

Stibnite Gold Project

Water Quality Specialist Report

Prepared by:
USDA Forest Service
Payette National Forest

for:
Payette and Boise National Forests

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List of Acronyms

AADT	Annual Average Daily Traffic
ABA	Acid-Base Accounting
AGP	Acid-Generating Potential
ANP	Acid-Neutralizing Potential
AP	Acidification Potential
API	American Petroleum Institute
ARD	Acid Rock Drainage
ASAOC	Administrative Settlement Agreement and Order for Consent for Removal Actions
ASTM	American Standard Test Methods
BMP	Best Management Practice
BNF	Boise National Forest
°C	degrees Celsius
CFR	Code of Federal Regulations
COLD	Cold water communities
CR	County Road
CWA	Clean Water Act
DD	Detrimental Soil Disturbance
DWS	Domestic Water Supply
East Fork SFSR	East Fork of the South Fork of the Salmon River
EOY	End of Mining Year
EPA	United States Environmental Protection Agency
FR	Forest Road
HCT	Humidity Cell Test
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game

IDL	Idaho Department of Lands
IDWR	Idaho Department of Water Resources
IPCo	Idaho Power Company
IPDES	Idaho Pollution Discharge Elimination System
LSP	Landslide Prone
m	meters
m ²	square meters
m ³	cubic meters
MCL	Maximum Contaminant Level
MeHg	Methylmercury
MGII	Midas Gold Idaho, Inc.
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MMP	Modified Mine Plan
MSDS	Material Safety Data Sheet
MSGP	Multi-Sector General Permit
MT	millions of tons
MWMP	Meteoric Water Mobility Procedure
n	number of samples
NAG	Net Acid Generation Test
ng/L	nanograms per liter
NHD	National Hydrography Dataset
NNP	Net Neutralizing Potential
NOAA	National Oceanic and Atmospheric Administration
NP	Neutralization Potential
NPR	Neutralization Potential Ratio
NPDES	National Pollution Discharge Elimination System
OSV	Over Snow Vehicle
PAB	Palustrine Aquatic Bed
PAG	Potentially Acid-Generating
PCR	Primary Contact Recreation
PEM	Palustrine Emergent

Perpetua	Perpetua Resources Idaho Inc.
PNF	Payette National Forest
ppm	parts per million
PSS	Palustrine Scrub-Scrub Wetlands
RCA	Riparian Conservation Area
ROW	Right-of-Way
SCR	Secondary Contact Recreation
SFSR	South Fork of the Salmon River
SGLF	Stibnite Gold Logistics Facility
SGP	Stibnite Gold Project
SODA	Spent Ore Disposal Area
SPCC	Spill Prevention, Control, and Countermeasure
SPLP	Synthetic Precipitation Leaching Procedure
SPLNT	Stream – Pit Lake Network Temperature
SS	salmonid spawning
s.u.	standard units for pH
SWPPP	Surface Water Pollution Prevention Program
SWWB	Site-Wide Water Balance
SWWC	Site-Wide Water Chemistry
TDS	Total Dissolved Solids
TRSC	Total Soil Resource Commitment
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
ug/L	micrograms per liter
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United State Geological Survey
WTP	Water Treatment Plant

1.0 Introduction

The United States (U.S.) Department of Agriculture Forest Service (Forest Service) received the Stibnite Gold Project (SGP) Plan of Restoration and Operations, (Midas Gold Idaho, Inc. 2016) for review and approval in accordance with regulations at 36 Code of Federal Regulations (CFR) 228 Subpart A for the proposed SGP in central Idaho. A revised Plan, also known as ModPRO1, was submitted to the Forest Service in 2019 (Brown and Caldwell 2019). A further modified Plan, also known as ModPRO2, was then submitted in October of 2021 (Perpetua 2021). Midas Gold changed their name to Perpetua Resources Idaho Inc. (Perpetua3) in February 2021.

The SGP would consist of mining operations, including an open pit hard rock mine and associated processing facilities, located within Valley County in central Idaho on federal, state, and private lands (**Figure 1-1**). The SGP would produce gold and silver doré, and antimony concentrate, for commercial sale by Perpetua. The SGP would have a life (construction, operation, closure, and reclamation), not including post-reclamation monitoring, of approximately 20 years, with active mining and ore processing occurring over approximately 15 years.

2.0 Alternatives, Including the Proposed Action

The SGP 2021 Modified Mine Plan (MMP) Alternatives Report (Forest Service 2022a) contains the details of the alternatives that are being considered and fully analyzed in this report. For reader usability, the alternatives are briefly summarized here.

2.1 No Action Alternative

The No Action Alternative provides an environmental baseline for comparison of the action alternatives. Under the No Action Alternative, the mining, ore processing, and related activities under the 2021 MMP or the Johnson Creek Route Alternative would not take place. In addition, certain legacy and existing mining impacts would be addressed as directed in the 2021 Administrative Settlement Agreement and Order on Consent, including installation of stream diversion ditches designed to avoid contact of water with sources of contamination and removal of development rock and tailings currently impacting water quality. However, existing and approved activities (i.e., approved exploration activities and associated reclamation obligations) would continue and Perpetua would not be precluded from subsequently submitting another plan of operations pursuant to the General Mining Law of 1872.

2.2 2021 Modified Mine Plan

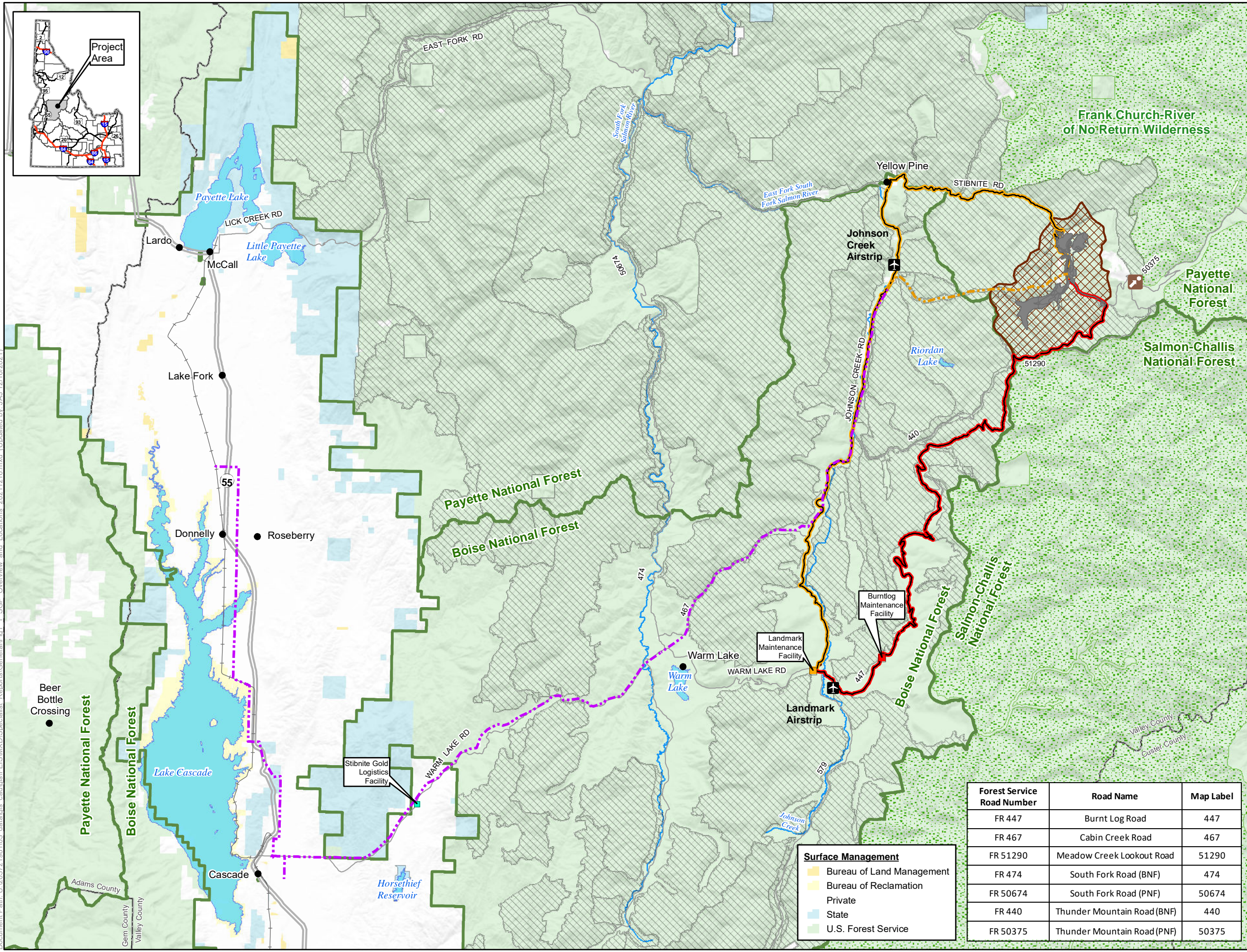
The 2021 MMP is based upon Perpetua's Revised Plan (ModPRO2) and is considered the Proposed Action. The description of this alternative has been updated per the Revised Plan submitted in 2021 (Perpetua 2021a). The SGP operations footprint has been modified but would still be within the previously identified Operations Area Boundary (**Figure 2-1**).

¹ Associated project documents may reference the Revised Plan as the ModPRO.

² Associated project documents may reference the Modified Plan as the ModPRO2.

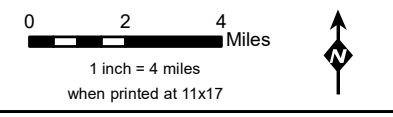
³ Documents provided by Perpetua prior to the February 2021 name change will still be cited and referenced as Midas Gold.

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- LEGEND**
- Project Components**
- SGP Features
 - Operations Area Boundary
- Access Roads and Trail System**
- Burntlog Route *
 - Johnson Creek Route
- Utilities**
- Upgraded Transmission Line
 - New Transmission Line
- Offsite Facilities**
- Burntlog Maintenance Facility *
 - Landmark Maintenance Facility **
 - Stibnite Gold Logistics Facility
- Other Features**
- U.S. Forest Service
 - Wilderness
 - IRA and/or Forest Plan Special Area
 - County
 - City/Town
 - Monumental Summit
 - Airport/Landing Strip
 - Railroad
 - Highway
 - Road
 - Stream/River
 - Lake/Reservoir

* Associated with 2021 MMP only
 ** Associated with Johnson Creek Route Alternative only
 Note:
 The McCall – Stibnite Road (CR 50-412) consists of Lick Creek Road, East Fork South Fork Salmon River Road (East Fork Road) and Stibnite Road.



Surface Management

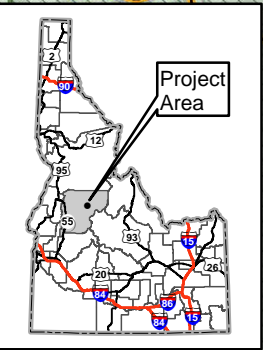
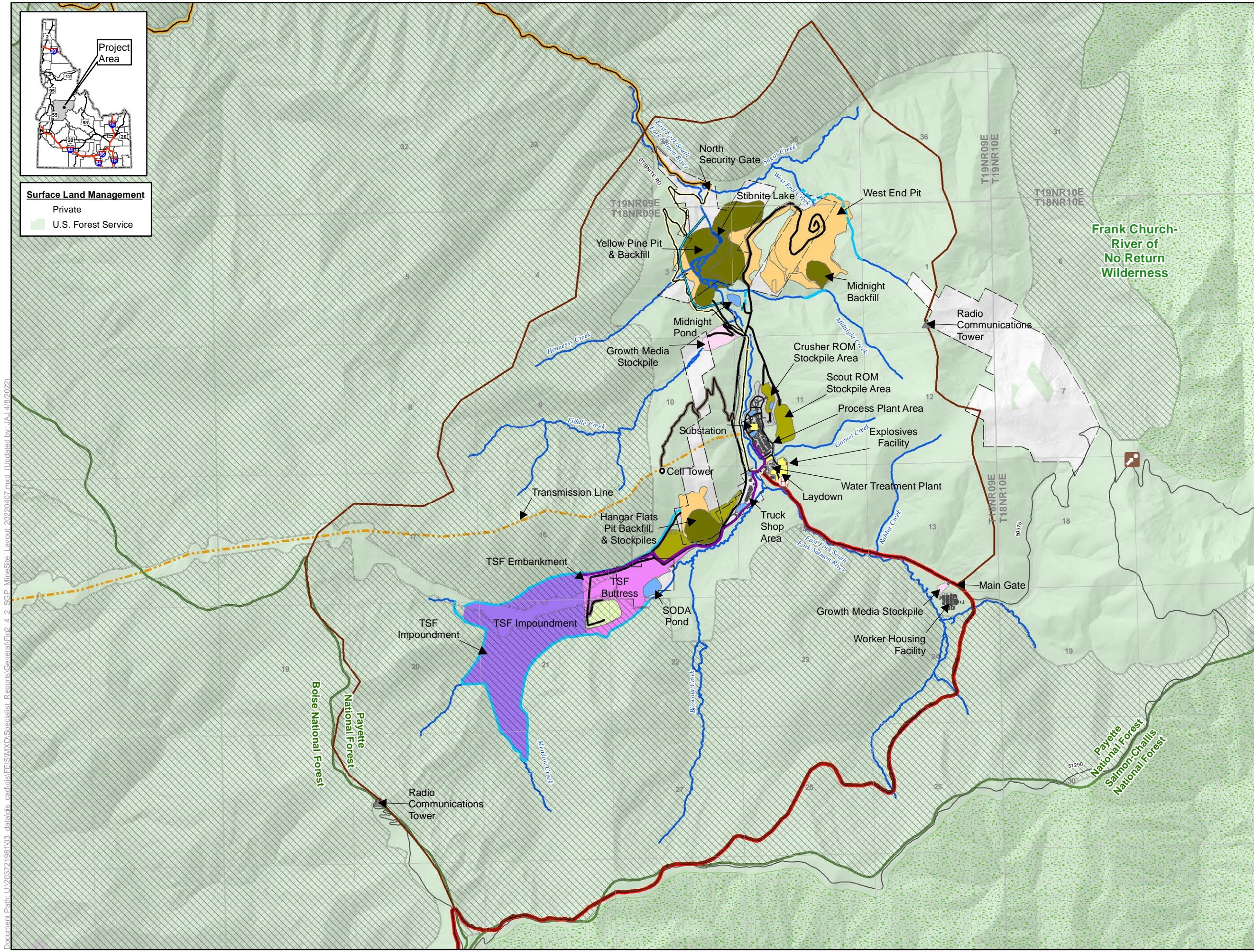
- Bureau of Land Management
- Bureau of Reclamation
- Private
- State
- U.S. Forest Service

Forest Service Road Number	Road Name	Map Label
FR 447	Burnt Log Road	447
FR 467	Cabin Creek Road	467
FR 51290	Meadow Creek Lookout Road	51290
FR 474	South Fork Road (BNF)	474
FR 50674	South Fork Road (PNF)	50674
FR 440	Thunder Mountain Road (BNF)	440
FR 50375	Thunder Mountain Road (PNF)	50375

**Figure 1-1
 SGP Overview
 and Location
 Stibnite Gold Project
 Stibnite, ID**

Base Layer:
 Other Data Sources: Perpetua; State of Idaho Geospatial Gateway (INSIDE Idaho); Boise National Forest; Payette National Forest





Surface Land Management

- Private
- U.S. Forest Service

- LEGEND**
- Project Components ***
- SGP Features**
- Pit Backfill
 - Growth Media Stockpile
 - Mining Pit
 - Laydown
 - Plant Site
 - TSF Buttress
 - TSF Liner
 - Alluvial Stockpile
 - Workers Housing
 - Stockpile
 - Explosive Facility
 - Operations Area Boundary
 - Patented Claim Boundary
 - Tailings Pipeline
 - Clean Water Diversion **
 - Clean Water Diversion - Piped **
 - East Fork South Fork Salmon River Tunnel ***
 - Stream ****
 - Pond
 - Stibnite Lake
 - Light Vehicle Road
 - Haul Road
 - Helicopter Pad
- Access Roads**
- Burntlog Route
 - Johnson Creek Route
 - Cell Tower Access Road
 - Public Access Road *****
- Utilities**
- Transmission Line
 - Substation *****
 - New Cell Tower
 - Existing Communication Tower
- Other Features**
- U.S. Forest Service
 - Wilderness
 - IRA and Forest Plan Special Areas
 - Monumental Summit
 - Road

* Project Components are associated with all Alternatives
 ** Some surface clean water diversions are not discernible at this figure scale (e.g., the diversions associated with the TSF/butress north, Fiddle culvert, Midnight Outfall, Scout ROM). Please refer to Figures 2.4-14 and 2.4-15 which provide greater detail regarding the Water Management Plan and its facility/diversion locations.
 *** The East Fork South Fork Salmon River Tunnel would only be utilized as a contingency to manage high flows upon completion of the restoration of the East Fork SFSR across the backfill in the Yellow Pine Pit.
 **** Perennial streams are not depicted for the entire map area. Only perennial streams within the Operations Area Boundary are depicted.
 ***** Public Access Road associated with 2021 MMP
 ***** Substation locations are approximate.

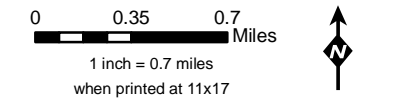


Figure 2-1
Mine Site Layout
Stibnite Gold Project
Stibnite, ID

Base Layer: Hillshade derived from LiDAR supplied by Midas Gold
 Other Data Sources: Perpetua; State of Idaho Geospatial Gateway (INSIDE Idaho); Boise National Forest; Payette National Forest



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The following mine components would be common to the action alternatives:

- Mine pit locations, areal extents, and mining and backfilling methods
- Transportation management on existing and proposed roads
- Pit dewatering, surface water management, and water treatment
- Ore processing
- Lime generation
- Tailings Storage Facility (TSF) construction and operation
- TSF Buttress construction methods
- Water supply needs and uses
- Management of mine impacted water and stormwater runoff
- Electrical transmission lines
- Stibnite Gold Logistics Facility (SGLF)
- A road maintenance facility
- Surface and underground exploration
- Stibnite Gold Project worker housing facility

For access, the 2021 MMP would utilize Warm Lake Road, Johnson Creek Road, and Stibnite Road during construction of the proposed Burntlog Route; then once constructed, the Burntlog Route would be utilized during operations and reclamation. The actions proposed under the 2021 MMP would take place over a period of approximately 20 years, not including the long-term, post-closure environmental monitoring or potential long-term water treatment.

2.3 Johnson Creek Route Alternative

The Johnson Creek Route Alternative was developed to evaluate potential reductions in impacts to various resources. The mining portion of this alternative would be the same as under the 2021 MMP. Therefore, the primary focus of the Johnson Creek Route Alternative would be using an existing road for mine access through operations and reclamation instead of the Burntlog Route that under the 2021 MMP requires new road construction in Inventoried Roadless Areas. The Johnson Creek Route Alternative would require extensive upgrades to both Johnson Creek Road and Stibnite Road. Construction schedule for upgrading the roads and construction of the SGP would increase from 3 years to 5 years.

The action alternatives are summarized in **Table 2-1**.

Table 2-1 Action Alternatives Summary

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	SGP timeline	<ul style="list-style-type: none"> • Construction: Approximately 3 years. • Operations: Approximately 15 years. • Exploration: Approximately 17 years (during construction and operations). • Reclamation: Approximately 5 years (except for the TSF which would require an additional 9 years for tailings dewatering and consolidation). • Closure/Post-Closure Water Treatment: Approximately through Mine Year 40. • Environmental Monitoring: As long as needed. 	<p>Same as 2021 MMP except:</p> <ul style="list-style-type: none"> • Construction: Approximately 5 years (upgrading the existing Johnson Creek and Stibnite Roads to provide permanent mine access).
All Phases	Access Roads	<p>Construction/Operations:</p> <ul style="list-style-type: none"> • Warm lake road from State Highway (SH) 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route for SGP access during early construction with minor improvements within the road prism. • Burntlog Route (38 miles) for SGP access during last year of construction, mining and ore processing operations, and closure and reclamation. Includes improvements of existing segments (23 miles) and road construction for new segments (15 miles). • Up to eight borrow areas developed along Burntlog Route for materials needed for road improvements and maintenance. • Access route around the Yellow Pine pit for public access. <p>Closure and Reclamation:</p> <ul style="list-style-type: none"> • New sections of Burntlog Route to be reclaimed after the closure and reclamation period. 	<p>Construction/Operations:</p> <ul style="list-style-type: none"> • Warm lake road from SH 55 to Johnson Creek Route intersection (34 miles). • Johnson Creek Route (39 miles: Johnson Creek Road 25 miles, Stibnite Road 14 miles) upgraded and used for access throughout life of mine (LOM) instead of the Burntlog Route. • Access route around the Yellow Pine pit for public access, employee access, and deliveries of supplies and equipment to the processing, warehouse, worker housing facility, and administration areas. • No improvements or construction of new segments for Burntlog Route. • Up to seven borrow sources developed along the Johnson Creek Route for materials needed for road improvements and maintenance. <p>Closure and Reclamation:</p> <ul style="list-style-type: none"> • Improved Johnson Creek and Stibnite roads would not be reclaimed to pre-existing conditions.

SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
All Phases	Public Access	<p>Construction:</p> <ul style="list-style-type: none"> • Temporary groomed over-snow vehicle (OSV) trail on the west side of Johnson Creek from Trout Creek to Landmark while Burntlog Route is constructed (8 miles). • OSV trail on west side of Johnson Creek from Wapiti Meadows to Trout Creek campground closed during construction (9 miles). • OSV trail from Warm Lake to Landmark closed during construction through operations (8.5 miles). • Cabin Creek Road Groomed OSV trail (11 miles). • Public roads remain open through the SGP with temporary closures as needed to accommodate construction. <p>Operations:</p> <ul style="list-style-type: none"> • Groomed OSV trail moves from west side of Johnson Creek Road to Johnson Creek Road from Landmark to Wapiti Meadows (16.7 miles). • Stibnite Road (County Road [CR] 50-412) / Thunder Mountain Road (FR 50375) closed through the SGP. • Seasonal public access through the Operations Area Boundary provided by constructing new road through Yellow Pine pit and below mine haul road to link Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). • Public access allowed on Burntlog Route to Thunder Mountain Road (FR 50375). <p>Closure and Reclamation:</p> <ul style="list-style-type: none"> • New road constructed over the Yellow Pine Backfill (backfilled Yellow Pine pit) connecting Stibnite Road (FR 50412) to Thunder Mountain Road (FR 50375). 	<p>Construction and Operations: Same as 2021 MMP except:</p> <ul style="list-style-type: none"> • OSV trail on the west side of Johnson Creek from Wapiti Meadows to Trout Creek campground would be closed from construction through mine closure (9 miles). • Groomed OSV trail on the west side of Johnson Creek from Trout Creek to Landmark lasting from construction through mine closure. <p>Closure and Reclamation: Same as 2021 MMP.</p>

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SGP Phase	Component/ Subcomponent	2021 MMP	Johnson Creek Route Alternative
Operations	Utilities – Transmission Lines	<ul style="list-style-type: none"> • Upgrade approximately 63 miles of the existing 12.5 kilovolt (kV) and 69 kV transmission lines. • New approximate 9-mile, 138 kV line would be constructed from the Johnson Creek substation to a new substation at the mine site. • Upgrade the substations located at Oxbow Dam, Horse Flat, McCall, Lake Fork, and Warm Lake. • Reroute approximately 5.4 miles of transmission line to avoid the Thunder Mountain Estates subdivision. • Reroute approximately 0.9 miles of transmission line between Cascade and Donnelly to use an old railroad grade on private property. • Installation of approximately 3 miles of new underground distribution line along Johnson Creek Road from the Johnson Creek substation south to Wapiti Meadows. 	Same as 2021 MMP.
Operations	Utilities - Communication Towers and Repeater Sites	<ul style="list-style-type: none"> • One cell tower located north of the Hangar Flats pit. • Locations along Burntlog Route for very high frequency (VHF) repeater sites. • Use existing access roads to repeater site locations along Burntlog Route. • Communication site at the SGLF. • Upgrades to existing communication site. 	Same as 2021 MMP except: <ul style="list-style-type: none"> • Cell tower sites constructed and maintained using helicopter (instead of constructing access roads) for sites within IRAs managed for Backcountry/Restoration. • Locations along Johnson Creek route for repeater sites.
Operations	Off-site Maintenance Facility	<ul style="list-style-type: none"> • SGLF located along Warm Lake Road. • Burntlog Maintenance Facility located at one of the borrow source locations 4.4 miles east of the junction of Johnson Creek Road and Warm Lake Road along the proposed Burntlog Route. 	<ul style="list-style-type: none"> • SGLF same as 2021 MMP • Landmark Maintenance Facility located at junction of Warm Lake Road at Johnson Creek Road.
Closure and Reclamation	Access road segments	<ul style="list-style-type: none"> • Removal and reclamation of new road segments constructed for Burntlog Route. • Return of previously existing road segments to pre-construction width and condition. 	<ul style="list-style-type: none"> • No removal or reclamation of pre-existing access routes.

Source: Perpetua 2021a

2.4 Applicable Environmental Design Features

The SGP must comply with all laws and regulations that apply to the proposed activities (Forest Service 2022a). Standards and guidelines in the Payette and Boise National Forest Land and Resource Management Plans (Forest Service 2003, 2010) that are designed to reduce or prevent undesirable impacts resulting from proposed management activities are incorporated into the action alternatives by reference. In addition, best management practices outlined in the Best Management Practices for Mining in Idaho (Idaho Department of Lands 1992) would be implemented where appropriate and applicable for operations to minimize site disturbance from mining and drilling activities.

In the design of the 2021 MMP, Perpetua has already considered many of the potential environmental impacts that might be caused by the SGP. This has led to an internal evaluation of project design features and operational characteristics that may have the effect of reducing and/or eliminating potential environmental impacts of the SGP. Such project-specific measures intended by a proponent to inherently reduce and/or avoid potential environmental impacts of a proposed action are referred to as environmental "design features".

Based on the application of permits and regulatory compliance requirements (Forest Service 2022a) to the project, regulatory requirements, standards and guidelines, best management practices, and likely permit conditions are listed in **Table 2-2**. The environmental design features that have been proposed and committed to by Perpetua are listed in **Table 2-3**. All of these environmental design measures have been assumed to be effective in conducting the environmental analysis presented in **Section 7.0**.

