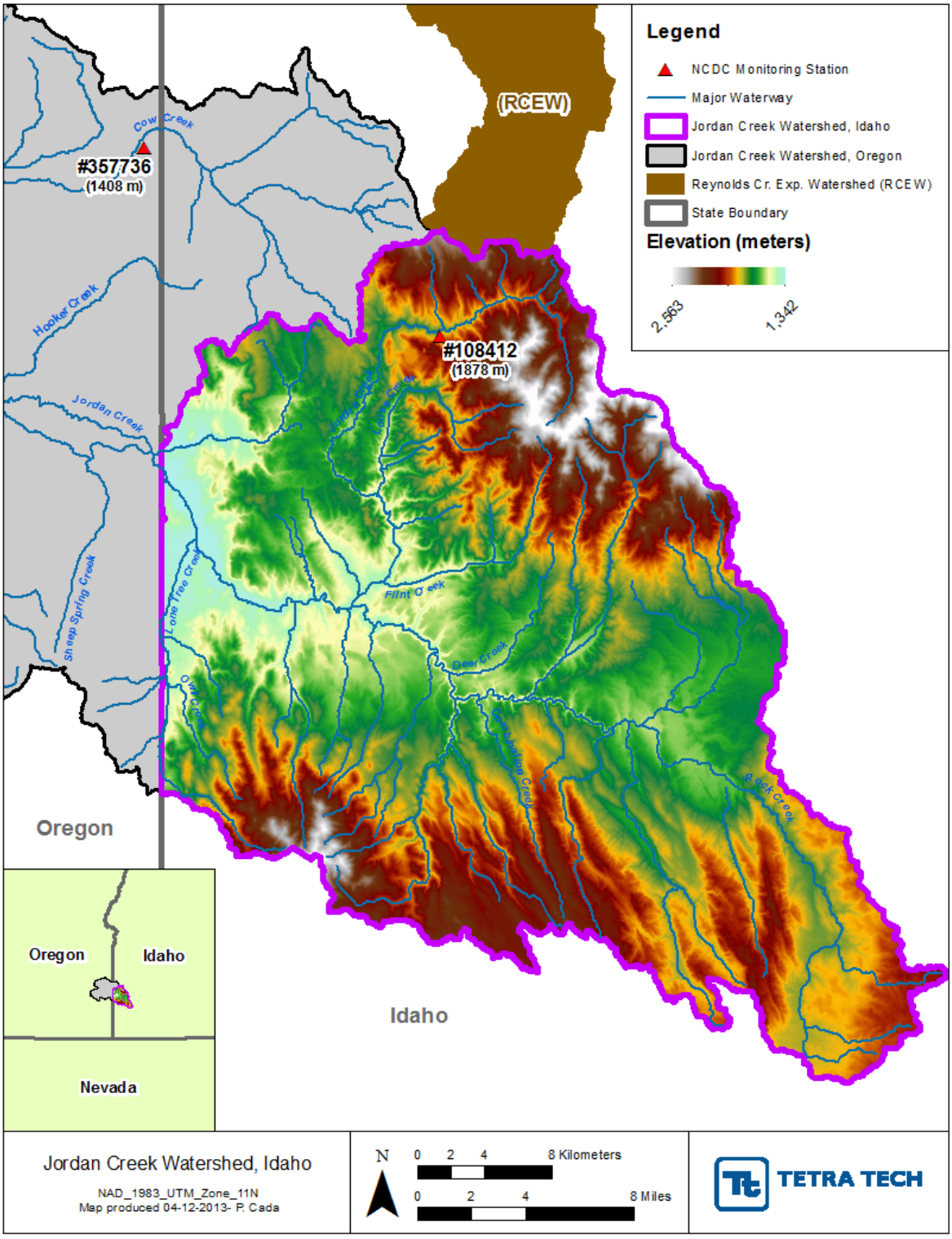


Figure 5. Location of NOAA NCDC meteorological stations, and Reynolds Creek Experimental Watershed used in estimating R-factor values.

1.1.1.1 Spatial Interpolation and Extrapolation of Precipitation Data

In a given location, the frequency, type, and intensity patterns of precipitation can vary widely over time and space. Elevation is often a factor determining where, when, what type, and how much precipitation is seen at any given location within a watershed. Using the two-point long-term averages described above for both NCDC stations—precipitation amounts (inches), and proportion of precipitation as rain)—an exponential regression was performed for all 24 half-month time periods. An exponential regression was chosen over a linear regression because it is not expected that an "upper ceiling", or elevation, exists where rainfall is not found ever. A linear relationship would have an X-axis intercept, i.e., an elevation above which no precipitation would ever occur. An example of the exponential regression is displayed in Figure 6 which shows regression results of the long-term average proportion of precipitation as rain for the January 1 to January 15 half-month time period. Figure 7 displays the regression results for estimated precipitation amounts for the same half-month time period. A total of 48 exponential regressions [(24 half-month time periods) x (2 precipitation long term average estimates)] were performed developing equations used for all spatial interpolations and extrapolations of precipitation data.

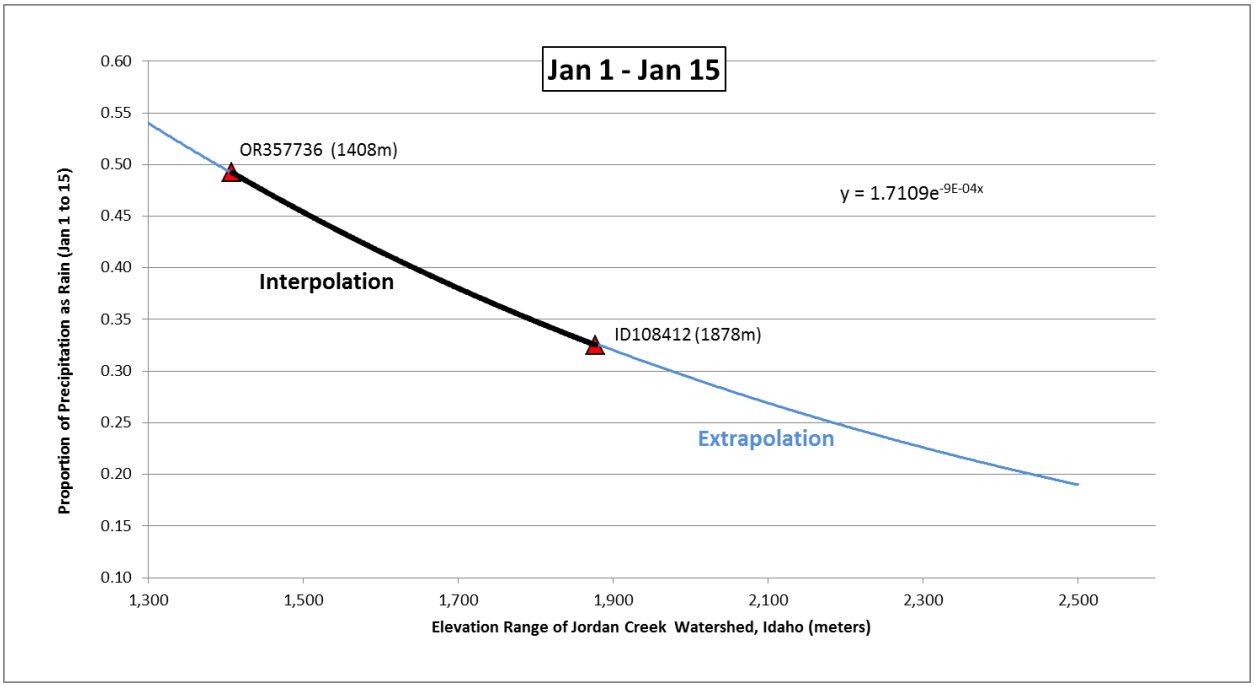


Figure 6. "Proportion of Precipitation as Rain" regression example (Jan. 1 – Jan. 15)

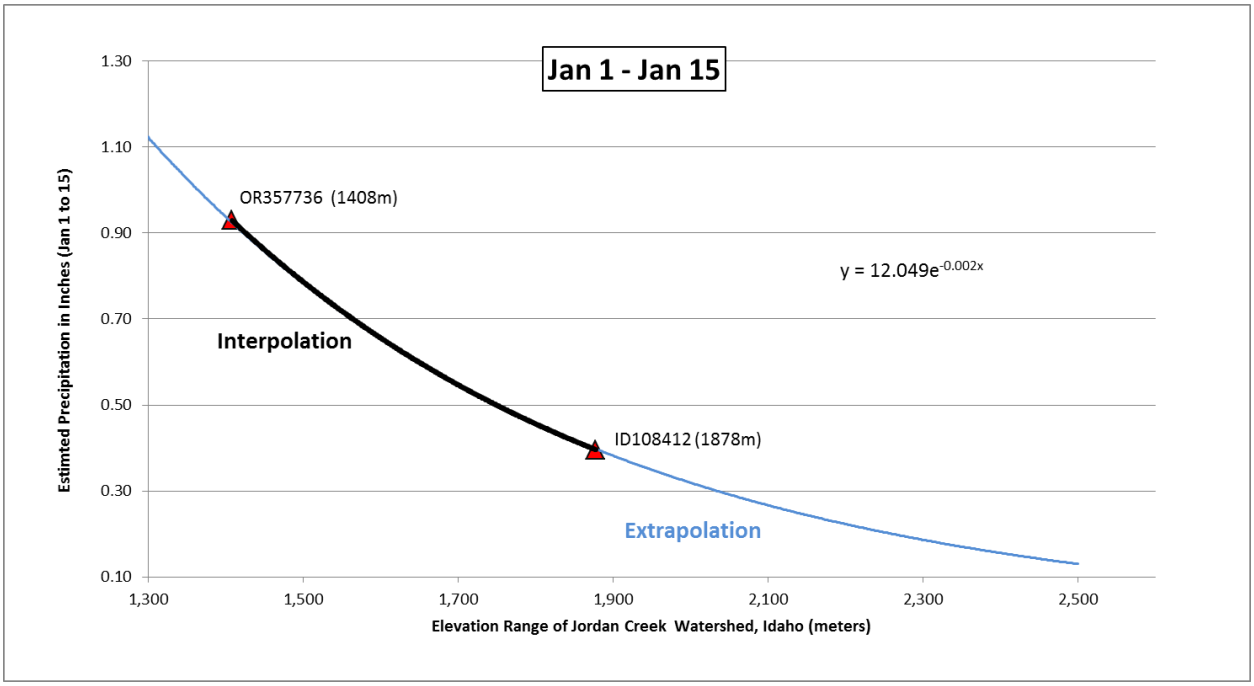


Figure 7. "Estimated Precipitation Amount" Regression Example (Jan. 1 – Jan. 15).

A spatial grid was created for each half-month time period by using each cell's average elevation in the following general equation in the Raster Calculator tool of ESRI's ArcGIS v10.1 software program:

Y = a * (Exp (b * DEM)

where,

Y = estimated precipitation amount in inches, or proportion of precipitation as rain

a = coefficient unique to each 48 exponential regressions (e.g., 1.7109 in Figure 6 example)

b = coefficient unique to each 48 exponential regressions (e.g., -0.0009 in Figure 6 example)

DEM = each grid cell's elevation value (in meters) within the Jordan Creek Watershed

Next, a net precipitation (PPT) grid for each half-month time period was created by simply multiplying the "estimated precipitation amount in inches" grid by the "proportion of precipitation as rain" grid (again, using the Raster Calculator tool in GIS).

The final step to create an R-factor grid for each half-month time period is to compute R-factor values from the 12 estimated net PPT grids. The Cooley et al. (1988) approach was selected as most appropriate for the area of interest based on their investigations related to the implications of snowfall precipitation in mountainous regions when estimating R-factor values

during winter periods. The following equation was used from the Cooley et al. (1988) study to create an R-factor grid for each half-month time period.

R = 22.17 * (PPT ^ 2.56)

1.1.1.2 Snow Cover Implications

Based on a long-term analysis of the available snow cover data recorded at both NCDC stations (Figure 8) annual average persistent snow cover was estimated to begin October 15th and continue until May 15th above an elevation of 1,800 meters.

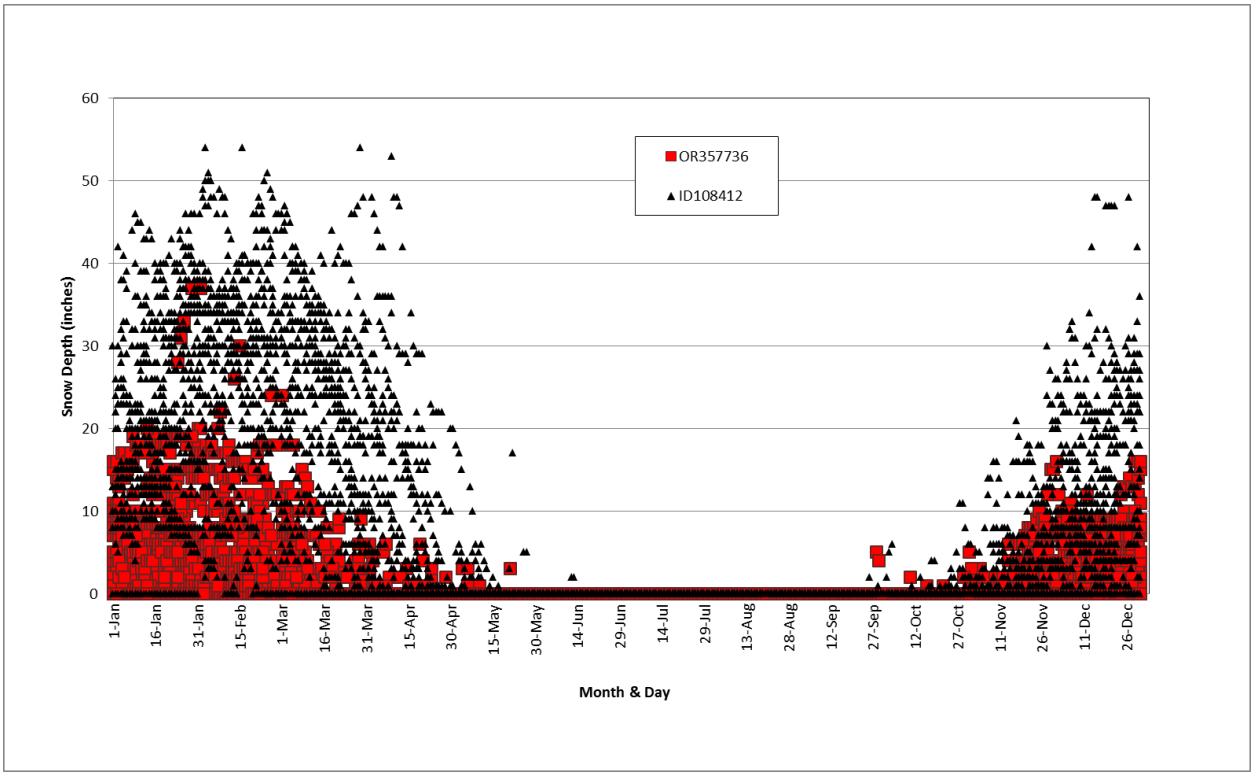


Figure 8. Long-Term Snow Depth Measurements at NCDC Stations of Interest

Supplemental snow cover data from the Reynolds Creek Experimental Watershed (RCEW)—located in Idaho adjacent to the Jordan Creek watershed—was reviewed to bolster the decision to use 1,800 meters above which persistent snow cover would be expected on average. Consequently, for half-month time periods between October 15th and May 15th areas of the watershed above 1,800 meters in elevation were removed from consideration (i.e., R-factor = 0) when estimating soil loss by sheet and rill erosion as the soil surfaces were assumed to be under snow, and therefore protected from erosion caused by rain drop impacts (Figure 9). This is a simplified approach as it does not consider movement of snow through drifting, impacts of hillslope aspect on solar radiation and subsequent snowmelt, and other factors that may affect locations of persistent snow cover.

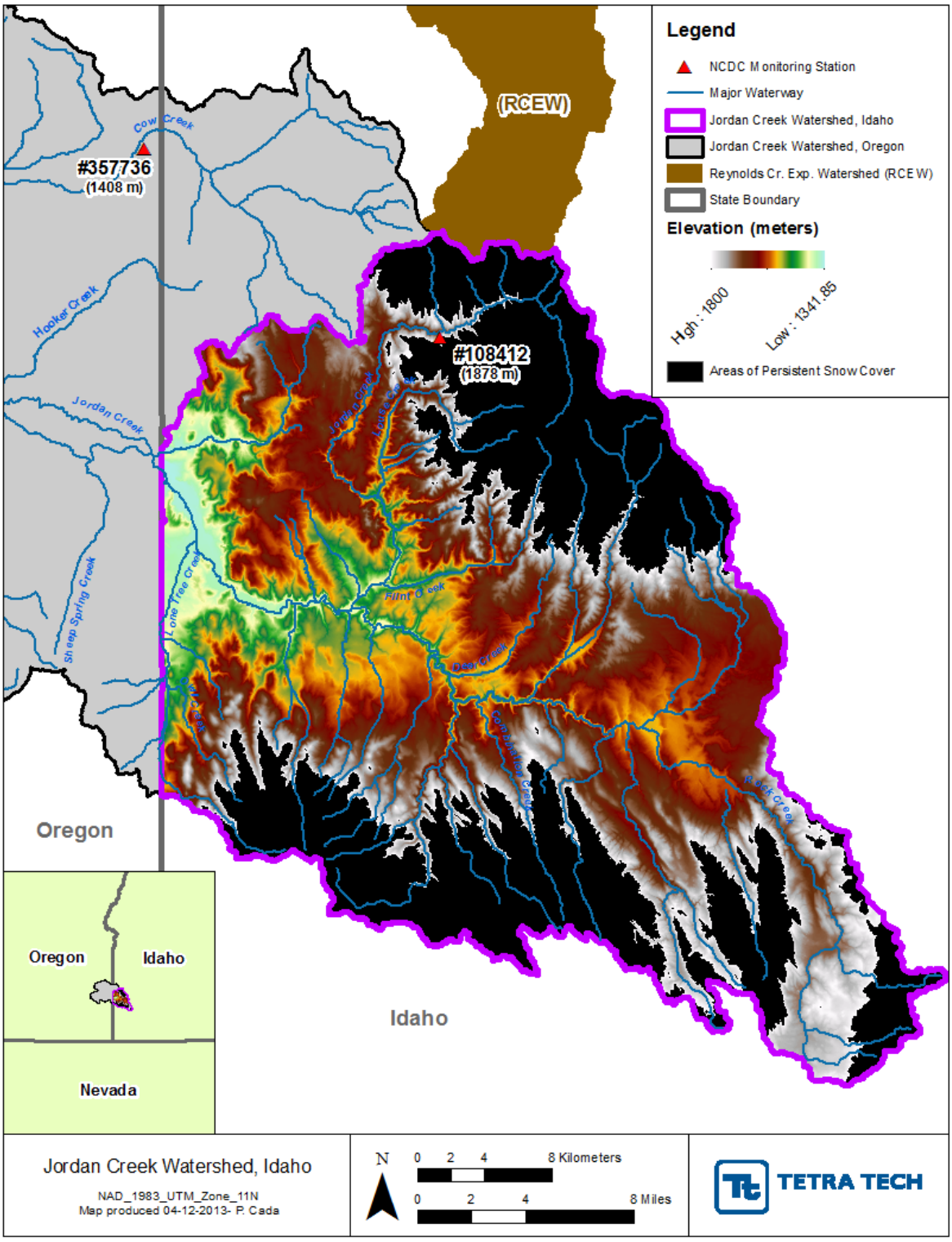


Figure 9. Areas assumed under persistent snow cover from October 15th to May 15th.