Table 2-2 Prominent Regulatory and Forest Plan Requirements for Water Quality

Description	Type	Reference
Surface water withdrawal intake hoses would be situated so as to prevent generation of turbidity in bottom sediments during pumping.	Design Feature	
Prohibit solid and sanitary waste facilities in RCAs. If no alternative to locating mine waste (waste rock, spent ore, tailings) facilities in RCAs exists, then: Analyze waste material using the best conventional methods and analytic techniques to determine its chemical and physical stability characteristics. Locate and design waste facilities using the best conventional geochemical and geotechnical predictive tools to ensure mass stability and prevent the release of acid or toxic materials. If the best conventional technology is not sufficient to prevent such releases and ensure stability over the long term, and such releases or instability would result in exceedance of established water quality standards or would degrade surface resources, prohibit such facilities in RCAs. Monitor waste and waste facilities to confirm predictions of chemical and physical stability and make adjustments to operations as needed to avoid degrading effects to beneficial uses and native and desired non-native fish and their habitats. Reclaim and monitor waste facilities to ensure chemical and physical stability and revegetation to avoid degrading effects to beneficial uses and native and desired non-native fish and their habitats. Require reclamation bonds adequate to ensure long-term chemical and physical stability and successful revegetation of mine waste facilities.	FP Component	BNF and PNF: MIST09

Description	Type	Reference
<p>A Spill Prevention, Containment, and Control Plan (SPCC) shall be prepared in accordance with 49 CFR parts 171 through 180, including packaging, transportation, incident reporting, and incident response.</p> <p>Include the following items within the SPCC Plan:</p> <ul style="list-style-type: none"> • During off-loading of fuel from fuel vehicles or during refueling operations have a standard marine-type fuel containment boom (which would be of sufficient length for a worst-case discharge), spill prevention kit, and fire kit readily available on site. • Store two or more spill containment/response caches along each of the fuel delivery routes. • Spill response team will carry sufficient containment equipment for one full fuel tanker. • Include the Forest Service as a party to be notified in the event of a hazardous materials spill. • Intake pumps, engines, fuel storage, fuel containment site, and other equipment with fuel or lubricants would be inspected at each refueling and periodically between refueling for leakage or spillage. • Pilot and emergency spill response vehicles would carry appropriate containment and first aid equipment. • All fuel containers would be marked with contents, owner’s name and contact information. • Material Safety and Data Sheets for all products would be posted and available on site with the SPCC plan. • Intake pumps would not be situated within the active stream/ditch channel and would be placed within containment vessels capable of holding 120 percent of the pump engine’s fuel, engine oil and hydraulic fluid. The smallest practical pump and intake hose would be used. • Following large storm events, the intake pumps would be inspected to determine if stream flow has encroached into the pump area and if the pump needs to be moved so it remains above flowing water. • A spill prevention and clean-up kit would be placed at the intake pump site and would consist of absorbent pads and/or boom (which would be sufficient length for a worst-case discharge), drip pan, a shovel, and a fire extinguisher. • Spare fuel for the water intake pump would be stored in approved [29 CFR 1926.152(a)(1)] fuel storage containers placed into a secondary containment vessel capable of holding at least 120 percent of the volume of the fuel in the fuel container. • A copy of the SPCC plan would be kept at an appropriate on-site facility. 	Regulatory Requirement and Design Features	49 CFR 171
<p>Unless otherwise authorized, all garbage or refuse should be removed from National Forest System lands.</p> <p>This includes, but is not limited to, empty fuel and lubricant containers.</p> <p>Food and garbage would be stored either indoors, in vehicles, or if outside, in wildlife-proof containers.</p> <p>No garbage would be burned.</p>	FP Component and Design Features	Design Feature developed for compliance with BNF and PNF: MIGU04
<p>Reclamation cover material (e.g., growth media) used in places including but not limited to the TSF and TSF Buttress would be evaluated for contaminants prior to use during reclamation. Acceptable metal/contaminant concentrations and sampling and testing methodology would be documented in a sampling and analysis plan developed prior to reclamation.</p>	Design Feature	

Description	Type	Reference
Measures such as, but not limited to, segregating and stockpiling topsoil, implementing stormwater and sediment BMPs, backfilling, revegetation and concurrent reclamation would be conducted, where possible and practical, for areas where the soil has been exposed by ground-disturbing activities. These areas/sites include, but are not limited, to burrow sites, utility corridors, skid trails, firebreaks, temporary roads, cut and fill slopes, and areas where construction activities have occurred.	Design Feature	Design Feature developed for compliance with BNF and PNF: SWST03, SWGU05
Road rutting from operations, outside the mine site, would be minimized by construction and maintenance of surface drainage structures, application of surfacing material, and by restricting road use when conditions are unacceptable due to moisture that is leading to the onset of rutting and concentrated turbid flow. (Note typical guidance is ‘no use’ if ruts deeper than 4” are created.) This design feature does not apply to the mine site.	Design Feature	Design Feature developed for compliance with BNF and PNF: SWST02 SWST03
Handling of road waste material (e.g., slough, rocks) would avoid or minimize delivery of waste material to streams that would result in degradation of soil, water, riparian, and aquatic resources.	Design Feature	Design Feature developed for compliance with BNF and PNF: FRST05
Mitigate degrading effects from locatable mining operations situated within RCAs by identifying reasonable locations for access, processing, and disposal facilities outside of RCAs, wherever possible.	FP Component	BNF and PNF: MIST04, LSST07, MIST08, FRGU05
To minimize the degradation of watershed resource conditions, prior to expected water runoff, water management features would be constructed, installed, and/or maintained. Activities and features include, but are not limited to, water bars, rolling dips, seeding, grading, slump removal, barriers/berms, distribution of slash, and culvert/ditch cleaning in all applicable areas.	Design Feature	Design Feature developed for compliance with BNF and PNF: SWST01 and SWST04
To accommodate floods, including associated bedload and debris, new culverts, replacement culverts, and other stream crossings would be designed to accommodate a 100-year flood recurrence interval unless site-specific analysis using calculated risk tools or another method, determines a more appropriate recurrence interval.	FP Component	BNF and PNF: FRST02
To minimize sediment runoff from the temporary roads and roadbeds, water management features would be constructed, installed, and/or maintained on authorized temporary roads and roadbeds, on completion of use, before expected water runoff, or before seasonal shutdown. Activities and features could include, but would not be limited to, water bars, silt fencing, certified weed-free wattles, and/or weed-free straw bales, rolling dips, seeding, grading, slump removal, barriers/berms, distribution of slash, and culvert/ditch cleaning. These features would be installed in strategic downslope areas and in RCAs, where and when appropriate.	Design Feature	Design Feature developed for compliance with BNF and PNF: SWGU06
Snow removal would be accomplished in accordance with the following standards of performance: <ul style="list-style-type: none"> • All debris, except snow and ice, that is removed from the road surface and ditches would be deposited away from stream channels at approved locations. • During snow removal operations, banks would not be undercut, and gravel or other surfacing material would not be bladed off the roadway surface. • Ditches and culverts would be kept functioning during and following plowing. Berms left on the shoulder of the road would be removed and/or 	Design Feature	

Description	Type	Reference
<p>drainage openings would be created and maintained. Drainage openings would be spaced to maintain satisfactory surface drainage without discharge on erodible fills.</p> <ul style="list-style-type: none"> • Dozers would be used on an as-needed basis for plowing snow. The dozer operator would maintain an adequate snow floor over the gravel road surface. • Snow would not be totally removed to the gravel road surface. Appropriate snow floor depth would be maintained to protect the roadway. • Damage of roads from, or as a result of, snow removal would be repaired in a timely manner. • Culverts and stream crossings would be clearly marked before snow removal begins to avoid placing berm openings in locations that would allow runoff to enter drainages directly at the culverts or stream crossings. Excessive snow would not be plowed into locations that would impact operation of the culverts or prevent positive drainage from drainage areas. Some snow is necessary around culvert openings and in the bar ditches as this would insulate the ditch and culvert and would prevent the water in the ditch and culvert from freezing. • No ice and snow removal chemicals would be used on roads. • Traction material would be 3/8-inch diameter gravel or greater. 		
<p>New facilities for storage of fuels and other toxicants would be located outside of occupied TEPC plant habitat.</p>	<p>FP Component</p>	<p>BNF and PNF: TEST11</p>
<p>Section 6 of IDL's Best Management Practices for Mining in Idaho (IDL 1992) would be observed, including if water is encountered in exploration holes, water zones would be sealed off during abandonment to prevent crossflow.</p>	<p>Regulatory Requirement</p>	<p>Section 6 of IDL's Best Management Practices for Mining in Idaho (IDL 1992)</p>
<p>The proponent would implement surface water quality baseline turbidity monitoring, as defined in the IDEQ permit clauses.</p>	<p>Design Feature</p>	
<p>Do not authorize storage of fuels and other toxicants or refueling within RCAs unless there are no other alternatives. Storage of fuels and other toxicants or refueling sites within RCAs shall be approved by the responsible official and have an approved spill containment plan commensurate with the amount of fuel.</p>	<p>FP Component</p>	<p>BNF and PNF: SWST11</p>
<p>Dust abatement chemicals would be used in accordance with the applicable road maintenance Biological Assessment. Apply dust-abatement additives and stabilization chemicals (typically MgCl₂, CaCl₂, or lignin sulphonates) to avoid run-off of applied dust abatement solutions to streams. Spill containment equipment would be available during chemical dust abatement application. Where the road surface is within 25 feet (slope distance) of surface water, dust abatement would only be applied to a 10-foot swath down the centerline of the road. The rate and quantity of application would be regulated to insure all of the chemical is absorbed before leaving the road surface.</p>	<p>Design Feature</p>	
<p>Drilling mud and hole plug products, if utilized, would conform to American Petroleum Institute guidelines for ensuring groundwater integrity.</p>	<p>Design Feature</p>	<p>American Petroleum Institute guidelines</p>
<p>Trees or snags that are felled in RCAs would be left unless determined not to be necessary for achieving soil, water, riparian, and aquatic desired conditions. Felled trees or snags left in RCAs would be left intact unless resource protection (e.g., the risk of insect infestation is unacceptable) or public safety requires bucking them into smaller pieces.</p>	<p>FP Component</p>	<p>BNF and PNF: SWST10</p>

Description	Type	Reference
The proponent would monitor stormwater runoff and stormwater BMPs as per the SWPPP. Stormwater monitoring, inspections, and reporting would be conducted in accordance with the NPDES Multi-Sector General Permit and the SWPPP.	Permitting Requirement	NPDES Multi-Sector General Permit and the SWPPP
All activities would be conducted in accordance with Idaho environmental anti-degradation policies, including IDEQ water quality regulations at IDAPA 58.01.02 and applicable federal regulations.	IDAPA 58.01.02	

Table 2-3 Proponent Proposed Environmental Design Features

Description
Perpetua would implement measures to limit stream baseflow effects during active operations, including a combination of lining key reaches of streams potentially impacted by pit dewatering. Maintain instream flows for fish species and other aquatic resources: flows within natural stream channels affected by SGP operations would be maintained to meet seasonally appropriate and stream-specific low-flow needs to the maximum extent practicable. Perpetua would continue to evaluate options and measures to further avoid and minimize the magnitude and duration of effects of the SGP through other measures in consultation with federal, state, and tribal agencies.
Perpetua would stabilize and restore Blowout Creek. Blowout Creek wetland restoration would consist of restoring and enhancing palustrine aquatic bed (PAB), palustrine emergent (PEM), Palustrine scrub-scrub (PSS) wetlands that were impacted when a historical dam failed on Blowout Creek. Headcutting and shallow aquifer dewatering have impaired and reduced functions of the wetland vegetation classes. A grade control and groundwater cutoff structure is proposed to raise the water level in Blowout Creek as well as recharge the shallow groundwater system and reduce stream headcutting. A coarse rock drain would be constructed within the chute downstream of the failed dam to isolate the flow of Blowout Creek from the actively eroding chute side slopes and to prevent further erosion of the gully bottom, facilitating subsequent restoration of a surface channel on top of the drain. Perpetua would stabilize the steep, confined, erosive middle reach to address the significant fine sediment load currently produced from this reach and restore the downstream, relatively low-gradient reach.
Perpetua would lead annual site visits for U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (EPA), Idaho Department of Fish and Game (IDFG), and other interested agency personnel as needed to facilitate agency review of mitigation areas if desired. Final reporting and data archival requirements would be subject to permit conditions; however, at a minimum, it is anticipated that monitoring reports would be prepared by Perpetua annually and submitted to USACE Walla Walla District, EPA, IDFG, Idaho Department of Lands (IDL), National Oceanic and Atmospheric Administration (NOAA) Fisheries, USFWS, the Forest Service, and other interested agencies, SGP partners, and stakeholders.
Perpetua would repair and rehabilitate habitats adversely affected by historical mining impacts in the SGP area.
Minor surface improvements (e.g., ditch and culvert repair, adding gravel, winter snow removal, and summer dust suppression) would occur on the Johnson Creek Route to reduce sediment runoff and dust generation.
Contact water which exceeds discharge water quality limits and that cannot be used during operations would be disposed of through a variety of methods including forced evaporation using sprayers located within the TSF or other managed areas, or active water treatment. Water would be treated to meet IPDES permit limits and treated water would then be discharged to IPDES permitted outfalls.
Groundwater pumped from the dewatering wells would be considered to be contact water and would be managed through forced evaporation or active water treatment when the volume of pumped water exceeds the ore processing facility demand.
One or two IPDES-permitted surface water outfalls (specific number and locations of outfalls to be determined via IPDES permitting through DEQ) would be used to discharge treated contact water from active mine pits, the TSF buttress, and the ore processing facility. An outfall located near the ore processing facility would discharge to the East Fork SFSR, and a second outfall, if needed, would discharge to Meadow Creek to augment streamflow during pit dewatering.

Description
Channel segments constructed over fill or excavated in permeable materials would additionally be lined with a geosynthetic liner to minimize seepage. A transition layer of sand/gravel followed by riprap or similar would be placed over the liner for erosion protection.
Secondary containment for pipelines would consist of an open geosynthetic-lined trench, pipe-in-pipe, or backfilled geomembrane-wrapped trench, depending on location, and the pipeline corridor would drain to one of two pipeline maintenance ponds – one at the truck shop and one at the ore processing facility.
A lined tailings pipeline maintenance pond would be located at the ore processing facility, to which tailings and process water in the tailings distribution or water reclaim pipelines would drain by gravity during maintenance shutdowns or if there is a leak in either pipeline. The pond would typically be empty except during maintenance or unforeseen problems with the tailings pipeline, pumping system, or TSF. The pond is designed to contain the contents of the pipelines and the runoff from the pond and lined pipeline corridor from a 100-year, 24-hour storm event plus snowmelt.
Underdrain collection sumps and downgradient monitoring wells would be used for TSF leak detection.
Water treatment would continue until metal concentrations from each source have stabilized at levels that meet water quality standards for discharge.
A truck wash facility would include an oil/water separation system and water treatment facilities to enable reuse of the wash water.
During mine operations, summer low flows in perennial diversion channels around the TSF impoundment and buttress (Meadow Creek), Yellow Pine pit (Hennessy Creek and East Fork SFSR tunnel), and West End pit (West End Creek) would be piped underground to maintain cold stream temperatures.
Hennessy Creek flow would be disconnected from the current unlined ditch to avoid creek flows from contacting the legacy waste rock in the Northwest Bradley dumps.
A liner would be installed under the Meadow Creek stream/floodplain corridor to minimize water seepage into the Hangar Flats pit or the pit dewatering well system, and to avoid potential pit wall instability or loss of stream habitat as a result of stream dewatering.
An underdrain system would convey spring and seep flows beneath the TSF and buttress to a collection sump at the buttress toe where the flows would be monitored for water quality prior to release into the stream system or capture for use in the processing circuit or treatment prior to discharge, depending on water quality.
Runoff generated from direct precipitation on the TSF would be retained in the TSF water pool for reclaim to the ore processing circuit.

In addition to the environmental design features listed in **Table 2-3** that are specific to water quality, Perpetua has proposed additional environmental measures for the SGP as described in the following documents:

- Stibnite Gold Mitigation Plan (Perpetua 2021b)
- Water Management Plan (Perpetua 2021c)
- Water Resources Monitoring Plan (Perpetua 2021d)

3.0 Relevant Laws, Regulations, and Policy

3.1 Land and Resource Management Plan

Physical, social, and biological resources on National Forest System lands are managed to achieve a desired condition that supports a broad range of biodiversity and social and economic opportunity. National Forest Land and Resource Management Plans embody the provisions of the National Forest Management Act and guide natural resource management activities on National Forest System land.

In the SGP area, the Payette National Forest Land and Resource Management Plan (Payette Forest Plan; Forest Service 2003), and the Boise National Forest Land and Resource Management Plan (Boise Forest Plan; Forest Service 2010) provide management prescriptions designed to realize goals for achieving desired condition for surface water and groundwater quality and include various objectives, guidelines, and standards for this purpose.

3.2 Federal Laws, Regulations, and Policy

Federal laws that apply to water quality include the Clean Water Act (CWA) and the Safe Drinking Water Act. The U.S. Environmental Protection Agency (EPA) is responsible for enforcing the federally mandated CWA. Section 402 of the CWA, which authorizes the National Pollutant Discharge Elimination System permit program, controls water pollution by regulating point sources that discharge pollutants into waters of the U.S. On June 5, 2018, EPA approved the Idaho Pollutant Discharge Elimination System Program and authorized the transfer of permitting authority to the state beginning on July 1, 2018. EPA will retain the authority to issue National Pollutant Discharge Elimination System permits for facilities located on tribal lands and/or discharging to tribal waters.

EPA's other responsibilities under Section 404 of the CWA include promulgating and interpreting environmental criteria used in evaluating permit applications under Section 404(b)(1): Guidelines for Specification of Disposal Sites for Dredged or Fill Material; coordinating with the U.S. Army Corps of Engineers (USACE, the Section 404 federal permitting authority) in the review of Section 404 permit applications; and sharing responsibility with the USACE in determining the geographic scope of CWA jurisdiction. Section 311 of the CWA also gives EPA regulatory authority with regard to spill prevention, control, and countermeasure plans required for oil storage. Facilities with aboveground and underground storage tanks in excess of specific thresholds are required to develop and implement a Spill Prevention, Control, and Countermeasure Plan.

Under the Safe Drinking Water Act, EPA has established primary and secondary maximum contaminant levels (MCLs) to protect the public against consumption of drinking water contaminants that present a risk to human health. The MCL is the maximum allowable amount of a contaminant in drinking water that is delivered to a consumer (EPA 2018a, 2018b).

In addition, EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 constituents. EPA does not enforce these secondary MCLs. They were established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These constituents are not considered a risk to human health.

3.3 State and Local Policy

The Idaho Department of Environmental Quality (IDEQ) implements the CWA in Idaho and regulates waterbodies in the state under its jurisdiction to meet Idaho water quality standards that are protective of designated uses and uses that may not be designated. **Table 3.9-1** lists the strictest potentially applicable surface water quality criteria used in the water quality analysis in Idaho. These standards represent a combination of human health and cold-water aquatic life criteria that provide a benchmark for evaluating baseline water quality at the mine site and predicted concentration changes resulting from the SGP alternatives.

IDEQ administers the Idaho Pollutant Discharge Elimination System (IPDES) program regulating discharges of pollutants into waters of the U.S. under its jurisdiction. EPA approved the State's IPDES program in accordance with the Memorandum of Agreement between IDEQ and Region 10 (IDEQ and EPA 2016). Per this memorandum, EPA will oversee IDEQ administration of the Idaho Pollutant Discharge Elimination System program on a continuing basis for consistency with the CWA, Idaho laws and rules, and all applicable federal regulations (IDEQ and EPA 2016).

Projects that may result in a discharge to waters of the U.S. require Water Quality Certification under Section 401 of the CWA that the discharge is consistent with the CWA and applicable water quality standards. IDEQ is the regulatory authority for Section 401 permitting in Idaho. The IDEQ must grant (with or without conditions), deny, or waive Section 401 certification for any project in Idaho that requires a federal permit or license under the CWA before the federal permit or license can be granted, including the Section 404 permit issued by the USACE. This Water Quality Certification is designed to ensure that a federally approved project would comply with state water quality standards for surface water and any other water quality requirements under state law.

The CWA also requires the state to prepare a report listing the current condition of all state waters and those waters that are impaired and in need of a total maximum daily load. The first list is referred to as the Section 305(b) list; the second is the Section 303(d) list. Both lists are named in accordance with the sections of the CWA where they are defined; together, and with additional supplementary information, they are known as the Integrated Report.

Impaired waters on the Section 303(d) list are simply a subset of those on the Section 305(b) list. The current applicable report is IDEQ's 2018/2020 Integrated Report (IDEQ 2020a).

The Idaho Nonpoint Source Management Plan describes the state's strategy for addressing nonpoint source pollution collaboratively with local, state, and federal partners, and provides guidance on evaluating and measuring success in meeting water quality goals for the state (IDEQ 2020b). IDEQ's role in nonpoint source management as it relates to mining and natural resource extraction includes the following:

- Conduct monitoring and total maximum daily load development;
- Conduct site investigations and inspections as necessary;
- Focus on site cleanup and remediation in areas where mining activities have contaminated soils and surface water; and
- Provide technical assistance to responsible state and federal agencies and private organizations/owners as requested.

Under Idaho’s Rules for Ore Processing by Cyanidation (Idaho Administrative Procedures Act [IDAPA] 58.01.13), mining facilities that use cyanide in their mineral extraction processes are required to obtain a permit from the IDEQ. IDAPA 58.01.13 establishes procedures and requirement for the issuance and maintenance of permits to construct, operate, and close that portion of a cyanidation facility that is intended to contain, treat, or dispose of process water or process contaminated water containing cyanide. The provisions of these rules also establish requirements for water quality protection which address design, performance, construction, operation, and closure of a cyanidation facility. The rules are intended to ensure that pollutants associated with the cyanidation process are safely contained, controlled, and treated so that they do not endanger public safety or the environment, or interfere with beneficial use of waters of the state.

In addition to regulations enforced by IDEQ, the Idaho Department of Water Resources (IDWR) regulates stream channels under the Idaho Stream Channel Protection Act. This act requires that a Stream Channel Alteration Permit be obtained from IDWR before any type of channel alteration work, including removal and/or fill and installation of in-water or over-water structures with the potential to affect flow, within the beds and banks of a continuously flowing stream. IDWR, the USACE, and the Idaho Department of Lands have established a joint process for activities impacting jurisdictional waterways that require review and/or approval of both the USACE and the State of Idaho. Additionally, IDWR regulates water dams (which may apply to SGP contact water storage ponds) and mine tailings impoundments.

The Idaho Ground Water Quality Rule (IDAPA 2011) establishes minimum requirements for the protection of groundwater by setting standards and beneficial uses and categorizing aquifers to be protected at different levels. The protection levels in IDAPA 58.01.11, summarized in **Table 3-1**, include both primary and secondary numerical groundwater quality standards promulgated by IDEQ to protect human health and the environment. These standards apply to *in situ* groundwater. After groundwater or artificial recharge through the rapid infiltration basins reaches surface water, the surface water quality standards shown in **Table 3-1** would apply.

Table 3-1 Surface Water and Groundwater Quality Guidelines Used in the Water Quality Analysis

Parameter	Units	Groundwater Quality Standard Value ⁽¹⁾	Surface Water Quality Standard Value ⁽²⁾	Surface Water Standard Source
pH	s.u.	6.5-8.5 S	6.5-9.0	IDAPA 58.01.02 – Aquatic Life Use
Alkalinity, Total	mg/L as CaCO ₃	---	>20	EPA Freshwater Aquatic Life Criteria
Aluminum	mg/L	0.2 S	0.05 t	EPA Secondary Drinking Water Standard
Antimony	mg/L	0.006 P	0.0052 d	IDAPA 58.01.02 – Human Health
Arsenic	mg/L	0.05 P	0.010 t	IDAPA 58.01.02 – Human Health
Barium	mg/L	2 P	2 t	EPA Drinking Water MCL
Beryllium	mg/L	0.004 P	Narrative	IDAPA 58.01.02
Cadmium	mg/L	0.005 P	0.00033 ⁽²⁾ d	IDAPA 58.01.02 - CCC (chronic)
Chloride	mg/L	250 S	230	EPA Freshwater Aquatic Life Criteria
Chromium, Total	mg/L	0.1 P	0.1 t	EPA Drinking Water MCL
Copper	mg/L	1.3 P	0.0024 ⁽³⁾ d	IDAPA 58.01.02 – CCC (chronic)
Cyanide, Total	mg/L	0.2 P	0.0039	IDAPA 58.01.02 – Human Health
Cyanide, WAD	mg/L	---	0.0052	IDAPA 58.01.02 - CCC (chronic)
Iron	mg/L	0.3 S	0.3 t	EPA Secondary Drinking Water Standard

Parameter	Units	Groundwater Quality Standard Value ⁽¹⁾	Surface Water Quality Standard Value ⁽²⁾	Surface Water Standard Source
Fluoride	mg/L	4 P	2	EPA Secondary Drinking Water Standard
Lead	mg/L	0.015 P	0.0009 ⁽²⁾ d	IDAPA 58.01.02 – CCC (chronic)
Manganese	mg/L	0.05 S	0.05 t	EPA Secondary Drinking Water Standard
Mercury	mg/L	0.002 P	0.000012 t	IDAPA 58.01.02 - CCC (chronic)
Methylmercury (fish tissue)	mg/kg	---	0.3	IDAPA 58.01.02 – Human Health
Nickel	mg/L	---	0.024 ⁽²⁾ d	IDAPA 58.01.02 – CCC (chronic)
Nitrate + nitrite	mg/L	10 P	---	N/A
Selenium	mg/L	0.05 P	0.0015 t	EPA Freshwater Aquatic Life Criteria
Silver	mg/L	0.1 S	0.0007 ⁽²⁾ d	IDAPA 58.01.02 - CMC (acute)
Sulfate	mg/L	250 S	250	EPA Secondary Drinking Water Standard
Total Dissolved Solids	mg/L	500 S	500	EPA Secondary Drinking Water Standard
Thallium	mg/L	0.002 P	0.000017 d	IDAPA 58.01.02 – Human Health
Zinc	mg/L	5 S	0.054 ⁽²⁾ d	IDAPA 58.01.02 – CMC/CCC (acute/chronic)

Sources: IDAPA 58.01.11; IDAPA 58.01.02; EPA 2018a, 2018b, 2019

¹ Groundwater standards obtained from IDAPA 58.01.11.

² Strictest potentially applicable surface water quality standard.

³ The criteria for these metals are hardness dependent. The values listed are based on the East Fork SFSR hardness of 40 mg/L as calcium carbonate, which represents the 5th percentile hardness during the driest four months at node YP-SR-10 (below the confluence with Meadow Creek) between April 2012 and May 2019.

⁴ Copper criterion was derived using the Biotic Ligand Model per guidance contained in IDEQ (2017). A conservative chronic copper standard was estimated by applying the lowest of the 10th percentile chronic criteria based on regional classifications for the Salmon River Basin, Idaho Batholith, and third order streams. Per the SGP Water Quality Management Plan (Brown and Caldwell 2020a), preliminary calculations using the Biotic Ligand Model and site-specific data have produced similar values to the standard derived using these regional classifications.

Narrative = No numeric human health standard has been established for beryllium. However, permit authorities will address beryllium in NPDES permit actions using the narrative criteria for toxics in Section 200 of IDAPA 58.01.02, which states: “Surface waters of the state shall be free from toxic substances in concentrations that impair designated beneficial uses. These substances do not include suspended sediment produced as a result of nonpoint source activities.”

s.u. = standard units; mg/L = milligrams per liter; mg/kg = milligrams per kilogram; CaCO₃ = calcium carbonate;

--- = Indicates no standard for this constituent; P = primary standard; S = secondary standard; d = dissolved fraction;

t = total fraction. CCC= criterion continuous concentration; CMC= criterion maximum concentration; N/A = Not Applicable.

The IDEQ is responsible for coordinating and administering groundwater quality protection programs in the state of Idaho. IDEQ also is responsible for establishing a point of compliance location, if requested by a mine operator and pursuant to the Idaho Ground Water Quality Rule (IDAPA 58.01.11), where groundwater and surface water downgradient of mining activity must meet established water quality standards. If a point of compliance is not applied for, the mine operator must meet the ground water quality standards in ground water both within and beyond the mining area.

The U.S. EPA recommends that a human health methylmercury criteria of 0.3 mg/kg translated to a total-mercury concentration of 2 ng/L in surface water be utilized in the analysis. This recommendation is incorporated into the impacts analyses, but table-reported standard values utilize the 12 ng/L (0.000012 mg/L) representing the lowest concentration adopted as a standard.

The Valley County Land Use and Development Ordinances have provisions for well head protection. These regulations would likely apply to any drinking water wells installed. The well head protection

regulations control the siting of drinking water wells and prevent wells and their potential capture zones from being installed near potential sources of groundwater contamination.

4.0 Issues and Resource Indicators

4.1 Significant Issues

Significant issues are those which are used to formulate alternatives to the Proposed Action and to develop mitigation measures. Construction and operation of mine infrastructure may impact water quality within the analysis area.

4.2 Resource Issues and Indicators

The analysis of effects to surface water and groundwater quality includes the following issues and indicators:

Issue: The SGP may affect water resources through acid rock drainage and/or metals leaching from mineralized rock in the mine pits, development rock, and the TSF.

Indicators:

- Volume and disposition of mineralized waste generated.
- Lithologic composition of final pit walls and exposure of potentially acid-generating material.
- Removal of legacy mine tailings and waste rock.
- Predicted and observed leachate chemistry of development rock and tailings.

Issue: The SGP may cause changes in surface water and groundwater quality.

Indicators:

- Surface water quality parameters (e.g., pH, temperature, major ions, TDS, metals, sediment content, and organic carbon).
- Groundwater quality parameters (e.g., pH, major ions, TDS, and dissolved metals).

Issue: The SGP may cause increased mercury methylation in adjacent waterbodies through SGP-related activities and discharges.

Indicator:

Predicted impact on methylmercury production.

5.0 Methodology

5.1 Analysis Area

The surface water quality analysis area includes streams and lakes located in the 22 sub-watersheds that encompass the SGP, access roads, transmission lines, and off-site facilities (**Figure 5-1**). Sub-watersheds are the hydrologic sub-basins that contain smaller tributary stream systems and are defined by the U.S. Geological Survey's (USGS) 12-digit Hydrologic Unit Codes (EnviroAtlas 2019; Seaber et al. 1987).

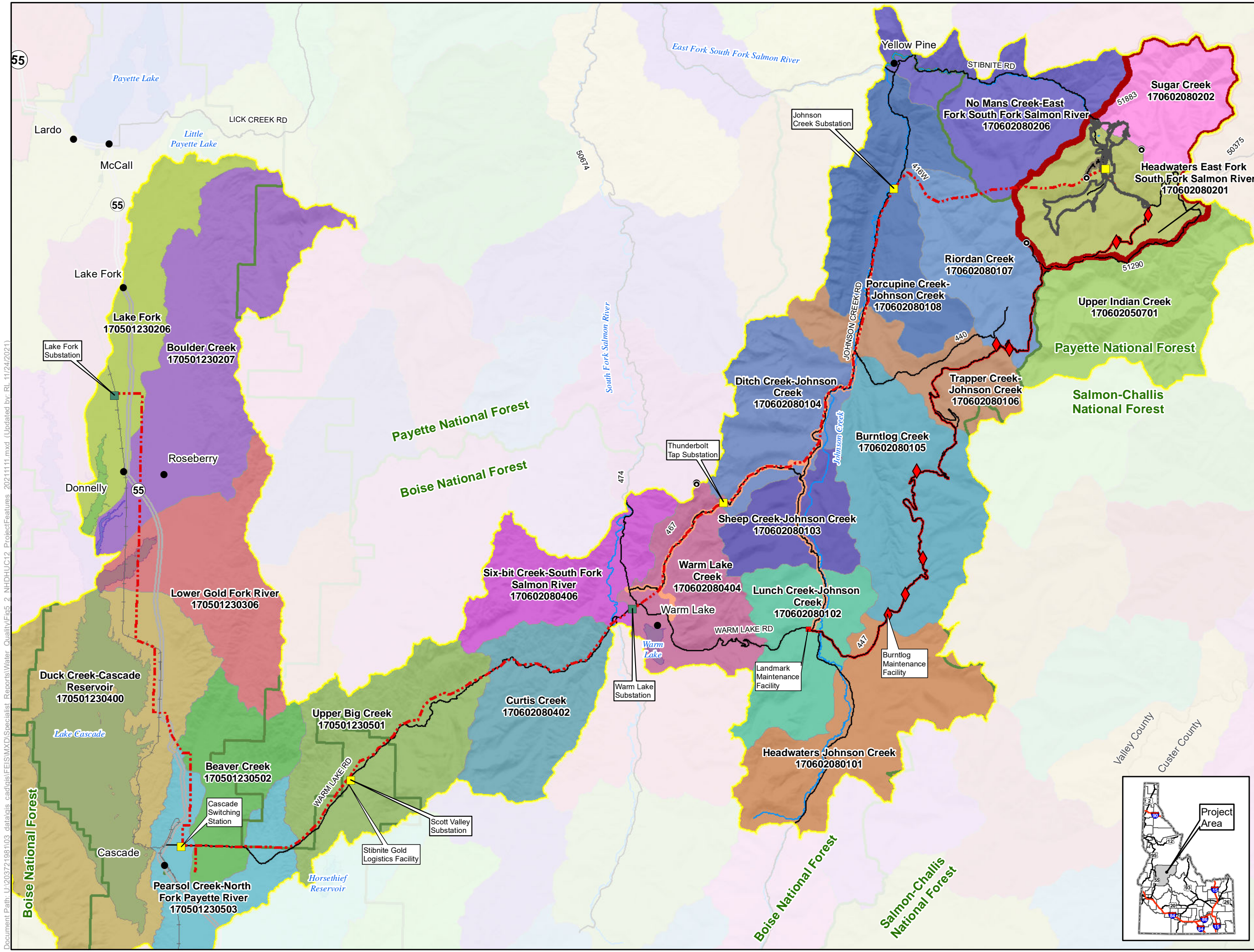
The analysis area for groundwater quality includes the Sugar Creek and Headwaters East Fork South Fork Salmon River (East Fork SFSR) sub-watersheds (**Figure 5-2**), which together encompass the SGP infrastructure that is most likely to influence groundwater quality. The groundwater quality analysis area focuses on the SGP where excavation of mineralized and unmineralized subsurface materials would occur. It does not cover all components, such as off-site facilities or supporting infrastructure corridors, which are limited to surface disturbance activities that would not affect groundwater quality. Based on the hydrogeologic conceptual model for the groundwater quality analysis area, groundwater flow is primarily controlled by topography, with mountain-front recharge flowing through shallow fractured bedrock and colluvium to unconsolidated alluvial deposits, and eventually discharging from the unconsolidated deposits to streams, springs, and seeps. As such, groundwater flow divides likely coincide with the sub-watershed boundaries that define the groundwater quality analysis area (Brown and Caldwell 2018a). The point where groundwater is most likely to flow out of the analysis area is through the alluvial aquifer at the farthest downstream point in the Headwaters East Fork SFSR sub-watershed. Any groundwater leaving the analysis area through this boundary would eventually discharge to the East Fork SFSR downgradient.