3.2.2 Soil Erodibility Factor (K-factor)

The soil erodibility factor (i.e., K-factor) was determined from the Owyhee County Soil Survey Geographic (SSURGO) dataset and the Idaho State Soil Geographic (STATSGO) dataset. STATSGO was used to populate several areas where data for K-factor was not available from SSURGO (Figure 10). Both SSURGO and STATSGO are available for download directly from the US Department of Agriculture (USDA) at *http://datagateway.nrcs.usda.gov/*. K-factor values were extracted from both datasets using the Soil Data Viewer tool for GIS available from *http://soils.usda.gov/sdv/*.

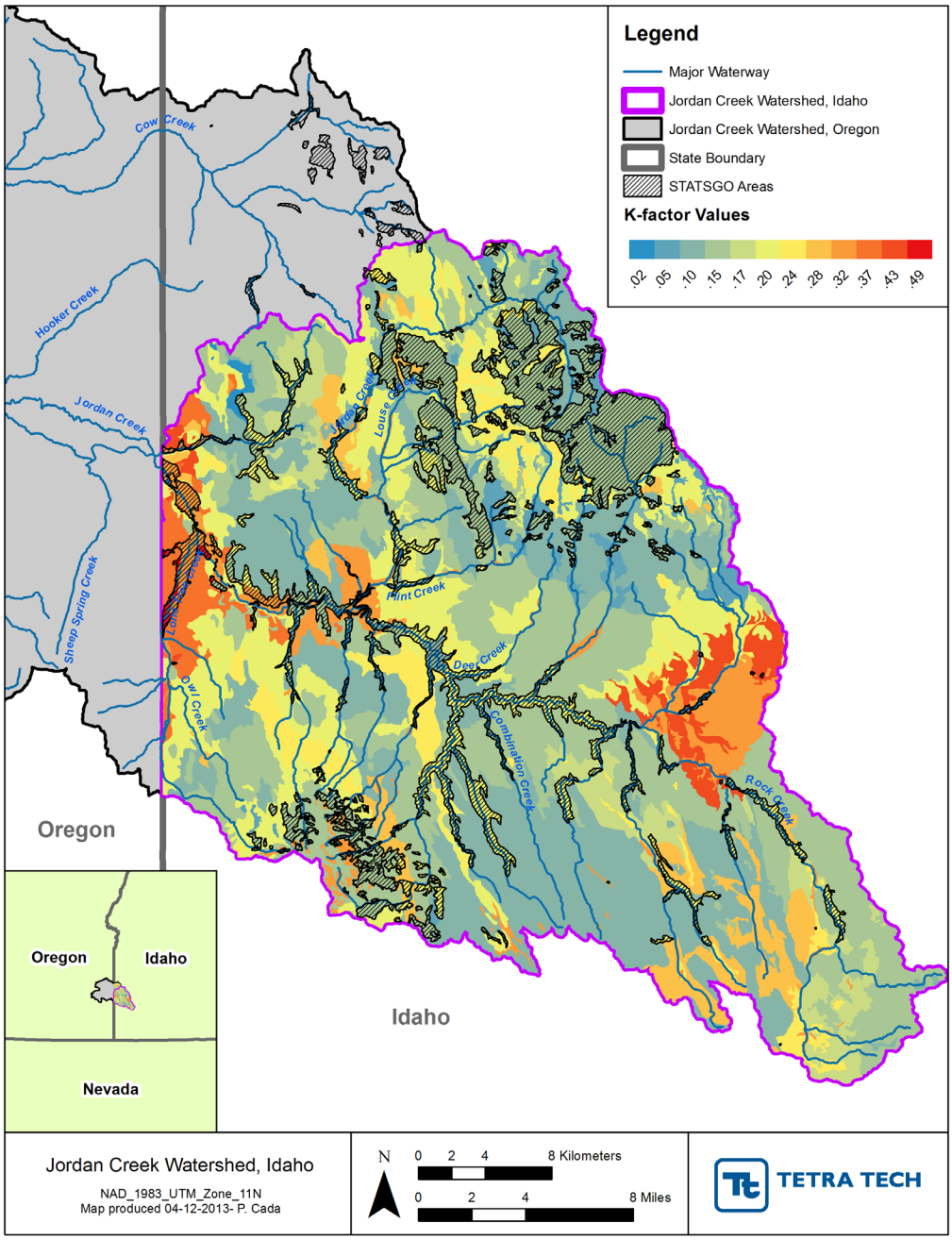


Figure 10. K-factor inputs derived from SSURGO and STATSGO databases.

3.2.3 Slope Length and Steepness Factor (LS-factor)

Determination of slope lengths can be difficult both in the field and/or remotely using geospatial terrain data. The biggest challenge is to appropriately designate the end of a slope length to avoid over-estimation of lengths. Mitasova et al. (1996) developed a GIS-based approach incorporating impacts of flow convergences by replacing hillslope length with upslope contributing area. Mitasova et al. acknowledge that direct application of USLE/RUSLE methods can be relatively restrictive in GIS, but results can be considered an extreme case where the maximum spatial extent of soil erosion possible is estimated. This approach being considered an extreme case align well with the goals of the larger Jordan Creek Watershed TMDL effort. The following equation from Mitasova allows for computation of the LS-factor at each point on a hillslope through the use of upslope contributing area values.

$$LS = (m+1) * [(A / a_0)]^m * [\sin b / b_0]^n$$

where,

m = parameter where a value of 0.6 was found by Moore and Wilson (1992) to give results consistent with RUSLE LS factor for slope lengths < 100m and slope angles <14 degrees.

n = parameter where a value of 1.3 was found by Moore and Wilson (1992) to give results consistent with RUSLE LS factor for slope lengths < 100m and slope angles <14 degrees.

A = upslope contributing area (m^2) per unit width (m)

a_0 = 22.13, which is the length of the standard USLE plot

b = slope

b_0 = 0.0896, which is the slope angle of the standard USLE plot

To implement the above equation in GIS several processes were needed to create the parameter inputs described above. First, a flow accumulation grid was created from an unconditioned 10-meter resolution DEM using output from ESRI's Flow Direction tool (ESRI's tool employs the D-8 flow direction method). Next, upslope contributing area was determined for each grid cell by multiplying the flow accumulation grid by cell dimensions (length and width, 2 * 8.93 meters in this case). Grid cells with estimated slopes less than 0.5% were considered to be areas of deposition, not erosion, and therefore removed from contributing area estimates. To be conservative these areas were later given the minimum value of all LS-factor values determined for the entire watershed.

In order to create the "A" parameter in the above equation the unit width was determined by classifying the flow direction grid into two groups; N, E, S, and W directions were given the width value of 9 meters; and NW, NE, SE, SW directions were given a width value of 13 meters.

The upslope contributing area grid was then divided by reclassified flow direction grid resulting in the "A" parameter. Next, a slope grid (in degrees) created in ArcGIS 10.1 from the DEM was used to create a LS-factor grid with the following equation in the Raster Calculator tool.

(1.6) * (("AperW_10m_id5" / 22.13) ^ 0.6) * ((Sin("slope_10m_id2" / 57.296) / 0.0896) ^ 1.3)

The final step in the LS-Factor grid creation was to remove outliers related to limitations of the contributing area approach described above and further by Moore and Wilson (1996). The m and n parameter defaults employed in the Jordan Creek watershed—0.6 and 1.3, respectively—are most appropriate, and have results similar to the RUSLE LS Factor approach for slope lengths < 100 meters, and slope angles < 14 degrees. Therefore, any cells that had a value larger than the highest estimated LS-factor in the RUSLE User's Guide (i.e., 72.15) where converted to 72.15 for subsequent average annual soil erosion estimates (Figure 11).

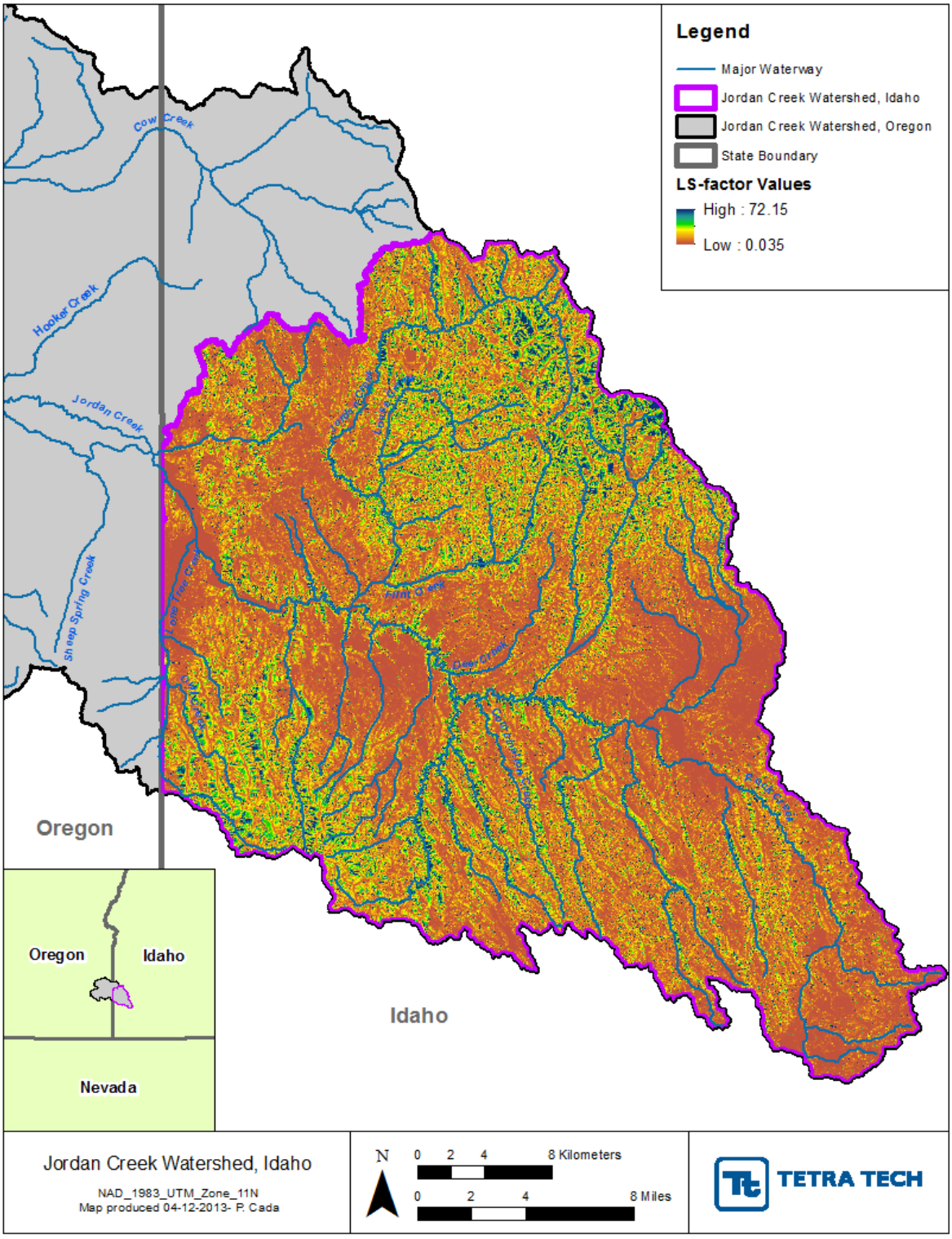


Figure 11. Final LS-factor grid output.

3.2.4 Cover and Management Factor (C-factor)

The cover and management factor is generally used to represent the effect of agricultural cropping and management practices employed to reduce erosion. With less than 1/2 percent of the watershed under these land use types this factor becomes more about the protection of the soil surface by the vegetative canopy, soil surface cover, soil surface roughness, and the impacts of low soil moisture on the reduction of runoff from lower intensity rainfall events (Renard, et al., 1996). The subfactor approach described by Renard, et al. used by RUSLE to estimate C-factor values for each time interval are as follows:

$$C = (SLR_1EI_1 + SLR_2EI_2 + SLR_3EI_3 + \ldots. SLR_nEI_n) / EI_t$$

where,

EI_i = the percentage of the annual Erosive Index for that time period.

EI_t = sum of all EI percentages for the entire time period

SLR_i = Soil Loss Ratio for that time period = PLU * CC * SC * SR * SM

where,

PLU = Prior Land Use Subfactor

CC = Canopy Cover Subfactor

SC = Surface Cover Subfactor

SR = Surface Roughness Subfactor

SM = Soil Moisture Subfactor

Because most of the watershed (rangeland, continuous pasture/meadow) does not rapidly change—as opposed to cropping methods and associated management techniques—it is suggested by Renard et al. that subfactors can be assumed to be annual averages and are simply multiplied to produce an overall C-factor for the year. However, in this approach the multiplication of the subfactors to produce SLR is done for each half-month time period and the variability in EI is accounted for in the R-factor determination approach already discussed. Consequently, the C-factor equation used for the Jordan Creek watershed is as follows:

$$C_i = PLU + CC_i + SC + SR + SM_i$$

where,

CC and SM Subfactors (and therefore C) vary for each half-month time period

Details about how each Subfactor, and thus C-factor, was determined for each half-month time period follow.

1.1.1.3 Prior Land Use Subfactor (PLU)

As described by Renard et al. (1996) PLU expresses the influence of subsurface residual effects from previous crops on *soil erosion* and the effect of previous tillage practices on *soil consolidation*. As previously mentioned less than 1/2 percent of the watershed is under active agricultural land use. For areas like rangeland that are assumed to have no burial of surface residues and undisturbed soil (i.e., no mechanical management practices) Pierson et al. (2001) was able to simplify Renard et al. (1996)'s PLU approach from:

$$PLU = C_f * C_b * Exp[(-c_{ur} * B_{ur}) + (c_{us} * B_{us} / (C_f \wedge (c_{uf}))]$$

to

$$PLU = 0.95 * Exp[-0.00938 * B_{ur}]$$

where,

B_{ur} = the mass of density of live and dead roots found in the upper inch of soil (lb/ac/in)

In many instances, live root mass values are not available for rangeland conditions. Renard et al., 1996 described a method for estimating root biomass (B_b) on rangelands using the total average annual site production potential (lb/ac) using the following equation:

$$B_b = B_a * n_i$$

where,

B_b = estimate of B_{ur}

B_a = total average annual site production potential (lb/ac)

n_i = the ratio of effective root mass to annual site production potential

To increase the accuracy of PLU estimates for the watershed the LANDFIRE Rapid Refresh (2008) Existing Vegetation Type spatial dataset was obtained from *http://www.landfire.gov/vegetation.php*. Table 5 and Figure 12 detail those existing vegetation types found in LANDFIRE's 30-meter resolution grid-based dataset within the Idaho portion of the Jordan Creek watershed. Table 5 also reports those parameter inputs and outputs of PLU Subfactor determinations. The B_a values found in Table 5 are the median values of all those reported in the USDA NRCS "Approved Ecological Site Description" (ESD) reports for two Idaho ESD sites within the same Major Land Resource Area (MLRA; in this case MLRA #25) as the Jordan Creek watershed under the "Plant Communities" section found at *http://esis.sc.egov.usda.gov/Welcome/pgApprovedSelect.aspx?type=ESD*. The n_i values were taken directly from, or estimated using, Table 5-4 within the RUSLE User's Guide (Renard, et al., 1996).

Table 5. Existing vegetation types, aggregation scheme, and PLU parameter inputs/outputs.

Existing Vegetation Type - System Group Name (LANDFIRE)	Aggregate Class	Percent of Watershed	PLU	Ba	ni
Open Water	Open Water	0.089	Vegetative growth in these areas protecting the soil surface were considered minimal.		
Developed-Roads	Developed-Roads	0.042			
Barren	Barren	0.116			
Quarries-Strip Mines-Gravel Pits	Quarries-Mines-Pits	0.003			
Mountain Mahogany Woodland/Shrubland	Curleaf Mountain-Mahogany	2.103	0.000008	6212.50	2.00
Sparse Vegetation	Sparse Vegetation	0.443			
Sparse Vegetation					
Grassland	Grama-Galetta	0.005	0.000028	741.50	1.50
Developed-Upland Deciduous Forest					
Developed-Upland Herbaceous					
Aspen Forest, Woodland, and Parkland	Aspen Woodland	11.096	0.000040	330.50	3.25
Aspen-Mixed Conifer Forest and Woodland					
Grassland	Fescue Grass	0.470	0.000117	480.00	2.00
Western Riparian Woodland and Shrubland	Cottonwood/Willow	3.270	0.000465	250.00	3.25
Western Riparian Woodland and Shrubland					
Big Sagebrush Shrubland and Steppe	Mountain Big Sagebrush	3.938	0.001198	219.00	
Developed-Upland Shrubland					
Desert Scrub					
Salt Desert Scrub					
Deciduous Shrubland					
Greasewood Shrubland					
Western Riparian Woodland and Shrubland					
Deciduous Shrubland					
Big Sagebrush Shrubland and Steppe	Wyoming Big Sagebrush	8.027	0.001353	215.00	
Desert Scrub					
Big Sagebrush Shrubland and Steppe	Basin Bigbrush	11.476	0.001460	212.50	
Low Sagebrush Shrubland and Steppe	Low Sagebrush	19.294	0.024490	120.00	
Alpine Dwarf-Shrubland, Fell-field and Meadow	Forb/Wetland/Ag.	4.950	0.024837	259.00	1.50
NASS-Row Crop-Close Grown Crop					
NASS-Row Crop					
NASS-Close Grown Crop					
NASS-Fallow/Idle Cropland					
NLCD-Herbaceous Semi-dry					
NLCD-Herbaceous Semi-wet					
Agriculture-Pasture and Hay					
Agriculture-Cultivated Crops/Irrigated Ag.					
NLCD-Herbaceous Wetlands					
Grassland					
Introduced Annual Grassland					
Introduced Perennial Grassland/Forbland					
Introduced Annual and Biennial Forbland					
NLCD-Herbaceous Wetlands					
NASS-Pasture and Hayland					
Juniper Woodland and Savanna	Bunch Grass	30.123	0.025908	480.00	0.80

Existing Vegetation Type - System Group Name (LANDFIRE)	Aggregate Class	Percent of Watershed	PLU	Ba	ni
Grassland and Steppe					
Pinyon-Juniper Woodland	Pinyon/Juniper	1.242	0.112450	70.00	3.25
Developed-Upland Evergreen Forest	Coniferous Tree	3.314	0.592259	15.50	
Limber Pine Woodland					
Douglas-fir-Ponderosa Pine-Lodgepole Pine Forest and Woodland					
Subalpine Woodland and Parkland					
Douglas-fir-Grand Fir-White Fir Forest and Woodland					
Lodgepole Pine Forest and Woodland					
Ponderosa Pine Forest, Woodland, and Savanna					
Spruce-Fir Forest and Woodland					
Spruce-Fir Forest and Woodland					
Spruce-Fir Forest and Woodland					
Douglas-fir Forest and Woodland					
Douglas-fir Forest and Woodland					
Douglas-fir Forest and Woodland					
Douglas-fir-Grand Fir-White Fir Forest and Woodland					

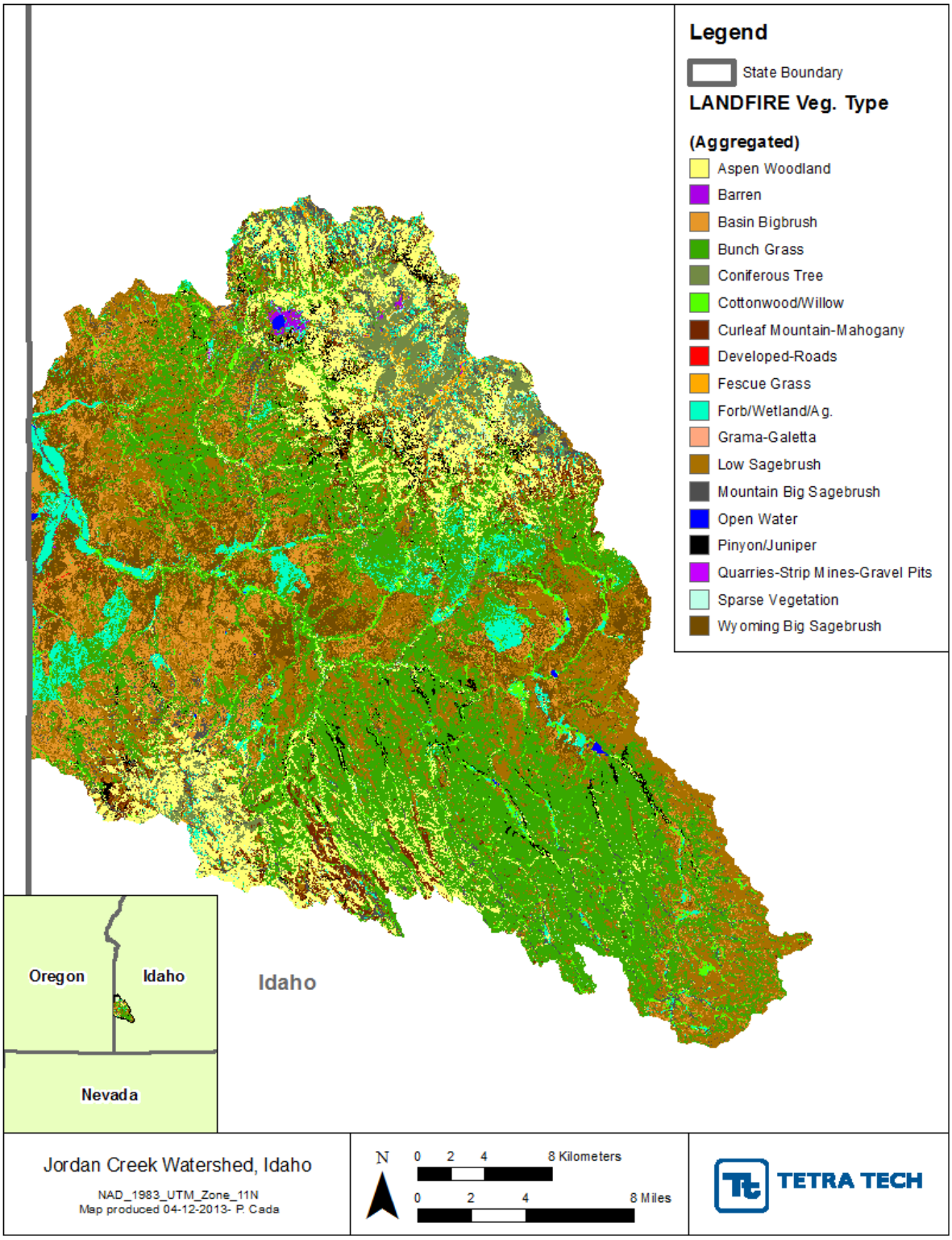


Figure 12. Aggregated LANDFIRE existing vegetation cover types

1.1.1.4 Surface Cover Subfactor (SC)

Surface cover is an important consideration when estimating soil erosion because of its potential to reduce the transport capacity of runoff through increased sediment deposition in ponded areas and by decreasing the amount of soil surfaces exposed to rain drops. Renard at al. give the SC Subfactor equation as:

$$SC = \text{Exp}\,[-b * S_p * (0.24 / R_u) \wedge 0.08]$$

where,

b = an empirical coefficient

S_p = percentage of land area covered by surface cover

R_u = surface roughness (inches)

The empirical coefficient "b" indicates the effectiveness of different surface cover types in reducing soil erosion often found to range between 0.02 and 0.070 (Renard, et al., 1996). Renard et al. recommends that a value of 0.039 is appropriate for rangelands conditions where the sub surface biomass is impacted. Because the majority of the watershed is under rangeland land use this value (0.039) was used watershed wide. Without the significant effort of field surveys across the watershed, or high-resolution aerial imagery classification, it was not feasible to estimate spatially explicit values for S_p. Instead, an assumed value of 50% was used watershed wide. However, the R_u parameter is spatially explicit data easily incorporated into this Subfactor. Table 6 shows the R_u values derived or estimated from Table 5-6 in the RUSLE User's Guide (Renard et al., 1996) and resulting SC Subfactor values.

Table 6. R_u Parameter Inputs and SC Subfactor Values

Aggregate Class	R_u	SC
Open Water	Surface cover considered minimal	
Developed-Roads		
Barren		
Quarries-Strip Mines-Gravel Pits		
Curleaf Mountain-Mahogany	0.80	0.17
Sparse Vegetation		
Grama-Galetta	0.30	0.15
Aspen Woodland	1.10	0.18
Fescue Grass		
Cottonwood/Willow		
Mountain Big Sagebrush		
Wyoming Big Sagebrush		
Basin Bigbrush		
Low Sagebrush		
Forb/Wetland/Ag.	0.30	0.15
Bunch Grass		
Pinyon/Juniper	0.60	0.16
Coniferous Tree	1.10	0.18

1.1.1.5 Surface Roughness Subfactor (SR)

Similar to the Surface Cover (SC) Subfactor surface roughness can decrease the transport capacity of runoff and runoff detachment of soil particles through the reduction of flow velocities. For areas not disturbed as frequently Renard at al. recommend the following SR Subfactor equation:

$$SR = Exp\ [-0.66 * (R_u - 0.24)]$$

where,

R_u = surface roughness (inches)

The empirical coefficient "b" indicates the effectiveness of different surface cover types in reducing soil.

As stated above for the SC Subfactor discussion the R_u parameter is spatially explicit data that can easily be incorporated into Subfactor development. Table 7 shows the R_u values derived or estimated from Table 5-6 in the RUSLE User's Guide (Renard et al., 1996) and resulting SR Subfactor values.

Table 7. R_u Parameter Inputs and SR Subfactor Values

Aggregate Class	R_u	SC
Open Water	Surface roughness impacts considered minimal	
Developed-Roads		
Barren		
Quarries-Strip Mines-Gravel Pits		
Curleaf Mountain-Mahogany	0.80	0.69
Sparse Vegetation		
Grama-Galetta	0.30	0.96
Aspen Woodland	1.1	0.57
Fescue Grass		
Cottonwood/Willow		
Mountain Big Sagebrush		
Wyoming Big Sagebrush		
Basin Bigbrush		
Low Sagebrush		
Forb/Wetland/Ag.	0.30	0.96
Bunch Grass		
Pinyon/Juniper	0.60	0.79
Coniferous Tree	1.1	0.57

1.1.1.6 Canopy Cover Subfactor (CC)

This Subfactor expresses the effectiveness of vegetative cover in reducing the energy of rain drops as they fall on the soil surface. Two other 30-meter resolution grid-based datasets from the LANDFIRE effort—existing vegetation height and existing vegetation cover—were used to create spatially explicit parameters for the CC Subfactor equation as used by RUSLE to be executed in ESRI's Raster Calculator tool.

$$CC = 1 - F_c * Exp(-0.1 * H)$$

where,

F_c = the fraction of the land surface covered by vegetative canopy

H = the distance in feet that a raindrop falls after striking the canopy

Table 8 provides statistics of heights and percent coverage for each of the aggregated LANDFIRE existing vegetative types created as part of the PLU Subfactor development.

Table 8. Percent canopy cover and height statistics for aggregated existing vegetation types

Aggregate Class	Percent of Watershed	Percent Canopy Cover (%)				Canopy Height (feet)			
		Min	Max	Mean	Median	Min	Max	Mean	Median
Aspen Woodland	11.091	0	100	30.7	35	0	123	54.4	57
Barren	0.116	0	100	1.3	0	0	57	0.1	0
Basin Bigbrush	11.478	0	100	27.0	25	0	123	1.7	1
Bunch Grass	30.127	0	100	21.9	25	0	123	31.3	16
Coniferous Tree	3.312	0	100	32.3	35	0	123	54.7	57
Cottonwood/Willow	3.272	0	100	20.1	15	0	123	39.3	57
Curleaf Mountain-Mahogany	2.102	0	75	23.6	25	0	123	34.0	16
Developed-Roads	0.042	0	100	4.1	0	0	57	0.3	0
Fescue Grass	0.471	0	100	37.5	35	0	123	2.9	1
Forb/Wetland/Ag.	4.949	0	100	50.3	55	0	123	2.1	1
Grama-Galetta	0.005	0	100	43.7	50	0	57	5.8	1
Low Sagebrush	19.285	0	100	27.9	25	0	123	1.6	1
Mountain Big Sagebrush	3.942	0	100	29.7	25	0	123	5.7	3
Open Water	0.088	0	100	0.7	0	0	123	0.2	0
Pinyon/Juniper	1.245	0	100	23.3	25	0	123	24.4	16
Quarries-Strip Mines-Gravel	0.003	0	25	1.5	0	0	3	0.1	0
Sparse Vegetation	0.443	0	100	8.3	5	0	123	5.3	1
Wyoming Big Sagebrush	8.028	0	100	24.4	25	0	123	1.6	1

As previously mentioned, the CC Subfactor varies over the 24 half-month time periods because the canopy coverage of many vegetative cover types is absent or minimized in winter months and takes several months to achieve full annual growth after the winter months. To address this variability the CC Subfactor calculations were weighted for all (original) different LANDFIRE existing vegetation types and 24 half-month time periods following the schema detailed in Table 9 and Table 10.

Table 9. Winter (minimum) F_c values for original LANDFIRE existing vegetation types

Aggregate Class	Existing Vegetation Type - System Group Name (LANDFIRE)	Fc Winter (as proportion of max)
Open Water	Open Water	0
Developed-Roads	Developed-Roads	0
Barren	Barren	1
Quarries-Strip Mines-Gravel Pits	Quarries-Strip Mines-Gravel Pits	0.1
Curleaf Mountain-Mahogany	Mountain Mahogany Woodland and Shrubland	0.5
Sparse Vegetation	Sparse Vegetation	0.1
	Sparse Vegetation	0.1
Grama-Galetta	Grassland	0.1
	Developed-Upland Deciduous Forest	0.5
	Developed-Upland Herbaceous	0.5
Aspen Woodland	Aspen Forest, Woodland, and Parkland	0.5
	Aspen-Mixed Conifer Forest and Woodland	0.5
Fescue Grass	Grassland	0.1
Cottonwood/Willow	Western Riparian Woodland and Shrubland	0.5
	Western Riparian Woodland and Shrubland	0.5
Mountain Big Sagebrush	Big Sagebrush Shrubland and Steppe	1
	Developed-Upland Shrubland	0.5
	Desert Scrub	1
	Salt Desert Scrub	1
	Deciduous Shrubland	1
	Greasewood Shrubland	0.1
	Western Riparian Woodland and Shrubland	0.5
	Deciduous Shrubland	0.5
Wyoming Big Sagebrush	Big Sagebrush Shrubland and Steppe	1
	Desert Scrub	1
Basin Bigbrush	Big Sagebrush Shrubland and Steppe	1
Low Sagebrush	Low Sagebrush Shrubland and Steppe	0.5

Forb/Wetland/Ag.	Alpine Dwarf-Shrubland, Fell-field and Meadow	0.1
	NASS-Row Crop-Close Grown Crop	0.1
	NASS-Row Crop	0.1
	NASS-Close Grown Crop	0.1
	NASS-Fallow/Idle Cropland	0.1
	NLCD-Herbaceous Semi-dry	0.1
	NLCD-Herbaceous Semi-wet	0.1
	Agriculture-Pasture and Hay	0.1
	Agriculture-Cultivated Crops and Irrigated Agriculture	0.1
	NLCD-Herbaceous Wetlands	0.1
	Grassland	0.1
	Introduced Annual Grassland	0.1
	Introduced Perennial Grassland and Forbland	0.1
	Introduced Annual and Biennial Forbland	0.1
	NLCD-Herbaceous Wetlands	0.1
	NASS-Pasture and Hayland	0.1
Bunch Grass	Juniper Woodland and Savanna	1
	Grassland and Steppe	0.1
Pinyon/Juniper	Pinyon-Juniper Woodland	1
Coniferous Tree	Developed-Upland Evergreen Forest	1
	Limber Pine Woodland	1
	Douglas-fir-Ponderosa Pine-Lodgepole Pine Forest and Woodland	1
	Subalpine Woodland and Parkland	1
	Douglas-fir-Grand Fir-White Fir Forest and Woodland	1
	Lodgepole Pine Forest and Woodland	1
	Ponderosa Pine Forest, Woodland, and Savanna	1
	Spruce-Fir Forest and Woodland	1

Spruce-Fir Forest and Woodland	1
Spruce-Fir Forest and Woodland	1
Douglas-fir Forest and Woodland	1
Douglas-fir Forest and Woodland	1
Douglas-fir Forest and Woodland	1
Douglas-fir-Grand Fir-White Fir Forest and Woodland	1

Table 10. Seasonal Weighting Factors for CC Subfactor Calculations

Model Period Start Date	CC modification
Jan-01	"F_c - Winter" (min)
Jan-16	"F_c - Winter" (min)
Feb-01	"F_c - Winter" (min)
Feb-16	"F_c - Winter" (min)
Mar-01	"F_c - Winter" (min)
Mar-16	0.1 * range
Apr-01	0.2 * range
Apr-16	0.3 * range
May-01	0.4 * range
May-16	0.5 * range
Jun-01	0.75 * range
Jun-16	0.9 * range
Jul-01	"F_c - Maximum"
Jul-16	"F_c - Maximum"
Aug-01	"F_c - Maximum"
Aug-16	"F_c - Maximum"
Sep-01	0.75 * range
Sep-16	0.5 * range
Oct-01	0.2 * range
Oct-16	0.1 * range
Nov-01	"F_c - Winter" (min)
Nov-16	"F_c - Winter" (min)
Dec-01	"F_c - Winter" (min)
Dec-16	"F_c - Winter" (min)

1.1.1.7 Soil Moisture Subfactor (SM)

The amount of moisture found in the soil before rain events (i.e., antecedent soil moisture) can have a significant influence on infiltration and therefore runoff timing and volumes. Timing and volumes of runoff have a direct impact on soil erosion rates. The addition of the Soil Moisture Subfactor is recommended by Renard et al. (1996) for areas in close proximity to the Jordan Creek watershed where soil moisture decreases over the summer to a nadir in early fall to be replenished through precipitation events and snowmelt after the growing season and into the winter season. Therefore, Figure 5-5 in the RUSLE User's Guide (Renard, et al., 1996)—Figure 13 herein—was used to derive SM Subfactor values for each of the half-month time periods (Table 11).

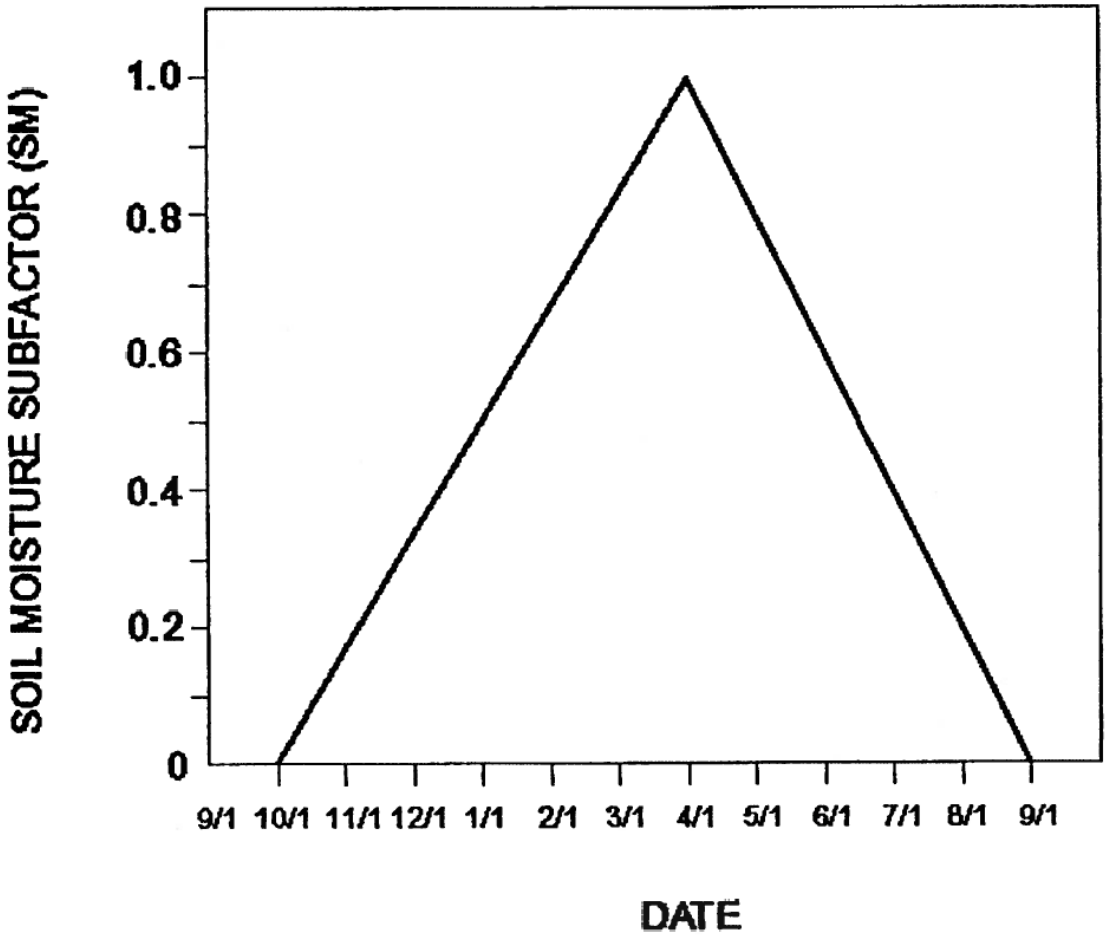


Figure 13. "Maximum Range in Soil-Moisture Subfactor as Affected by Profile Replenishment and Depletion for the Northwestern Wheat and Range Region", from Figure 5-5 in Renard, et al. (1996)

Table 11. SM Subfactors for Each Half-month Time Period

Model Period Start Date	SM Subfactor
Jan-01	0.5
Jan-16	0.6
Feb-01	0.7
Feb-16	0.75
Mar-01	0.8
Mar-16	0.9
Apr-01	1.0
Apr-16	0.9
May-01	0.8
May-16	0.7
Jun-01	0.6
Jun-16	0.5
Jul-01	0.4
Jul-16	0.3
Aug-01	0.2
Aug-16	0.1
Sep-01	0.01
Sep-16	0.01
Oct-01	0.01
Oct-16	0.1
Nov-01	0.2
Nov-16	0.25
Dec-01	0.3
Dec-16	0.4

Two example C-factor grids are displayed in Figure 14 and Figure 15. Figure 14 shows the combination of nearly the highest soil moisture while there is still no simulated canopy cover (March 1 to 15 time period). Figure 15 is for the August 16 to 31 time period where simulated canopy coverage is full and soil moisture is closest to its minimum. The comparison of the C-factor grids from these two time periods highlights the role percent canopy coverage estimates

and soil moisture weighting can play when estimating soil erosion rates under the USLE approaches.