The cumulative effects boundaries for water quality are coincident with the area of analysis for direct effects because other current and reasonably foreseeable future activities that could affect water quality conditions are within the same area.

5.2 Analysis Area Methodology

Surface water and groundwater quality were primarily analyzed using baseline water quality data, geochemical characteristics of development rock and tailings produced by mining, water quality predictions from modeling studies completed by Perpetua and their consultants for the SGP, and the Stibnite Gold Project Water Management Plan (Brown and Caldwell 2021c). Other sources consulted include scientific literature and governmental agency documents that identify impaired stream segments and applicable water quality standards.

Several models were developed by Perpetua to support the water quality analysis, including a site-wide water balance model (SWWB), a hydrologic model, a site-wide water chemistry (SWWC) model, and the Stream and Pit Lake Network Temperature (SPLNT) model. The methodology used to develop and calibrate the existing conditions and proposed action water resources models are outlined in **Section 7.2.2**. Summaries of the SWWB model, SWWC model, and the SPLNT model are provided below. The hydrologic model is summarized in the companion Water Quantity Report (Forest Service 2022b) and additional modeling details can be located in the modeling reports provided by Perpetua (Brown and Caldwell 2021a, 2021b, 2021f, SRK 2021a).



LEGEND

- Surface Water Analysis Area
- Mine Site Water Modeling Boundary
- Mine Site Components***
- Mine Site Components
- Access Roads and Trail System**
- Burntlog Route
- Groomed OSV Route
- Cell Tower Access Road
- ◆ Burntlog Route Borrow Source
- Utilities**
- Powerline
- New Substation**
- Existing Substation**
- Offsite Facilities**
- Logistics/Maintenance
- Other Features**
- U.S. Forest Service
- County
- City/Town
- Railroad
- Highway
- Road
- ~ Stream/River
- ☪ Lake/Reservoir

* Project Components are associated with all Alternatives
 ** Substation locations are approximate
 Note:
 Subwatersheds displayed are Hydrologic Unit Code (HUC) 6th level (12-digit)
 The McCall – Stibnite Road (CR 50-412) consists of Lick Creek Road, East Fork South Fork Salmon River Road (East Fork Road) and Stibnite Road.

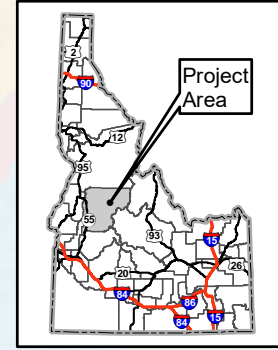
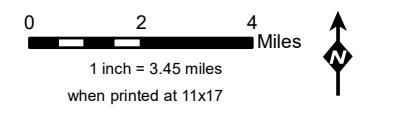
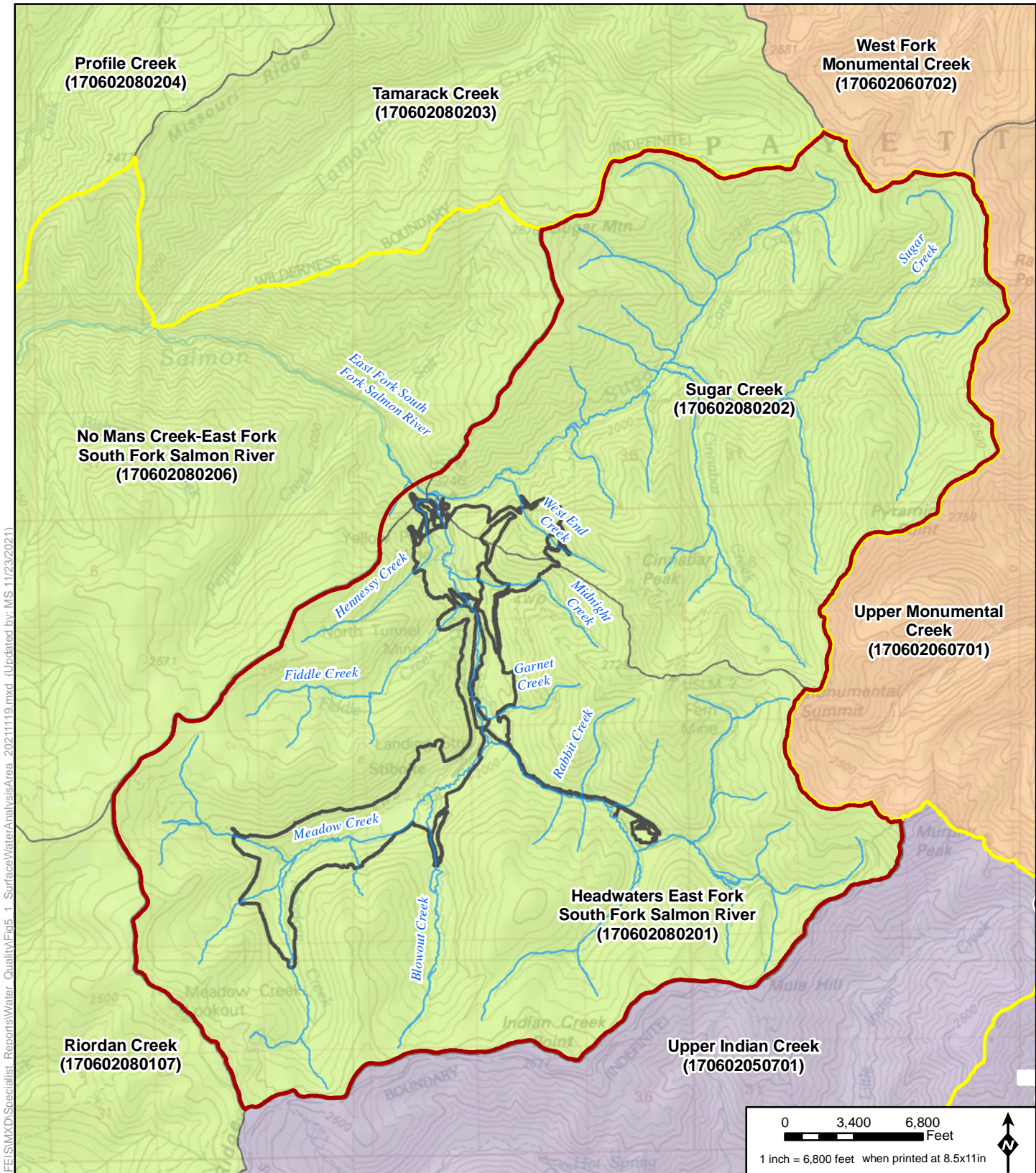


Figure 5-1
Surface Water Analysis Area
Stibnite Gold Project
Stibnite, ID

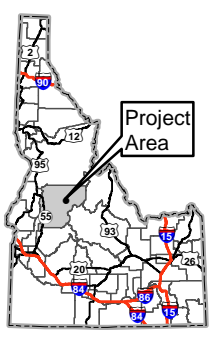
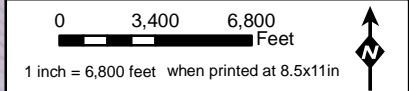
Base Layer: USGS The National Map: 3D Elevation Program.
 USGS Earth Resources Observation & Science (EROS) Center: GMTED2010, Data refreshed March, 2021.
 Other Data Sources: Perpetua; State of Idaho Geospatial Gateway (INSIDE Idaho); USGS; Boise National Forest; Payette National Forest



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- LEGEND**
- ▭ Surface Water Analysis Area
 - ▭ Mine Site Water Modeling Boundary
 - Mine Site Components*
 - Watersheds**
 - Upper Middle Fork Salmon (17060205)
 - South Fork Salmon (17060208)
 - Lower Middle Fork Salmon (17060206)
 - Stream/River

**Figure 5-2
Groundwater Quality
Analysis Area
Stibnite Gold Project
Stibnite, ID**

*Base Layer: ESRI USA Topographic Basemap Other
Data Sources: Perpetua; Boise National Forest;
Payette National Forest*




*Mine Site components are associated with all Alternatives
Note: Subwatersheds displayed are Hydrologic Unit Code (HUC) 6th level (12-digit)

5.2.1 Geochemical Characterization of Mined Materials

The leachate chemistry of the mine waste material was characterized through static and kinetic test work (SRK 2017, 2020). The kinetic tests were used to define potential acid generating (PAG) and non-PAG development rock source terms for geochemical modeling (SRK 2018b).

The humidity cell test (HCT) program was conducted in two different phases with the first phase focused on anticipated project mined materials and the second phase supplementing mined material samples as well as testing of synthesized and legacy tailings samples. Steady-state constituent release rates from the HCTs were used to develop leachate source terms for each development rock and wall rock lithology. The source terms were assigned by correlating each rock type to a representative HCT based on the lithology, location, and geochemistry of the HCT sample. The test cell HC-14 from the Phase I testing program was selected to represent PAG development rock and wall rock because this cell had the highest total sulfur and highest sulfate leaching rate, which corresponds to maximum sulfide oxidation and acid rock drainage (ARD) potential. The source terms were then scaled to field conditions to account for differences in reaction rates, temperatures, and liquid-to-solid ratios between laboratory tests and field conditions. For a more detailed discussion of source term development and the site-specific scaling factors used, the reader is referred to SRK 2018b and SRK 2021a. The development rock and wall rock source terms were used as inputs in a geochemical model to predict operational, closure, and post-closure groundwater and surface water quality resulting from the mine pits and/or development rock as activities change over time. Specific water quality predictions are discussed in subsequent sections.

5.2.2 Water Balance Model

A site-wide water balance model was performed by Brown & Caldwell to assess:

- meteoric precipitation contributions (i.e., rainfall and snowmelt) to surface water and groundwater,
- volumes of water requiring storage and management due to contact with mine facilities (i.e., contact water),
- consumptive use needs and water sourcing for mining and ore processing,
- volume of water requiring water treatment during operations and post-closure following the installation of geosynthetic covers over reclaimed mine facilities, and
- runoff, infiltration, and seepage of meteoric waters incident on stockpiles, the TSF Buttress, and other mined materials.

The modeling was conducted using the commercial GoldSIM software which is widely used in the mining industry for site and facility water balances.

5.2.3 Hydrologic Model

The effects of mine dewatering and production of water for consumptive use were simulated using a groundwater numerical MODFLOW model (Brown and Caldwell 2021b). This modeling effort is described in the companion Water Quantity Report (Forest Service 2022b).

With regard to water quality, the hydrologic model provides predictions to assess:

- groundwater inflows to open pits during operations and pit backfill during closure,

- groundwater discharge volume to surface waters, and
- groundwater flow paths from materials in the TSF Buttress, the West End pit lake and pit backfills that eventually emerge as a surface water flow.

5.2.4 Groundwater Chemistry Model

Geochemical modeling was performed by SRK to assess future water quality resulting from the SGP (SRK 2021a). The objective of the modeling was to determine the potential for groundwater (and surface water impacts) from the proposed open pits, the TSF, the TSF Buttress, ore stockpiles, and pit backfill material. The adopted methodology included development of conceptual models for operational and post-closure phases of the SGP, and numerical geochemical modeling. The numerical modeling was completed for: (1) Yellow Pine pit and backfill, (2) Hangar Flats pit and backfill, (3) West End pit lake, (4) Midnight pit and backfill, and (5) the TSF and TSF embankment. These models assumed leakage rates for proposed liners (e.g., liner above the TSF) to account for small volumes of infiltration through tailings and development rock and their effects on water chemistry.

The general modeling approach was to quantify the solute concentrations in water that would potentially seep from the base of those facilities during operations and post closure, and to predict the likely solute concentrations in the underlying groundwater.

Data used as input to the geochemical models included:

- Geological and mine planning information, including development rock production schedule and mine design;
- Hydrogeologic and hydrologic water balance information;
- Geochemical data from laboratory static and kinetic tests performed on representative/ materials, scaled to field conditions; and
- Precipitation chemistry data from long-term monitoring at the Smiths Ferry meteorological station, Idaho.

5.2.5 Surface Water Chemistry Model

The data sources and groundwater chemistry plus pit lake water chemistry forecasts were combined with surface water chemistry data from the Surface Water Quality Baseline Study (HDR 2017) to predict future surface water chemistry associated with project activities.

The surface water assessment nodes were established at or near surface water sampling locations monitored during the Surface Water Quality Baseline Study (HDR 2017). The main sources contributing to flow and constituent loading at each of the assessment nodes were identified from the baseline study, the Water Resources Summary Report (Brown and Caldwell 2017), and from an inventory of legacy mining features provided by Perpetua (SRK 2018a). These sources include upgradient stream flow, flow from seeps and adits in the watershed, loading from legacy mine features, plus any potential sources of groundwater inflow identified from the gain-loss analysis conducted as part of the Water Resources Summary Report (Brown and Caldwell 2017).

Predictive water quality modeling utilizes the U.S. Geological Survey's PHREEQC software (Parkhurst and Appelo 1999) to forecast water chemistry associated with

- infiltration and seepage from the TSF Buttress,
- the influence of the TSF on groundwater chemistry,
- inundated backfill in the Yellow Pine pit, Hangar Flats pit, and Midnight pit,
- the West End pit lake, and
- water treatment influent and effluent.

Results from the facility water chemistry models describing the source terms were then incorporated into the calibrated SWWC model to assess surface water chemistry at a series of prediction nodes downstream of the facilities (in Meadow Creek, West End Creek, Sugar Creek, and the East Fork SFSR) under high flow and low flow conditions, during both the mine operational and post-closure periods. Water chemistry at prediction node YP-SR-6 represents conditions in the lined stream channel crossing the Yellow Pine pit backfill, including the Stibnite Lake feature. The same mass balance approach described for the existing conditions model was used in the proposed action SWWC model. The loading sources contributing to predicted concentrations at each surface water assessment node are provided in Tables 8-2 and 8-3 of SRK (2021a) for the mine operational and post closure periods, respectively. Examples of loading sources that affect concentrations during the mine operational period include upstream surface water flows, seep flows, and groundwater discharge. During the post closure period, additional mass loading from the TSF, the TSF Buttress, pit lakes, and pit backfills were incorporated into the SWWC model. These loadings are discussed further in this specialist report.

Ammonia concentrations in surface waters were not explicitly modeled. Use of equilibrium models such as PHREEQC to simulate generally oxidized environmental conditions drives predicted nitrogen phases toward oxidized equilibrium phases (e.g., nitrate). This equilibrium model tendency is consistent with monitoring data from the existing mine site environment, where nitrate is regularly detected while ammonia concentrations are typically lower than analytical detection limits in 99% of analyzed site samples (Brown and Caldwell 2017, SRK 2017 appendices). Of the 109 analyses where ammonia was detected above a 0.05 mg/L analytical detection limit, the maximum detected concentrations was 0.57 mg/L, a concentration below the strictest potentially applicable water chemistry standard of 2.1 mg/L.

5.2.6 Surface Water Temperature Model

The SPLNT model was developed by Brown and Caldwell (2019a, 2021f) using two separate software packages: QUAL2K for stream temperature modeling, and the General Lake Model for simulating pit lake temperatures. Similar to the SWWC model, an existing conditions SPLNT model was developed to confirm that the modeling approach was capable of reproducing observed stream temperatures. After the existing conditions SPLNT model had been appropriately calibrated, it was used to generate future temperature predictions for the proposed action SPLNT model in Meadow Creek, West End Creek, Sugar Creek, and the East Fork SFSR. The proposed action model was run for three different model timelines: end of mining year 6 (EOY 6), EOY 12, and post closure. EOY 6 is approximately halfway through mining operations, and EOY 12 represents the full build-out occurring three years before end of active mining. A post closure timeline also was simulated to represent how the site would function after the mine facilities and permitted discharges have been removed, dewatering and mining have been discontinued, and the channels and vegetation have been fully reclaimed. All of these model results are discussed later in this specialist report.

The SPLNT model results were integrated with other modeling efforts for the SGP. Outputs from the hydrologic model and the site-wide water balance model became SPLNT inputs to simulate streams and

pit lakes. Output from the General Lake Model component of the SPLNT model supported development of the SWWC model by providing temperature and dissolved oxygen profiles for the pit lakes.

6.0 Affected Environment

The affected environment description for water quality is based on water quality data collected by Perpetua, their consultants, and the USGS. Surface water quality and groundwater quality baseline studies were summarized in reports by HDR (HDR 2016, 2017). Analytical data presented in the HDR reports were compiled from samples collected over a 4-year period between 2012 and 2016. Additional summary and analysis of the baseline study results were provided in the Stibnite Gold Project Water Resources Summary Report (Brown and Caldwell 2017). Since these initial baseline studies were published, two additional years of data were collected and tabulated in the Stibnite Gold Project Water Quality Summary Report, 2012 – 2018 (Midas Gold 2019), and data collection is ongoing. Additionally, the USGS collected a series of surface water quality samples in the study area between 2011 and 2017, with the study results and data analysis published in two separate reports (Etheridge 2015; Baldwin and Etheridge 2019;). Analytical data, statistics, and trends from the USGS and SGP baseline studies were used to characterize existing surface water and groundwater quality at the mine site and are discussed later in this report.

6.1 Geology and Mineralization

The geochemistry of the mine site is influenced by both the bedrock geology (including naturally occurring mineralization) and a legacy of historical mining activity that has altered the natural environment (Baldwin and Etheridge 2019). Locally, the Yellow Pine and Hangar Flats deposits are hosted by intrusive igneous rock associated with the Atlanta Lobe of the Idaho Batholith. Both deposits are situated along the Meadow Creek Fault Zone, a generally north trending, variably dipping, but near vertical complex fault zone that can be traced from north of the main Yellow Pine deposit south 1.85 miles through the Hangar Flats deposit, and beyond (SRK 2017). The West End deposit is hosted by metasedimentary rocks of the Stibnite roof pendant located above the Atlanta Lobe of the Idaho Batholith. **Figure 6-1** illustrates the various lithologic units located within the SGP area (Smitherman 1985, USGS 2007).

Both intrusive igneous rocks and metasedimentary rocks in the SGP area have undergone hydrothermal alteration associated with either Cretaceous magmatic events and/or Tertiary volcanic activity. Potassic and sodic metasomatism and widespread sericitization are characteristic of the earlier hydrothermal alteration event, while silicification and lower temperature hydrothermal alteration occurred in association with tertiary volcanic activity.

In the mine site ore deposits, precious metals (gold and silver) typically occur in association with very fine-grained disseminated arsenical pyrite ($\text{Fe}(\text{S},\text{As})_2$), and to a lesser extent, arsenopyrite (FeAsS) (SRK 2017). Antimony occurs as the mineral stibnite (Sb_2As_3) often in the same areas as precious metals mineralization but in deposits that are cross-cutting and generally more confined in distribution. Base metal sulfides (e.g., zinc, copper, and lead) are rare and occur at very low concentrations, at or below typical crustal abundance levels. Various oxidized products derived from weathering of the primary sulfides are associated with the intrusive rocks, including goethite, hematite, jarosite, and scorodite, and these host precious metal mineralization in the oxidized portions of the deposits (M3 2019).

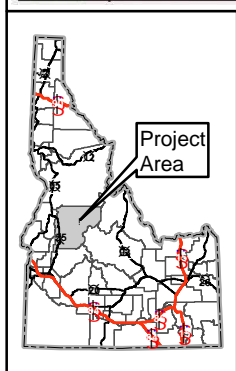
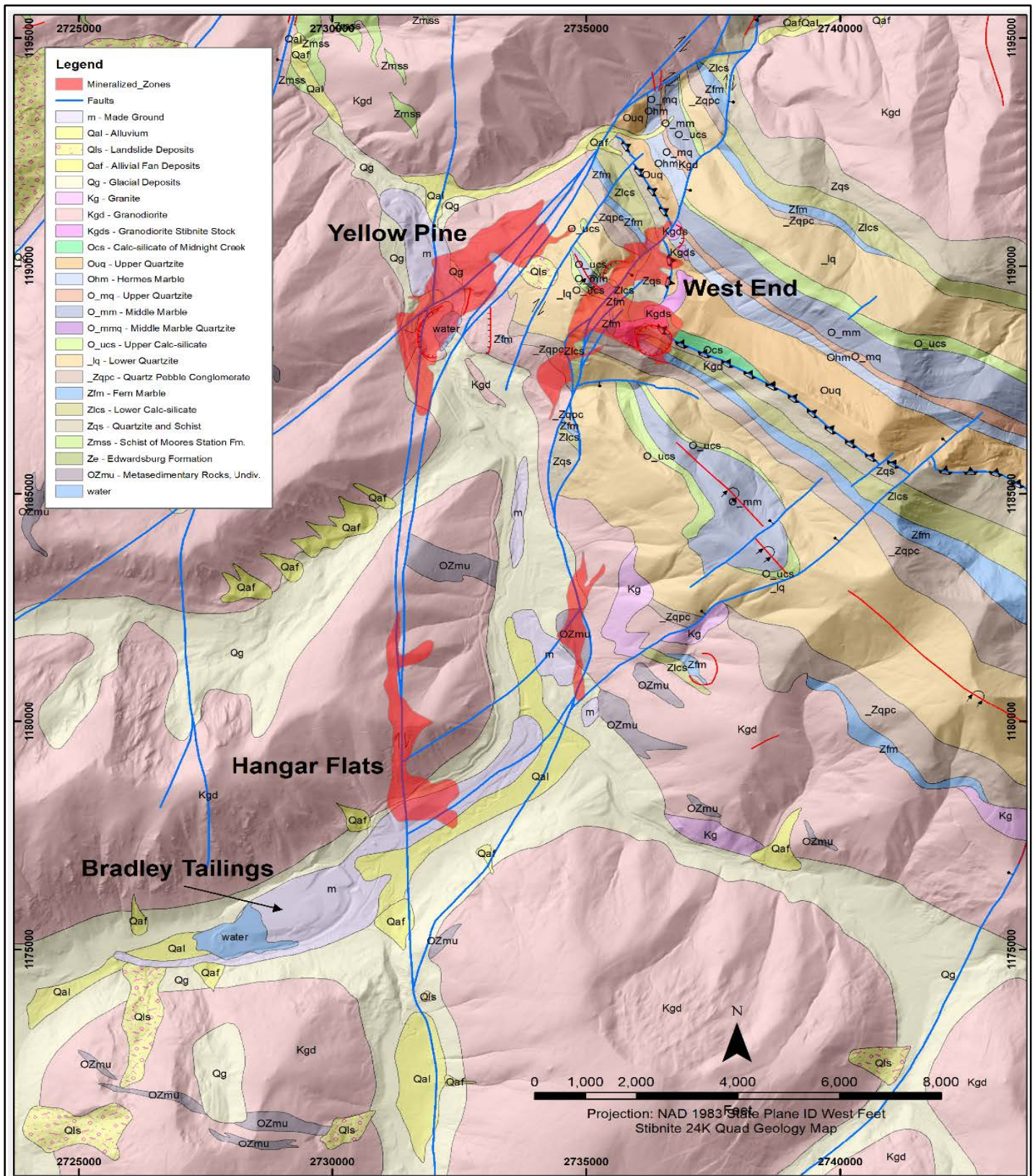


Figure 6-1
Stibnite Mining District
Geology

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Metasediment-hosted mineralization in the West End deposit has a similar sulfide suite and geochemistry, but with higher carbonate content in the gangue and a much more diverse suite of late-stage minerals. As in the intrusive-hosted mineralization, gold is associated with very fine-grained arsenical pyrite. Antimony mineralization is generally rare in the West End deposit.

The primary intrusive and metasedimentary rock types at the mine site include alaskite, granodiorite (i.e., quartz monzonite), diorite, rhyolite, calc-silicate, carbonates (e.g., dolomite and limestone), quartzite, stibnite stock, schist, breccia, gouge, and granite (SRK 2017). The intrusive rocks associated with the Yellow Pine and Hangar Flats deposits are predominantly composed of quartz monzonite and alaskite. In contrast, the metamorphosed sedimentary rocks of the West End deposit generally consist of calc-silicate, carbonates, quartzite, and schist.

The intrusive and metasedimentary mineralization of the main ore deposits has been extensively drilled during exploration and development, as well as during past mining operations focused on the previously exploited ores. The drilled materials represent the composition of future development rock and ore, as well as historical mine wastes. Samples from these holes were characterized via multi-element total metal analyses and tested for leachable metals (SRK 2017).

Results from the multi-element testing show that arsenic, mercury, sulfur, and antimony are enriched in the Yellow Pine, Hangar Flats, and West End ore bodies. These elements are typically associated with gold deposits (Rose et al. 1979) and their enrichment in the samples reflects the natural mineralization in the area. The enrichment of arsenic, mercury, sulfur, and antimony is generally more pronounced for the ore grade material (with a gold concentration greater than approximately 0.5 gram per ton) as would be expected; however, some of the waste grade material also is enriched with respect to these constituents (SRK 2017).

6.2 Geochemistry of Mined Materials

Mining operations expose mineralized and altered rocks to air and water and subsequent weathering reactions. Sulfide minerals undergo oxidation reactions that may result in the generation of acidic solutions or pH-neutral metal-bearing solutions that potentially could affect surface water and groundwater resources. Ore mined by the project would be processed on site with tailings placed in a lined TSF. Development rock material generated would be placed in the TSF Buttress or backfilled into the Yellow Pine pit or Hangar Flats pit (**Table 6-1** and **Figure 6-2**). The SGP also would expose mineralized and altered rock in the walls of the three open pits. This section provides a summary of the geochemical testing results performed to characterize the rock geochemistry of the proposed processed ore, development rock and exposed wall rock in the post-mining quarry.

Table 6-1 Origin and Placement of Development Rock

	TSF Buttress	Hangar Flats Pit Backfill	Midnight Pit Backfill	Yellow Pine Pit Backfill	TSF Embankment
Development Rock Sources	Hangar Flats pit, Yellow Pine pit, West End pit	Yellow Pine pit, West End pit	West End pit	Hangar Flats pit, Yellow Pine pit, West End pit	Hangar Flats pit, Yellow Pine pit, West End pit, SODA and Hecla heap leach legacy materials
Tons (millions)	81	18	7	113	61
Area (acres)	120	41	18	180	88
Height (feet)	460	460	320	740	460 (First state, 245)
Steepest Grade	3:1	5:1 to 2.5:1	3:1 (north side), 2:1 (south side)	2.5:1	2:1

Source: Perpetua 2021a

In addition to the development rock sources included in **Table 6-1**, advancement of the Scout Exploration Decline is expected to produce 25,000 tons of development rock, approximately 0.01 percent of the project’s mined material. The development rock from the Scout Exploration Decline would consist of the metasedimentary lithologies of the Stibnite roof pendant most prevalent in the West End area including quartzite, carbonate and schists with diorite and quartz monzonite intrusives (SRK 2021a). The development rock from the decline would be destined for the buttress and backfill locations along with the West End pit development rock. Hence, the characterizations of the open pit mined lithologies (**Table 6-2**) are applied to the limited amount of those lithologies present in the development rock from the Scout Exploration Decline.

The geochemical characterization program for mined materials included the following analysis:

- Review of site geology and identification of the primary material types;
- Collection of drill core and coarse reject samples representative of waste rock and ore;
- Collection of tailings representative of processed ore material; and
- Static and kinetic laboratory testing of selected samples.

The following sections describe the material types that would be mined by the SGP as well as the methods and results of the geochemical characterization program.

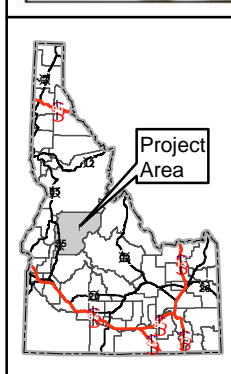
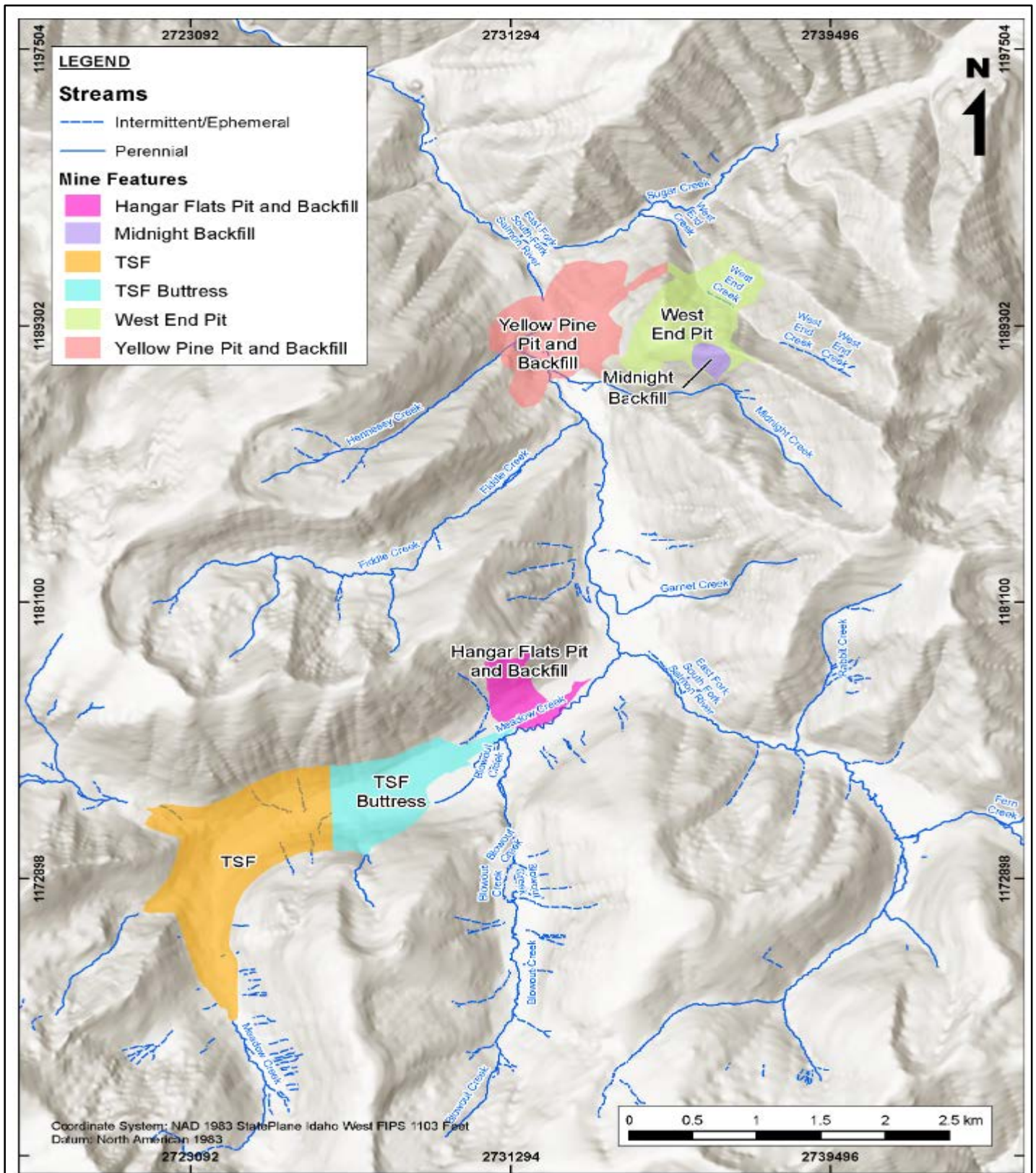


Figure 6-2
Facility Location Map

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



6.2.1 Mined Material Types

Waste rock and ore materials typically are classified and tested according to the material type and the number of samples selected for geochemical testing associated with the relative percentage of each material type expected to be mined following the mine geologic block model (**Table 6-2** and **Figure 6-3**). The term “material type” for the SGP refers to a site-specific set of rock classifications, primarily within the portion of a lithology where the mining is planned to occur (SRK 2017).