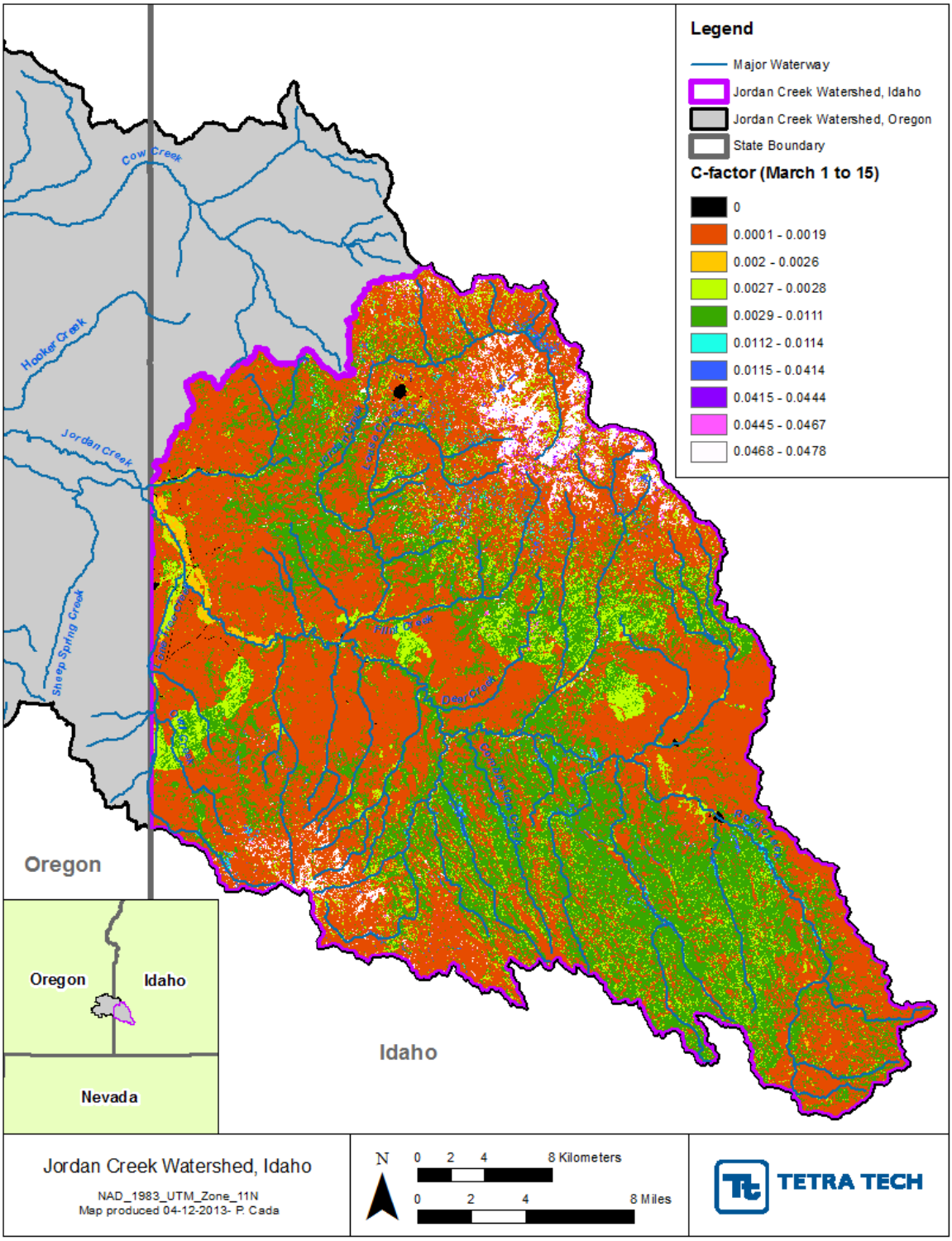


Figure 14. C-Factor grid example (March 1 to March 15)

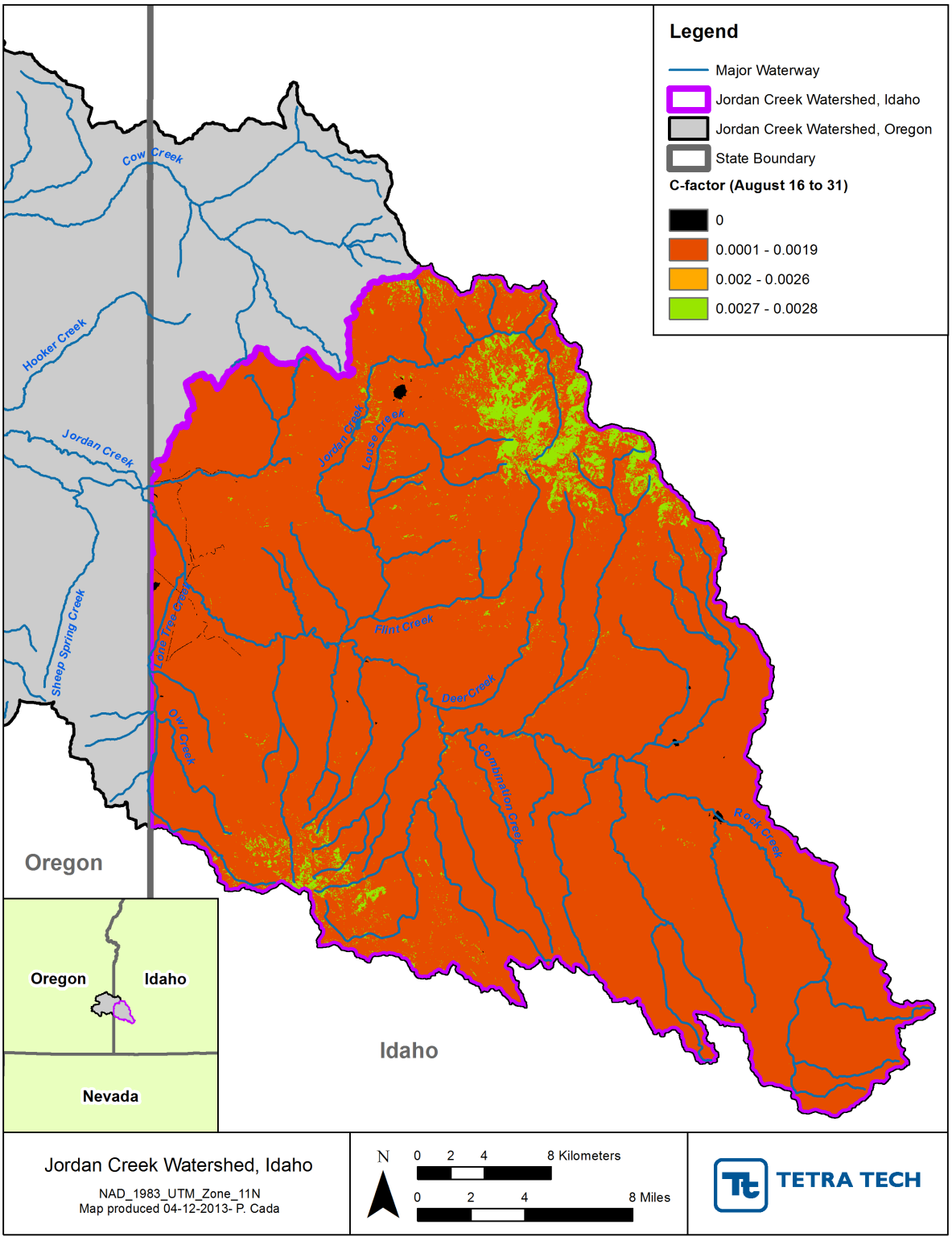


Figure 15. C-Factor grid example (August 16 to August 31)

1.1.1.8 Support Practice Factor (P-factor)

It was assumed that most of the watershed (rangeland, continuous pasture/meadow) is not managed by conservation and/or mechanical management practices and thus a P-factor of 1 was used watershed-wide for the average annual soil erosion estimates.

3.3 Sediment Yield Estimation

After all RUSLE factors (and related subfactors) were derived for each of the 24 half-month time periods in grid-based format, they were multiplied together in GIS using ESRI's Raster Calculator tool, resulting in an erosion estimate for each half-month time period for each individual grid cell. The Raster Calculator tool was used to sum the half-month erosion estimates together resulting in an annual sediment erosion estimate for each grid cell. This is a soil loss or movement rate, not an estimate of delivery to streams.

3.3.1 Mineralized Areas Erosion Rate

Within the mineralized areas identified in Figure 3, annual sediment erosion estimates from all grid cells were summed resulting in an estimated annual average estimate of soil loss of 2,390 short tons/year. Dividing this result by the area of only the mineralized portions of the watershed area (7,715 acres) results in an estimate of 0.31 short tons/acre/year—a value consistent with other model (e.g., Hydrological Simulation Program Fortran, or HSPF) rates for land categories similar to those found in the Jordan Creek watershed (USEPA, 2006).

3.3.2 Non-Mineralized Areas Erosion Rate

Annual sediment erosion estimates for all grid cells in the non-mineralized areas were summed resulting in an estimated annual average estimate of soil loss of 165,359 short tons/year over the watershed (excluding mineralized areas identified in Figure 3). Dividing this value by the total area of all remaining portions of the watershed area (328,779 acres) results in an estimate of 0.50 short tons/acre/year. Again, this value consistent with other model (e.g., HSPF) rates for land categories like those found in the Jordan Creek watershed (USEPA, 2006).

3.3.3 Estimated Sediment Delivery to Oregon

The two erosion rates estimated above are "gross erosion" estimates of local soil loss (or detachment), not sediment delivery to the watershed outlet. The approach employed to estimate delivery for the area of interest is often referred to as the "watershed area-based method" which multiplies the gross erosion estimate by a sediment delivery ratio (SDR) to account for sediment compaction, travel time, deposition, accumulation, re-suspension, etc. In the previous version of the TMDL, a uniform SDR was estimated using an equation from Bicknell et al. (2001) derived from the curve presented in the USDA SCS 1983 National Engineering Handbook (USDA-NRCS, 1983) to determine a watershed area-based estimate of SDR. Using this method, an estimated aggregate SDR of 0.049 was used for the previous Jordan Creek watershed mercury TMDL.

There has been minimal land use change in the watershed in recent years. For this reason, the previous RUSLE soil erosion estimates were maintained for the TMDL revision. The previous assessment, however, applied a uniform sediment delivery ratio (SDR) across the watershed. To derive spatially varied SDRs in the TMDL update a two-stage approach was used. In this approach we first apply the delivery calculator from USDA's Agricultural Conservation Planning Framework (ACPF) Toolbox (*https://acpf4watersheds.org/about-acpf/*). This method computes spatially varied sediment delivery using an equation where the input variable is distance in feet to the nearest stream (SDR = $x^{-0.2069}$) (Porter et al., 2018). A gridded, spatially varied SDR coverage was created using the ACPF equation and a 10-meter Digital Elevation Model (DEM). The DEM was used as an input to the ACPF tool 1b "D8 Terrain Processing" to obtain flow accumulation and direction rasters. Then, the flow direction raster and a stream reach polyline layer were used as inputs to ACPF's tool 3c "D8 Distance to Stream." In this tool, inputs of Stream Reach (polyline layer, with or without water bodies merged) and D8 Flow Direction grid to calculate the horizontal distance in meters to the channel from each grid cell, moving downslope according to the D8 flow model until a stream grid cell is encountered. Figure 16 shows a map of spatially varying SDR across the Idaho portion of the Jordan Creek watershed.

The ACPF analysis provides a spatial representation of the areas that are most sensitive for sediment and associated mercury loading to the stream network (Figure 17). However, the APCF tool only accounts for sediment delivery reduction between the source point and the nearest downslope defined stream segment and does not account for additional reduction during transport within these streams, many of which are ephemeral or intermittent.

The SPARROW model output provides total accumulated sediment load (average kg/yr) at each stream node (al_ss) as well as the incremental load for each segment (il_ss). SPARROW also predicts accumulated and incremental sediment load derived from channel erosion processes (al_ss_chan and il_ss_chan). We do not expect or require the RUSLE load estimates to exactly match those in SPARROW, but we can use the information in SPARROW to recalculate the final delivery ratio at the Oregon state line in the form of an adjustment factor to be applied to the load estimates at edge of stream provided by the ACPF analysis.

We represent the load entering Oregon by results from SPARROW COMID 23360265 (equivalent to the reach from node 178546 to node 178545), which is just over the state line into Oregon. SPARROW estimates the average annual accumulated load at this reach as 22,692,081 kg/yr; however, SPARROW also estimates that 58% of this load is derived from channel erosion processes. The portion of the load that represents upland erosion is 9,425,397 kg/yr, equivalent to 6.65 Mt/km^2/yr or 0.065 Mg/ha/yr. The ratio of the SPARROW average annual load derived from upland erosion to the ACPF-adjusted RUSLE sediment load is (in kg/yr) 9,425,397/44,737,815 = 0.210681. This factor is applied to the estimated output from the ACPF analysis to adjust the final load at the Oregon border for transit losses due to retention in streams and export to the floodplain. The resulting effective SDR (ACPF and SPARROW) averages around 0.1, which is greater than that assumed in the 2014 draft TMDL, but much lower than that obtained from the ACPF analysis alone.

Using the gridded SDR coverage for the Jordan Creek watershed and the erosion estimates from the previous TMDL work's RUSLE output, the two coverages were multiplied together using Raster Calculator in GIS to estimate the soil load delivered to the stream network for mineralized and non-mineralized area (Figure 17). The total sediment load was then adjusted by the SPARROW-derived factor of 0.210681 to give an estimated annual average sediment delivery of 166 tons/year of sediment from the mineralized areas and 10,224 tons/year from the remaining (non-mineralized) areas of the watershed at the Oregon border.

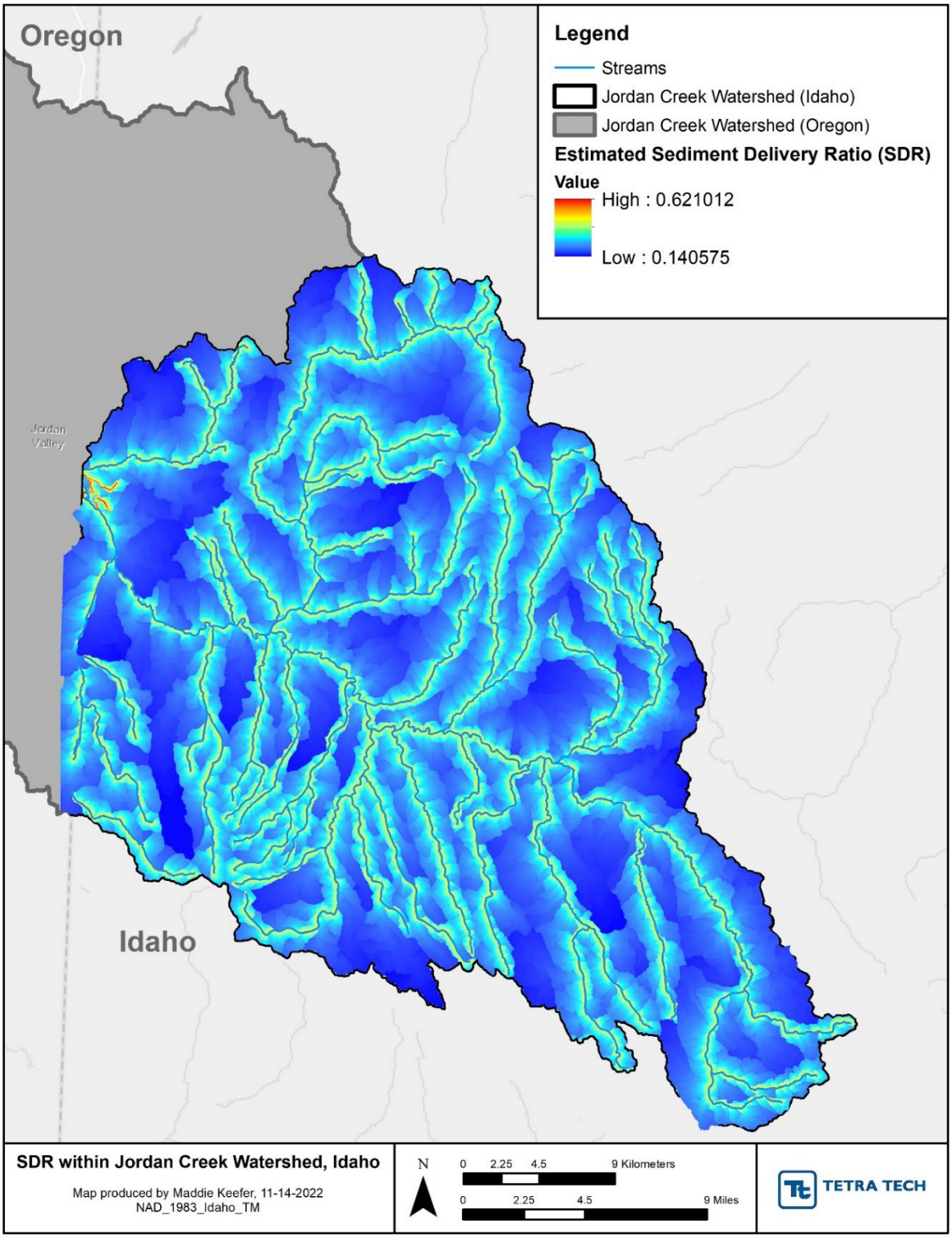


Figure 16. ACPF Sediment delivery ratio (SDR) from upland to stream for Jordan Creek Subbasin, Idaho.

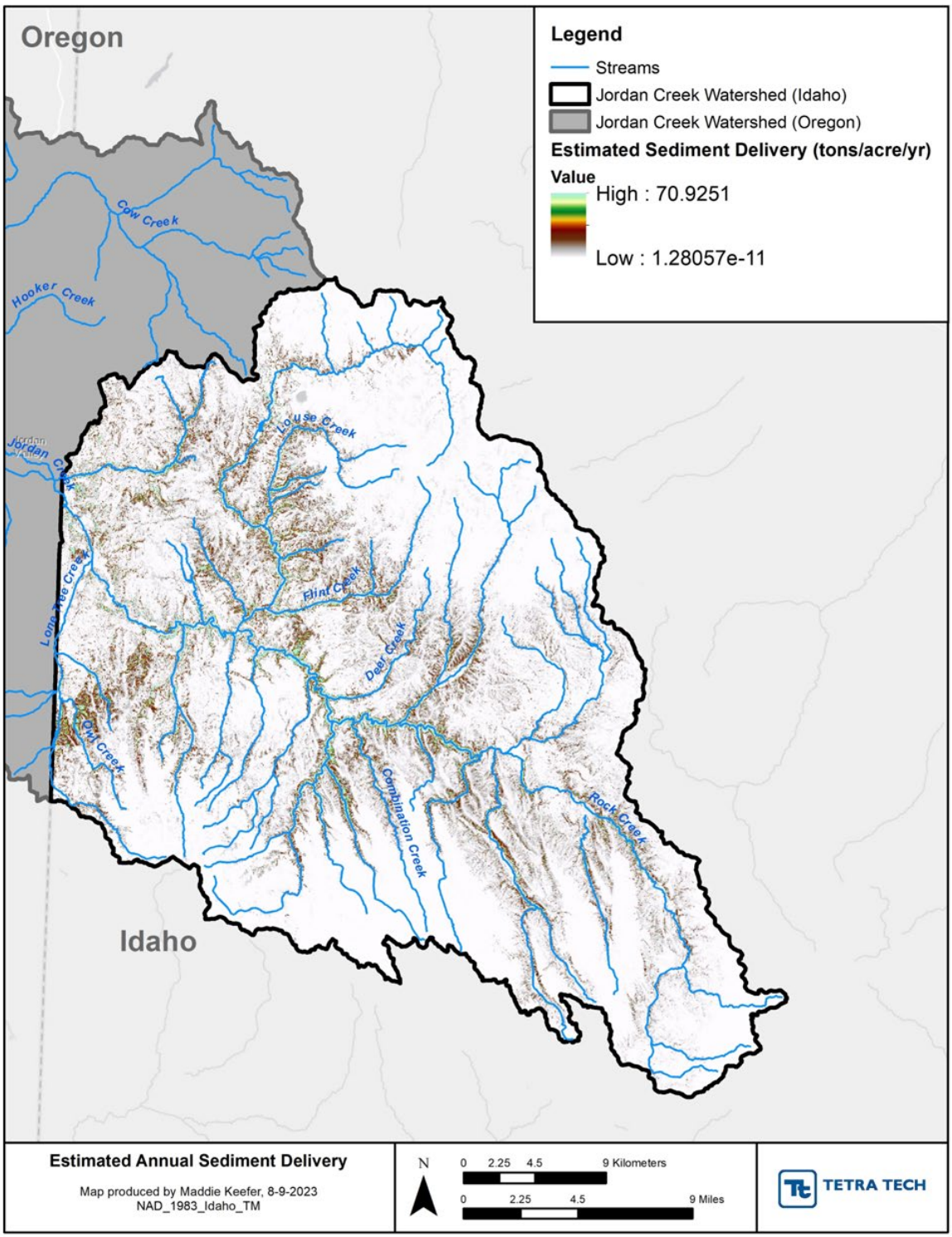


Figure 17. Estimated sediment delivery from uplands to stream network.