Once open pit mining concludes, the rock types exposed in the Yellow Pine and Hangar Flats pit walls would consist primarily of Quartz Monzonite and Alaskite while the West End pit walls would consist primarily of calc-silicate, quartzite, schist, and carbonate rock types (**Table 6-2**). Backfilling the Yellow Pine and Hangar Flats pits during the closure period will yield exposed rock types above the backfill consisting primarily of quartzite, quartz monzonite, alaskite, and alluvium in the Yellow Pine pit and quartz monzonite, fault gouge, and alluvium in the Hangar Flats pit.

Table 6-2 Mined Material Frequency and Testing

Lithology	Waste Rock (%)	Pit Wall (%)	Pit Wall above Backfill (%)	ABA	Siderite Corrected NP	NAG	MWMP	HCT
Yellow Pine Pit								
Alaskite	1	3	-	19	16	6	3	2
Quartz Monzonite	10	20	13	29	24	17	6	1
Granite	<1	2	-	18	16	7	1	1
Quartz Monzonite-Alaskite	40	32	26	47	33	25	3	2
Rhyolite	<1	<1	-	3	2	1	-	1
Calc-silicate	2	4	6	2	2	2	-	-
Quartzite	14	12	26	15	15	9	-	-
Schist	1	2	2	1	1	-	-	-
Breccia	<1	<1	<1	19	18	3	1	-
Gouge	2	2	4	26	23	7	1	-
Diorite	<1	<1	-	1	-	1	1	1
Alluvium	11	8	15	6	6	6	6	-
Hangar Flats Pit								
Alaskite	-	-	-	29	23	10	1	1
Quartz Monzonite	-	-	-	32	18	17	4	3
Granite	<1	<1	-	7	7	1	-	-
Quartz Monzonite-Alaskite	48	53	70	47	28	26	3	1
Diorite	1	<1	3	3	-	3	1	-
Rhyolite	<1	<1	-	7	3	4	2	-
Calc-silicate	<1	<1	-	-	-	-	-	-
Carbonate	<1	<1	-	-	-	-	-	-
Quartzite	<1	<1	-	2	-	2	-	-
Schist	<1	<1	-	-	-	-	-	-

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Lithology	Waste Rock (%)	Pit Wall (%)	Pit Wall above Backfill (%)	ABA	Siderite Corrected NP	NAG	MWMP	HCT
Breccia	<1	<1	<1	9	7	3	1	1
Gouge	13	9	16	11	7	6	1	1
Alluvium	38	37	11	6	6	6	6	-
West End Pit								
Quartz Monzonite	<1	<1	na	5	2	3	1	-
Stibnite Stock	14	11	na	3	3	1	-	-
Calc-silicate	15	14	na	29	13	20	6	2
Carbonate	18	19	na	13	7	7	3	2
Quartzite	30	37	na	20	16	14	3	1
Schist	15	14	na	19	13	7	3	2
Breccia	<1	<1	na	2	2	-	-	-
Gouge	<1	<1	na	2	1	1	-	-
Tailings Material	-	-		5	-	5	5*	7
Bailey Tunnel	-	-		2	2	2	-	-
Homestake Legacy Material	-	-		1	1	1	1	-
Totals				440	315	223	63	29

Source: SRK 2017, 2021a

ABA = Acid-base accounting and multi-element analyses

HCT = Humidity Cell Test

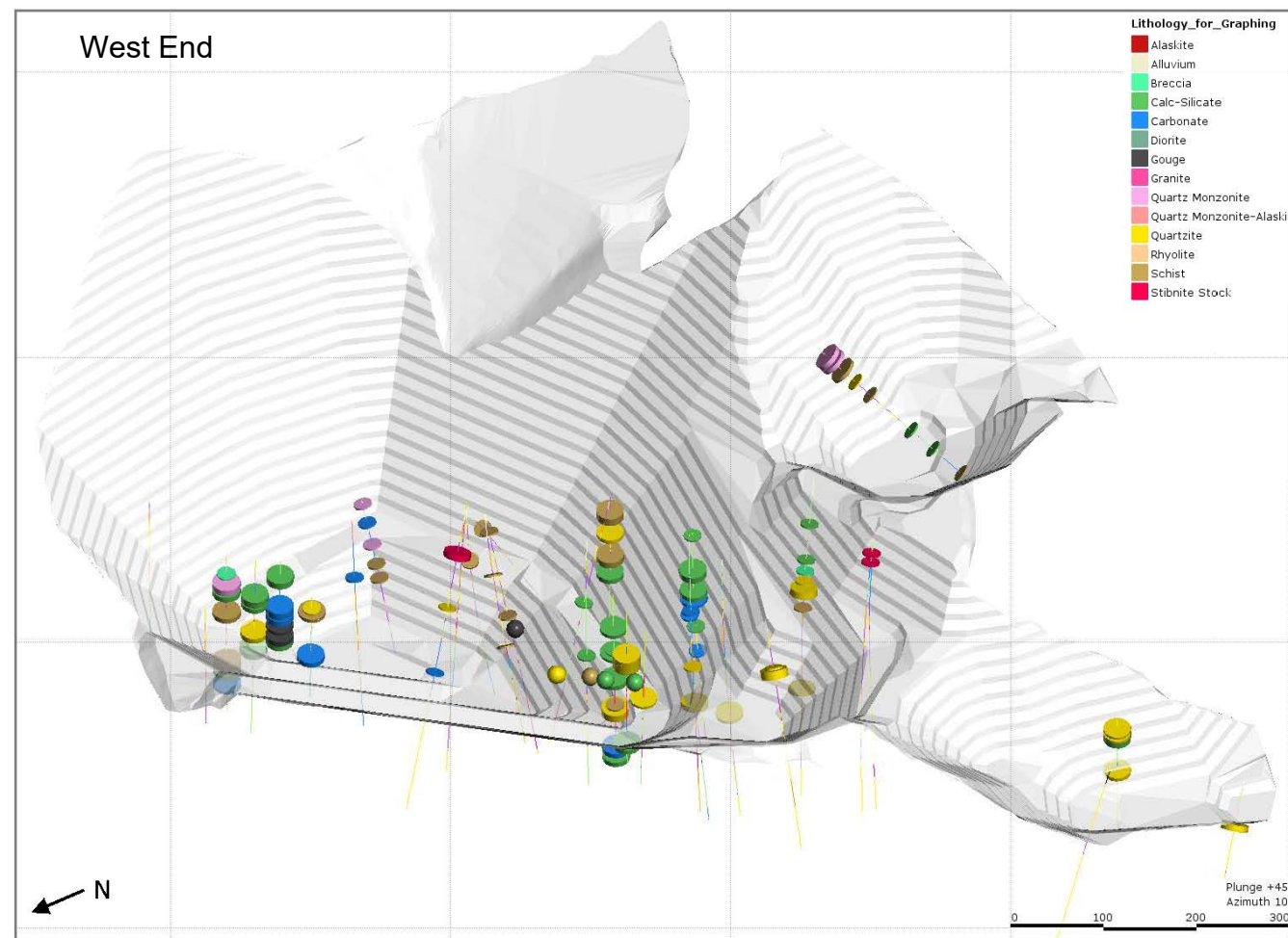
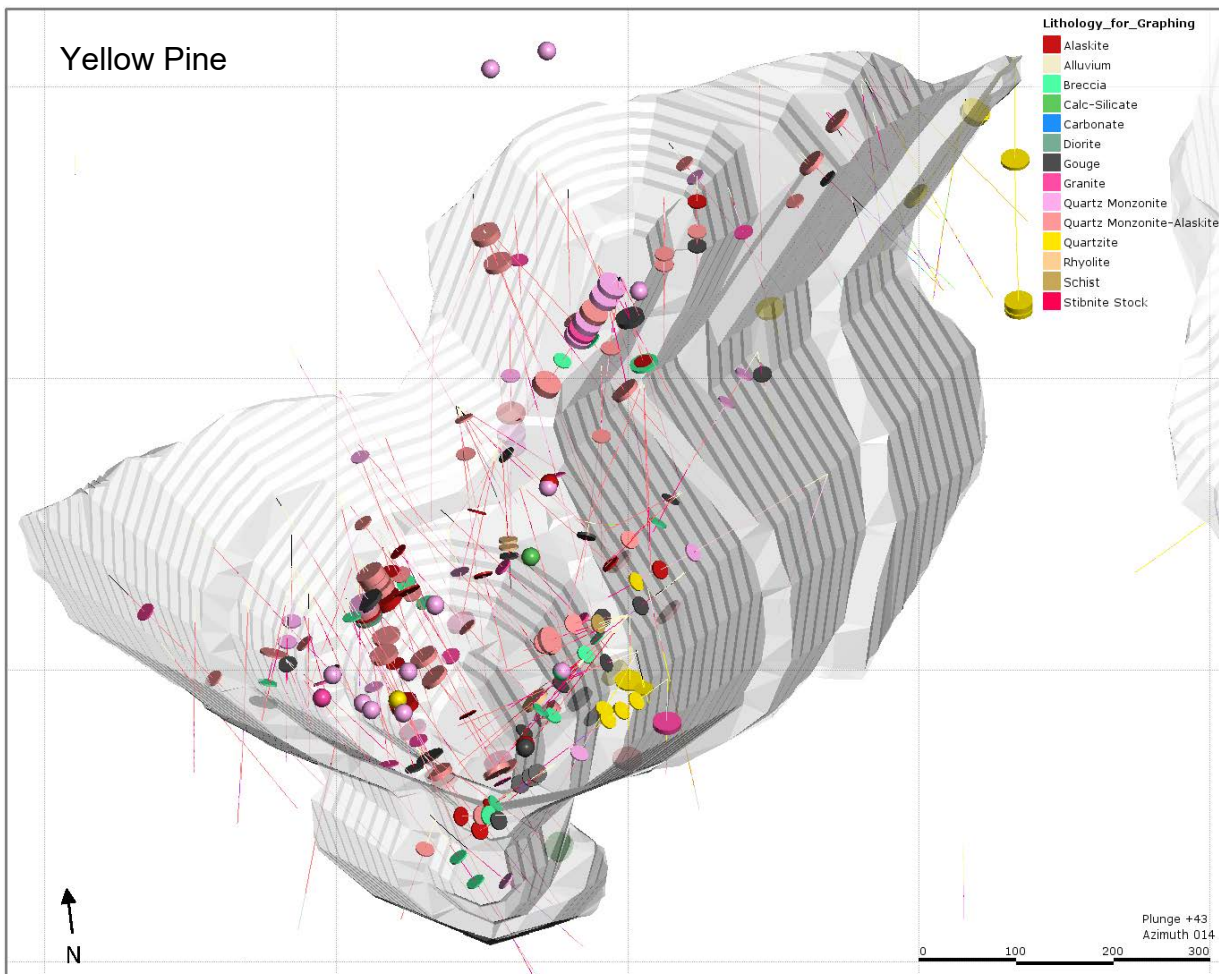
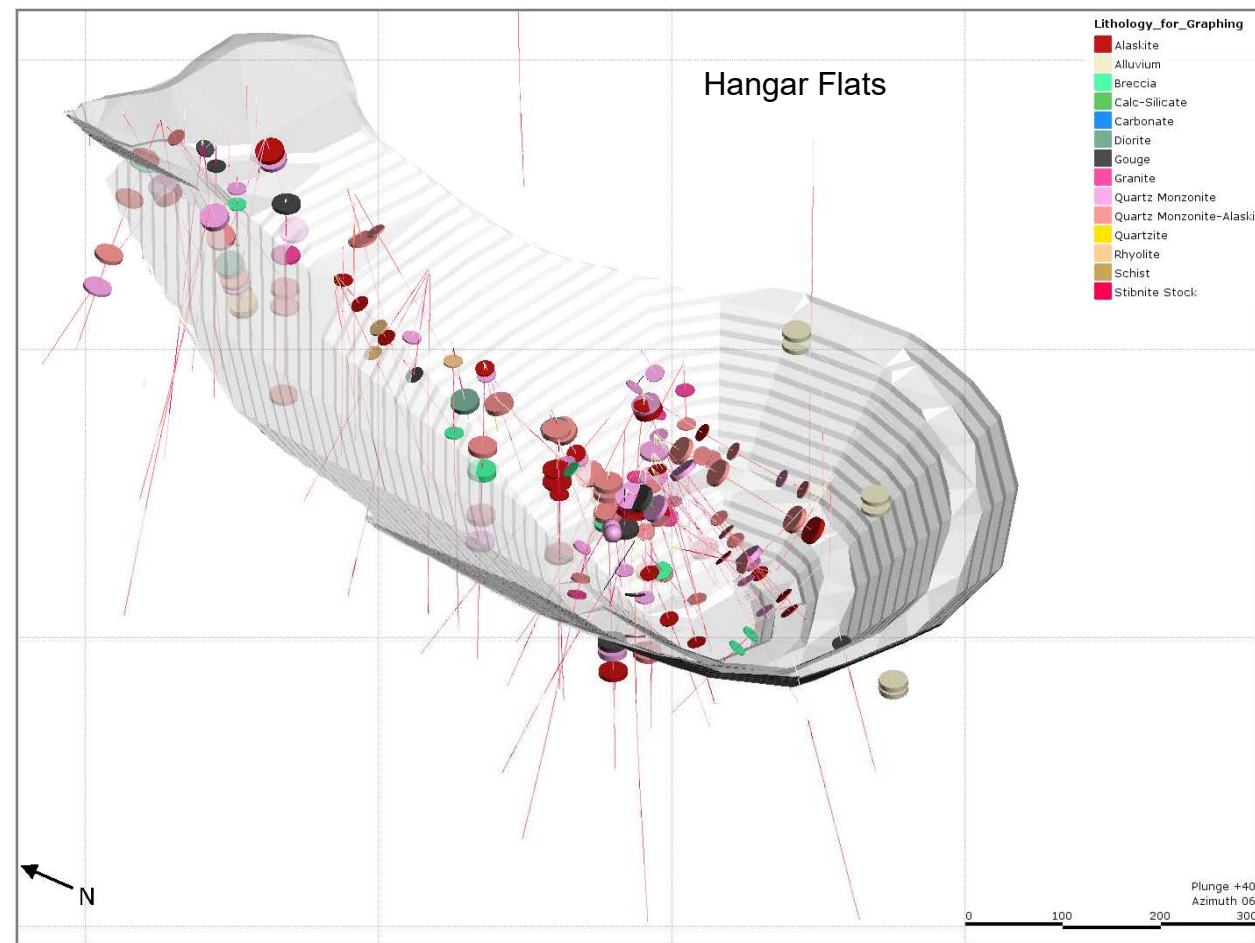
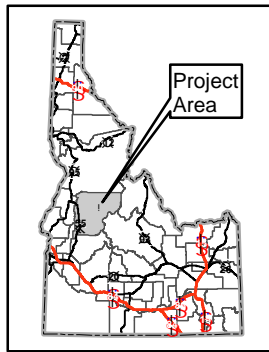
MWMP = Meteoric Water Mobility Procedure

na = not applicable; West End pit would not be backfilled

NAG = Net acid generation test

NP = Neutralization Potential

*Tailings samples were tested using a Modified Synthetic Precipitation Leaching Procedure (SPLP; EPA 1998)



**Figure 6-3
Geochemical Sample
Locations**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2017)



6.2.1.1 Multi-Element Analyses

In addition to the static and kinetic test work, multi-element analyses of exploration samples were available for approximately 46,000 exploration samples collected from drill holes. Multi-element analyses quantify the concentration of metals and analyte concentrations in whole rock samples and represent the relative masses of metals available for leaching from exposed mined materials. When compared to average crustal abundance of analytes (Mason 1966), the local lithologies exhibited enriched concentrations of antimony, arsenic, mercury, and sulfur (**Table 6-3**).

Table 6-3 Average Multi-Element Rock Composition

	Antimony (ppm)	Arsenic (ppm)	Mercury (ppm)	Sulfur (%)
Crustal Abundance	0.2	1.8	0.08	0.026
Yellow Pine Development Rock	62	1,300	0.48	0.56
Yellow Pine Ore	1,600	4,200	1.2	1.3
Hangar Flats Development Rock	260	1,200	1.6	0.35
Hangar Flats Ore	3,900	5,400	4.4	1.4
West End Development Rock	84	340	0.93	0.25
West End Ore	130	2,500	1.8	0.85

Source: SRK 2017

In addition to whole rock analyses, mineralogical analyses were performed on a subset of rock samples to examine the mineral phases present (SRK 2017). Arsenic and antimony-bearing sulfide minerals such as pyrite, arsenopyrite, and stibnite were detected amongst matrix silicate minerals (quartz, microcline, and albite) and carbonate minerals (ferroan dolomite, calcite, and siderite). Minor to major amounts of clay mineralization (illite, muscovite, chlorite, kaolinite, and biotite) were also observed.

6.2.1.2 Acid Base Accounting

Static ABA is an industry recognized method of assessing the potential for acid generation of sulfide-bearing rocks based on the acidification potential of the sulfide minerals and the neutralization potential of carbonates, aluminosilicates, and clays within the rock. The Modified Sobek Procedure (Sobek 1978) method was used, which includes both laboratory analysis and empirical calculations based on the acidification potential (AP) and the neutralizing potential (NP) (SRK 2017). The AP values are calculated based on sulfide sulfur concentrations in the rock and reported as calcium carbonate equivalents per 1,000 tons of rock. The NP values are determined using a modified Sobek protocol that includes digestion to expel carbon dioxide followed by back titration with sodium hydroxide to a pH of 8.3 and also is reported as calcium carbonate equivalents per 1,000 tons of rock. The difference ANP-AGP is the net neutralizing potential, or NNP. The ratio of NP/AP is the net potential ratio, or NPR. The NNP and NPR both characterize the potential for acid generation as a net potential or as a ratio of acid-neutralization to acid-generation, respectively. The ratio has become more favored for use by regulatory agencies because it provides a clearer description of relative quantities of acid producing and acid consuming constituents (MEND 1996).

Table 6-4 summarizes the ABA test results by lithology of mined material.

Table 6-4 Average ABA Test Results for Development Rock and Ore

Lithology	Type	N	Paste pH (s.u.)	NAG pH (s.u.) ¹	AGP (CaCO ₃ eq/t)	ANP (CaCO ₃ eq/t)	NNP (CaCO ₃ eq/t)	NPR
Alaskite	Development	31	8.6	7.7	8.1	27.5	19.4	14.0
	Ore	17	7.8	2.6	27.1	19.2	-8.0	1.25
Quartz Monzonite	Development	46	8.3	7.1	12.8	35.6	22.9	19.5
	Ore	23	6.4	4.9	20.4	11.6	-8.9	6.4
Granite	Development	19	8.7	6.4	10.3	28.6	18.3	10.4
	Ore	6	8.3	3.6	25.3	17.2	-8.1	1.0
Quartz Monzonite-Alaskite	Development	67	8.3	6.3	15.8	33.2	17.5	13.7
	Ore	27	8.0	3.4	33.9	21.1	-12.8	0.8
Diorite	Development	3	8.1	8.7	2.3	121	119	150
	Ore	1	7.7	9.6	9.1	91.5	82.4	10.1
Rhyolite	Development	10	8.4	7.6	1.8	23.0	21.2	65.2
Stibnite Stock	Development	3	7.0	5.3	5.4	11.5	6.2	4.4
Calc-silicate	Development	23	8.6	7.7	5.5	323	317	805
	Ore	8	8.1	8.9	32.6	210	177	93.8
Carbonate	Development	13	8.7	8.5	1.9	725	723	1926
Quartzite	Development	34	8.3	6.3	4.4	61.3	57.1	96.0
	Ore	3	8.6	6.6	7.8	41.4	33.6	6.4
Schist	Development	14	8.1	7.5	7.7	45.8	38.3	19.4
	Ore	6	8.4	-	30.9	135	104	7.0
Breccia	Development	15	8.1	8.1	20.6	58.6	38.0	18.8
	Ore	15	7.9	4.9	44.3	57.2	12.9	5.7
Gouge	Development	32	8.1	8.1	16.1	113	97.2	122
	Ore	7	8.2	6.2	35.4	36.4	1.0	1.1
Alluvium	Development	6	8.6	5.6	<0.3	12.2	12.2	40.6
Tailings	Processed Ore	5	8.7	7.5	6.5	113	106	26.7

Source: SRK 2017, 2021c

¹NAG testing conducted on a subset of samples where acid-generating potential was uncertain based on ABA analyses.

Bold font represents PAG material.

Siderite (iron carbonate) is a mineral reported in the project deposits. The presence of siderite can result in the overestimation of neutralization potential. Therefore, a subset of samples was submitted for the Siderite Correction Method analyses and those results indicated that the correction was not required for project lithologies.

The ABA analyses indicate that while detectable sulfides are present in all the development rock and ore lithologies (aside from the alluvium), most lithologies are not prone to acid-generation as observed in the paste pH results. Ore samples typically had higher acid-generating potentials than development rock samples due to their higher sulfide concentrations.

6.2.1.3 Net Acid Generation Analysis

Static NAG tests are conducted to determine the maximum potential for acid generation. The NAG test provides a direct empirical estimate of the overall sample reactivity, including any acid generated by semi-soluble sulfate minerals along with acid generation by sulfide minerals. In this regard, the NAG test differs from the Static ABA test and thus provides another measure of the potential for acid-generation by sulfide and sulfate bearing samples from materials in the SGP lithology.

The method used for NAG testing was that summarized by Stewart et al. (2006). This method involves intensive oxidation of the sample with hydrogen peroxide, which accelerates the oxidation of sulfide and dissolution of sulfate minerals. The leachate is then titrated with sodium hydroxide in two stages (pH 4.5 and pH 7.0) to determine the NAG value. The NAG values are calculated from an equation using the titration results.

NAG testing confirmed that ores from the alaskite, quartz monzonite, granite, quartz monzonite-alaskite, and breccia lithologies had the potential for acid-generation. However, while some individual development rock samples exhibited low potential for acid-generation, the development rock tested was non-acid-generating in aggregate (SRK 2021a).

6.2.1.4 Meteoric Water Mobility Procedure (MWMP) Results

The Meteoric Water Mobility Procedure (MWMP) test is used to evaluate the leachability of metals from mine material by a laboratory simulation of rainwater leaching in the environment. The MWMP is conducted according to standard test methods (ASTM E-2242-02 [ASTM 1996]) that involve a 24-hour single pass column leach using a ratio of 1:1 for distilled water: rock material. The resulting leachate is analyzed for metals and other analytes of interest. Because materials tested in the procedure must be crushed to a finer state than would occur in field-scale mined materials in order to accelerate reactions in the laboratory, the MWMP results provide a qualitative evaluation of potential leachability of material types. The MWMP test is best applied to oxidized materials as it does not account for changes in pH resulting from long-term oxidation reactions because it is a single pass test.

MWMP tests were run on samples collected from subsurface drill cores and on samples collected from weathered rock exposures on site (**Table 6-5**). Tests on core samples had circumneutral pH with low total dissolved solids (TDS) with concentrations below 280 mg/L. Effluent concentrations of aluminum, antimony, arsenic, and mercury frequently exceeded their respective most stringent water quality criteria while concentrations of other analytes were generally not detected at concentrations above their criteria (SRK 2017). Tests on weathered surface materials also had circumneutral pH with the exception of one sample of alaskite material that had an acidic pH of 3.8. Leached TDS concentrations from the weathered rock were generally higher than those from cores samples ranging between 77 mg/L and 630 mg/L for non-acidic leachate and 2,300 mg/L for the acidic alaskite sample. Like the tested cores samples, effluent concentrations of antimony, arsenic, and mercury were generally above criteria. However, aluminum concentrations were low or below reported detection limits except for the acid-generating sample. This suggests that the leachable mass of aluminum is exhausted more readily in exposed rock than the leachable masses of antimony, arsenic, and mercury.

Table 6-5 Average MWMP Results – Development Rock and Ore

Parameter	Units	Strictest Potentially Applicable Standard	Alaskite Core	Alaskite Surface	Quartz Monzonite Core	Quartz Monzonite Surface	Granite Core	Quartz Monzonite/Alaskite Core	Rhyolite Core	Calc-Silicate Core	Calc-Silicate Surface	Diorite Core	Quartzite Core	Quartzite Surface	Schist Core	Schist Surface
Samples			3	1	6	6	1	6	2	5	1	2	2	1	2	1
Alkalinity	mg/L CaCO ₃	>20	98	-	72	-	13	48	9	11	50	16	15	16	5	53
Aluminum	mg/L	0.05	0.047	20	0.054	2.7	<0.045	0.049	0.067	0.058	<0.045	0.070	0.069	<0.045	0.13	<0.045
Antimony	mg/L	0.0052	0.041	0.012	0.026	0.339	0.13	0.061	<0.0025	0.0035	0.005	0.039	0.0028	0.005	<0.0025	0.005
Arsenic	mg/L	0.01	0.25	0.2	0.37	0.91	2.6	0.49	0.0075	0.014	0.05	0.013	0.017	0.10	<0.01	0.02
Barium	mg/L	2	0.011	<0.01	<0.01	0.03	<0.01	0.011	<0.01	<0.01	<0.01	0.012	<0.01	<0.01	<0.03	<0.01
Beryllium	mg/L	-	<0.001	0.09	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.001
Bismuth	mg/L	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1
Boron	mg/L	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1
Cadmium	mg/L	0.00033	<0.001	0.002	<0.001	0.0004	<0.001	<0.001	<0.001	<0.001	<0.00015	<0.001	<0.001	<0.00015	<0.001	<0.00015
Calcium	mg/L	-	7	430	5	47	15	5	3	5	31	14	6	12	2	83
Chloride	mg/L	230	1	10	2	3	11	2	<1	2	<1	<1	3	<1	<1	<1
Chromium	mg/L	0.0106	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.015	<0.005
Cobalt	mg/L	-	<0.01	0.28	<0.01	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	0.002	<0.05	0.41	<0.05	0.032	<0.05	<0.05	<0.05	<0.05	<0.003	<0.05	<0.05	0.0042	<0.05	<0.003
Fluoride	mg/L	2	<0.1	1.2	<0.1	0.44	<0.1	0.1	<0.1	<0.1	0.15	0.12	<0.1	<0.1	<0.1	0.22
Iron	mg/L	0.3	<0.01	0.65	<0.01	3.01	<0.01	0.11	<0.01	<0.01	<0.01	0.03	<0.01	0.016	0.03	<0.01
Lead	mg/L	0.0009	<0.0025	0.002	<0.0025	0.001	<0.0025	<0.0025	<0.0025	<0.0025	<0.0007	<0.0025	<0.0025	<0.0007	<0.0025	<0.0007
Magnesium	mg/L	-	3	110	1	23	2	1	1	2	1	4	2	2	2	2
Manganese	mg/L	0.05	0.028	9.2	0.007	1.18	0.022	0.011	<0.005	0.008	<0.005	0.041	0.006	<0.005	0.015	<0.005
Mercury	mg/L	0.000012	<0.0002	<0.0001	0.00012	0.0003	0.00021	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00019	<0.0001	<0.0002	<0.0001
Molybdenum	mg/L	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.01
Nickel	mg/L	0.024	<0.01	0.93	<0.01	0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate	mg/L as N	-	<1	0.5	<1	1.52	<1	<1	<1	<1	2	<1	<1	6.3	<1	1.3
Nitrite	mg/L as N	-	0.028	0.12	0.029	0.09	0.027	0.029	0.027	<0.025	0.030	<0.025	0.032	0.030	<0.025	0.030
pH	s.u.	6.5 – 9.0	7.0	3.8	6.8	5.2	6.8	6.7	6.8	6.8	7.9	6.9	6.8	6.8	6.6	7.4
Phosphorus	mg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	1.5	<0.5
Potassium	mg/L	-	2	7	1	3	3	1	1	1	5	2	1	2	2	8
Selenium	mg/L	0.0031	<0.01	0.004	<0.01	0.003	<0.005	<0.01	<0.01	<0.01	<0.002	<0.005	<0.01	<0.002	<0.01	<0.002
Silver	mg/L	0.0007	<0.005	<0.0004	<0.005	<0.0004	<0.005	<0.005	<0.005	<0.005	<0.0004	<0.005	<0.005	<0.0004	<0.005	<0.0004
Sodium	mg/L	-	2	1	1	1	1	1	1	<0.5	<0.5	3	1	<0.5	2	2
Sulfate	mg/L	250	21	1800	6	243	18	6	<1	5	31	39	2	2	<1	160
Thallium	mg/L	0.000017	<0.005	<0.0004	<0.005	<0.0004	<0.002	<0.002	<0.005	<0.002	<0.0004	<0.001	<0.005	<0.0004	<0.002	<0.0004
TDS	mg/L	500	52	2300	37	341	64	36	50	47	110	97	39	80	23	300
Vanadium	mg/L	-	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.01
Zinc	mg/L	0.054	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.014	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Source: SRK 2021c