4 Stream Sediment and Floodplain Sources

Wet weather sampling by EPA in April and May 2021 revealed total mercury concentrations in Jordan Creek mainstem stations within Idaho (JC1, JC2, and JC5; see Section 5 in main TMDL document for site locations and data) ranging from 156 to 380 ng/L (see main document Section 5). EPA also obtained instantaneous streamflow measurements and JC1 and estimated flow at JC5. Multiplying concentration times flow yields estimated total mercury loading rates of 64 – 108 g/day at JC1 (upstream near DeLamar) and 152 - 657 g/day at downstream station JC5 (personal communication from Dr. Chris Eckley, December 23, 2022). These concentrations and loading rates are much higher than can be accounted for by background soil erosion and atmospheric deposition, indicating the presence of additional sources of mercury load.

Sediment concentrations in the Jordan Creek mainstem also appear to be elevated. In the 2005 IDEQ sampling mainstem stations had concentrations of 0.948 – 4.260 mg THg/kg sediment (dry weight, equivalent to µg/g or ng/mg), while non-mainstem reference sites had concentrations of 0.03 – 0.016 mg/g. Trout unlimited sediment samples from the mainstem in the Silver City mining area had concentrations of 3.77 – 4.22 mg/kg, although EPA's 2021 mainstem sediment samples were only 0.40 – 0.73 mg/kg. The sediment concentrations are variable in part because mainstem bedded sediment is largely composed of sand, whereas mercury concentrations are expected to be higher on the fine sediment fraction. Trout Unlimited also sampled floodplain sediment in the Silver City mining area, reporting "fluvial tails" deposits with concentrations up to 20 mg/kg and concentrations of 49.1 and 65.7 mg/kg in near-stream waste rock at the Blaine Mill and Cosmos Mill sites.

The Silver City area has a long history of silver and gold mining primarily in the late 19th century. Ore was ground to powder in stamping mills (originally driven by waterpower and thus adjacent to streams) then extracted using the mercury amalgamation process. The mercury used in this process was primarily imported from California. After amalgamation, the mercury was burnt off. That process, along with many reported spills of elemental mercury resulted in extensive contamination of stream and floodplain sediment near the Silver City mill sites, as is described in further detail in Section 6.2.3 of the main report. Much of this mercury was subsequently transported downstream and appears to be distributed throughout the Jordan mainstem, likely concentrated in hot spots where fine sediment has collected on the floodplain and riparian areas. This mining-derived mercury appears to drive the high instream mercury concentrations observed throughout the Jordan Creek mainstem.

Mercury load associated with erosion of sediment in the Jordan Creek main channel and floodplain, and ultimately derived from past ore processing, has not been previously quantified. The SPARROW model output provides a way to do so because SPARROW estimates the incremental and accumulated average annual flow and sediment load for NHD v2 stream segments and also identifies the portion of the load that is due to estimated channel erosion.

In EPA's 2021 sampling at three stations on the Jordan Creek mainstem within Idaho (JC1, JC2, and JC5) a median of 84% of the mercury present in the water column during the high flow period (which transports the majority of the load) is sediment-associated (with lower fractions

during the fall low-flow sampling event). The median ratio of particulate total mercury to total suspended solids is 12.35 mg/kg (also referred to as the potency factor). In contrast, the average potency factor in uncontaminated background sites is 0.05 mg/kg. (The background potency factor is estimated from data collected from Rock Creek [BG1] and Williams Creek [WC1]. Flint Creek [FC1] samples were not included in the estimation of background potency factor because of past mining history in that drainage.) Because the background potency factor is so low, applying the mainstem potency factor to the annual load of sediment estimated by SPARROW to be derived from the Jordan Creek mainstem channel between the most upstream mine site in Silver City and a downstream monitoring station provides a reasonable approximation of the mercury load that is derived from the erosion of the mainstem channel and associated floodplain areas and can be corrected for the background potency factor to attribute loads to the legacy mining operations.

The potency factors used here are the median of the ratios of particulate Hg to TSS in the EPA sampling. These samples include one baseflow sample and one to three samples from higher flow spring events. Bias toward wet weather conditions is appropriate for mass loading estimation because most of the sediment-associated load moves during higher flow events. Example calculations based on SPARROW average annual flows and loads, and 2021 EPA monitoring data are shown in Table 12. The resulting concentration estimates are compared to the 2021 EPA sampling results in Figure 18. Predictions and observations are in close agreement at JC1 and JC2. JC5 observed concentrations are higher than the SPARROW-based predictions, likely reflecting uncertainty in the SPARROW-based estimates but possibly also indicating an additional load source in this area. EPA did not obtain observations at the state line in 2021 so predictions are compared to observations at station JC5.5, slightly downstream.

Table 12. Estimation of nonpoint source Hg loads for Jordan Creek mainstem

Component	at JC1 (COMID 23360695)	at JC2 (COMID2360657)	at JC5 (COMID23360317)	at state line (COMID 23360265)
average annual flow (cfs)	24.56	39.44	170.84	186.07
particulate Hg potency factor (mg/kg)	9.56	20.43	14.50	4.62
accumulated mainstem channel TSS load (MT/yr)	206.99	481.84	719.73	791.31
mainstem channel Hg load (kg/yr)	1.98	7.60	11.04	11.37
non-mainstem particulate Hg potency factor (mg/kg)	0.05	0.05	0.05	0.05
accumulated non-mainstem channel TSS (MT/yr)	699.68	1,532.86	10,510.29	12,475.37
non-mainstem channel Hg load (kg/yr)	0.04	0.08	0.56	0.66
Hg from mainstem channel sources (ng/L)	90.19	215.51	72.34	68.41
Hg from non-mainstem channel sources (ng/L)	1.69	2.31	3.66	3.98
Hg total from channel sources (ng/L)	91.88	217.82	76.00	72.40
Hg total from channel sources (kg/yr)	2.02	7.68	11.60	12.04
upland erosion Hg load (kg/yr)	0.10	0.14	0.35	0.33
upland dissolved Hg load (kg/yr)	0.04	0.06	0.26	0.26
total Hg load kg/yr	2.16	7.88	12.22	12.63
predicted tHg concentration (ng/L)	98.25	223.65	80.03	75.98

Notes: Flows and sediment loads are long-term annual averages predicted by the SPARROW model (Wise, 2019; 2020). COMID identifies the NHD v2 segment in the SPARROW model. Stations JC1, JC2, and JC5 are from the EPA 2021 sampling effort. Estimated loads and concentrations are based on SPARROW channel-derived sediment loads multiplied by the relevant Hg potency factor derived from the median of EPA 2021 sampling results. Total load estimates and predicted Hg concentration omit loads from permitted point sources.

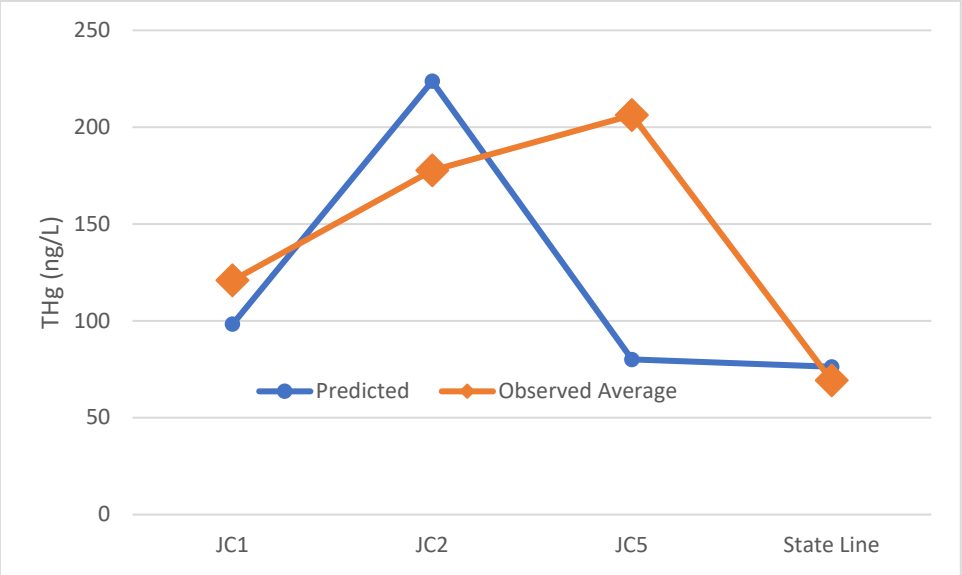


Figure 18. Comparison of Jordan Creek mainstem total Hg concentration estimates from Table 12 to average observed concentration in IDFG 2021 sampling.

5 Mercury Yield Estimates

Direct, "background" sources of mercury derived from the Idaho portions of the Jordan Creek watershed via surface water pathways are 1) sorbed mercury derived from erosion of watershed soils and 2) upland dissolved mercury contained in runoff and groundwater discharge, and 3) dry atmospheric deposition of mercury direct to water surfaces. These loads are augmented by mercury derived from channel and flood plain sources that are attributed to legacy mining activities.

5.1 Soil-Based Mercury

The interpolated data from USGS (Smith et al., 2019) resulted in an estimated native soil mercury concentration for non-mineralized areas ranging from approximately 0.01 to 0.03 mg Hg/kg of soil.

Literature reviews and modeling in Sections 3.2 and 3.3 produced an annual average (net) sediment delivery of 48,528 short tons/year from non-mineralized areas after using the ACPF method to account for delivery to streams. Further reductions instream during transport to the Oregon state line are accounted for based on SPARROW simulations. The product of these spatially varying estimates suggests an estimated annual contribution of mercury from non-mineralized, native soils is approximately 321.2 g-Hg/year for the Jordan Creek watershed in Idaho delivered to the Oregon state line.

For the mineralized area, the background contribution is the product of the gridded sediment delivery coverage and 1.0 g Hg/ton of soil (the upper bound preferred by IGS) results in an

estimate of approximately 13.3 g-Hg/year delivered from the Jordan Creek watershed to Oregon, for a total of 334.5 g-Hg/year delivered to the state line from background concentrations associated with Idaho's soils within the Jordan Creek watershed.

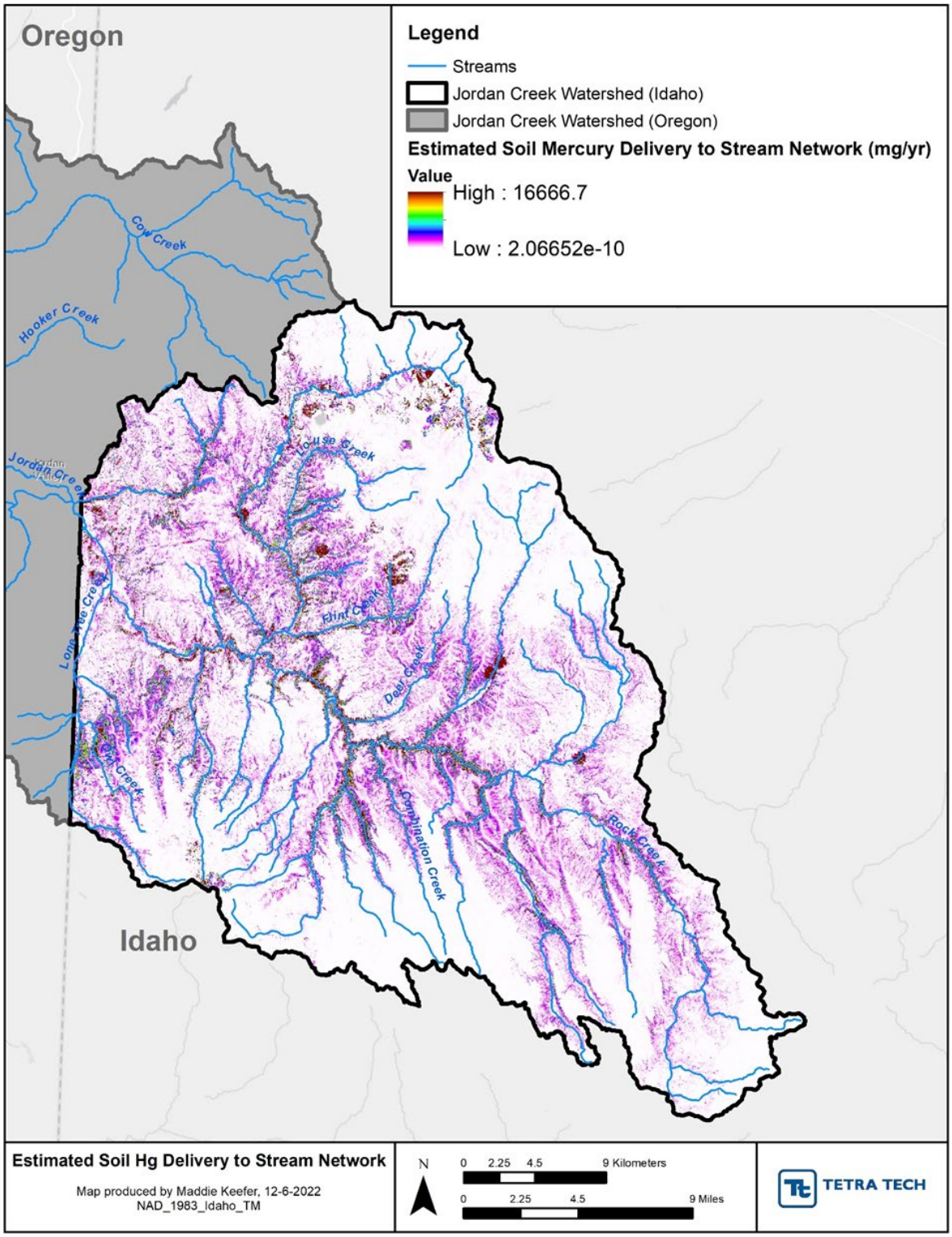


Figure 19. Estimated yield of mercury derived from native Soil within Jordan Creek Subbasin.

5.2 Mercury from Upland Runoff and Groundwater Discharge

The dissolved mercury delivery ratios described in Section 2.2.2 vary spatially within the Idaho portion of the Jordan Creek watershed. Zonal statistics summaries of atmospheric deposition estimates described in Section 2.2 produced estimated loading rates for different land covers from wet deposition of atmospheric mercury. By applying the mercury delivery to the wet deposition rates shown in Table 1, the estimate of atmospheric mercury delivered from the Jordan Creek watershed to the Oregon state line via surface waterways is approximately 262 g/year.

5.3 Mercury from Dry Deposition on Waterbody Surfaces

Dry atmospheric mercury deposition fluxes were obtained for year 2009 from Domagalski et al. (2016) and were used as an approximation of annual dry mercury deposition across the Jordan Creek watershed study area. Given that dry deposition contributes mercury to soils, which is a separately quantified source, only dry deposition loads direct to waterbody surfaces were computed. Gridded annual total mercury dry deposition ($\mu g/m^2/yr$) data was calculated over Jordan Creek watershed major streams and areas classified as Open Water land use in NLCD 2006, yielding a total estimated annual yield of mercury derived from dry atmospheric deposition on waterbody surfaces as 33.39 µg/yr (0.000033 g/yr).

5.4 Mercury from Channel and Floodplain Sources

Estimates of mercury load from channel and floodplain erosion are summarized in Section 4. For source attribution these mercury loads can be separated into loads generated from channel and floodplain sediment affected by mercury contamination from historic mining and ore processing operations and loads generated from channel and floodplain sediments in areas not impacted by historic mining and ore processing. The mining impacted loads dominant these contributions in the upstream area near Silver City; however, the non-mining loads become more important moving downstream, despite the low mercury potency factor, due to the large amount of additional contributing area.

5.5 Summary of Delivered Nonpoint Source Mercury Loads

Sections 5.1-5.3 summarize mercury loads from soil, wet atmospheric deposition, channel/floodplain erosion, and dry atmospheric deposition delivered to the Oregon state line. Adding the delivered mercury loads from all four sources, the total load of mercury delivered from Jordan Creek Watershed in Idaho is estimated to be 12,633 grams per year, with the majority of delivered mercury coming from channel and floodplain erosion, especially the portion of the Jordan Creek mainstem contaminated by past ore processing activities. Table 13 summarizes the mercury loads delivered to the Oregon border.

Table 13. Summary of nonpoint source mercury loads delivered to Oregon state line from Jordan Creek Watershed, Idaho.

Category of Delivered Mercury	Delivered Hg Load (g/yr)	Percent of Delivered Mercury Load
Background Soil Erosion and Transport	334	2.65%
Non-mineralized Area	321	2.55%
Mineralized Area	13	0.11%
Channel and Floodplain Erosion	12,037	95.28%
Legacy Mining Sources to Jordan Creek Mainstem	11,333	89.70%
Background Channel Erosion	705	5.58%
Upland Dissolved Mercury in Runoff	262	2.07%
Dry Atmospheric Deposition to Waterbodies	< 0.01	~0%
Watershed Total	12,633	100.00%

Note: Table addresses background loads and does not include contributions from minor point sources estimated to be approximately 28 g/yr in the main TMDL document. Stormwater load derived from the DeLamar mine reclamation site is a permitted point source and is subtracted from the wet deposition nonpoint load total.

The average annual attribution of mercury loads at the state line (including the minor point source loads discussed in the main TMDL document) is summarized graphically in Figure 20. About two-thirds of the total estimated load is derived from legacy mining sources.