< denotes less than reported analytical detection limit

Table 6-5 continued Average MWMP Results – Development Rock and Ore

Parameter	Units	Strictest Potentially Applicable Standard	Breccia Core	Breccia Surface	Carbonate Core	Carbonate Surface	Gouge Core	Gouge Surface	Hangar Flats Alluvium	Bradley Dumps Alluvium	West Side East Fork SFSR Alluvium
Samples			1	1	2	1	1	1	6	2	4
Alkalinity	mg/L CaCO ₃	>20	32	19	14	52	14	45	30	7	5
Aluminum	mg/L	0.05	<0.045	<0.045	0.048	<0.045	0.076	<0.045	0.096	0.050	0.29
Antimony	mg/L	0.0052	0.45	0.53	0.013	0.018	0.014	0.26	0.033	0.0038	0.032
Arsenic	mg/L	0.01	0.35	2.20	0.16	0.032	0.022	0.08	0.67	0.03	0.003
Barium	mg/L	2	0.16	0.04	<0.01	<0.01	0.086	0.06	0.16	0.02	0.04
Beryllium	mg/L	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth	mg/L	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.04	<0.05
Boron	mg/L	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.15	<0.02	0.038
Cadmium	mg/L	0.00033	<0.001	<0.00015	<0.001	<0.00015	<0.001	0.00032	<0.00015	<0.00005	<0.00007
Calcium	mg/L	-	42	100	5	17	3	120	6	6	2
Chloride	mg/L	230	5	5	4	<1	<1	5	3	1	3
Chromium	mg/L	0.0106	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0125
Cobalt	mg/L	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.0125
Copper	mg/L	0.002	<0.05	0.011	<0.05	<0.003	<0.05	0.003	0.005	0.0009	<0.0125
Fluoride	mg/L	2	0.16	0.5	<0.1	0.12	<0.1	0.53	0.75	0.30	0.13
Iron	mg/L	0.3	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.81	0.06	0.18
Lead	mg/L	0.0009	<0.0025	<0.0007	<0.0025	<0.0007	<0.0025	<0.0007	0.0008	0.0006	0.00015
Magnesium	mg/L	-	1	31	3	5	1	39	1	1	<1
Manganese	mg/L	0.05	0.21	0.12	<0.005	<0.005	<0.005	0.016	0.034	<0.01	0.030
Mercury	mg/L	0.000012	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	<0.0001	0.00011	0.000024	<0.0002
Molybdenum	mg/L	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.048	<0.02	<0.025
Nickel	mg/L	0.024	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.008	0.011
Nitrate	mg/L as N	-	<1	35	<1	2	<1	1	<0.1	-	-
Nitrite	mg/L as N	-	0.029	0.12	0.028	0.040	<0.025	0.14	<0.05	-	-
pH	s.u.	6.5 – 9.0	7.2	7.0	7.0	7.4	6.8	7.4	7.5	6.6	6.3
Phosphorus	mg/L	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.15	0.25
Potassium	mg/L	-	6	29	1	2	2	22	1	1	4
Selenium	mg/L	0.0031	<0.01	<0.002	<0.01	<0.002	<0.01	<0.002	<0.002	<0.0001	0.0002
Silver	mg/L	0.0007	<0.005	<0.0004	<0.005	<0.001	<0.005	<0.0004	<0.0004	<0.0001	0.00018
Sodium	mg/L	-	8	1	<0.5	1	2	2	24	6	3
Sulfate	mg/L	250	150	290	5	5	1	400	26	20	1
Thallium	mg/L	0.000017	<0.002	<0.0004	<0.001	<0.0004	<0.005	<0.0004	<0.0005	<0.0001	<0.0001
TDS	mg/L	500	280	600	52	77	29	630	137	67	103
Vanadium	mg/L	-	0.022	<0.01	<0.01	<0.01	<0.01	0.013	<0.01	<0.01	<0.0125
Zinc	mg/L	0.054	<0.01	<0.01	<0.01	<0.01	0.035	<0.01	0.019	<0.02	<0.025

Source: SRK 2021c

< denotes less than reported analytical detection limit

Tailings Decant Solution Chemistry

Decant solution chemistry for five samples of synthetic tailings materials representative of the different ores that would be processed during the project lifetime yielded circum-neutral to alkaline pH values between 7.2 and 9.4 (**Table 6-6**). Several constituents in the decant solutions were present at concentrations above their most stringent potentially applicable criteria including antimony, arsenic, mercury, sulfate, and TDS (SRK 2021b). Residual cyanide in the tailings was measured in two of the five tests. Constituent concentrations from Yellow Pine pit and Hangar Flats pit decant solutions were generally higher than the concentrations in the West End pit decant solution, consistent with the lower total concentrations of these analytes in the West End pit ore based on whole rock analyses (**Table 6-3**).

Table 6-6 Tailings Decant Solution Chemistry (mg/L)

Parameter	Yellow Pine and Hangar Flats Tailings (SB100 Con 10 PP)	Late Yellow Pine Tailings (Con 5 combined tailings)	West End Sulfide Tailings (Con 11 combined tailings)	West End and Hangar Flats Tailings (Con 12 combined tailings)	West End Oxide Tailings WEV03	Weighted consolidation water chemistry ¹
Proportion - all Mine Years	32%	21%	11%	6%	30%	100%
Proportion - last 3 years of tailings production	0%	18%	12%	3%	67%	100%
pH	8.38	7.93	8.38	8.50	7.24	7.95
Alkalinity, CaCO ₃	170	130	210	190	130	155
Ag	0.015	0.00057	< 0.0020	< 0.0020	< 0.0008	0.0055
Al	< 0.45	< 0.45	< 0.45	< 0.45	< 0.25	-
As	6.50	11.0	11.0	12.0	0.042	6.35
B	< 1.00	< 1.00	< 1.00	< 1.00	< 0.50	-
Ba	< 0.10	0.15	< 0.10	< 0.10	< 0.10	0.11
Be	< 0.010	< 0.010	< 0.010	< 0.010	< 0.0050	-
Ca	470	580	560	470	200	422
Cd	0.00030	< 0.00015	< 0.00075	< 0.00075	0.0003	0.00034
Cl	< 100	13.0	< 100	< 100	20.0	57.5
Co	< 0.10	< 0.10	< 0.10	< 0.10	< 0.050	-
Cr	< 0.050	< 0.050	< 0.050	< 0.050	< 0.025	-
Cu	0.29	0.047	0.55	0.39	0.12	0.22
F	< 10.0	2.10	< 10.0	< 10.0	< 1.00	5.62
Fe	< 0.20	< 0.20	< 0.20	< 0.20	< 0.10	-
Hg	0.00096	0.00024	0.097	0.068	0.00015	0.015
K	210	66.0	71.0	80.0	67.0	113
Mg	430	120	370	330	31.0	232
Mn	0.11	0.84	0.18	0.18	0.14	0.29
Mo	< 0.20	0.20	< 0.20	< 0.20	0.15	0.18

Stibnite Gold Project, Water Quality Specialist Report

Parameter	Yellow Pine and Hangar Flats Tailings (SB100 Con 10 PP)	Late Yellow Pine Tailings (Con 5 combined tailings)	West End Sulfide Tailings (Con 11 combined tailings)	West End and Hangar Flats Tailings (Con 12 combined tailings)	West End Oxide Tailings WEV03	Weighted consolidation water chemistry¹
Na	5000	520	6800	5700	1300	3176
Ni	< 0.10	< 0.10	< 0.10	< 0.10	< 0.050	-
P	< 5.00	< 5.00	< 5.00	< 5.00	< 2.50	-
Pb	< 0.0014	< 0.0007	< 0.0035	< 0.0035	< 0.0014	-
Sb	0.13	0.16	5.60	4.00	0.085	0.96
Se	< 0.040	< 0.0040	< 0.040	< 0.040	< 0.0040	-
SO4	12000	2600	15000	13000	2400	7508
Tl	0.0044	0.00046	0.0046	0.0041	< 0.0008	0.0025
V	< 0.10	< 0.10	< 0.10	< 0.10	< 0.050	-
Zn	< 0.10	< 0.10	< 0.10	< 0.10	< 0.050	-
Total nitrogen, N	< 15.0	1.90	22.0	< 15.0	< 1.25	8.85
NO2 + NO3, N	N/A	N/A	N/A	N/A	N/A	N/A
Cyanide, total	0.11	0.033	0.090	0.17	0.19	0.12
Cyanide, WAD	0.059	0.015	0.011	0.023	0.16	0.073
TDS	15000	2743	20000	15000	3700	9544

All concentrations are for dissolved constituents unless otherwise noted.

'<' indicates value is below analytical detection limits; 'NA' indicates not analyzed.

¹ Weighted consolidation water chemistry is a weighted average of the five decant solution samples, with chemistry weighted according to the production of each tailings stream during the entire mine life. For parameters that are below detection for all five samples, the parameter was excluded from the weighted consolidation water chemistry. For parameters that have one or more value below detection, the detection limit was used in the calculation of the weighted consolidation water chemistry.

'-' Indicates parameter was below analytical detection limits in all samples and was not included in the model input.

Humidity Cell Test Results

The Phase 1 and Phase 2 HCT cells were operated for between 98 and 184 weeks to achieve stable effluent chemistry. The methodology for humidity cell testing calls for a test duration of 20 weeks. In practice, HCT cells are run until their effluent chemistries stabilize and the potential for acid-generation can be conclusively determined. The termination of each HCT test for the SGP was approved by the Forest Service once these conditions were met. Leachate from each of the HCTs was circum-neutral to moderately alkaline, with pH values ranging from 6.5 to 9.1. The effluent pH also was stable for each of the test cells, indicating that acid generation did not occur, or that the available neutralizing potential was sufficient to offset any acid generation. SRK (2017, 2021b, 2021c) also found that the consumption of neutralizing potential was slow in each of the HCT cells, with over 80 percent of the initial neutralizing potential remaining when the cells were terminated. This indicates that significant buffering capacity is still available and/or that acid generation is limited or occurs at a slow rate despite relatively high sulfide concentrations in the tested samples. These results are consistent with observations from the site. Historic waste rock and tailings have been left at the surface for decades (a duration more than 50 years longer than the proposed SGP mine life), with little evidence of acid rock drainage (SRK 2017).

Despite the finding of low acid generation potential, a few metals constituents still proved to be leachable from the HCTs under neutral to alkaline pH conditions (**Table 6-7**). A few constituents are mobile under these neutral to alkaline pH conditions, including aluminum, antimony, arsenic, manganese, and mercury, which were frequently leached at concentrations above the strictest potentially applicable surface water quality standard. In addition, sulfate, selenium, TDS, copper, cadmium, and zinc were occasionally elevated above the respective water quality criteria. Concentrations of beryllium, bismuth, boron, cadmium, chromium, cobalt, lead, lithium, molybdenum, nickel, selenium, silver, tin, titanium, and vanadium were at or below the strictest potentially applicable water quality criteria in the HCT leachates, indicating a low potential for leaching of these constituents (SRK 2020, 2021c).

Table 6-7 Summary of Humidity Cell Test

Lithology	Ending pH Range	Remnant Neutralizing Potential	Constituents with at least one analysis above the strictest potentially applicable water quality criteria	Description
Alaskite (3 tests)	7.2-8.0	>80%	alkalinity, aluminum, antimony, arsenic, copper, manganese, mercury, sulfate, thallium, and TDS	Effluent arsenic and antimony concentrations were above standards throughout the test with peak arsenic concentrations of 2.2 mg/L. Other exceedances occurred sparsely, typically in the during the first 28 weeks of the tests.
Quartz Monzonite / Alaskite (3 tests of composites from Hangar Flats and Yellow	6.7-8.0	>79%	alkalinity, aluminum, antimony, arsenic, copper, lead, manganese, mercury, and nickel	Effluent arsenic and antimony concentrations were above standards throughout the test with peak arsenic and antimony concentrations of 5.2 mg/L and 0.52 mg/L, respectively. Other exceedances occurred sparsely, typically in the during the first eight weeks of the tests.

Lithology	Ending pH Range	Remnant Neutralizing Potential	Constituents with at least one analysis above the strictest potentially applicable water quality criteria	Description
Pine rock types where alaskite occurs as dikes				
Quartz Monzonite (4 tests)	7.7-8.0	>91%	alkalinity, aluminum, antimony, arsenic, lead, manganese, mercury, and zinc	Effluent arsenic and antimony concentrations were above standards throughout the test with peak arsenic and antimony concentrations of 3.4 mg/L and 0.29 mg/L, respectively. Other exceedances occurred sparsely, typically in the during the first eight weeks of the tests.
Diorite (1 test)	8.3	95%	aluminum, antimony, manganese, and sulfate	Effluent antimony concentrations were above standards throughout the test. Other exceedances occurred sparsely, typically in the during the first five weeks of the test.
Quartzite (1 test)	8.7	>99%	aluminum, antimony, arsenic, copper, mercury, selenium, silver, and thallium	Effluent arsenic concentrations up to 0.2 mg/L were above its standard throughout the test. Antimony concentrations were above its standard for 100 weeks of testing before decreasing to levels below the standard. Other exceedances occurred sparsely, typically in the during the first four weeks of the test.
Rhyolite (1 test)	8.3	87%	aluminum, antimony, arsenic, fluoride, and mercury	Antimony concentrations were above its standard for 50 weeks of testing before decreasing to levels below the standard. Other exceedances occurred sparsely.
Calc-Silicate (2 tests)	7.7-8.0	>97%	alkalinity, aluminum, antimony, arsenic, copper, lead, manganese, mercury, selenium, sulfate, and TDS	Effluent arsenic and antimony concentrations were above standards throughout the test with peak arsenic and antimony concentrations of 1.9 mg/L and 0.15 mg/L, respectively. Other exceedances occurred sparsely.
Schist (2 tests)	7.8-8.2	>86%	alkalinity, aluminum, antimony, arsenic,	Effluent arsenic and antimony concentrations were above standards

Lithology	Ending pH Range	Remnant Neutralizing Potential	Constituents with at least one analysis above the strictest potentially applicable water quality criteria	Description
			copper, manganese, and mercury	throughout the test. Other exceedances occurred sparsely.
Carbonate (2 tests)	8.0-8.1	>99%	aluminum, antimony, arsenic, copper, lead, mercury, and nickel	Effluent antimony concentrations were above its standard throughout the test while one test exhibited sustained arsenic concentrations above its standard. Aluminum concentrations were observed above its standards in approximately 20% of the analytical results. Other exceedances occurred sparsely.
Gouge (1 test)	7.9	91%	alkalinity, aluminum, antimony, arsenic, cadmium, manganese, and mercury	Effluent arsenic and antimony concentrations were above standards throughout the test. Other exceedances occurred sparsely, typically in the during the first 28 weeks of the test. There were occasional detections of mineral acidity but these were <40% of effluent alkalinity concentrations.
Breccia (1 test)	8.0	90%	alkalinity, antimony, arsenic, manganese, mercury, and TDS	Effluent arsenic and antimony concentrations were above standards throughout the test. Other exceedances occurred sparsely, typically in the during the first week of the test.
Granite (1 test)	7.3	91%	alkalinity, aluminum, antimony, arsenic, manganese, and mercury	Effluent arsenic and antimony concentrations were above standards throughout the test. Other exceedances occurred sparsely, typically in the during the first 16 weeks of the test.

Humidity cell test analytical results were utilized in developing modeling source terms for the water chemistry predictions described in **Section 7.0**. In the development of source terms, the initial flushes from the humidity cell tests were not utilized (SRK 2018b) because the first flush chemistries would be indicative of material leaching during the mine operating period, when leachate would be collected as contact water for water treatment or would be expected to dissipate in the near-term due to dilution and/or solubility controls. For the principal constituents of interest, antimony and arsenic, humidity cell test concentrations from the first 12 weeks of testing were compared concentrations derived from the long-term testing. First flush antimony concentrations ranged between one half and twelve times the long-term antimony concentrations while first flush arsenic concentrations ranged between one half and five times the long-term arsenic concentrations. In aggregate, retaining first flush concentrations in the source term

calculations would result in higher predicted model concentrations. However, predicted antimony and arsenic concentrations are above the strictest potentially applied water quality standard regardless of assumptions applied to first flush HCT chemistry.

6.2.1.5 Potentially Acid-Generating (PAG) Material Threshold

The threshold developed to identify PAG material was established to be $NPR = 1.5$. This value falls between the MEND Prediction Manual for Drainage Chemistry from Sulfidic Geology Materials (MEND 2009) thresholds for PAG ($NPR < 1$) and non-PAG ($NPR > 2$). This value was verified through examination of the ABA, NAG, and humidity cell test data where samples with $NPR > 1.5$ did not yield acidic pH in their paste pH, NAG pH or humidity cell effluent. Further, none of the samples with $NPR < 1.5$ generated acidity when tested via kinetic tests. However, humidity cell tests of these materials also exhibited higher concentrations of calcium, magnesium, and sulfate in their effluent, suggesting that acid-generating and acid-neutralization reactions were occurring within the test sample. Therefore, the $NPR = 1.5$ threshold was selected to identify PAG material (SRK 2018b, Figure 3-5).

6.2.1.6 Summary

Development waste rock and materials exposed in pit walls are non-acid-generating but have the potential to leach some metals and metalloids at neutral pH conditions, particularly antimony, arsenic, and mercury at concentrations above their most stringent potentially applicable criteria. Metal leaching under neutral pH conditions is attributable to metal-bearing minerals within the samples tested. Most analyte concentrations leached from non-acid-generating materials do not persist past the initial flush of those materials. While concentrations of metalloid oxyanions (i.e., antimony and arsenic) are higher in the initial flush of some material samples, concentrations of arsenic and, to a lesser extent, antimony appear at more consistent levels over the duration of the test, often remaining above the strictest potentially applied water quality standards for the duration of testing due to geochemical equilibrium between the rock material the leaching solution. This is the same equilibrium that affects metalloid oxyanion concentrations in naturally occurring groundwater.

Prior to processing, ore materials may be acid-neutralizing or acid-generating based on their initial sulfide concentrations. When leached, ore samples have leaching characteristics similar to acid-neutralizing development rock except they yield higher concentrations of metalloid oxyanions, and sulfide. These higher leachate concentrations are attributable to the higher concentrations of these analytes in the ore zone. After processing, tailings materials generated from ores are acid-neutralizing but continue to leach antimony, arsenic, mercury, and sulfate at concentrations above the strictest potentially applied water quality standards.

6.3 Geochemical Influence of Historical Mining Wastes

Mining and mineral processing, primarily of gold, antimony, and tungsten, have occurred at and in the vicinity of the mine site intermittently since the early 1900s. Historical features at the mine property are shown on **Figure 6-4**. The types of waste generated by past mining activity include spent ore (i.e., material that has been leached or otherwise processed to recover metals) in the Spent Ore Disposal Area (SODA) and heap leach pads, tailings (i.e., Bradley tailings), and waste rock in the Bradley and West End dumps. These historical mining wastes have created geochemical and legacy impacts typical for this type of mining district that are part of the affected environment. The following sections describe the geochemical influence of the historical mining wastes on water quality.

Locally, concentrations of antimony, arsenic, mercury, and cyanide in surface water are potentially attributable to the geochemistry of historical mining wastes present at the mine site (URS, Inc. [URS]

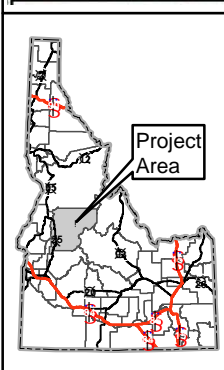
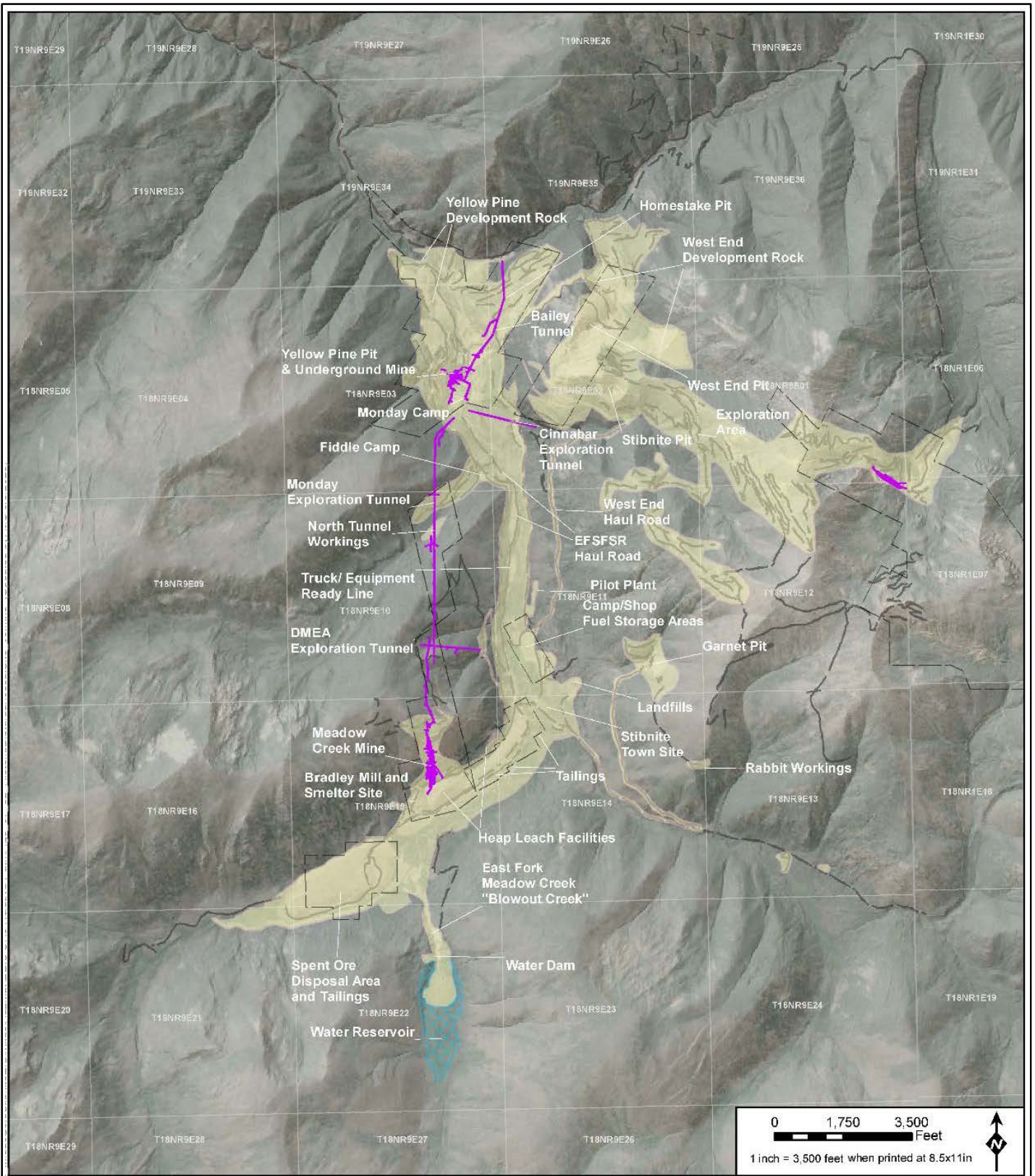
2000). In the late 1990s, concentrations of antimony and arsenic in Meadow Creek were highest immediately below the historical Bradley tailings deposits in the lower Meadow Creek valley, suggesting that the Bradley tailings provide a continuous source of antimony and arsenic in Meadow Creek (URS 2000). This conclusion also is supported by recent data collected during Perpetua's surface water quality baseline study, which indicate that dissolved antimony concentrations in Meadow Creek increase from an average of 0.32 µg/L at YP-T-33 above the SODA (**Figures 6-5 and 6-6**) to 6.1 µg/L at YP-T-27 below Keyway Marsh. Average dissolved arsenic concentrations also increase along this stretch from 1.2 µg/L at YP-T-33 to 34.8 µg/L at YP-T-27 (Midas Gold 2019). Farther downstream in Meadow Creek and the EFSRSR, average dissolved arsenic concentrations vary by location (**Figure 6-7**), but average dissolved antimony concentrations continue to increase, reaching a high of 31.0 µg/L at East Fork SFSR assessment node YP-SR-4 below the Yellow Pine pit area. The increase in dissolved antimony concentrations downstream of YP-T-27 occurs due to multiple factors including seeps and springs emanating from historical mining features; metals leached from spent ore and waste rock; in situ mineralization traversed by Meadow Creek (i.e., the Hangar Flats deposit), and other naturally occurring mineralization present throughout the East Fork SFSR drainage.

Mercury concentrations are not similarly elevated by the mine tailings and waste rock, despite periodically exceeding the strictest potentially applicable surface water quality standard (**Figure 6-8**). Although elevated concentrations of mercury are observed in Sugar Creek, these concentrations have a well-documented source in the upstream Cinnabar (mercury) Mine located outside the proposed SGP mine area. Sugar Creek also traverses known mineralized occurrences (based on outcrop) along its length.

Bradley tailings are present in both upper Meadow Creek valley and lower Meadow Creek valley, where the tailings have been covered with approximately 40 feet of waste rock, alluvial fill material, and neutralized "spent" ore material (URS 2000). Groundwater hydrology studies have indicated that, in 1997 and 1999, the alluvial aquifer water table elevation was high enough to contact the bottom of the historical Bradley tailings deposit throughout most of the Meadow Creek valley (URS 2000). Elevated concentrations of dissolved arsenic (over 12,000 µg/L) and dissolved antimony (over 1,000 µg/L) were associated with groundwater wells screened completely or partially in the Bradley tailings material, suggesting that the historical Bradley tailings currently present throughout the Meadow Creek valley have an adverse influence on groundwater quality within the mine site. A more recent study (Brown and Caldwell 2017) also found elevated arsenic and antimony concentrations in groundwater near the Bradley tailings and former leach pads, with concentrations higher in the alluvial aquifer than in bedrock. The water quality of nearby seeps associated with the Bradley tailings, SODA, and Keyway Dam also was elevated in metals, an indication that historical mining features are impacting the alluvial and bedrock aquifers.

In the East Fork SFSR valley below Meadow Creek, alluvial and bedrock water quality samples show multiple locations where arsenic and antimony are elevated above applicable groundwater quality standards. Arsenic concentrations tend to be higher in the bedrock aquifer than the alluvium. The higher concentrations of arsenic in bedrock groundwater where little mining activity has occurred may reflect naturally occurring arsenic sources derived from unmined mineralized zones (Brown and Caldwell 2017).

Historical mining activity at the mine site has contributed to the development of artificial groundwater seeps from tailings, waste rock piles, and adits. Many of these features have been present at the mine site for decades and have been sampled recently as part of baseline monitoring efforts. Natural springs and seeps also occur where bedrock faults and fractures intersect the ground surface outside the influence of tailings and historical mining features (**Figures 6-4 and 6-5**).