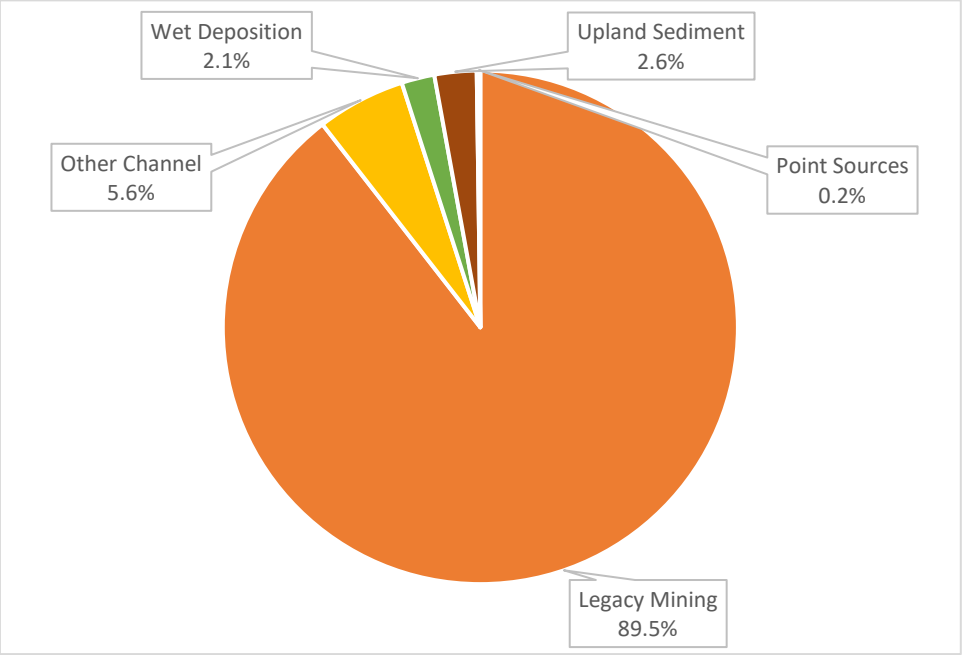


Figure 20. Summary of Jordan Creek watershed mercury loads at the Oregon state line.

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Appendix E. Public Participation and Public Comments

The Idaho Department of Environmental Quality (DEQ) developed this total maximum daily load (TMDL) with participation from the Jordan Creek Watershed Advisory Group, including public meetings on February 14, 2023 and February 18, 2025. A news release was published on March 27, 2025, followed by an updated news release on April 14, 2025 to extend the comment period. DEQ conducted the public comment period from March 27 to June 11, 2025. One entity submitted comments, which are included at the end of this appendix.

Comments and Response Table – Jordan Creek Mercury TMDL		
Public Comment Period: March 27 to June 11, 2025		
June 11, 2025 **Integra Resources – DeLamar Mining Co.**		
Comment #	**Section**	**Comment**
1	General	***Historic mercury impacts in the Jordan Creek subbasin should not preclude new development*** – The Draft TMDL aptly characterizes the nature of mercury impacts in Jordan Creek as almost entirely sourced from decades of outdated mining practices dating back more than a century. Although it is appropriate to curb additional impacts, operational parameters should not be restrictive as to prevent new development. Integra Resources intends to operate on the historic DeLamar Mine site safely and responsibly and can do so only within a regulatory framework that acknowledges the current and projected minimal contributions of mercury into Jordan Creek from DeLamar and considers this in the establishment of new water quality discharge limits. Included comments seek a balance that minimizes new impacts while allowing for reasonable development.
Idaho DEQ Response 1: To consider future growth, DEQ has included revised language in Section 5.4.4 to facilitate potential new sources and subsequent permit implementation: "An explicit growth reserve has not been included in this TMDL. The entire existing load capacity has been allocated to current sources within the watershed. However, new permitted discharges may be accommodated if they do not result in an increase in the overall watershed load. While the TMDL target concentration is 2.4 ng/L THg, discharges exceeding this concentration may still be permissible if the associated load—calculated based on concentration and flow—does not exceed the equivalent load at the target concentration. Offset projects may also be considered to accommodate new or expanded discharges, provided they achieve at least a 1.5:1 offset ratio, ensuring a net reduction in overall watershed loading."		
2	General	***Onerous requirements for new point-source discharges will not serve the goals of the TMDL*** – Reducing mercury in the Jordan Creek sub-basin and achieving the overarching goals of the TMDL will likely take decades. Targeted reductions of mercury at the watershed scale will not realize appreciable improvement from new point-source discharge requirements for minor contributors of flow to Jordan Creek that are (1) lower than background water quality concentrations, (2) not likely attainable based on current practicable water treatment solutions, and (3) will discharge clean water that serves only to facilitate mobilization of mercury-laden sediment in Jordan Creek. Preferable alternatives would include practical solutions that provide incremental benefit in the short term and support (and potentially help facilitate) longer-term improvements in the watershed.
Response 2: Thank you for your comment. DEQ must account for all point sources and provide wasteload allocations within a TMDL per IDAPA 58.01.02.055 and 40 CFR § 130.7.		

(1) Note that DEQ distinguishes between "background" and "natural" sources. Background sources are defined as diffuse load sources that are already present in the environment which include ongoing and past anthropogenic activity as well as natural mercury of geogenic origin. See DEQ's responses to comments 7 and 12 for further discussion of background concentrations. (2) Any new discharge permit applications will be considered new point sources and will be subject to new source performance standards (NSPS, 40 CFR 440.104), which establish 1,000 ng/L as the effluent limit for mercury. Any new source subject to this subsection must achieve the degree of effluent reduction attainable by the application of the best available demonstrated technology. Since NSPS language was most recently updated in the 1980s, newer facilities should have the ability to install equipment with improved treatment capabilities. (3) Since DEQ is obligated to establish wasteload allocations for all point sources within a TMDL, the agency offers alternatives such as offsets and water quality trading to reduce the potential burden of these allocations.		
3	General	***Reasonable discharge limits can facilitate complementary mitigation*** – Successful approval and permitting of the DeLamar Mine creates the potential to identify new opportunities and actions that can support the broader goals of the Jordan Creek TMDL. Required mitigation efforts (e.g., 404 compensatory mitigation) can be informed by these objectives and conceivably could serve multiple needs with lasting benefits. As noted in our comments, the potential benefits of these actions should be accounted for in a clear and quantifiable manner when considering allowances for new point-source discharge limits. We understand that the drafting of the Jordan Creek Mercury TMDL has been a long and arduous process, and we recognize DEQ's dedication to address long-standing water quality issues in the Jordan Creek sub-basin. The attached comments highlight the extreme importance of the draft TMDL with respect to Integra's plans to revitalize the DeLamar Project, and it is our hope that they underscore our team's willingness to work collaboratively and responsibly towards an outcome that serves the interests of all. In summary we believe it is critical for the TMDL to provide a clear path for the Delamar project to move forward. We believe the best way to accomplish this within the regulatory framework is for the final TMDL to determine that the existing discharges are insignificant (less than .1% of the load) and can continue to discharge at current levels, that a specific future reserve be allowed for the Project's future discharges and that the TMDL be phased in over years and likely decades. As set forth in the attached Memo there is clear precedent for these approaches, and why they are appropriate here. Finally, we acknowledge IDEQ's preference for offsets or pollutant trading in the draft TMDL. However, we believe that if such an approach is required for the Project to move forward, clear targets should be specified in the final TMDL and any offsets must be proportional to the minimal impacts the Project will have on mercury loading in the future.
Response 3: As stated in DEQ's response to comment 2, DEQ must account for all point sources and provide wasteload allocations within a TMDL according to IDAPA 58.01.02.055 and 40 CFR § 130.7.		

To consider any potential future growth, DEQ has included revised language in Section 5.4.4 to facilitate potential new sources and subsequent permit implementation as noted in DEQ's response to comment 1.

4	Table 29 P. 15	**Achieving the target load reduction is technically challenging due to legacy mining-impacted sediment/soil.** The Draft TMDL states that the target load reductions (Table 29 of the Draft TMDL), which exceed 95 percent, are "technically feasible." However, because Legacy Mining Impacted Sediment/Floodplain Soil contributes nearly 90 percent of the existing load, achieving the target load reductions will likely require investigation and remediation of more than 34 miles of impacted sediment along the mainstem of Jordan Creek, which may take decades to complete. The determination that the target load reductions are "technically feasible" is premature given the known extent of impacted sediment, its estimated load contribution, and the lack of specific controls to address this non-point source, included estimated load reductions. USEPA (1991) TMDL Guidance states that *"in order to allocate loads among both nonpoint and point sources, there must be reasonable assurances that nonpoint source reduction will in fact be achieved"* (page 15, last paragraph). The Draft TMDL should clearly state that the attainment of the target load reductions is highly uncertain due to the extent of Legacy Mining Impacted Sediment/Floodplain Soil deposited along more than 34 miles and its contribution of nearly 90 percent of the mercury load at the state border.

Response 4: Thank you for your comment. To address the uncertain nature of remediating legacy mining impacts, DEQ added language to Section 5.5 (Implementation Strategies):

DEQ recognizes that, in spite of all reasonable efforts, attainment of restoration targets may not be possible due to the potential presence of unalterable human-caused sources and natural background sources of metals loading. Per DEQ's Implementation Guidance for Idaho Mercury Water Quality Criteria, section 5.1.2 Adaptive Management (DEQ 2005), an adaptive management approach will be considered for mercury and implemented under the implementation plan developed for this TMDL. Under this adaptive management approach, the nature of the impairment will ultimately fall into one of the three categories identified below:

- Implementation of restoration activities results in full attainment of restoration targets.
- Implementation of restoration activities fails to result in target attainment due to underperformance or ineffectiveness of restoration actions. Under this scenario the waterbody remains impaired and will require further restoration efforts associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.
- Implementation of restoration activities fails to result in target attainment, but target attainment is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards and/or the reclassification of the waterbody may be necessary. This would then lead to a new mercury target (and TMDL),

and the new target could either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The agencies charged with developing the implementation plan for this TMDL, in coordination with DEQ and the Jordan Creek Watershed Advisory Group, will determine the appropriate management approach relative to the specific mine cleanup activities or any impairment condition improvement efforts associated with mining impacts. DEQ's IPDES Bureau will also be involved in all permitted point sources. DEQ will evaluate the performance of restoration activities along with available in-stream data to determine the suitability of any given target and beneficial use support. Reclamation activities and monitoring conducted by other parties should be incorporated into the process as well. The information will also help determine any further cleanup or load reduction needs for any applicable waterbody in the Jordan Creek watershed and will ultimately measure the success of water quality restoration.

DEQ acknowledges that restoration, construction, maintenance, and future development may result in short term increase in surface water metals concentrations. For any activities that occur within the stream or floodplain, all appropriate permits should be obtained before beginning the activity. Federal and state permits necessary to conduct work within a stream or stream corridor are intended to protect the resource and reduce, if not completely eliminate, pollutant loading or degradation from the permitted activity. The permit requirements typically have mechanisms that allow for some short-term impacts to the resource, as long as all appropriate measures are taken to reduce impact to the least amount possible.

5	Tables 13 and 14	**Because impacted sediment is present along the mainstem, discharge meeting the target wasteload allocation will become re-impacted with mercury in suspended sediment.** The introduction to this memorandum describes how mercury loading in Jordan Creek occurs all along the mainstem due to suspension of mercury-impacted sediment from increased flows. Because of this source of loading, any point source discharge meeting the target wasteload allocation will become re-impacted with mercury in suspended sediment after entering Jordan Creek. This is consistent with the data presented in the Draft TMDL showing that, although the mercury concentrations in tributaries to Jordan Creek (Table 14 of the Draft TMDL) are generally low, concentrations in Jordan Creek (Table 13 of the Draft TMDL) remain elevated and the mercury load increases along the mainstem.
Response 5: Thank you for your comment. DEQ must account for all point sources and provide wasteload allocations within a TMDL (IDAPA 58.01.02.055 and 40 CFR § 130.7). However, DEQ offers additional options for point source dischargers as noted in our response to comment #1.		
6		**Achieving the water quality targets through water treatment may be technically challenging and/or economically infeasible.** Achieving the target water column concentration of 2.4 nanograms per liter (ng/L), which is the basis for the wasteload allocations presented in the Draft TMDL, represents a reduction of more than 95 percent from existing Jordan Creek concentrations. The effluent limitation representing the degree of effluent

		reduction attainable by the application of the best practicable control technology (40 Code of Federal Regulations [CFR] 440.102) for mercury is 1,000 ng/L, which is almost three orders of magnitude greater than the TMDL target concentration. This technology-based effluent limit is consistent with values provided by treatment technology manufacturers such as ion exchange treatment systems (ResinTech, Inc.). Given the large difference between the TMDL target concentration and the technology-based limits, achieving the water quality targets through water treatment may be technically challenging and/or economically infeasible for point source discharges.
Response 6: Any new discharge permit applications will be considered new point sources and will be subject to new source performance standards (NSPS, 40 CFR 440.104), which establish 1,000 ng/L as the effluent limit for mercury. Any new source subject to this subsection must achieve the degree of effluent reduction attainable by the application of the **best available demonstrated technology**. Since NSPS language was most recently updated in the 1980s, newer facilities should have the ability to install equipment with improved treatment capabilities. For example, other proposed limits within areas of Idaho affected by mercury from legacy mining include 10 ng/L. DEQ has updated language in the Reserve for Growth section (Section 5.4.4) to provide options for new point sources in attaining these wasteload allocation targets through offsets, as noted in response to comment 1.		
7	Section 3.1.1, p. 43	**The TMDL load allocation does not fully account for natural background load as estimated for existing conditions.** The estimated natural background concentration and associated load are not consistently represented throughout the Draft TMDL. TMDLs as defined by the Idaho Water Quality Standards (Idaho Administrative Procedures Act [IDAPA] 58.01.02.010.99) should include natural background. The Draft TMDL estimates that the natural background concentration for the DeLamar Mine area is 6 ng/L (Section 3.1.1, page 43). However, the wasteload allocations for the DeLamar Mine are based on meeting 2.1 ng/L during baseflow conditions and 2.4 ng/L annual average concentration. The Idaho Water Quality Standards (IDAPA 58.01.02.200.09) state that when the natural background conditions exceed any applicable criteria, the applicable water quality criteria shall not apply. Based on the natural background concentration for the DeLamar Mine area and the wasteload allocations provided in the Draft TMDL, the TMDL would not be attainable due to the elevated natural background concentration in the DeLamar Mine area.
Response 7: This comment first refers to the text on pages 42–43 of the Public Comment Draft: "In addition to flow, SPARROW also provides estimates of sediment load with separate accounting for upland and in-channel or riparian sediment sources. This information is used in Appendix D to estimate mercury loads from the contributing pathways. Over the drainage area upstream of JC1, the average annual total mercury load derived from upland soil erosion and runoff of atmospheric deposition (i.e., excluding the load from highly contaminated stream and riparian sediment near the ore processing mills) is 139.7 gram per year (g/yr) in a flow of 24.6 cfs, which yields a concentration of 6.36 ng/L. A similar calculation for the area upstream of station JC2 yields an estimate of 5.82 ng/L. These concentrations are higher than the		

		background load concentration of 3.37 ng/L for the whole watershed because sediment concentrations of Hg are higher in the mineralized area around the mining district. Atmospheric deposition rates are higher than the watershed average due to higher elevations. It is therefore assumed that the total mercury concentration in stormwater runoff at the DeLamar Mine site that would occur under natural conditions can be approximated as 6 ng/L (as a flow-weighted average)…" The concentrations referred to in this paragraph are flow-weighted concentrations, which are equal to the total annual mercury load divided by the total annual flow volume. These are not the same as time-weighted average concentrations (i.e., the arithmetic average of observed or simulated concentrations throughout a year). The flow-weighted concentrations are driven by infrequent high runoff events and are essentially a measure of load. These flow-weighted concentrations are expected to be higher than the average concentrations that would be encountered on a daily basis and are not representative of the "natural background concentration" referred to in the standards. The background stream mercury concentration estimation, expressed as time-weighted averages, is addressed in Section 3.2.4, starting at page 58. These are separated by seasons, recognizing that higher concentrations are observed due to the entrainment of stream sediment during higher flows, primarily associated with spring snowmelt. The estimated background concentrations that are not influenced by historical mining activity are 1.54 ng/L during baseflow and 2.13 ng/L during higher flow. As expected, these background concentrations are lower than the flow-weighted concentrations mentioned above. Section 3.2.4 also discusses the differences between natural concentrations and background concentrations: "Mercury loads derived from atmospheric deposition or from watershed soils and sediment erosion are considered background sources. Note that DEQ distinguishes between "background" and "natural" sources. Background sources are defined as diffuse load sources that are already present in the environment which includes ongoing and past anthropogenic activity as well as natural mercury of geogenic origin. Background is not equivalent to "natural" sources, which are only of geogenic origin. The global pool of atmospheric mercury has significantly increased over the last century from industrial and mining emissions, creating increased mercury deposition onto the landscape (Schuster et al. 2002). The United Nations Environment Programme estimated that human activities have increased atmospheric mercury concentrations by 450% above natural levels (UNEP 2019). The mercury currently stored in western stream and riparian sediment is affected by the worldwide increases in anthropogenic atmospheric loads and by inputs from mining activity and ore processing that occurred in the western U.S primarily between the 1860s and 1920s." IDAPA 58.01.02 defines "natural background conditions" as "The physical, chemical, biological, or radiological conditions existing in a water body without human sources of pollution within the watershed." An allocation to background sources is provided in Section 5.4.1.2. This is based on the flow-weighted background concentrations. DEQ revised TMDL language in Section 3.1.1 to ensure that the stormwater runoff value of 6 ng/L is not conflated with natural background.
8	(Recommendation) Table 27	**Delamar's existing discharges (MSGP and Groundwater Remediation Permit) are insignificant and can therefore continue to discharge at current levels.**

		The existing point source discharges for the DeLamar Mine were estimated to be 19 g/yr, only 0.1 percent of the total load at the state border (Table 27) and which is likely an overestimation because it was not based on low level mercury sampling. However, the draft TMDL includes wasteload allocations for this source of loading, even though such load reductions would offer no discernible water quality benefit. The TMDL should instead determine that these point source discharges associated with the DeLamar project are insignificant and can discharge at current levels (estimated at 19 g/yr). There is precedent around the United States for approved TMDLs in which certain point sources were determined to be "de minimis" or "insignificant" and therefore can continue to discharge at current levels or "performance-based limits". A summary of TMDLs around the country that found certain point sources "insignificant" is set forth in Region 9 USEPA (2015)'s Helpful Practices for Addressing Point Sources and Implementing TMDLs in NPDES Permits. The general reasoning for a determination that a point source is "insignificant" is that the discharge is so small that there would be no benefit to regulate them further. The Upper Monocacy River Watershed Sediment TMDL (Md. 2009) is one of the many examples of this approach in which USEPA 's Decision Rationale found that "no reductions were applied" for permitted process water point sources, "because at 0.2 percent of the total load, such controls would produce no discernable water quality benefit." The same reasoning applies with equal force here (and even more so since any discharge will become recontaminated as noted above), DMC's current discharges should be deemed "insignificant" and be allowed to continue to discharge at current levels or performance-based limits.
Response 8: Thank you for your comment. DEQ must develop wasteload allocations that comply with Idaho Water Quality standards and applicable downstream standards. However, our response to comment 1 provides additional language to the Reserve for Growth section (Section 5.4.4) for potential new point sources in the subbasin. Additionally, any "de minimis" determinations would be made during the permitting process rather than during TMDL development.		
9	(Recommendation) Section 5.4.4	**Set aside a future reserve sufficient to cover the proposed Delamar future discharge.** Section 5.4.4 of the Draft TMDL states that an explicit growth reserve was not included, the entire existing load capacity was allocated to existing sources in the watershed, and that new permitted discharges could be added if they discharge at the TMDL target concentration of 2.4 ng/L or less. Confusingly, the Draft TMDL acknowledges that future stormwater discharges may use a portion of the load capacity that has been reserved for future growth. It is common practice for IDEQ to include a load capacity allowing for future growth in TMDLs throughout Idaho, particularly when the agency knows there will be a future discharger. As DMC will likely be the only future point source in the watershed, the Company seeks additional clarity around the future reserve issue. Accordingly, the final TMDL should be revised to include a future reserve sufficient to cover discharges for the proposed DeLamar Project by incorporating the recommendations provided above which may also address offsets/credits. Discharges

		for the proposed DeLamar Project are being evaluated as part of the planning and permitting process and additional follow-up will be required with IDEQ to evaluate the future reserve quantity required.
Response 9: DEQ's response to comment #1 addresses concerns regarding new development: To consider any potential future growth, DEQ included revised language in Section 5.4.4 to facilitate potential new sources and subsequent permit implementation: "An explicit growth reserve has not been included in this TMDL. The entire existing load capacity has been allocated to current sources within the watershed. However, new permitted discharges may be accommodated if they do not result in an increase in the overall watershed load. While the TMDL target concentration is 2.4 ng/L total mercury (THg), discharges exceeding this concentration may still be permissible if the associated load—calculated based on concentration and flow—does not exceed the equivalent load at the target concentration. Offset projects may also be considered to accommodate new or expanded discharges, provided they achieve at least a 1.5:1 offset ratio, ensuring a net reduction in overall watershed loading." DEQ also revised the language in section 5.5.2.2 relating to stormwater discharges using a portion of load capacity that has been reserved for growth: If the new MSGP dischargers cannot make those demonstrations, they may ~~use a portion of the load capacity that has been reserved for growth or~~ demonstrate the discharge from the facility will not exceed any concentration-based targets established in the TMDL.		
10	(Recommendation) P. 86	**The TMDL should allow for permitted discharge with credit for offsets through pollutant/water quality trading.** The Idaho Water Quality Standards (IDAPA 58.01.02.060.06) state that TMDLs may include pollutant trading (elsewhere referred to as offsets or water quality trading). The Draft TMDL acknowledges that achieving the TMDL target or load allocations may depend on water quality trading (page 86) but does not describe what type of offsets would be considered in water quality trading. Additional discussion should be added, including for the wasteload allocations, that describes how a water quality trading program could provide credits for discharge. The proposed DeLamar Project is expected to use existing surface water rights on Jordan Creek to provide makeup water and also discharge treated contact water at a new outfall on Jordan Creek, in addition to existing and new stormwater outfalls. Although the draft TMDL acknowledges offsets may be appropriate for future point sources, there is no specificity on how offsets would apply. As DMC's point source(s) will be the only future point source in the watershed, the Company requests additional certainty on how the offsets should be implemented. For planning purposes as DMC moves through the federal and state permitting processes, the Company needs to have certainty on what the compliance targets for the project will be. The following are some examples of specific offsets that can be included in any final TMDL: • *Mercury mass removed from Jordan Creek through intake water*. For example, if 10 acre-feet of water are removed from Jordan Creek with an intake mercury concentration of 80 ng/L, a credit of 1 gram of mercury should be counted toward the wasteload allocation for the mass removed.