- LEGEND**
- Roads
 - Disturbance Areas
 - Underground Workings
 - Patented Claims

**Figure 6-4
Past Mining and Related
Activities in the
Stibnite Mining District**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (Midas Gold 2016b)

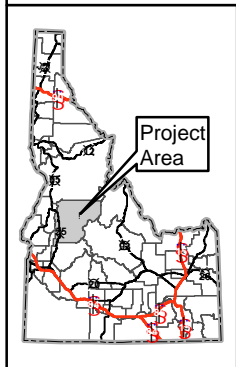
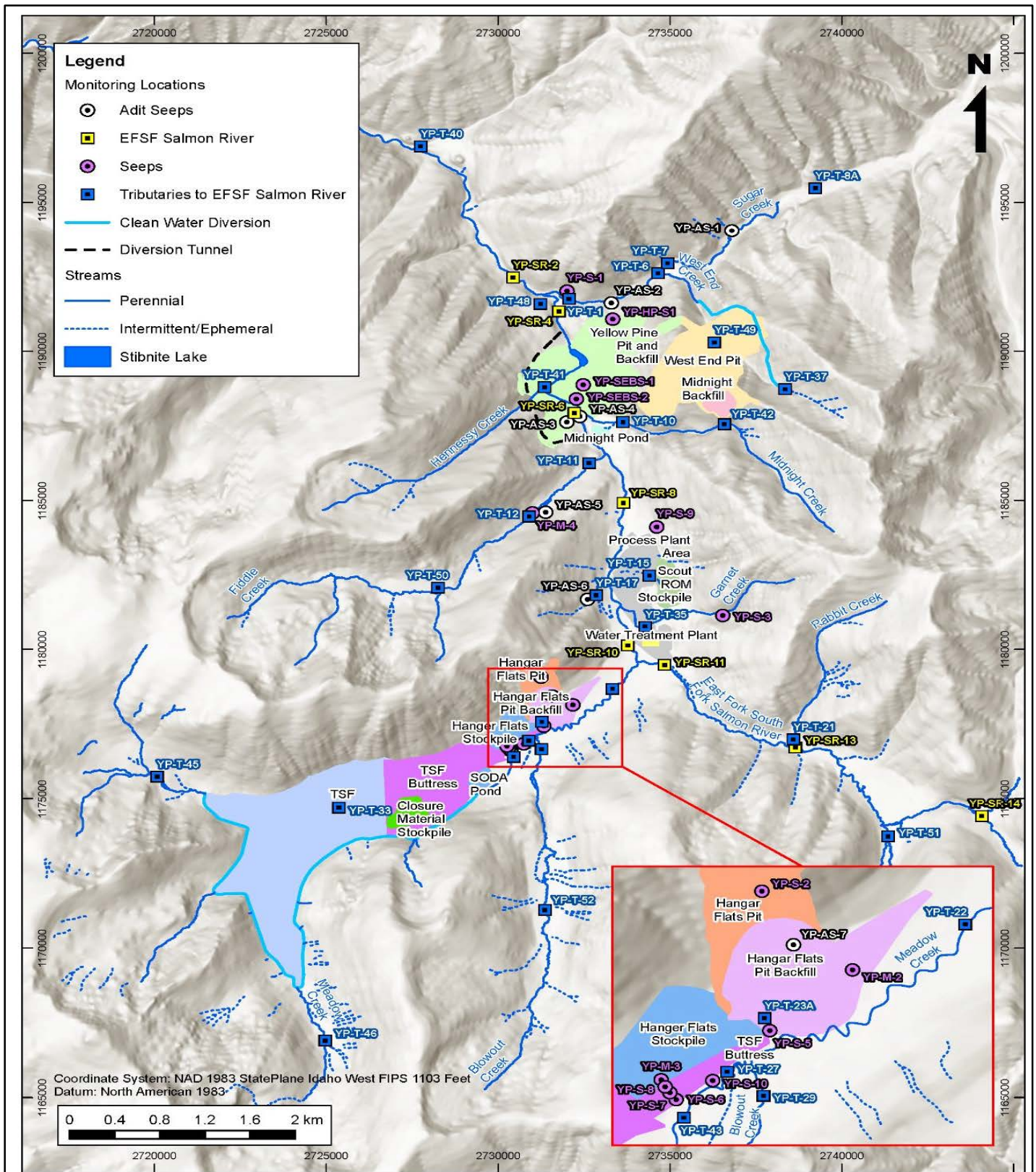
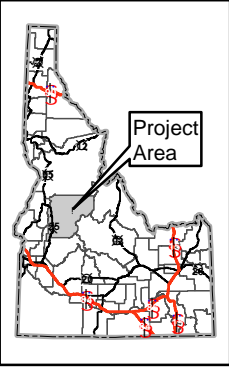
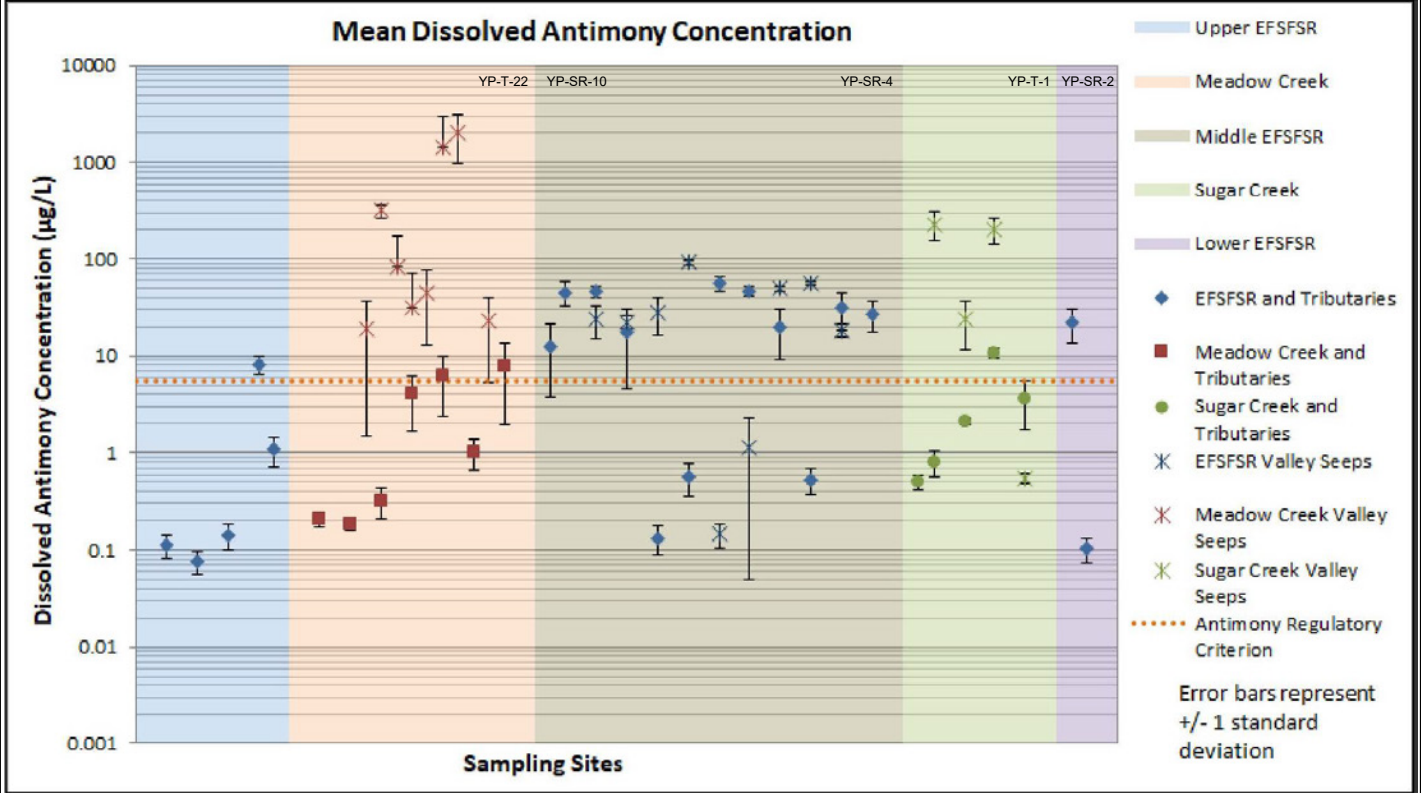


Figure 6-5
Surface Water Chemistry
Monitoring Locations

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



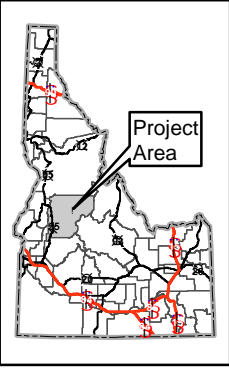
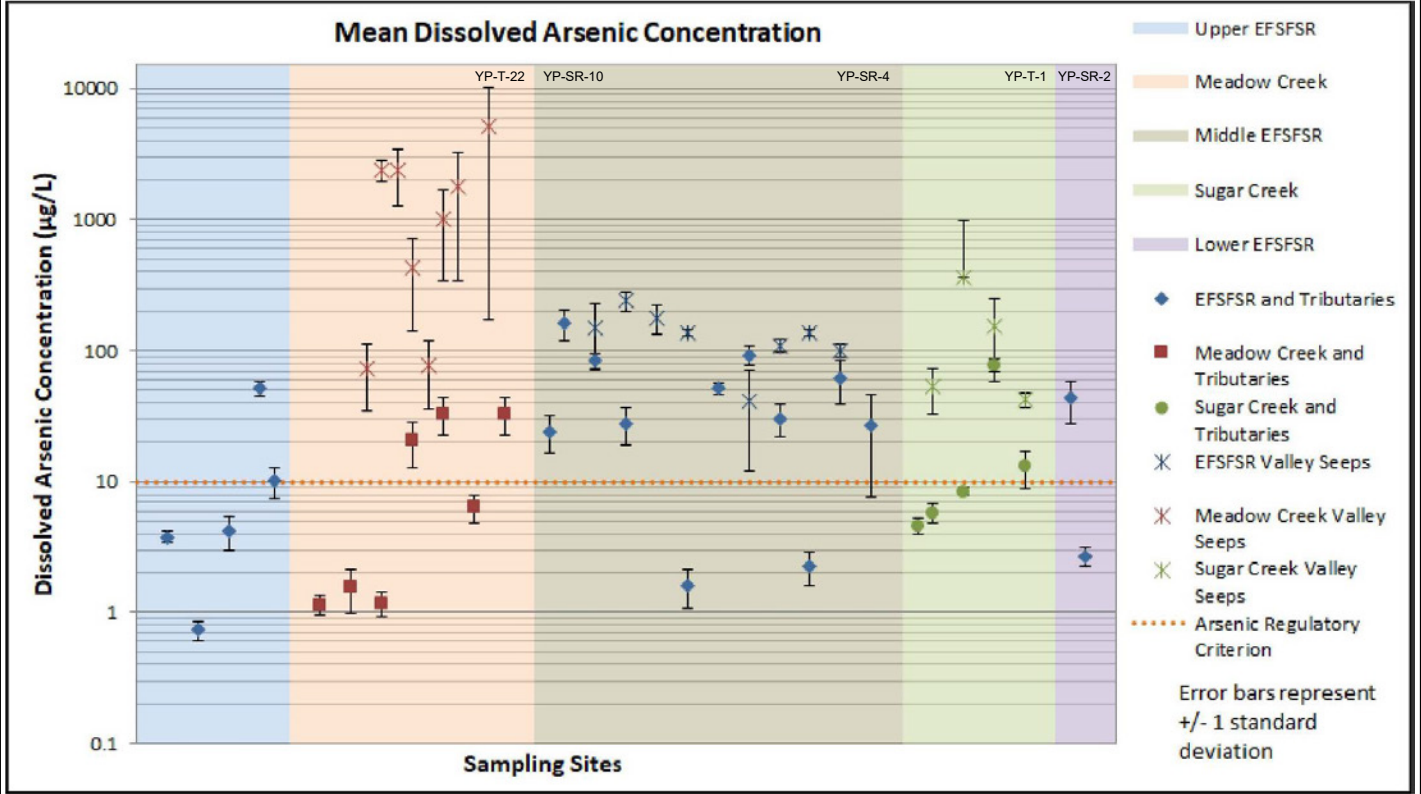


**Figure 6-6
Dissolved Antimony
Concentrations in Surface
Water**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (HDR 2021)





**Figure 6-7
Dissolved Arsenic
Concentrations in Surface
Water**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (HDR 2017)



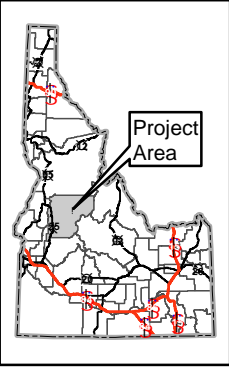
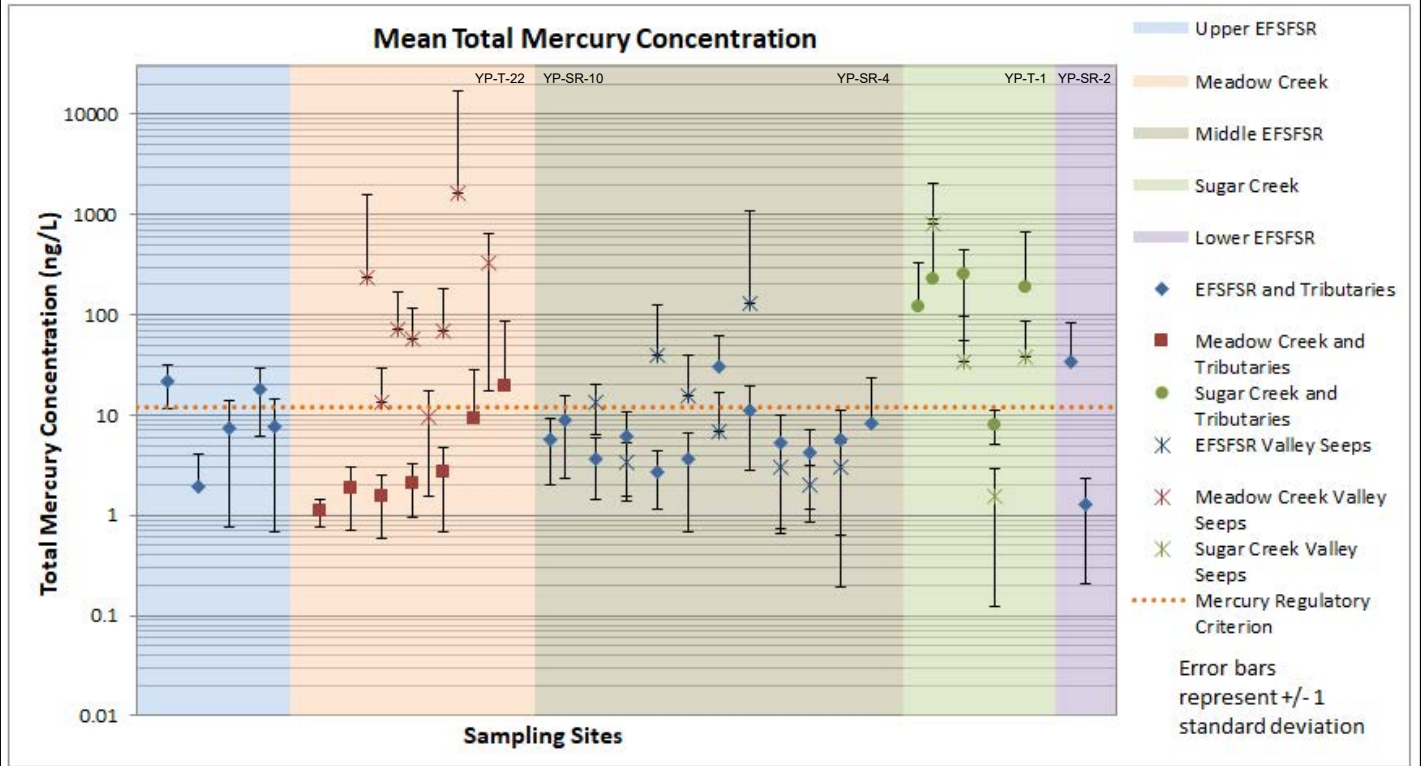


Figure 6-8
Total Mercury
Concentrations in Surface
Water

Stibnite Gold Project
Stibnite, ID

Data Sources: (HDR 2017)

Data from the mine spoil seeps have been compared to natural seeps. The results of this comparison indicate that at least some of the metals found in the mine spoil seeps are endemic to the region, particularly antimony and arsenic, which were found to exceed the applicable water quality criteria in the majority of natural seep sites sampled (HDR 2017).

The seeps and springs in the Bradley tailings-impacted areas of the Meadow Creek valley may transport dissolved constituents from groundwater to surface water. Sulfate levels in seeps and springs were variable and ranged from 4 to 136 mg/L, and pH values in the seep and spring water samples ranged from 6.3 to 8.1, indicating that acid rock drainage is not characteristic of the seeps and springs in the mine site area (URS 2000). Sulfate and pH concentrations in the mine site springs and seeps were similar during the Surface Water Quality Baseline Study, with median values of 42 mg/L for sulfate and 7.2 for pH (Brown and Caldwell 2017; HDR 2017).

Similarly, in the East Fork SFSR drainage, arsenic and antimony concentrations in seeps and springs are elevated below the Yellow Pine pit and Northwest Bradley waste rock dump, suggesting that these historical mine facilities are responsible for elevated concentrations of arsenic and antimony in discharging groundwater (URS 2000).

6.4 Surface Water

For a discussion of the mine site surface water hydrology and the sub-watersheds that comprise the analysis area, see the companion SGP Water Quantity Report (Forest Service 2022b).

6.4.1 Mine Site Area

This section focuses on quantifying the baseline water chemistry at the ten surface water assessment node sampling locations (**Figure 6-5**). The discussion of baseline chemistry is organized around the water quality indicators, which include pH, temperature, major cations and anions, TDS, metals, methylmercury, sediment content, and organic carbon. It should be noted that baseline water quality at the mine site is influenced by both natural mineralization and historical mining activity (Baldwin and Etheridge 2019). Locally, remnant features from historical mining include underground mine workings; multiple open pits; development rock dumps, piles, and tailings deposits; heap leach pads and spent heap leach ore piles; contaminated soils from the former mill and smelter sites; former surface water diversions, dams, townsites, and roads; and an abandoned water diversion tunnel (Midas Gold 2016). The geochemistry subsection describes the influence of historical mining wastes on surface water quality in the analysis area.

6.4.1.1 Major Ions, pH, and TDS

The average baseline major ion chemistry for the surface water assessment nodes is summarized in **Table 6-8**. The East Fork SFSR and Sugar Creek sampling locations each exhibit a calcium-magnesium-bicarbonate water type, meaning that calcium and magnesium are the dominant cations in solution, and bicarbonate is the dominant anion. The samples from Meadow Creek had on average a higher relative proportion of calcium and are therefore classified as calcium-bicarbonate water.

Average TDS concentrations also were consistent in the Meadow Creek and East Fork SFSR sampling locations. The average TDS ranged from 56 to 57 mg/L in the Meadow Creek samples and appears to increase downstream in the East Fork SFSR from about 53 mg/L in the farthest upstream reach (YP-SR-10) to 67 mg/L in the downstream reaches. It appears that despite the higher TDS load in Sugar Creek (116 mg/L), the creek does not appreciably contribute to TDS concentrations in the East Fork SFSR,

based on the similar average TDS concentrations obtained for the East Fork SFSR sampling points located just upstream (YP-SR-4) and downstream (YP-SR-2) of the Sugar Creek confluence.

Baseline samples from Fiddle Creek exhibited a slightly different water quality signature compared to the East Fork SFSR and Meadow Creek. Although Fiddle Creek is classified as a calcium- bicarbonate water, the creek has a lower proportion of magnesium and a higher proportion of sodium compared to the other monitoring locations. It also has a lower proportion of sulfate and higher proportion of bicarbonate. Some of these differences may be due to the relatively low average TDS concentration observed in Fiddle Creek during the baseline monitoring period (36 mg/L). The low sulfate and TDS concentrations also could point to a lack of mineralized deposits and historical mining-related impacts in the Fiddle Creek drainage, and different lithologies in the catchment area, specifically calcareous rock formations.

West End Creek stands out as having the most notably different major ion signature among the surface water assessment nodes (**Figure 6-9**). During the baseline period, West End Creek surface water exhibited a calcium-magnesium-bicarbonate-sulfate water type. With the exception of chloride and sodium, the West End Creek samples also had the highest major ion constituent concentrations among the surface water assessment nodes considered, with baseline sulfate and TDS concentrations averaging 57 and 209 mg/L, respectively. West End Creek sample point YP-T-6 is located downstream of both the upper and lower historical West End waste rock dumps; it is therefore possible that the water chemistry at this location has been influenced by the waste material, especially where the creek flows directly through historical development rock piles. Mapped metamorphic bedrock in the West End valley (including marble, quartzite, and schist) in contrast to granitic batholith rocks in the East Fork SFSR drainage also may affect the stream chemistry, as these rock types locally tend to produce higher TDS and alkalinity (SRK 2017).

Field-measured pH values for the surface water assessment nodes were generally in the range of 7 to 8 standard units. The highest average pH (8.4) was observed at West End Creek sample location YP-T-6. Elevated baseline pH measurements at this location are likely another indicator of the geochemical influence exerted by legacy waste rock material, natural mineralization, and the predominance of carbonate bedrock in the West End Creek drainage. Overall, the neutral to alkaline pH values observed in streams near the mine site show that the geochemistry of the natural mineralized deposits and the legacy mine materials is not conducive to acidic drainage.

Table 6-8 Average Major Ion Chemistry for Surface Water Assessment/Prediction Nodes (mg/L)

Sampling Point	Stream	No. Samples	pH	Hardness as CaCO ₃	Bicarbonate as CaCO ₃	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulfate	TDS	Water Type
YP-T-27	Meadow Creek	45	7.3	37.4	38.4	11.5	1.25	2.13	0.87	2.44	5.97	57	Calcium-bicarbonate
YP-T-22	Meadow Creek	45	7.4	37.5	39.5	11.3	1.00	2.18	0.84	2.42	5.16	56	Calcium-bicarbonate
YP-SR-10	East Fork SFSR	45	7.4	35.3	38.7	10.3	0.63	2.25	0.78	2.12	4.15	53	Calcium-magnesium-bicarbonate
YP-SR-8	East Fork SFSR	45	7.5	39.1	42.2	11.4	0.73	2.55	0.83	2.36	6.77	60	Calcium-magnesium-bicarbonate
YP-SR-6	East Fork SFSR	45	7.4	39.0	40.3	11.4	0.68	2.54	0.83	2.34	6.44	58	Calcium-magnesium-bicarbonate
YP-SR-4	East Fork SFSR	45	7.5	43.8	42.5	12.7	0.63	2.89	0.88	2.30	8.86	65	Calcium-magnesium-bicarbonate
YP-SR-2	East Fork SFSR	45	7.6	48.4	48.1	14.4	0.52	3.01	0.85	2.31	9.31	67	Calcium-magnesium-bicarbonate
YP-T-11	Fiddle Creek	45	7.2	17.3	24.9	5.66	<0.20	0.74	0.54	2.21	1.74	36	Calcium-bicarbonate
YP-T-6	West End Creek	45	8.4	179	120	43.1	<0.20	17.6	1.94	1.10	56.7	209	Calcium-magnesium-bicarbonate-sulfate
YP-T-1	Sugar Creek	46	7.7	54.2	56.1	16.5	<0.20	3.09	0.76	2.24	9.00	116	Calcium-magnesium-bicarbonate

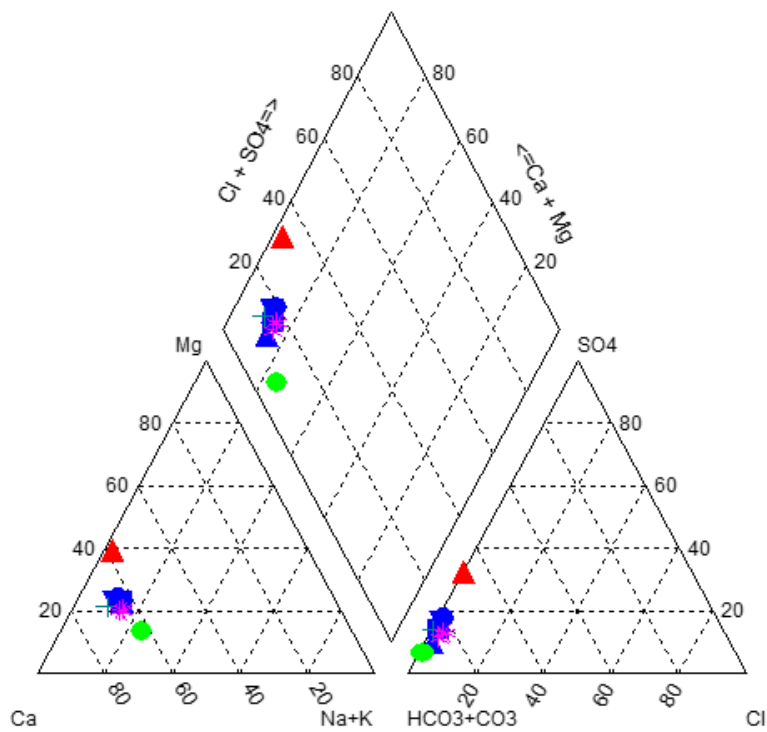
Source: Data obtained from Midas Gold 2019

CaCO₃ = calcium carbonate.

Units are milligrams per liter except for pH, which is in standard units.

Values in the table represent the average of sample results collected between 2012 and 2018.

Average concentrations for calcium, magnesium, potassium, and sodium represent the dissolved fraction.



- ▲ YP-T-6: West End Creek
- * YP-T-27: Meadow Creek
- * YP-T-22: Meadow Creek
- YP-T-11: Fiddle Creek
- + YP-T-1: Sugar Creek
- ◆ YP-SR-8: EFSFSR
- YP-SR-6: EFSFSR
- YP-SR-4: EFSFSR
- ▼ YP-SR-2: EFSFSR
- ▲ YP-SR-10: EFSFSR

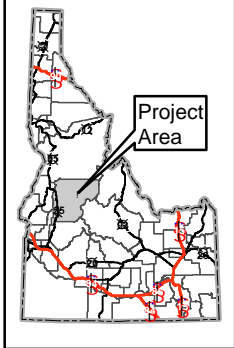


Figure 6-9
Tri-Linear Diagram of
Average Major Ion
Chemistry for Surface
Waters
Stibnite Gold Project
Stibnite, ID



6.4.1.2 Constituents of Interest

The Surface Water Quality Baseline Study (HDR 2017) showed that most metals analyzed in mine site streams occur at concentrations that are below the strictest potentially applicable surface water quality standard. Exceptions include antimony, arsenic, and mercury. Therefore, these metals were selected as constituents of interest because of their potential to exceed regulatory standards and impact water and biological resources. Naturally occurring mineralization and historical mining activity have resulted in surface water quality impairments for these constituents (Baldwin and Etheridge 2019). As such, recent surface water baseline studies conducted by both Perpetua and USGS have attempted to characterize antimony, arsenic, and mercury concentrations in the Headwaters East Fork SFSR and Sugar Creek sub-watersheds.

Monitoring by Baldwin and Etheridge (2019) found that antimony in mine site streams primarily occurs in the dissolved phase (primarily as Sb(V); Dovick et al. 2016) with lower antimony concentrations recorded during high flow periods, suggesting a groundwater source. **Figure 6-6** illustrates the range in dissolved antimony concentrations for stream monitoring locations sampled during the Surface Water Quality Baseline Study (HDR 2017). Data for seeps in the Meadow Creek, East Fork SFSR, and Sugar Creek valleys also are provided on the figure for comparison. The stream and seep sample locations are organized from upstream (left) to downstream (right) on the horizontal axis of the figure. Overall, the figure depicts increasing dissolved antimony concentrations from upstream to downstream across the mine site.

As shown on **Figure 6-6**, average dissolved antimony concentrations are generally below the strictest potentially applicable surface water quality standard in the upper East Fork SFSR drainage. In the Meadow Creek drainage, dissolved antimony concentrations are higher, possibly due to loading from seeps associated with historical mining materials and/or the presence of natural mineralization in adjacent bedrock. The seeps in Meadow Creek valley had the highest concentrations of dissolved antimony across the site. Below the confluence with Meadow Creek, both the stream and seep sample locations in the middle East Fork SFSR drainage generally exhibited dissolved antimony concentrations above the strictest potentially applicable surface water quality standard. Exceptions included tributary sample locations associated with Fiddle Creek (YP-T-11 and YP-T-12) and Hennessy Creek (YP-T-41). In the Sugar Creek valley, which flows across historically mined areas and natural mineralization, seep samples typically contained dissolved antimony above the strictest potentially applicable water quality standard, but the surface water dissolved antimony concentrations tended to be lower due to dilution of the seep inputs. Below the confluence with Sugar Creek, the average dissolved antimony concentration in the East Fork SFSR at monitoring location YP-SR-2 was found to be 21.9 micrograms per liter ($\mu\text{g/L}$), which is above the strictest potentially applicable surface water quality standard. This concentration is within the range of average antimony values documented at upstream East Fork SFSR assessment nodes YP-SR-4, YP-SR-6, YP-SR-8, and YP-SR-10 (**Table 6-9**).

Table 6-9 Average, Minimum, and Maximum Measured Constituent Concentrations for Surface Water Assessment Nodes

Sampling Point	Stream	Aluminum (µg/L) Standard: 50 µg/L			Ammonia, as Nitrogen (mg/L) Standard: 2.1 mg/L			Antimony (µg/L) Standard: 5.2 µg/L			Arsenic (µg/L) Standard: 10 µg/L			Cadmium (µg/L) Standard: 0.33 µg/L	Copper (µg/L) Standard: 2.4 µg/L			Cyanide, Total (mg/L) Standard: 0.039 mg/L	Iron (µg/L) Standard: 300 µg/L		
		Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Range	Avg	Min	Max	Range	Avg	Min	Max
YP-T-27	Meadow Creek	12.0	4.2	25.3	NC	<0.05	0.053	6.10	2.04	16.9	34.8	11.8	60.7	<0.02	0.3	0.1	0.7	<0.0027 - 0.0104	63.3	<20	124
YP-T-22	Meadow Creek	12.2	3.6	57.7	NC	<0.05	0.062	8.12	2.4	35.8	34.4	13.6	56.8	<0.02	0.3	0.1	1	<0.0027	69.9	21	149
YP-SR-10	East Fork SFSR	9.4	3.0	32.2	NC	<0.05	0.084	12.2	3.93	47.1	24.6	8.6	41.4	<0.02	0.2	<0.1	0.5	<0.0027	39.7	<20	84
YP-SR-8	East Fork SFSR	9.4	3.1	25.6	NC	<0.05	0.065	16.9	5.7	61.8	28.1	12.3	48.7	<0.02 - 0.27	0.3	0.1	2.6	<0.0027 - 0.0104	34.5	<20	59
YP-SR-6	East Fork SFSR	9.8	2.6	41	NC	<0.05	<0.05	19.3	6.37	46.9	30.6	12.6	41.4	<0.02	0.2	0.1	0.5	<0.0027	35.4	22	54
YP-SR-4	East Fork SFSR	11.9	2.5	33.9	NC	<0.05	0.191	31.0	10.4	62.0	63.0	20.8	105	<0.02	0.3	0.1	0.6	<0.0027	65.3	24	187
YP-SR-2	East Fork SFSR	14.0	2.2	111	NC	<0.05	0.09	21.9	6.79	38.2	44.5	14.7	71.1	<0.02 - 0.03	0.2	0.1	0.6	<0.0027	40.5	<21	160
YP-T-11	Fiddle Creek	15.7	4.4	45.6	NC	<0.05	<0.05	0.56	0.23	1.09	1.6	0.5	2.9	<0.02	0.2	<0.1	0.6	<0.0027 - 0.0128	22.3	<14	40.2
YP-T-6	West End Creek	4.0	3.0	6.3	NC	<0.05	<0.05	10.5	5.72	13.0	79.6	45	97.3	<0.02	0.3	<0.1	0.9	<0.0027	NC	<21	<21
YP-T-1	Sugar Creek	9.0	2.0	80.2	NC	<0.05	<0.05	3.41	1.25	8.64	13.0	6.5	22.4	<0.02 - 0.32	8.5	0.1	342	<0.0027	21.4	<21	39

Source: Data obtained from Midas Gold 2019

µg/L = micrograms per liter; mg/L = milligrams per liter; ng/L = nanograms per liter.

Avg/Min/Max = sample average, minimum, and maximum.

NC = average value not calculated due to the high percentage of non-detect results.

Values represent the dissolved fraction unless otherwise noted.

Values in the table represent the average of sample results collected between 2012 and 2018. A range of values is provided for sample populations where most results were non-detect.