		• *Mercury mass removed through diversion of stormwater runoff*. The area of stormwater runoff contributing flow to Jordan Creek will be reduced as a result of new facility construction or expansion of existing facilities, and credit should be allowed for mercury mass currently reporting to the state border that is derived from this stormwater flow to Jordan Creek. Because the main source of mercury is Legacy Mining Impacted Sediment/Floodplain Soil present all along the drainage to the state border, the credit should be proportional to the overall load balance in Jordan Creek. For example, if the annual storm-water flow to Jordan Creek is reduced by 10 acre-feet, and the average concentration at the state border is 80 ng/L, 1 gram of mercury should be counted as a credit toward a future wasteload allocation. • *Mercury mass removed through mitigation of existing nonpoint sources*. Offset credits should be allowed for implementation of any controls that reduce mercury loading from existing nonpoint sources such as Legacy Mining Impacted Sediment/Floodplain Soil. For example, if best management practices are implemented that would reduce mercury loading, credit for the reduction in mercury loading should be counted towards the wasteload allocations. A simple ratio should be specified in the final TMDL on how offsets/credits will be implemented. In the examples noted above, if 1 gram is removed through diversions will DMC's future discharge be given a 1 gram credit? Similarly, if DMC were to mitigate nonpoint sources and remove 100 grams of mercury from flood-plain soils, will DMC's future discharge be given a 100 gram credit? Whatever credit ratio IDEQ utilizes, it should be proportional to the impact of any future discharge.

Response 10: DEQ's response to comment #1 addresses reserve for growth and establishes an offset ratio: "Offset projects may also be considered to accommodate new or expanded discharges, provided they achieve at least a 1.5:1 offset ratio, ensuring a net reduction in overall watershed loading."

DEQ also added a new section to address the potential for Water Quality Trading (Section 5.5.5):
"Water quality trading (also known as pollutant trading) is a contractual agreement to exchange pollution reductions between two parties. Water quality trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Water quality trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed.

Trading is often appealing when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.
Water quality trading is voluntary. Parties trade only if both are better off because of the trade, and trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements.

Water quality trading is recognized in Idaho's water quality standards in IDAPA 58.01.02.055.06. DEQ allows for water quality trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ's *Water Quality Pollutant Trading Guidance* establishes the procedures for water quality trading (DEQ 2016b).

5.5.5.1 Trading Components
The major components of water quality trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Ratios are used to ensure the environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database by DEQ or its designated party.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant load beyond a level required by existing federal, state, local, and tribal regulations and TMDL implementation documents:

- Point sources create credits by reducing pollutant discharges below NPDES effluent limits set consistent with the assumptions and requirements of the TMDL wasteload allocations.
- Nonpoint sources create credits by implementing approved BMPs that reduce pollutant runoff below current loading levels. Nonpoint sources must follow the specific design, maintenance, and monitoring requirements for that BMP, as established in relevant trading guidance and framework documents; apply discounts to credits generated, if required (i.e., attenuation or uncertainty ratios); meet trading baseline requirements (i.e., existing federal, state, tribal, and local regulations and any requirements established via TMDL implementation plans); and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit) is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL. This last step is important because it helps to demonstrate reasonable assurance toward meeting TMDL goals and not just pollutant offsetting between point and nonpoint sources.

5.5.5.2 Watershed-Specific Environmental Protection
Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL is protected. To do this, hydrologically-based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally better outcomes at the point of environmental concern. Localized adverse impacts to water quality are not allowed.

5.5.5.3 Trading Authorization
Water quality trading is authorized in the Idaho water quality standards (IDAPA 58.01.02.055). Trading should be implemented per the Clean Water Act and other existing regulations, EPA's water quality trading policy (EPA 2003), and DEQ's water quality trading guidance (DEQ 2016b)."

11	(Recommendation) Section 5.5.1	**The TMDL should include an implementation schedule that addresses the main source of loading.**

		Section 5.5.1 of the Draft TMDL acknowledges that, "the targets established for point and nonpoint sources in this TMDL may take decades to achieve" but then states that, "the staged implementation strategy for the Jordan Creek subbasin acknowledges that IPDES-permitted point sources will strive to achieve the TMDL as soon as possible." However, because the Idaho Pollutant Discharge Elimination System- (IPDES-) permitted point sources only contribute 0.1 percent of the total mercury load in Jordan Creek at the state border, and because any current or future permitted discharges meeting the target wasteload allocations would become re-impacted with mercury in suspended sediment after entering Jordan Creek, it will be impossible for the point source wasteload allocations to achieve the TMDL without also addressing the Legacy Mining Impacted Sediment/Floodplain Soil. USEPA (2006)'s Guidance provide clarification on various scenarios and approaches where TMDLs change over time due to uncertainties, including uncertainty in the effectiveness of load reduction controls. The California Regional Water Quality Control Boards (2006) Guadalupe River Mercury TMDL included load allocations that changed over time in two phases. Subsequently the first phase was extended for another 10 years. The TMDL should include an implementation schedule for current and future point source that is based on implementing controls for Legacy Impacted Sediment/Floodplain Soil, which contributes nearly 90 percent of the existing load in Jordan Creek. The implementation schedule would adjust point source wasteload allocations based on corresponding improvements to Jordan Creek water quality through control measures for Legacy Impacted Sediment/Floodplain Soil. By including an implementation schedule that is based on achieving load reductions for Legacy Impacted Sediment/Floodplain Soil, IDEQ would be providing reasonable assurances that the TMDL can be attained.
Response 11: Generally, implementation schedules are addressed in separate TMDL implementation plan documents, which are developed by the primary landowner representative within the watershed. The primary state/federal landowner identified as representative in the Jordan Creek watershed is the Bureau of Land Management. Implementation of an approved TMDL is primarily the responsibility of designated agencies, as stated in Idaho Code 39-3612, in cooperation with the Jordan Creek Watershed Advisory Group. To address concerns of the extent of nonpoint source pollution and reasonable assurance, DEQ added adaptive management language to Section 5.5, as noted in response to comment 4.		
12	(Recommendation) Section 3.1.1, p. 43	**Use natural background to calculate the wasteload allocations for DeLamar Mine.** TMDLs as defined by the Idaho Water Quality Standards (Idaho Administrative Procedures Act [IDAPA] 58.01.02.010.99) should include natural background. The Draft TMDL estimates that the natural back-ground concentration for the DeLamar Mine area is 6 ng/L (Section 3.1.1, page 43). However, the wasteload allocations for the DeLamar Mine are based on meeting 2.1 ng/L during baseflow conditions and 2.4 ng/L annual average concentration. The Idaho Water Quality Standards (IDAPA 58.01.02.200.09)

		state that when the natural background conditions exceed any applicable criteria, the applicable water quality criteria shall not apply. The TMDL should be revised to use the natural background concentration to calculate the wasteload allocations for DeLamar Mine.

Response 12: As noted in the response to comment #7, the figure of 6 ng/L total mercury estimated for the DeLamar Mine area is a flow-weighted concentration estimate of load and is not equivalent to the time-weighted average concentration and does not match the IDAPA definition of natural background conditions.

Two permitted point sources are associated with the DeLamar Mine area and are assigned wasteload allocations. The first is the groundwater remediation point source discharge to Louse Creek, which is covered under a general permit for groundwater remediation (number ID-G91-0007) and described in Section 5.4.2.1. The wasteload allocation for the groundwater remediation discharge is based on attaining the achieving the proposed chronic criterion of 2.1 ng/L total mercury (Table 32). The flow-weighted average concentration of 6 ng/L, which predominantly reflects sediment-associated load to streams during surface runoff events, is not relevant to the groundwater discharge.

The second permitted point source is for stormwater discharge from the DeLamar Mine area under Idaho's 2021 IPDES Stormwater MSGP. The wasteload allocation, described in Section 5.4.1.2, is calculated based on the TMDL annual average instream target of 2.4 ng/L total mercury. 2.4 ng/L is an instream target based on the TMDL load capacity and is greater than the estimated average time-weighted background concentrations for both high flow and base flow conditions.

The cited flow-weighted background concentration of 6 ng/L is not relevant to this calculation. Further, the target is specified to be achieved as an annual average. The TMDL at page 80 emphasizes that "The TMDL annual average target concentration of 2.4 ng/L THg should not be interpreted as a water quality-based effluent limit relative to the stormwater permit. However, a benchmark value can be assigned to the permit as a maximum daily load calculated using the statistical techniques described in EPA (1991) for estimating an upper confidence limit on the daily concentration."

Appendix F. Integra Resources Comments on the draft Jordan Creek Mercury Total Maximum Daily Load Letter

Integra Resources Corp.
225 N. 9th Street
Boise, ID, 83702

June 11, 2025

[Electronic Delivery]
Melissa Wigton-Hill
1445 N. Orchard St.
Boise, ID 83706
melissa.wigton-hill@deq.idaho.gov

Subject: Integra Resources Comments on the draft *Jordan Creek Mercury Total Maximum Daily Load (TMDL)*

Dear Melissa Wigton-Hill,

With this letter and attached content, Integra Resources and its wholly owned subsidiary DeLamar Mining Co., submit to the Idaho Department of Environmental Quality (DEQ) review comments on DEQ's draft *Jordan Creek Mercury Total Maximum Daily Load* (TMDL).

The draft TMDL is of great interest to Integra Resources, the owner of the currently inactive DeLamar Mine. As noted in the draft TMDL, the facility has two existing permits through the Idaho Pollution Discharge Elimination System (IPDES) program for discharge into the Jordan Creek subbasin of stormwater and remediated groundwater produced as part of the care and maintenance of the inactive mine. Integra Resources has proposed to re-initiate open pit mining at DeLamar and is currently working to obtain all appropriate federal, state and local approvals and permits for this proposed activity. Therefore, we are eager to work with DEQ to develop a mercury TMDL that is protective of the environment, technologically and financially attainable, and imminently practicable.

Integra's comments on the draft TMDL are provided in the attached technical memorandum, prepared by Arcadis. Since 2023, Arcadis has conducted hydrological baseline studies at the DeLamar Mine including characterization of surface water and groundwater quality and quantity, and preparation of a hydrogeological model to serve as the basis for environmental effects analysis by the Bureau of Land Management (BLM) in accordance with the National Environmental Policy Act (NEPA). Arcadis will also provide support for obtaining several permits for the DeLamar Mine related to water quality, including IPDES, the Multi-Sector General Permit (MSGP), and Groundwater Point of Compliance (POC). They are therefore well acquainted with the hydrological dynamics of the site from both qualitative and quantitative perspectives.

Several comments included in the attached technical memorandum are introduced here to highlight their importance and provide additional context.

Historic mercury impacts in the Jordan Creek sub-basin should not preclude new development – The Draft TMDL aptly characterizes the nature of mercury impacts in Jordan Creek as almost entirely sourced from decades of outdated mining practices dating back more than a century. Although it is appropriate to curb additional impacts, operational parameters should not be restrictive as to prevent new development. Integra Resources intends to operate on the historic DeLamar Mine site safely and

responsibly and can do so only within a regulatory framework that acknowledges the current and projected minimal contributions of mercury into Jordan Creek from DeLamar and considers this in the establishment of new water quality discharge limits. Included comments seek a balance that minimizes new impacts while allowing for reasonable development.

Onerous requirements for new point-source discharges will not serve the goals of the TMDL – Reducing mercury in the Jordan Creek sub-basin and achieving the overarching goals of the TMDL will likely take decades. Targeted reductions of mercury at the watershed scale will not realize appreciable improvement from new point-source discharge requirements for minor contributors of flow to Jordan Creek that are (1) lower than background water quality concentrations, (2) not likely attainable based on current practicable water treatment solutions, and (3) will discharge clean water that serves only to facilitate mobilization of mercury-laden sediment in Jordan Creek. Preferable alternatives would include practical solutions that provide incremental benefit in the short term and support (and potentially help facilitate) longer-term improvements in the watershed.

Reasonable discharge limits can facilitate complementary mitigation – Successful approval and permitting of the DeLamar Mine creates the potential to identify new opportunities and actions that can support the broader goals of the Jordan Creek TMDL. Required mitigation efforts (e.g., 404 compensatory mitigation) can be informed by these objectives and conceivably could serve multiple needs with lasting benefits. As noted in our comments, the potential benefits of these actions should be accounted for in a clear and quantifiable manner when considering allowances for new point-source discharge limits.

We understand that the drafting of the Jordan Creek Mercury TMDL has been a long and arduous process, and we recognize DEQ's dedication to address long-standing water quality issues in the Jordan Creek sub-basin. The attached comments highlight the extreme importance of the draft TMDL with respect to Integra's plans to revitalize the DeLamar Project, and it is our hope that they underscore our team's willingness to work collaboratively and responsibly towards an outcome that serves the interests of all.

In summary we believe it is critical for the TMDL to provide a clear path for the Delamar project to move forward. We believe the best way to accomplish this within the regulatory framework is for the final TMDL to determine that the existing discharges are insignificant (less than .1% of the load) and can continue to discharge at current levels, that a specific future reserve be allowed for the Project's future discharges and that the TMDL be phased in over years and likely decades. As set forth in the attached Memo there is clear precedent for these approaches, and why they are appropriate here. Finally, we acknowledge IDEQ's preference for offsets or pollutant trading in the draft TMDL. However, we believe that if such an approach is required for the Project to move forward, clear targets should be specified in the final TMDL and any offsets must be proportional to the minimal impacts the Project will have on mercury loading in the future.

We appreciate your consideration of our submitted comments and look forward to productive collaboration on helping improve water quality in the Jordan Creek drainage.

Should you have any questions or wish to discuss further, please feel free to contact me directly at 208-870-7993 or dale@integraresources.com.

Sincerely,



Dale Kerner
Vice President - Permitting
Integra Resources

Attachment: Comments on the Draft *Jordan Creek Mercury Total Maximum Daily Load* (Arcadis)

Technical Memorandum

225 North 9th Street, Suite 810
Boise, ID 83702

Technical Memorandum

Subject: DeLamar Mining Company Comments on the Proposed Jordan Creek Mercury Total Maximum Daily Load, March 2025

Date: June 11, 2025

To: Idaho Department of Environmental Quality

From: Arcadis-U.S., Inc. on behalf of Integra Resources/DeLamar Mining Company

Introduction

On behalf of Integra Resources (Integra) dba DeLamar Mining Company (DMC), Arcadis-U.S., Inc. (Arcadis) is submitting these comments on the Draft Jordan Creek Mercury Total Maximum Daily Load (Draft TMDL) published by Idaho Department of Environmental Quality (IDEQ) in March 2025. DMC is the operator of the DeLamar Mine located within the Jordan Creek watershed. The historical DeLamar Mine is located along the Silver City Range near the headwaters of Jordan Creek. DMC is currently in the process of permitting a proposed gold and silver open pit mining operation (the DeLamar Project) within the historical DeLamar Mine area.

The Draft TMDL includes an evaluation of the existing mercury loads in Jordan Creek; potential sources of mercury; and provides target mercury water column concentrations, target mercury load reductions, and wasteload allocations. The Draft TMDL provides estimates of mercury loading from the following sources: Legacy Mining Impacted Sediment/Floodplain Soil, atmospheric-derived mercury in runoff, native sediment/floodplain soil, erosion of mineralized and non-mineralized bedrock/soil, and permitted point source discharges at the historical DeLamar Mine. IDEQ estimates that nearly 90 percent of the total mercury load in the water column at the state border is contributed by Legacy Mining Impacted Sediment/Floodplain Soil. Tables 27 and 28 of the Draft TMDL provide the estimated loads at the state border and at station JC2 (located approximately mid-way between the headwaters and the state border), respectively. Mercury is primarily present in the suspended sediment, which increases with higher flows. As a result, the load increases 66 percent along the lower reach between JC2 and the state border due to increasing flow suspending mercury-impacted sediment within the streambed and floodplains.