Table 6-9 Continued Average, Minimum, and Maximum Measured Constituent Concentrations for Surface Water Assessment Nodes

Sampling Point	Stream	Lead (µg/L) Standard: 0.9 µg/L	Manganese (µg/L) Standard: 50 µg/L			Mercury, Total (ng/L)			Mercury, Dissolved (ng/L) Standard: 12 ng/L			Nitrate+Nitrite as Nitrogen (mg/L) Standard: 10 mg/L			Selenium (µg/L) Standard: 1.5 µg/L	Thallium (µg/L) Standard: 0.017 µg/L	Zinc (µg/L) Standard: 54 µg/L		
		Range	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Range	Range	Avg	Min	Max
YP-T-27	Meadow Creek	<0.04	25.6	4.5	42.7	2.5	<1	11.8	1.5	<0.6	3.8	NC	<0.05	0.091	<1	<0.04	1.7	<0.5	3.0
YP-T-22	Meadow Creek	<0.02 - 0.04	23.4	5.7	39.0	15.6	1.3	404	1.7	<0.7	4	NC	<0.05	0.095	<1	<0.04	1.7	<0.5	3.3
YP-SR-10	East Fork SFSR	<0.04 - 0.06	13.1	3.1	21	6.1	2.0	31.5	2.5	<1	5.7	NC	<0.05	0.063	<1	<0.04	1.4	<0.5	2.5
YP-SR-8	East Fork SFSR	<0.03 - 0.06	11.3	3.6	18.9	6.0	1.6	20.1	2.4	<0.5	5	NC	<0.05	0.080	<1	<0.02 - 0.04	1.5	<0.5	4.1
YP-SR-6	East Fork SFSR	<0.02 - 0.04	8.5	3.5	15.4	5.6	1.9	24.7	2.4	1.4	4.7	NC	<0.05	0.066	<1	<0.04	1.6	<0.5	3.0
YP-SR-4	East Fork SFSR	<0.02 - 0.04	20.4	5.7	50.6	5.9	<0.5	32.7	2.4	1.3	4.5	NC	<0.05	0.061	<1	<0.02 - 0.04	1.4	<0.5	2.4
YP-SR-2	East Fork SFSR	<0.02 - 0.04	11.1	3.4	25.8	41.3	3.1	395	5.7	1.7	29.5	NC	<0.05	0.114	<1	<0.02 - 0.04	1.3	<0.5	3.0
YP-T-11	Fiddle Creek	<0.02 - 0.03	1.1	<1.1	1.6	3.3	<1.0	13.9	1.8	<0.1	4.2	NC	<0.05	0.082	<1	<0.04	1.6	<0.5	2.0
YP-T-6	West End Creek	<0.02 - 0.06	NC	<1.1	<1.1	7.8	5.1	18.1	4.2	3.0	8.9	0.448	0.147	0.770	<1	<0.04	1.6	<0.6	2.5
YP-T-1	Sugar Creek	<0.02 - 19.3	1.3	<1.1	4	159	9.6	2380	7.4	1.6	14.2	NC	<0.05	0.061	<1	<0.02 - 0.04	6.8	<0.6	234

Source: Data obtained from Midas Gold 2019

µg/L = micrograms per liter; mg/L = milligrams per liter; ng/L = nanograms per liter.

Avg/Min/Max = sample average, minimum, and maximum.

NC = average value not calculated due to the high percentage of non-detect results.

Values represent the dissolved fraction unless otherwise noted.

Values in the table represent the average of sample results collected between 2012 and 2018. A range of values is provided for sample populations where most results were non-detect.

Up to 96 percent of arsenic in the mine site drainages occurs in the dissolved phase (primarily as As(V); Dovick et al. 2016), suggesting a groundwater source similar to antimony (Baldwin and Etheridge 2019). **Figure 6-7** illustrates the trend in dissolved arsenic concentrations for stream and seep monitoring locations sampled during the Surface Water Quality Baseline Study (HDR 2017). Overall, the dissolved arsenic concentration data exhibit an increasing concentration trend from upstream to downstream across the mine site.

As shown on **Figure 6-7**, average dissolved arsenic concentrations are generally below the strictest potentially applicable surface water quality standard in the upper East Fork SFSR drainage. In the Meadow Creek drainage, dissolved arsenic concentrations increase where Meadow Creek flows past the SODA and former smelter site, presumably due to inputs from seeps and groundwater influenced by historical mining materials. The seeps in Meadow Creek valley had the highest concentrations of dissolved arsenic across the site. Below the confluence with Meadow Creek, both the stream and seep sample locations in the middle East Fork SFSR drainage generally exhibited dissolved arsenic concentrations above the strictest potentially applicable surface water quality standard. Exceptions included tributary sample locations associated with Fiddle Creek (YP-T-11) and Hennessy Creek (YP-T-41), both of which drain less mineralized areas. In the Sugar Creek valley, the seep samples typically contained dissolved arsenic above the strictest potentially applicable surface water quality standard, but the dissolved arsenic concentrations in stream flow tended to be lower. Below the confluence with Sugar Creek, the average dissolved arsenic concentration in the East Fork SFSR at monitoring location YP-SR-2 was found to be 44.5 µg/L, which is above the strictest potentially applicable surface water quality standard.

Based on data from the 10 surface water assessment nodes (**Table 6-10**), the average dissolved mercury concentration measured in water samples during the baseline study was calculated to range from 4 to 56 percent of the average total mercury concentration (HDR 2017). This finding illustrates that, in contrast to antimony and arsenic, mercury primarily occurs in the particulate phase. The association with particles indicates that mercury is derived from erosion and/or re-suspension of surface material, rather than groundwater (Baldwin and Etheridge 2019).

Table 6-10 Comparison of Average Baseline Concentrations between Midas Gold and USGS Sample Locations

Sample Location	YP-SR-10 (East Fork SFSR below Meadow Creek)	EF2	% Difference	YP-SR-4 (East Fork SFSR above Sugar Creek)	EF3	% Difference	YP-T-1 (Sugar Creek)	Sugar Creek	% Difference
Data Source	Midas Gold*	USGS	---	Midas Gold*	USGS	---	Midas Gold*	USGS	---
No. Samples	45	28 - 40	---	45	31 - 39	---	46	35 - 38	---
Antimony, dissolved	12.2	10.9	11.3	31.0	27.9	10.5	3.41	3.35	1.8
Arsenic, dissolved	24.6	23.7	3.7	63.0	56.5	10.9	13.0	12.1	7.2
Mercury, dissolved	0.003	0.004	46.2	0.002	0.004	50.0	0.007	0.014	61.7
Mercury, total	0.006	0.017	95.7	0.006	0.008	28.6	0.159	1.19	152.9

Source: Baldwin and Etheridge 2019; Midas Gold 2019

* Document provided prior to February 2021 name change, therefore cited as Midas Gold.

USGS = United States Geological Survey.

Concentration units are in micrograms per liter.

Values in the table represent the average of sample results collected between 2012 and 2018 for Midas Gold samples, and between 2011 and 2017 for USGS samples.

The mean total mercury concentrations for streams and seeps across the mine site are presented on **Figure 6-8**. The figure shows that average total mercury concentrations were generally below the water quality standard at most of the surface water sampling locations. However, many of the seep sample locations in the Meadow Creek, Middle East Fork SFSR, and Sugar Creek drainages exceeded the regulatory criterion. In contrast, a similar plot for dissolved mercury (**Figure 6-10**) shows that the mean dissolved mercury concentration is below the Idaho surface water quality standard for total recoverable mercury at the majority of locations sampled, further supporting the notion that much of the mercury in the mine site area is associated with particulates.

The surface water assessment nodes YP-SR-10 (East Fork SFSR below Meadow Creek), YP-SR-4 (East Fork SFSR below Yellow Pine pit), and YP-T-1 (Sugar Creek above East Fork SFSR) closely correspond to sample locations EF2, EF3, and Sugar Creek monitored by the USGS (Baldwin and Etheridge 2019). A side-by-side comparison of average dissolved antimony, dissolved arsenic, and dissolved and total mercury concentrations for these sites is presented in **Table 6-10**. Data used to calculate the averages shown in the table were collected between 2011 and 2017 for the USGS locations and 2012 to 2018 for the Midas Gold sample points. Overall, the average dissolved antimony and arsenic concentrations from the two studies are in good agreement, with relative percent difference values between the means of 1.8 to 11.3 percent. Greater variability is evident between the dissolved and total mercury sample averages. The variability in mercury results may be attributable to the generally low concentration values, differing amounts of particulate matter in the total mercury samples, laboratory protocol differences between the two studies, or different runoff conditions in the non-overlapping years sampled (2011 and 2018).

Temporal variations in antimony, arsenic, and mercury concentrations can be correlated to daily mean stream flow (Baldwin and Etheridge 2019). A representative trend plot is provided on **Figure 6-11** for downstream sampling location YP-SR-4 on the East Fork SFSR below Yellow Pine pit. The figure shows that total and dissolved antimony and arsenic concentrations are inversely correlated to streamflow and tend to be higher during low flow conditions. These findings indicate that groundwater inflows are likely the main source contributing to surface water antimony and arsenic concentrations at the mine site because groundwater discharge to the streams is relatively greater during low flow. The highest concentrations of arsenic are consistently observed during the July to March low flow period. For antimony, the highest concentrations occur near the end of the low flow period as streamflow is beginning to rise during the first flush of spring snowmelt. This first flush phenomenon has been observed at other mine sites and is attributable to the dissolution of soluble salts and the flushing of water concentrated by evaporation (Nordstrom 2009).

Conversely, mercury concentrations are positively correlated to streamflow, with the highest total mercury concentrations occurring during high flow conditions. This relationship indicates that mercury is derived from erosion and resuspension of surface material, which occurs during high flows (Baldwin and Etheridge 2019).

Methylmercury (MeHg) also was sampled by HDR as part of the Surface Water Quality Baseline Study (HDR 2017), with additional sampling performed in 2017 and 2018 (Midas Gold 2019). Sample results for the 10 surface water assessment nodes are provided in **Table 6-11**. Each assessment node was sampled for MeHg 26 to 27 times between 2012 and 2018, with approximately 90 percent of the sample results reported below the method detection limit (<0.1 nanograms per liter [ng/L]). The range of observed MeHg values varied between a minimum of <0.1 ng/L (all sites) to a maximum of 0.64 ng/L (Sugar Creek). Mean MeHg values (calculated using the method detection limit for non-detect results) were at or just above the 0.1 ng/L detection limit.

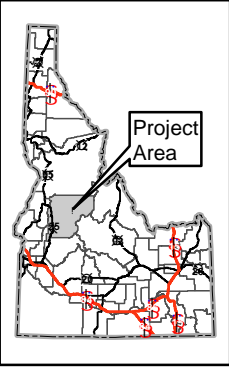
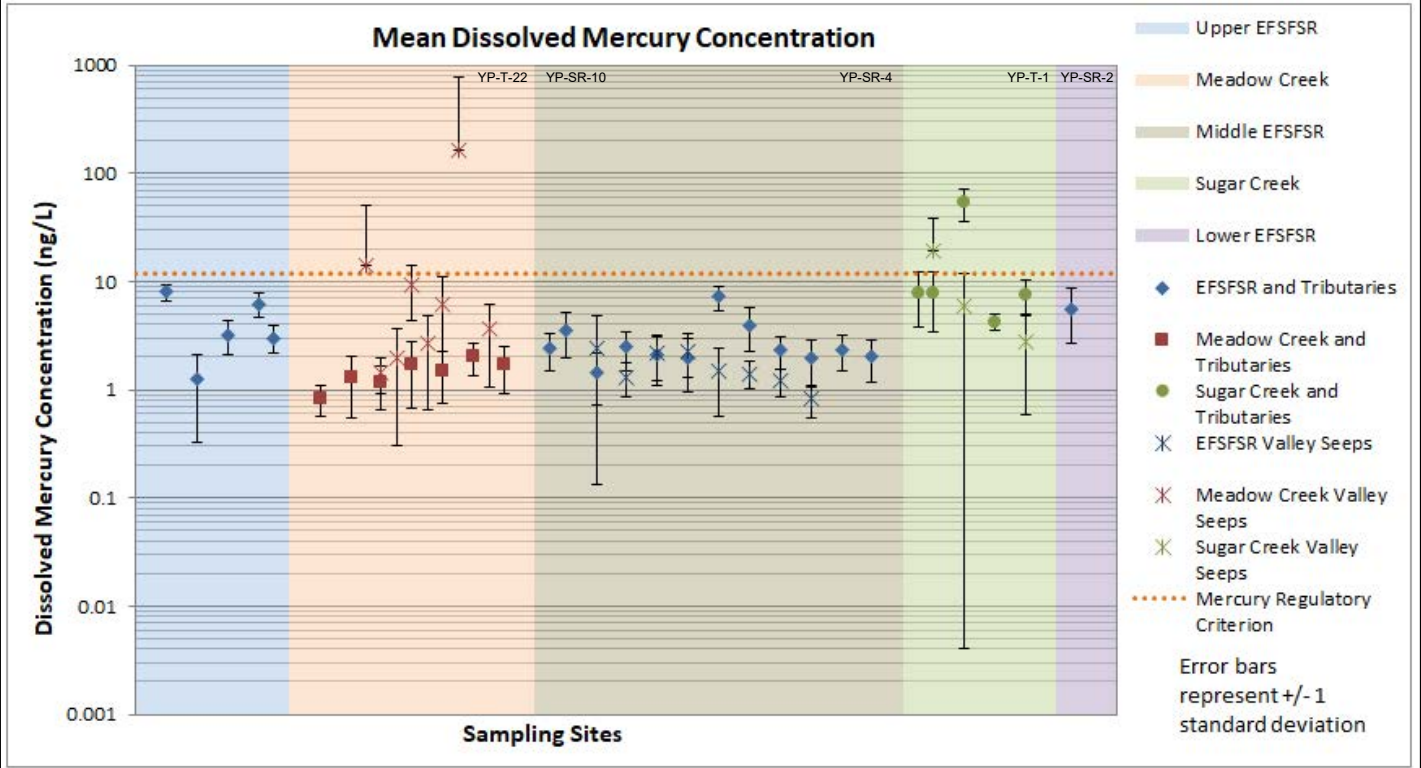


Figure 6-10
Dissolved Mercury
Concentrations in Surface
Water

Stibnite Gold Project
Stibnite, ID

Data Sources: (HDR 2017)



EFSFSR below Yellow Pine pit (YP-SR-4)

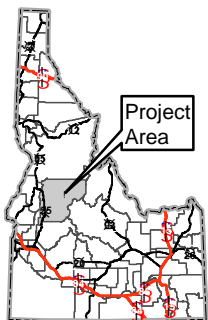
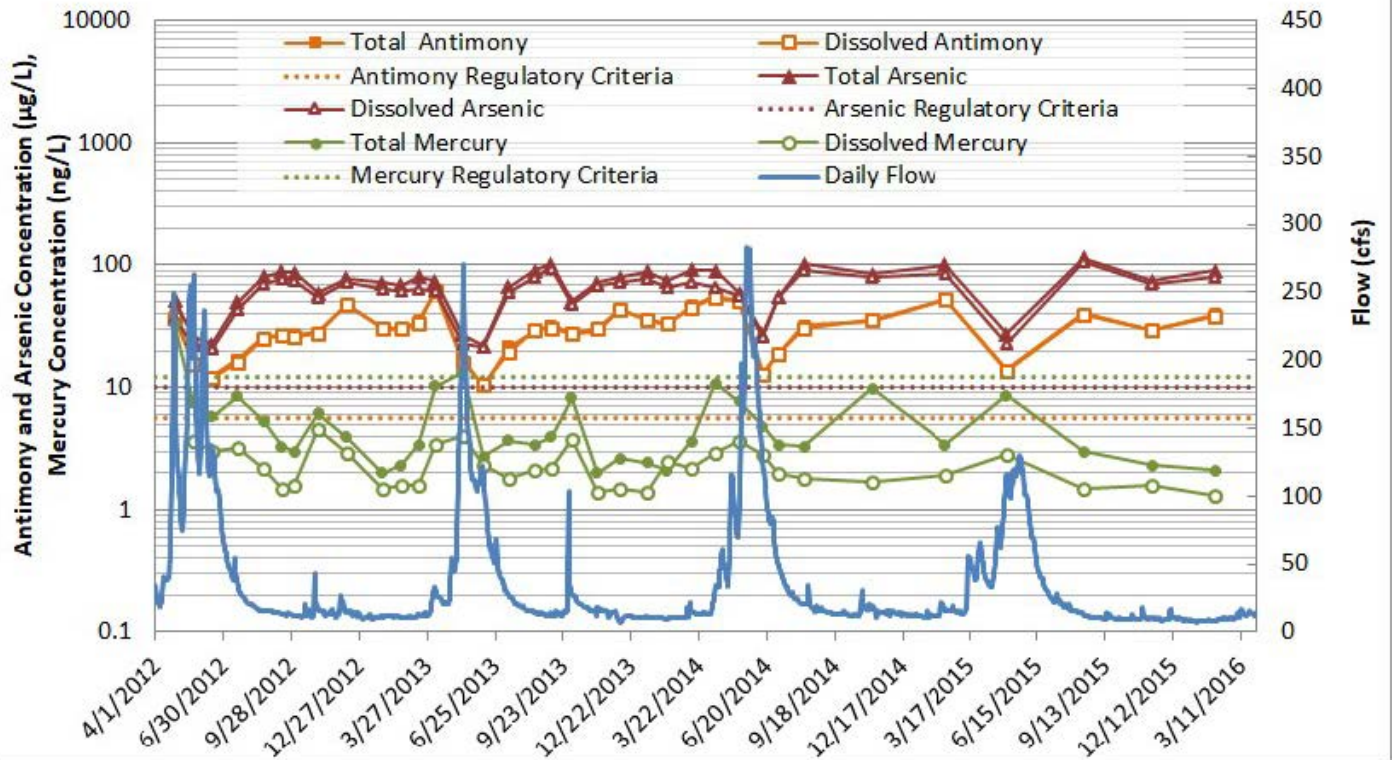


Figure 6-11
Average Daily Flow Rates Compared to Antimony, Arsenic, & Mercury Concentrations at a Surface Water Location Downstream of Historical Mine Activity (YP-SR-4)

Stibnite Gold Project
Stibnite, ID

Data Sources: (HDR 2017)



Table 6-11 Baseline Methylmercury Concentrations for Surface Water Assessment/Prediction Nodes

Sampling Point	Stream	No. Samples	Percent Non-Detects	Average MeHg (ng/L)	Min MeHg (ng/L)	Max MeHg (ng/L)
YP-T-27	Meadow Creek	26	96	<0.1	<0.1	0.13
YP-T-22	Meadow Creek	26	89	0.11	<0.1	0.18
YP-SR-10	East Fork SFSR	26	89	<0.1	<0.1	0.17
YP-SR-8	East Fork SFSR	26	100	<0.1	<0.1	<0.1
YP-SR-6	East Fork SFSR	26	92	<0.1	<0.1	0.20
YP-SR-4	East Fork SFSR	26	96	<0.1	<0.1	0.11
YP-SR-2	East Fork SFSR	26	81	<0.1	<0.1	0.15
YP-T-11	Fiddle Creek	26	89	0.11	<0.1	0.35
YP-T-6	West End Creek	27	96	<0.1	<0.1	<0.1
YP-T-1	Sugar Creek	27	67	0.14	<0.1	0.64

Source: Data obtained from Midas Gold 2019

Max = sample maximum.

MeHg = methylmercury.

Min = sample minimum.

ng/L = nanograms per liter.

Values in the table were compiled from sample results collected between 2012 and 2018.

To provide context for the mine site MeHg values, the baseline concentration ranges in **Table 6-11** were compared to summary statistics from a USGS study of MeHg in U.S. streams (USGS 2009). In this study, the USGS found no statistical difference in surface water MeHg concentrations between previously mined and unmined stream basins. Stream MeHg concentrations across all sites sampled during the study were found to range from <0.010 ng/L to 4.11 ng/L, with a mean concentration of 0.19 ng/L. In most cases, the maximum MeHg concentrations observed in the mine site assessment nodes were less than this nationwide average. Exceptions include the East Fork SFSR above the Yellow Pine area at YP-SR-6 (maximum concentration of 0.20 ng/L), Fiddle Creek (maximum concentration of 0.35 ng/L), and Sugar Creek (maximum concentration of 0.64 ng/L). However, even at Sugar Creek, which has a well-documented upstream source of mercury from the former Cinnabar Mine, MeHg was not detected in 67 percent of the samples collected. The range of results from the Surface Water Quality Baseline Study (HDR 2017) and subsequent sampling suggests that MeHg concentrations in SGP site streams are not appreciably different from those reported by the USGS nationwide study, and that historical mining activity in the analysis area has not increased MeHg concentrations above those observed at similar reference locations throughout the U.S.

This finding is important because MeHg is present at elevated concentrations in several mine site seeps, as summarized in **Table 6-12**. The calculated means for the seep samples range from <0.1 ng/L to 0.93 ng/L at Smelter Flats Seep (YP-S-5). Maximum MeHg values for the seeps also tend to be higher, reaching 6.6 ng/L at the Smelter Flats Seep (YP-S-5). Despite these relatively high concentrations, the mine site seeps do not appear to significantly influence surface water MeHg levels (e.g., loading), either due to the low seep flow rates compared to surface water flows.

Table 6-12 Methylmercury Concentrations at Seep Sampling Locations

Seep Location	Description	No. Samples	Percent Non-Detects	Mean MeHg (ng/L)	Max MeHg (ng/L)	MeHg Standard Deviation (ng/L)
YP-S-2	Fault seep above workings	7	14	0.18	0.35	0.09
YP-S-3	Garnet Pit Seep	20	85	<0.1	0.1	0.01
YP-S-5	Smelter Flats Seep	8	75	0.93	6.6	2.29
YP-S-6	Adjacent to Keyway Marsh	20	30	0.30	1.0	0.23
YP-S-7	East side of SODA berm, adjacent to large marsh east of SODA on Hangar Flats	23	57	0.16	0.6	0.13
YP-S-8	East side of SODA berm, adjacent to large marsh east of SODA on Hangar Flats	24	88	0.35	5.9	1.18
YP-S-10	Keyway Marsh outlet	25	80	0.11	0.2	0.03
YP-AS-7	The Meadow Creek Mine adit seep	15	33	0.32	1.6	0.41
YP-T-23a	Heap leach seep southwest corner of the heap leach pile on Hangar Flats	13	85	0.12	0.3	0.06

Source: Midas Gold 2019

MeHg = methylmercury

ng/L = nanograms per liter

SODA = spent heap leach ore disposal area

Other constituents that occur in mine development rock or may be used in ore processing include aluminum, cadmium, copper, total cyanide, iron, lead, manganese, selenium, thallium, and zinc. Baseline concentrations of these constituents measured at the 10 surface water assessment nodes are provided in **Table 6-9**. The table also includes the minimum and maximum concentrations measured for each constituent to illustrate the range of values reported during the baseline study.

6.4.1.3 Sediment

Wildfires in the past have burned much of the forested area at the SGP and vicinity, resulting in increased erosion from the burned areas. In addition, the failure of a water dam on East Fork Meadow Creek in 1965 caused extensive erosion both upstream and downstream of the former dam, with deposition of eroded sediment in Meadow Creek and transport of this sediment into the East Fork SFSR continuing to occur.

The ongoing erosion and sediment transport affect the turbidity and TSS content of surface water. The dynamics and relationships between turbidity and TSS are functions of watershed-specific factors; but in general, the more TSS in the water, the murkier it seems and the higher the turbidity. **Table 6-13** and **Table 6-14** provide the TSS (in mg/L) and turbidity (in Nephelometric Turbidity Units), respectively, for the 10 surface water assessment nodes. As shown in the tables, while concentrations of TSS and turbidity are typically low during some months under existing conditions, seasonal variations occur, and concentrations reach moderate to high levels during high flow periods.

An overview of sediment transport at the mine site also is provided in Etheridge (2015). This study found that much of the sediment entering the East Fork SFSR was derived from Sugar Creek, Meadow Creek, and East Fork Meadow Creek (i.e., Blowout Creek). The Meadow Creek reach contributes more sediment than Sugar Creek, but most of the sediment load discharged from the Meadow Creek reach is deposited in the Yellow Pine pit lake (Etheridge 2015). Load modeling by Etheridge (2015) also showed that about 90 percent of coarse-grained sediment derived from upgradient is deposited in the Yellow Pine pit, but over 80 percent of the fine-grained sediment (<0.0625 millimeter in diameter) entering the pit lake passes through and is transported downstream. Thus, the Yellow Pine pit is an effective sediment trap for coarse-grained particles but does not have a long enough residence time to deposit the majority of the fine-grained sediment load.

Table 6-13 Summary of Baseline Total Suspended Solids for Surface Water Assessment/Prediction Nodes (Total Suspended Solids (mg/L))

Assessment Node	YP-T-27 Meadow Creek (n=35)			YP-T-22 Meadow Creek (n=35)			YP-SR-10 East Fork SFSR below Meadow Creek (n=35)			YP-SR-8 East Fork SFSR above Fiddle Creek (n=35)			YP-T-11 Fiddle Creek (n=35)			YP-SR-6 East Fork SFSR above Yellow Pine Pit (n=35)			YP-T-6 West End Creek (n=34)			YP-T-1 Sugar Creek (n=35)			YP-SR-4 East Fork SFSR above Sugar Creek (n=35)			YP-SR-2 East Fork SFSR below Sugar Creek (n=35)		
	Min	Average	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
January	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-
February	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
March	-	5	-	-	6.5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-
April	5	5.167	5.5	5	9.167	17.5	5	8.333	13.5	5	7.5	9.5	5	5	5	5	5.5	6	-	5	-	5	6.5	9.5	5	7.833	13.5	5	5.5	6.5
May	5	6.5	8	8	27.38	73.5	5	8.25	16	5	9.875	24.5	5	12.25	34	5	7.875	13.5	5	5.25	6	5	17.62	33.5	5	5.5	7	5	6.875	10
June	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
July	5	5	5	5	5	5	5	5.667	7	5	5.833	7.5	5	5	5	5	6	8	5	15.5	36.5	5	5	5	5	6.833	10.5	5	5	5
August	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	11.25	30	5	5	5	5	5	5
September	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-
October	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-
November	5	5	5	5	5	5	5	5	5	5	6.25	10	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
December	-	5	-	-	17.75	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-	-	5	-

Source: HDR 2017

Where sample number is <3, only average values are reported.

- = No monitoring data available

Max = maximum; mg/L = milligrams per liter; Min = minimum

Table 6-14 Summary of Baseline Turbidity for Surface Water Assessment/Prediction Nodes (Turbidity (NTU))

Assessment Node	YP-T-27 Meadow Creek (n=35)			YP-T-22 Meadow Creek (n=35)			YP-SR-10 East Fork SFSR below Meadow Creek (n=35)			YP-SR-8 East Fork SFSR above Fiddle Creek (n=35)			YP-T-11 Fiddle Creek (n=35)			YP-SR-6 East Fork SFSR above Yellow Pine Pit (n=35)			YP-T-6 West End Creek (n=34)			YP-T-1 Sugar Creek (n=35)			YP-SR-4 East Fork SFSR above Sugar Creek (n=35)			YP-SR-2 East Fork SFSR below Sugar Creek (n=35)		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
January	-	3.6	-	-	6.65	-	-	2.8	-	-	2.55	-	-	3.1	-	-	3.3	-	-	4.1	-	-	3.15	-	-	3.1	-	-	2.2	-
February	0	1.3	2.8	0.5	2.275	3.1	0	1.4	2.3	0	0.925	2.1	0	1.85	4.2	0	2.925	8.1	2.7	5.875	13	0	1.925	5.6	0	2.85	5.9	0	1.7	3.1
March	-	2.85	-	-	4.9	-	-	2.2	-	-	2.2	-	-	2.25	-	-	2.35	-	-	2.15	-	-	2.6	-	-	2.6	-	-	2.95	-
April	1.6	4.6	9	2.8	10.9	25	2.1	8.9	18	3.5	7.367	11	3	6.867	12	4.4	13.73	30	-	1.7	-	4.3	10.1	19	6.1	18.17	41	5.1	15.37	27
May	2.8	4.25	5.5	4.9	23.88	70	2.6	5.875	8.2	3	5.95	8.7	3.8	6.45	13.1	4	16.58	50	1.7	4.325	5.5	4.7	14.92	22	5.4	9.1	16	2.9	6.4	10
June	1.1	5.033	12	1.7	4.4	8.8	0.4	1.633	2.5	1.2	3.2	6.2	0.1	2.2	4	0.4	3.4	5.6	1.3	2.033	3.2	1.3	2.133	2.9	0.6	2.467	3.6	2.4	3.067	4
July	0	1.133	1.8	0	1.167	2.1	0.5	1.9	2.8	0.5	1.967	2.7	0.8	1.633	2.5	2.1	2.967	3.9	1.1	3.233	6.5	1.4	2	2.8	1.9	10.4	27	0.3	2.633	6.4
August	0	1.275	3.3	0	1.375	2.6	0	0.925	2.1	0.4	1.2	2.6	0.4	1.325	1.7	0.5	1.225	2.3	0.3	1.575	2.3	0	0.65	2.6	1.1	1.7	2.6	0.1	0.875	1.9
September	-	1.55	-	-	1.25	-	-	1.85	-	-	1.95	-	-	1.25	-	-	3.05	-	-	1.75	-	-	0.75	-	-	2.45	-	-	1.95	-
October	-	2.2	-	-	2.35	-	-	3.2	-	-	2.05	-	-	1.3	-	-	1.9	-	-	6.95	-	2.2	-	-	-	2.85	-	-	2.15	-
November	1.2	2.275	3.1	1.3	2.75	5.3	0.6	1.85	3.1	0.6	2.775	5.5	1.5	1.95	3.2	1.7	3.45	4.6	2.1	2.625	3.2	0.4	1.45	2.4	2	3.575	5.6	0.3	2.525	4.6
December	-	3.05	-	-	8.65	-	-	2.5	-	-	2.85	-	-	2.6	-	-	3.5	-	-	3.65	-	3.3	-	-	-	3.7	-	-	2.7	-

Source: HDR 2017

NTU = Nephelometric Turbidity Units.

Where sample number is <3, only average values are reported.

- = No monitoring data available

Max = maximum; Min = minimum

6.4.1.4 Organic Carbon

No samples were analyzed for organic carbon during the Surface Water Quality Baseline Study (HDR 2017). However, a previous study by Holloway et al. (2017) found relatively low dissolved organic carbon concentrations (1.1 to 1.7 mg/L) in the East Fork SFSR, Meadow Creek, and Sugar Creek. The dissolved organic carbon concentrations in a watershed can be correlated to vegetation density, vegetation type, and soil composition, with higher vegetation densities and organic-rich soils resulting in higher levels of organic carbon (Camino-Serrano et al. 2014; Larsen et al. 2011; Mzobe et al. 2018). Thus, dissolved organic carbon concentrations are expected to be low in the SGP drainage area containing poorly developed mineral soils and sparse vegetation.