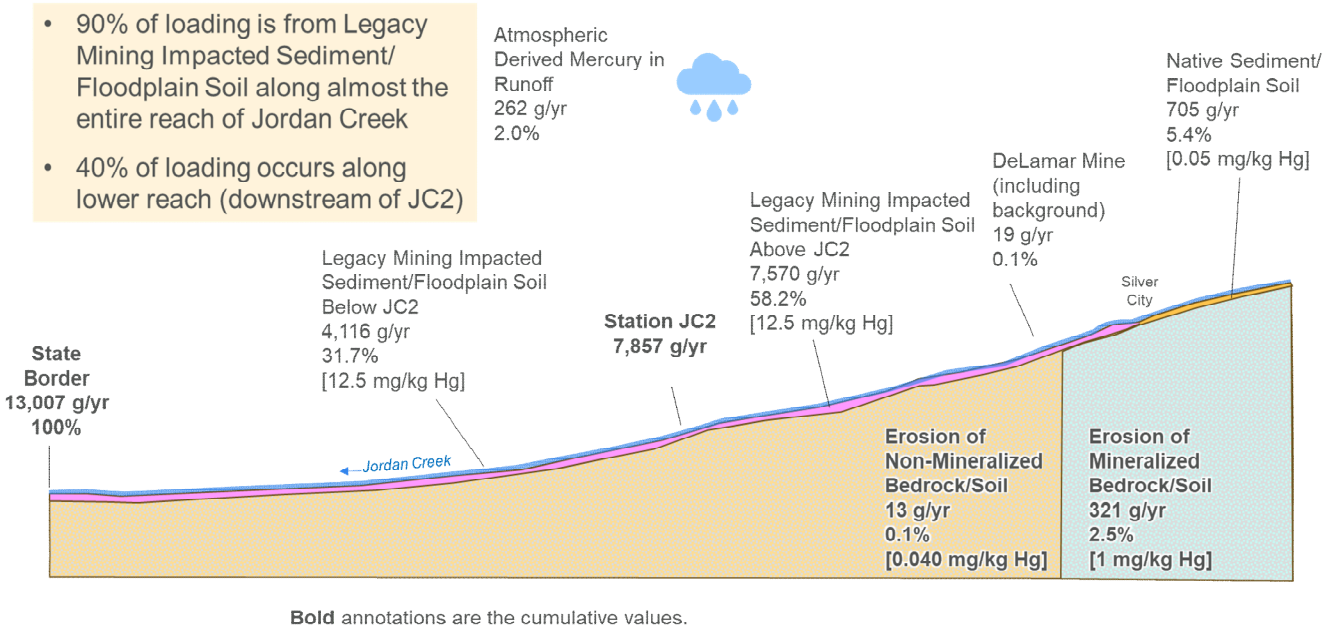


Figure 1. Mercury Loading Schematic with Estimated Values from Tables 27 and 28 of the Draft TMDL

The key finding of the Draft TMDL, that Legacy Mining Impacted Sediment/Floodplain Soil is contributing nearly 90 percent of the mercury load in Jordan Creek at the state border, is supported by surface water and sediment data collected within the watershed. A map of stream channel sediment concentrations measured within the Jordan Creek watershed (Figure 12 of the Draft TMDL) shows elevated sediment concentrations all along the main channel beginning near Silver City and continuing to the state border. Mercury was released to Jordan Creek sediment and upland soil areas during historical mineral extraction activities in the

watershed, with the majority of releases occurring at mining operations near Silver City. Mercury was freely and haphazardly used to extract gold and silver from the ore. Subsequently, mercury in sediment and floodplain soil has continued to migrate downstream, and this residual mercury in streambed sediment and floodplain soil represents the primary source of loading under current conditions.

Filtered and unfiltered water column concentrations presented in Table 14 of the Draft TMDL also indicate that the majority of mercury in the water column is associated with suspended sediment during both high-flow and low-flow conditions. The Draft TMDL highlights a conclusion of the 2021 United States Environmental Protection Agency (USEPA) study noting that, during high-flow conditions, a median of 84 percent of mercury in the water column is associated with suspended sediment based on a comparison of unfiltered and filtered concentrations.

Profiles of average annual unfiltered mercury water column concentrations (calculated from Table 14 of the Draft TMDL[1]), surface water flow (model estimates from Table 12 of the Draft TMDL), and mercury load (calculated using the concentration and flow values) along the mainstem of Jordan Creek are presented below as Figure 2. Although the concentration is lower near the state border, the total mercury load in the water column increases all along Jordan Creek, with the load increasing approximately 66 percent along the downstream reach (downstream of station JC2). The continued increase in load along the downstream reach is consistent with the key finding of the Draft TMDL that nearly 90 percent of the mercury load in Jordan Creek is contributed by Legacy Mining Impacted Sediment and Floodplain Soil. Mercury loading continues all along the mainstem due to suspension of mercury-impacted sediment with increased flow.

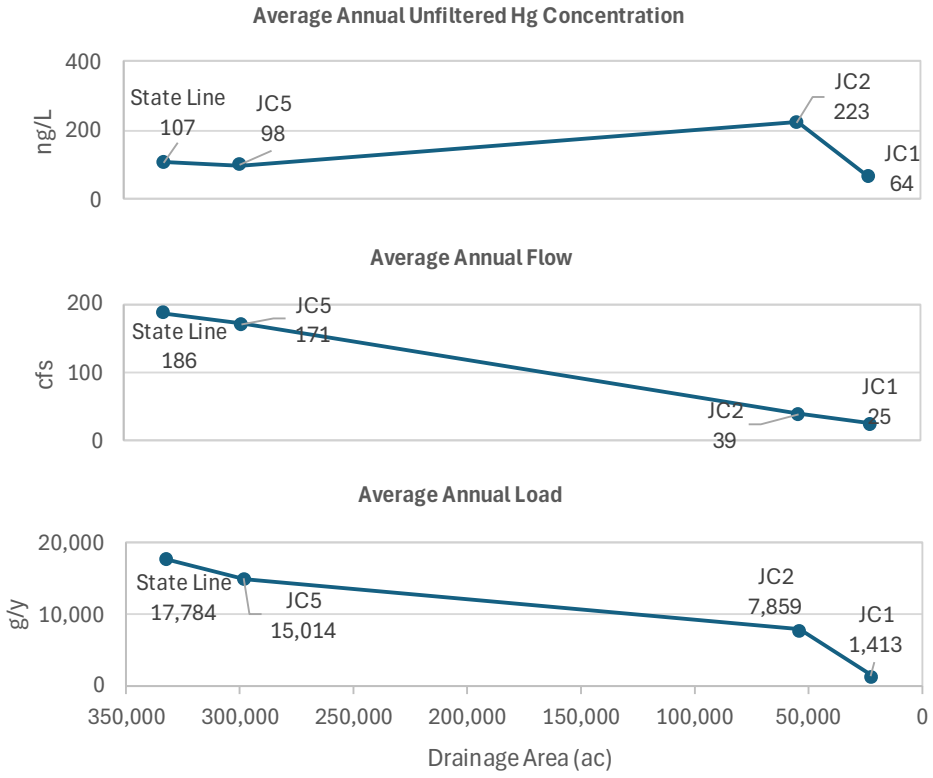


Figure 2. Average Annual Unfiltered Mercury Concentration, Flow, and Load Profiles for Jordan Creek

[1] The average annual concentration at station JC5.5 is used to represent the concentration at the state border.

The two point sources identified in the Draft TMDL are for the existing DeLamar Mine stormwater discharge and groundwater remediation discharge. The current permit limits and associated monitoring detection limits are greater than the target TMDL concentrations, although low-level mercury sampling at detection limits lower than the target TMDL concentration began in 2021 on Henrietta Gulch, Louse Creek, and Jordan Creek downstream of DeLamar Mine facilities. The Draft TMDL uses conservative assumptions for the existing point source loading from the DeLamar Mine site and estimates the existing loading at 19 g/yr (including natural background sources). This existing load from DeLamar Mine is found to be only 0.1 percent of the total load in Jordan Creek at the state border (Table 27 of the Draft TMDL). The proposed DeLamar Project, described in the Draft Mine Plan of Operations (MPO), includes an additional outfall on Jordan Creek for discharge of treated mine contact water, although DMC will actively treat this water pursuant to an individual IPDES Permit.

Specific Comments

Achieving the target load reduction is technically challenging due to legacy mining-impacted sediment/soil.

The Draft TMDL states that the target load reductions (Table 29 of the Draft TMDL), which exceed 95 percent, are "technically feasible." However, because Legacy Mining Impacted Sediment/Floodplain Soil contributes nearly 90 percent of the existing load, achieving the target load reductions will likely require investigation and remediation of more than 34 miles of impacted sediment along the mainstem of Jordan Creek, which may take decades to complete. The determination that the target load reductions are "technically feasible" is premature given the known extent of impacted sediment, its estimated load contribution, and the lack of specific controls to address this non-point source, included estimated load reductions. USEPA (1991) TMDL Guidance states that "*in order to allocate loads among both nonpoint and point sources, there must be reasonable assurances that nonpoint source reduction will in fact be achieved*" (page 15, last paragraph). The Draft TMDL should clearly state that the attainment of the target load reductions is highly uncertain due to the extent of Legacy Mining Impacted Sediment/Floodplain Soil deposited along more than 34 miles and its contribution of nearly 90 percent of the mercury load at the state border.

Because impacted sediment is present along the mainstem, discharge meeting the target wasteload allocation will become re-impacted with mercury in suspended sediment.

The introduction to this memorandum describes how mercury loading in Jordan Creek occurs all along the mainstem due to suspension of mercury-impacted sediment from increased flows. Because of this source of loading, any point source discharge meeting the target wasteload allocation will become re-impacted with mercury in suspended sediment after entering Jordan Creek. This is consistent with the data presented in the Draft TMDL showing that, although the mercury concentrations in tributaries to Jordan Creek (Table 14 of the Draft TMDL) are generally low, concentrations in Jordan Creek (Table 13 of the Draft TMDL) remain elevated and the mercury load increases along the mainstem.

Achieving the water quality targets through water treatment may be technically challenging and/or economically infeasible.

Achieving the target water column concentration of 2.4 nanograms per liter (ng/L), which is the basis for the wasteload allocations presented in the Draft TMDL, represents a reduction of more than 95 percent from existing Jordan Creek concentrations. The effluent limitation representing the degree of effluent reduction attainable by the application of the best practicable control technology (40 Code of Federal Regulations [CFR] 440.102) for mercury is 1,000 ng/L, which is almost three orders of magnitude greater than the TMDL target concentration. This technology-based effluent limit is consistent with values provided by treatment

technology manufacturers such as ion exchange treatment systems (ResinTech, Inc.)[2]. Given the large difference between the TMDL target concentration and the technology-based limits, achieving the water quality targets through water treatment may be technically challenging and/or economically infeasible for point source discharges.

The TMDL load allocation does not fully account for natural background load as estimated for existing conditions.

The estimated natural background concentration and associated load are not consistently represented throughout the Draft TMDL. TMDLs as defined by the Idaho Water Quality Standards (Idaho Administrative Procedures Act [IDAPA] 58.01.02.010.99) should include natural background. The Draft TMDL estimates that the natural background concentration for the DeLamar Mine area is 6 ng/L (Section 3.1.1, page 43). However, the wasteload allocations for the DeLamar Mine are based on meeting 2.1 ng/L during baseflow conditions and 2.4 ng/L annual average concentration. The Idaho Water Quality Standards (IDAPA 58.01.02.200.09) state that when the natural background conditions exceed any applicable criteria, the applicable water quality criteria shall not apply. Based on the natural background concentration for the DeLamar Mine area and the wasteload allocations provided in the Draft TMDL, the TMDL would not be attainable due to the elevated natural background concentration in the DeLamar Mine area.

[2] ResinTech Inc. Undated. SIR-200 Product Specification Sheet and Technical Data. https://eadn-wc03-12732172.nxedge.io/wp-content/uploads/2023/01/SIR200_PDS.pdf

Recommendations

The following recommendations are provided for consideration for the TMDL.

Delamar's existing discharges (MSGP and Groundwater Remediation Permit) are insignificant and can therefore continue to discharge at current levels.

The existing point source discharges for the DeLamar Mine were estimated to be 19 g/yr, only 0.1 percent of the total load at the state border (Table 27) and which is likely an overestimation because it was not based on low level mercury sampling. However, the draft TMDL includes wasteload allocations for this source of loading, even though such load reductions would offer no discernible water quality benefit. The TMDL should instead determine that these point source discharges associated with the DeLamar project are insignificant and can discharge at current levels (estimated at 19 g/yr). There is precedent around the United States for approved TMDLs in which certain point sources were determined to be "de minimis" or "insignificant" and therefore can continue to discharge at current levels or "performance-based limits". A summary of TMDLs around the country that found certain point sources "insignificant" is set forth in USEPA Region 9 (2015)'s *Helpful Practices for Addressing Point Sources and Implementing TMDLs in NPDES Permits*[3]. The general reasoning for a determination that a point source is "insignificant" is that the discharge is so small that there would be no benefit to regulate them further. The Upper Monocacy River Watershed Sediment TMDL (Md. 2009) is one of the many examples of this approach in which USEPA 's Decision Rationale[4] found that "no reductions were applied" for permitted process water point sources, "because at 0.2 percent of the total load, such controls would produce no discernable water quality benefit." The same reasoning applies with equal force here (and even more so since any discharge will become recontaminated as noted above), DMC's current discharges should be deemed "insignificant" and be allowed to continue to discharge at current levels or performance-based limits.

Set aside a future reserve sufficient to cover the proposed Delamar future discharge.

Section 5.4.4 of the Draft TMDL states that an explicit growth reserve was not included, the entire existing load capacity was allocated to existing sources in the watershed, and that new permitted discharges could be added if they discharge at the TMDL target concentration of 2.4 ng/L or less. Confusingly, the Draft TMDL acknowledges that future stormwater discharges may use a portion of the load capacity that has been reserved for future growth. It is common practice for IDEQ to include a load capacity allowing for future growth in TMDLs throughout Idaho, particularly when the agency knows there will be a future discharger. As DMC will likely be the only future point source in the watershed, the Company seeks additional clarity around the future reserve issue. Accordingly, the final TMDL should be revised to include a future reserve sufficient to cover discharges for the proposed DeLamar Project by incorporating the recommendations provided above which may also address offsets/credits. Discharges for the proposed DeLamar Project are being evaluated as part of the planning and permitting process and additional follow-up will be required with IDEQ to evaluate the future reserve quantity required.

[3] USEPA Region 9. 2015. Helpful Practices for Addressing Point Sources and Implementing TMDLs in NPDES Permits. Available at: https://www.epa.gov/sites/default/files/2018-04/documents/tmdls-npdes_permits_helpful_practices_final_6_30_15.pdf

[4] USEPA. 2009. Decision Rational Total Maximum Daily Load of Sediment in the Upper Monocacy River Watershed. Available at: https://mde.maryland.gov/programs/Water/TMDL/DocLib_UpperMonocacy_02140303/UpperMoncacySedAL_DR.pdf

The TMDL should allow for permitted discharge with credit for offsets through pollutant/water quality trading.

The Idaho Water Quality Standards (IDAPA 58.01.02.060.06) state that TMDLs may include pollutant trading (elsewhere referred to as offsets or water quality trading). The Draft TMDL acknowledges that achieving the TMDL target or load allocations may depend on water quality trading (page 86) but does not describe what type of offsets would be considered in water quality trading. Additional discussion should be added, including for the wasteload allocations, that describes how a water quality trading program could provide credits for discharge. The proposed DeLamar Project is expected to use existing surface water rights on Jordan Creek to provide makeup water and also discharge treated contact water at a new outfall on Jordan Creek, in addition to existing and new stormwater outfalls. Although the draft TMDL acknowledges offsets may be appropriate for future point sources, there is no specificity on how offsets would apply. As DMC's point source(s) will be the only future point source in the watershed, the Company requests additional certainty on how the offsets should be implemented. For planning purposes as DMC moves through the federal and state permitting processes, the Company needs to have certainty on what the compliance targets for the project will be. The following are some examples of specific offsets that can be included in any final TMDL:

- *Mercury mass removed from Jordan Creek through intake water*. For example, if 10 acre-feet of water are removed from Jordan Creek with an intake mercury concentration of 80 ng/L, a credit of 1 gram of mercury should be counted toward the wasteload allocation for the mass removed.
- *Mercury mass removed through diversion of stormwater runoff*. The area of stormwater runoff contributing flow to Jordan Creek will be reduced as a result of new facility construction or expansion of existing facilities, and credit should be allowed for mercury mass currently reporting to the state border that is derived from this stormwater flow to Jordan Creek. Because the main source of mercury is Legacy Mining Impacted Sediment/Floodplain Soil present all along the drainage to the state border, the credit should be proportional to the overall load balance in Jordan Creek. For example, if the annual stormwater flow to Jordan Creek is reduced by 10 acre-feet, and the average concentration at the state border is 80 ng/L, 1 gram of mercury should be counted as a credit toward a future wasteload allocation.
- *Mercury mass removed through mitigation of existing nonpoint sources*. Offset credits should be allowed for implementation of any controls that reduce mercury loading from existing nonpoint sources such as Legacy Mining Impacted Sediment/Floodplain Soil. For example, if best management practices are implemented that would reduce mercury loading, credit for the reduction in mercury loading should be counted towards the wasteload allocations.

A simple ratio should be specified in the final TMDL on how offsets/credits will be implemented. In the examples noted above, if 1 gram is removed through diversions will DMC's future discharge be given a 1 gram credit? Similarly, if DMC were to mitigate nonpoint sources and remove 100 grams of mercury from floodplain soils, will DMC's future discharge be given a 100 gram credit? Whatever credit ratio IDEQ utilizes, it should be proportional to the impact of any future discharge.

The TMDL should include an implementation schedule that addresses the main source of loading.

Section 5.5.1 of the Draft TMDL acknowledges that, "the targets established for point and nonpoint sources in this TMDL may take decades to achieve" but then states that, "the staged implementation strategy for the Jordan Creek subbasin acknowledges that IPDES-permitted point sources will strive to achieve the TMDL as soon as possible." However, because the Idaho Pollutant Discharge Elimination System- (IPDES-) permitted point sources only contribute 0.1 percent of the total mercury load in Jordan Creek at the state border, and because any current or future permitted discharges meeting the target wasteload allocations would become re-impacted with mercury in suspended sediment after entering Jordan Creek, it will be impossible for the point source wasteload allocations to achieve the TMDL without also addressing the Legacy Mining Impacted Sediment/Floodplain Soil.

USEPA (2006)'s Guidance[5] provide clarification on various scenarios and approaches where TMDLs change over time due to uncertainties, including uncertainty in the effectiveness of load reduction controls. The California Regional Water Quality Control Boards (2006) Guadalupe River Mercury TMDL[6] included load allocations that changed over time in two phases. Subsequently the first phase was extended for another 10 years[7].

The TMDL should include an implementation schedule for current and future point source that is based on implementing controls for Legacy Impacted Sediment/Floodplain Soil, which contributes nearly 90 percent of the existing load in Jordan Creek. The implementation schedule would adjust point source wasteload allocations based on corresponding improvements to Jordan Creek water quality through control measures for Legacy Impacted Sediment/Floodplain Soil. By including an implementation schedule that is based on achieving load reductions for Legacy Impacted Sediment/Floodplain Soil, IDEQ would be providing reasonable assurances that the TMDL can be attained.

Use natural background to calculate the wasteload allocations for DeLamar Mine.

TMDLs as defined by the Idaho Water Quality Standards (Idaho Administrative Procedures Act [IDAPA] 58.01.02.010.99) should include natural background. The Draft TMDL estimates that the natural background concentration for the DeLamar Mine area is 6 ng/L (Section 3.1.1, page 43). However, the wasteload allocations for the DeLamar Mine are based on meeting 2.1 ng/L during baseflow conditions and 2.4 ng/L annual average concentration. The Idaho Water Quality Standards (IDAPA 58.01.02.200.09) state that when the natural background conditions exceed any applicable criteria, the applicable water quality criteria shall not apply. The TMDL should be revised to use the natural background concentration to calculate the wasteload allocations for DeLamar Mine.

[5] USEPA. 2006. Clarification Regarding "Phased" Total Maximum Daily Loads. Available at: https://www.epa.gov/sites/default/files/2015-10/documents/2006_08_08_tmdl_tmdl_clarification_letter.pdf

[6] California Regional Water Quality Control Board. 2006. Guadalupe Watershed Mercury Total Maximum Daily Loading Report. Available at: https://www.waterboards.ca.gov/rwqcb2/water_issues/programs/TMDLs/guadalupe_river_mercury/guadalupemercuryprojectreport012406.pdf

[7] California Regional Water Quality Control Board. 2022. Ten Year Implementation Status of the Guadalupe River Watershed Mercury Total Maximum Daily Load. Available at: https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/guadalupe_river_mercury/10yearreport/Guad_Hg_TMDL_10_yr.pdf