6.4.1.5 Temperature

Stream temperature criteria have been established for chinook salmon, steelhead, and bull trout in the Payette National Forest Land and Resource Management Plan as amended (Forest Service 2003). IDEQ also has published thermal criteria for salmonid species that vary based on the aquatic life classification of a water body (e.g., warm water aquatic life, cold water aquatic life, salmonid spawning, etc.) (IDEQ 2019). The IDEQ standards include requirements for Maximum Daily Maximum Temperature, Maximum Weekly Maximum Temperature, and Maximum Daily Average Temperature.

Establishing existing surface water temperature conditions at the SGP was important to provide a baseline dataset for comparing future temperature changes caused by the action alternatives. Two methods for establishing baseline temperatures were used: monthly grab samples and 15-minute temperature measurements. Temperature ranges from both datasets are discussed below; however, the 15-minute temperature measurements are believed to provide a more accurate representation of diurnal temperature variability for comparison to thermal criteria.

A summary of monthly grab sampling temperature statistics is provided in **Table 6-15** for the surface water assessment nodes. The data and statistics shown in the table were compiled from the Surface Water Quality Baseline Study (HDR 2017). A review of the monthly temperature statistics indicates that summer monthly stream temperatures are typically highest in July and August, with July temperatures ranging from a low of 6.8 degrees Celsius (approximately 44 degrees Fahrenheit) at West End Creek (YP-T-6) to a high of 17.8 degrees Celsius (approximately 64 degrees Fahrenheit) at the East Fork SFSR above Yellow Pine pit (YP-SR-6). Average monthly fall temperatures are highest in September, ranging from 6.7 degrees Celsius (approximately 44 degrees Fahrenheit) at West End Creek (YP-T-6) to 12.7 degrees Celsius (approximately 55 degrees Fahrenheit) at Meadow Creek near the SODA (YP-T-22).

For comparison to the monthly statistics, a graphical depiction of 15-minute temperature measurements is provided for the two-week periods centered on August 1 (**Figure 6-12**) and September 21 (**Figure 6-13**). These dates approximately coincide with the average timing of maximum summer and fall stream temperatures in the SGP area.

Table 6-15 Summary of Average, Minimum, and Maximum Monthly Grab Sample Water Temperatures for the Surface Water Assessment Nodes (Temperature (°C))

Assessment Node	YP-T-27 Meadow Creek (n=35)			YP-T-22 Meadow Creek (n=35)			YP-SR-10 East Fork SFSR below Meadow Creek (n=35)			YP-SR-8 East Fork SFSR above Fiddle Creek (n=35)			YP-T-11 Fiddle Creek (n=35)			YP-SR-6 East Fork SFSR above Yellow Pine Pit (n=35)			YP-T-6 West End Creek (n=34)			YP-T-1 Sugar Creek (n=35)			YP-SR-4 East Fork SFSR above Sugar Creek (n=35)			YP-SR-2 East Fork SFSR below Sugar Creek (n=35)		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
January	-	0.45	-	-	0.35	-	-	0.8	-	-	1.1	-	-	0.45	-	-	1.05	-	-	1.85	-	-	0.45	-	-	0.95	-	-	0.75	-
February	0.1	0.425	1.1	0	0.825	2.8	0.1	0.25	0.5	0	0.475	1.3	0	0.4	0.9	0	0.375	0.6	2.1	2.775	3.2	0.2	0.875	1.8	0.3	0.7	1.6	0.1	0.475	1.2
March	-	0.25	-	-	1.4	-	-	2.15	-	-	1.95	-	-	0.75	-	-	0.25	-	-	2.7	-	-	1.15	-	-	1.9	-	-	1.6	-
April	1.5	1.567	1.7	1.9	2.467	2.9	1.1	2.967	5.2	0.5	2.767	4.7	1.9	1.933	2	2.2	2.533	2.7	-	2.75	-	2.5	3.367	4.3	2.8	3	3.2	3.3	3.833	4.3
May	4	5.525	6.4	4.7	6.7	7.5	2.8	4.125	6.7	3.2	5.775	10.3	2.4	3.25	4.3	3.9	4.95	6.3	4.9	5.175	5.8	4.8	6.225	8.6	4.5	4.8	5.2	5.1	6.15	6.8
June	6.2	7.767	9	6.5	7.4	9	7.2	8.2	9	7.5	8.833	10.7	4.1	6.667	9.4	4.8	8	11.7	5.4	7.033	7.9	5.5	8.7	10.6	5.5	7.933	10.3	5.4	8.933	11.2
July	10	12.37	14.5	13.5	15.6	16.8	8	11.53	13.7	8.6	12.87	16.2	9.2	10.53	11.9	8	11.87	17.8	6.8	8.367	10.2	11.1	13.1	14.6	12.7	15.03	16.8	10.8	13.63	17.4
August	9.2	13.45	16.4	13.3	16.27	17.4	9.5	12.88	15.8	7	8.325	10.2	8	9.75	11	7.9	9.4	12.5	6.7	7.425	7.8	11.3	12.52	13.8	12.5	13.58	14.5	11.5	13.58	15.1
September	-	10.3	-	-	12.65	-	-	12	-	-	10.8	-	-	9.05	-	-	7.8	-	-	6.65	-	-	8.9	-	-	11.1	-	-	11.4	-
October	-	6.1	-	-	7.8	-	-	3.8	-	-	3.15	-	-	3.6	-	-	4.05	-	-	3.75	-	-	2.4	-	-	7	-	-	6.6	-
November	0	1.925	4.7	0	2.575	4.6	0.1	1.8	4.3	0	1.975	4.6	0	2.075	4.4	0.6	1.825	3.8	3	4.15	5	0.3	2.4	3.9	0.8	2.55	4.2	1	2.725	4.1
December	-	0.7	-	-	0.05	-	-	0.4	-	-	0.25	-	-	0.8	-	-	0.15	-	-	1.45	-	-	0.1	-	-	0.35	-	-	0.1	-

Source: HDR 2017

Where sample number is < 3, only average values are reported.

- = No monitoring data available

°C = degrees Celsius

Max = maximum

Min = minimum

The 15-minute temperature data used in the water quality evaluation spans a period of record extending from 2012 through 2017. During this timeframe, 2016 was found to be the year with the warmest summer stream temperatures (**Figure 6-12**). The maximum summer temperatures in 2016 occurred on July 29, slightly before the average date of August 1. Observed conditions during the weekly periods immediately before and after July 29, 2016, therefore represent the period of low-flow, maximum, weekly summer temperatures. The range of observed temperatures across the mine site during this two-week period in 2016 was 7.2 to 19.6 degrees Celsius (approximately 45 to 67 degrees Fahrenheit) (Brown and Caldwell 2018b).

During the fall period, maximum stream temperatures were observed two years earlier in 2014 (**Figure 6-13**). The maximum daily fall temperature in 2014 occurred on September 24, slightly after the average date of September 21. Observed conditions during the weekly period immediately before and after September 24, 2014, therefore represent the period of low-flow, maximum weekly fall temperatures. The range of observed temperatures during this fall period was 6.6 to 15.7 degrees Celsius (approximately 44 to 60 degrees Fahrenheit) (Brown and Caldwell 2018b).

Overall, these weekly summer and fall values offer a better representation of the low flow, maximum seasonal temperatures than the monthly data, and therefore provide a better baseline for comparison to thermal criteria and future predicted temperature increases.

6.4.1.6 Impaired Waterbodies

The federal CWA requires states to prepare a report listing the current condition of all state waters and identifying streams that are impaired because they do not meet their designated beneficial uses. IDEQ's 2018/2020 Integrated Report (IDEQ 2020a) provides the Section 305(b) list (condition of state waters) and the Section 303(d) list of impaired waters in the State of Idaho. Stream segments identified on the Section 303(d) list are classified as Category 5 waters, defined as waters that do not meet applicable water quality standards for one or more beneficial uses due to one or more pollutants.

Based on data from the 2016 Integrated Report, all inventoried waterbodies at the mine site are classified as Category 5 impaired waters except for West End Creek (which is a Category 2 stream that fully supports its designated uses). A summary of the current designated beneficial uses and causes of impairment for the impaired waterbodies at the mine site is provided in **Table 6-16**. The causes for listing are associated with arsenic, with the East Fork SFSR also being listed for antimony (downstream of Meadow Creek), and Sugar Creek also being listed for mercury. The listed constituents are similar to the constituents of interest identified in the Surface Water Quality Baseline Study (HDR 2017).

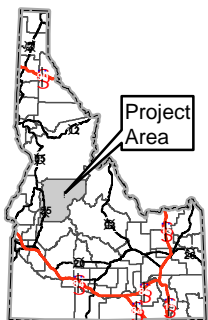
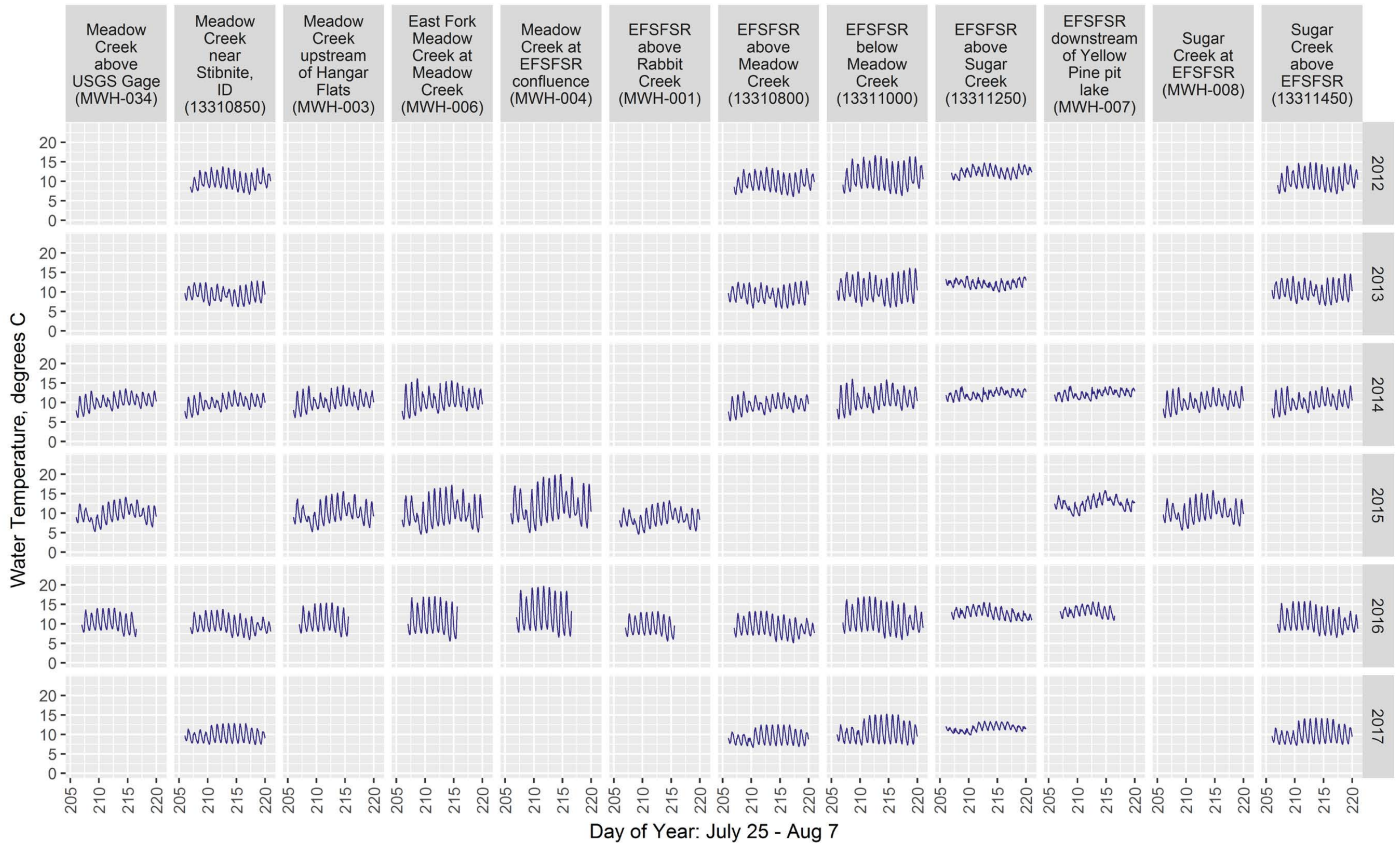


Figure 6-12
Summer Surface Water
Temperature Observations
(centered on August 1)

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2018)



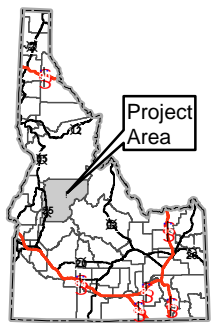
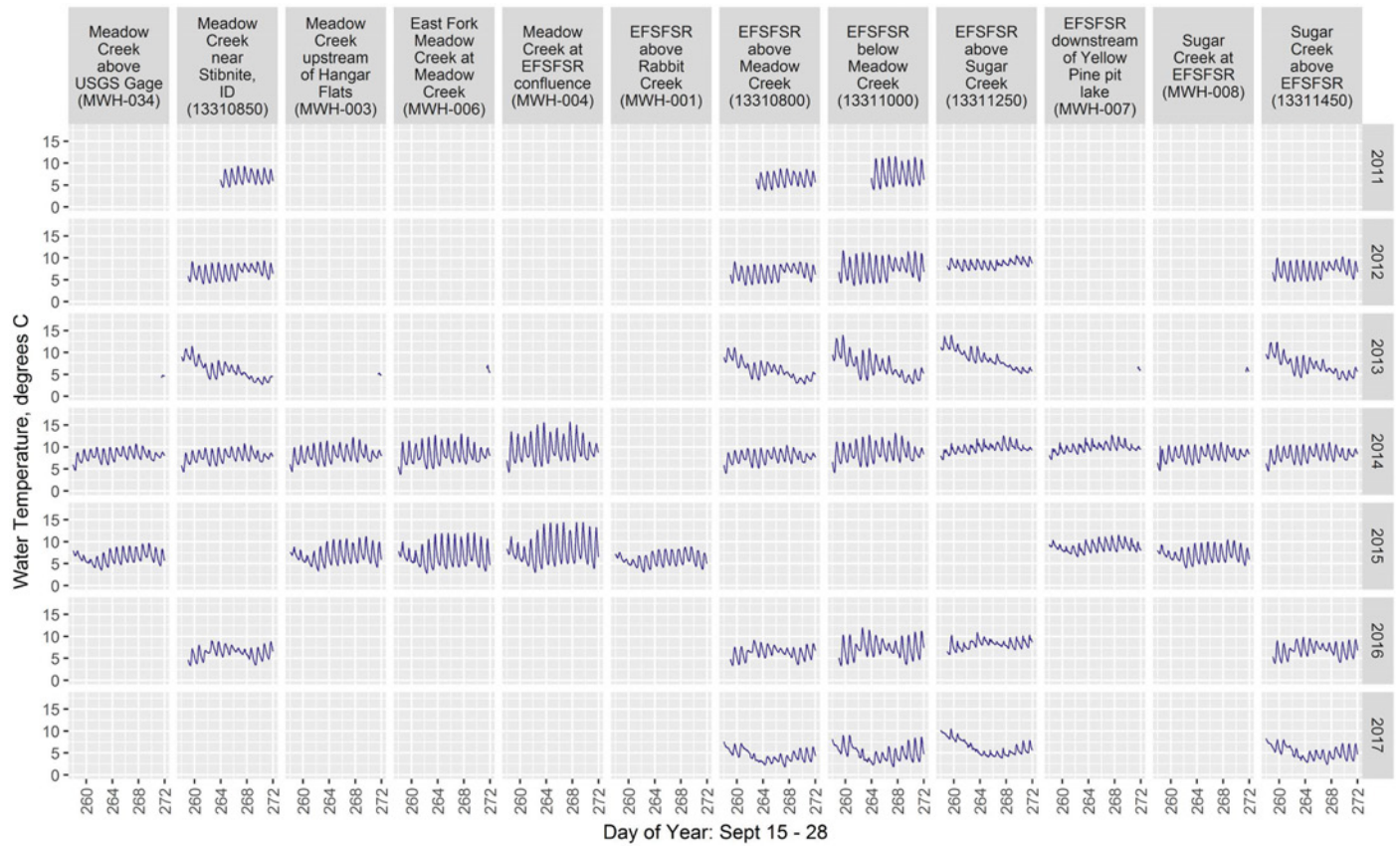


Figure 6-13
Fall Surface Water
Temperature Observations
(centered on September 21)

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2018)



Table 6-16 IDEQ Designated Beneficial Uses and Waterbody Status at the Mine Site

NHD Waterbody¹	Beneficial Uses²	IDEQ Status²	Cause of Impairment²	IDEQ Category²
East Fork South Fork Salmon River 3rd order	COLD, DWS, PCR, SCR, SS	Not supporting DWS and SCR	Antimony (DWS), arsenic (DWS, SCR)	303(d) listed Category 5
East Fork South Fork Salmon River 1st and 2nd order	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
Unnamed tributary to East Fork SFSR (Rabbit Creek)	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
Meadow Creek	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
Garnet Creek	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
Fiddle Creek	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
Midnight Creek	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
Unnamed tributary to East Fork SFSR (Hennessy Creek)	COLD, DWS, PCR, SS	Not supporting DWS and SCR	Arsenic	303(d) listed Category 5
West End Creek	COLD, PCR, SCR, SS	Fully supporting	-	Category 2
Sugar Creek (3rd order Cane Creek to mouth)	COLD, PCR, SS	Not supporting COLD and SCR	Arsenic (PCR), mercury (COLD, PCR, SS)	303(d) listed Category 5

Source: Brown and Caldwell 2017

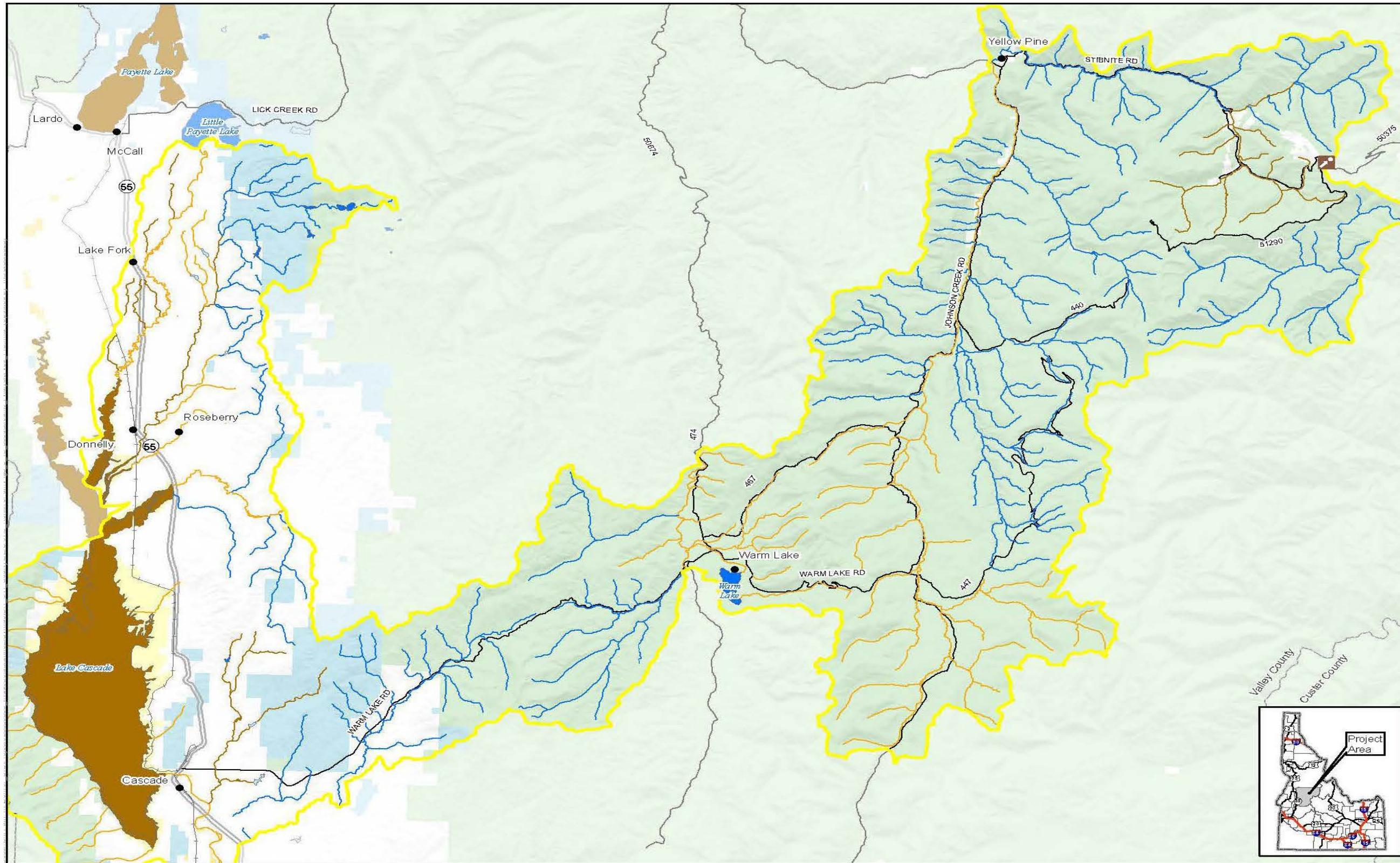
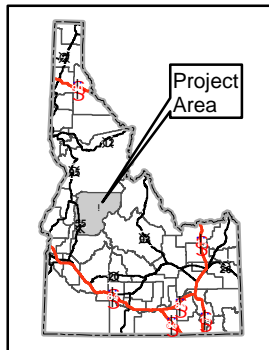
¹ National Hydrography Dataset (NHD) waterbody Proper Name. Parenthesized names are unofficial but locally common names included for clarity.

² Status and causes from 2018/2020 Integrated Report (IDEQ 2020a). COLD = cold water aquatic life; SS = salmonid spawning; PCR = primary contact recreation; SCR = secondary contact recreation; DWS = drinking water supply.

6.4.2 Off-Site Facilities and Access Roads

The Surface Water Quality Baseline Study (HDR 2017) did not include sample locations outside of the proposed SGP. However, streams adjacent to proposed access roads, utility corridors, and off-site facilities have the potential to be impacted by these SGP activities. The types of impacts that could occur are usually described qualitatively because little is known about the existing water quality of these streams. However, for Category 5 waters that have a 303(d)-listed water quality impairment, it is possible to conduct a more specific analysis evaluating how levels of the impaired constituent(s) may be impacted by SGP activities.

IDEQ has inventoried 11 lakes and 701 different stream segments in the surface water quality analysis area. Of these features, 66 are classified as Category 5 waters. **Figure 6-14** shows the inventoried stream segments within the analysis area, broken down by “Fully Supporting” beneficial uses (Categories 1 and 2), “Not Assessed” (Category 3), “Not Supporting” beneficial uses (Category 4), and “Not Supporting/303(d) Listed” (Category 5).



- LEGEND**
- Surface Water Analysis Area
 - IDEQ Streams**
 - Fully Supporting
 - Not Assessed
 - Not Supporting
 - Not Supporting/303d Listed - IDEQ Lakes**
 - Fully Supporting
 - Not Assessed
 - Not Supporting - Other Features**
 - County
 - City/Town
 - Monumental Summit
 - Railroad
 - Highway
 - Road - Surface Land Management**
 - Bureau of Land Management
 - Bureau of Reclamation
 - Private
 - State
 - U.S. Forest Service

Note:
The McCall – Stibnite Road (CR 50-412) consists of Lick Creek Road, East Fork South Fork Salmon River Road (East Fork Road) and Stibnite Road.

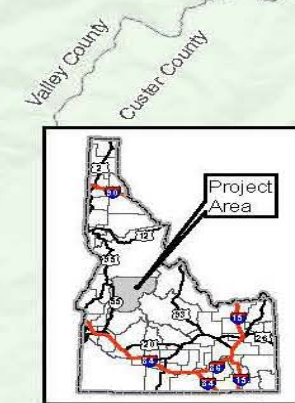
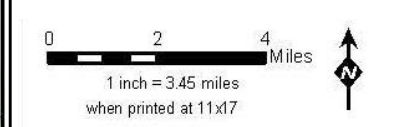
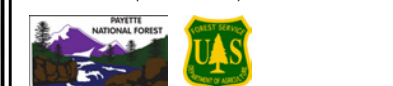


Figure 6-14
IDEQ Current
Conditions for Surface
Waters

Stibnite Gold Project
Stibnite, ID
Data Sources: (AECOM 2020)



In the western portion of the inventory area, waters that are not supporting beneficial uses are concentrated in the agricultural valley that drains towards Lake Cascade (Cascade Reservoir). Causes for the listing of these waters are largely tied to phosphorus and flow regime alteration, with some streams also listed for temperature, sedimentation/siltation, and biota/habitat assessment considerations. Cascade Reservoir is specifically listed for phosphorus and pH.

In the central portion of the inventory area, waters that are not supporting beneficial uses are primarily associated with the South Fork Salmon River and its tributaries, and Johnson Creek and its tributaries. Causes for listing of the South Fork Salmon River and tributaries are primarily associated with temperature and sedimentation/siltation; causes for listing of Johnson Creek and tributaries are primarily associated with temperature.

Impaired waterbodies in the eastern portion of the inventory area are primarily associated with the Meadow Creek and upper East Fork SFSR watershed impacted by elevated arsenic concentrations. Water quality impairments for the mine site streams have been discussed above and are summarized in **Table 6-16**.

6.5 Yellow Pine Pit Lake

A lake has formed in the former Yellow Pine pit where the East Fork SFSR flows through it. The existing pit lake has an estimated maximum depth of 35 feet and an approximately 4.75-acre surface area with a contained water volume of approximately 92 acre-feet. Originally, the pit was excavated to a depth 125 feet below the current water level, but the excavation has filled with approximately 90 feet of sediment (Brown and Caldwell 2017).

Water chemistry samples were collected in two 1999 sampling events at the surface and bottom of the lake at three locations across the lake from inflow to outlet plus one intermediate depth at the middle location (URS 2000, Tables 8.1-21, 8.1-22, and 8.1-23). Circumneutral pH values were observed ranging from 7.2 to 8.2 with low TDS concentrations between 47 and 78 mg/L. Analyses of total and dissolved metals indicated that concentrations of most metals were below reported analytical detection limits with the exceptions of antimony, arsenic, iron, magnesium, and manganese. Dissolved mercury was detected in a single sample at 0.23 mg/L but all other dissolved and total mercury analyses (including the companion total mercury analysis for that location) were below method detection limits reported between 0.042 mg/L and 0.063 mg/L. Analyses able to detect mercury concentrations at lower concentrations were not conducted as part of the 1999 investigation. These analytical method detection limits are greater than the strictest potentially applied water quality standard and it is uncertain whether the pit lake water meets that standard.

Concentrations of antimony and arsenic exceeded the strictest potentially applied water quality standards for all samples analyzed with total antimony concentrations ranging between 0.020 mg/L and 0.033 mg/L and total arsenic concentrations ranging between 0.047 mg/L and 0.098 mg/L. There was no clear spatial trend in the antimony and arsenic concentration measurements and total concentrations for these analytes were close to dissolved concentrations. The other metals detected were below the strictest potentially applied water quality standards.

Continuous water temperature data was collected from the Yellow Pine pit lake at locations near its inflow and outflow (**Figure 6-15**, Brown and Caldwell 2021g). These temperature measurements closely resemble stream water temperature measurements collected from USGS Gauges 13311000 and 13311250 upstream and downstream of the lake, respectively (**Figure 6-16**). In general, there are wider diurnal

ranges in upstream water temperatures than in the downstream water temperatures, indicating that the Yellow Pine pit lake acts to moderate daily temperature variability (**Figure 6-16**).

6.6 Groundwater

This section focuses on quantifying the baseline groundwater chemistry in areas monitored by the 17 monitoring wells of interest listed in **Table 6-17** with locations shown on **Figure 6-17**. The discussion of baseline chemistry is organized around the groundwater quality indicators, which include pH, major cations and anions, TDS, and metals.

It should be noted that baseline water quality at the mine site is influenced by both natural mineralization and historical mining activity.

6.6.1 Major Ions, pH, and TDS

Average baseline water quality characteristics measured between 2012 and 2018 for the groundwater monitoring wells of interest are summarized in **Table 6-17**. Calcium tends to be the dominant cation in most of the alluvial monitoring wells with bicarbonate or sulfate dominant anions. As a result, most alluvial wells in the mine site have a calcium bicarbonate water quality signature, but a few wells (MWH-A05, MWH-A07, MWH-A18, and MWH-A19) exhibit a calcium-sulfate water type. The calcium-sulfate wells are located proximal to and immediately downgradient of legacy mining facilities (HDR 2016). Overall, the major ion chemistry of alluvial groundwater at the mine is similar to surface water, illustrating the interconnectedness between the groundwater and surface water systems.

Most of the bedrock monitoring wells (screened between a range of 208 to 815 feet bgs) also display a calcium-bicarbonate water quality signature. Notably, several alluvial and bedrock well pairs exhibit similar characteristics. Many of the bedrock wells are screened at relatively shallow depths below ground surface near the valley walls where the alluvial aquifer is thinner (HDR 2016), and the bedrock is hydraulically connected to the alluvium deposits.

Despite the overall dominance of calcium and bicarbonate, the major ion chemistry of the bedrock aquifer tends to be more variable than the alluvium. For instance, samples from bedrock wells MWH-B03, MWH-B04, and MWH-B07 consistently have sodium and bicarbonate as the major cation-anion pair. These wells are screened at deeper depths near the center of the alluvial valleys. In addition, monitoring well MWH-B05 typically exhibits monthly variations in the major ion geochemistry potentially attributable to its shallower screened interval in the bedrock observing the effects of seasonal recharge in the overlying alluvium.

Average TDS concentrations in the groundwater wells of interest are variable but tend to be less than the 500 mg/L Idaho secondary groundwater standard. The average TDS values shown in **Table 6-17** range from 58 to 465 mg/L for the alluvial wells, and from 60 to 415 mg/L for the bedrock wells.

Field-measured pH values for the groundwater wells of interest were generally in the range of 6.1 to 8.9 standard units. The highest average pH (8.86) was observed in bedrock well MWH-B04. This pH value slightly exceeds the Idaho secondary groundwater standard. Overall, the circumneutral to alkaline pH values observed in groundwater near the mine site show that the geochemistry of natural mineralized deposits and legacy mine materials is not conducive to acidic rock drainage.

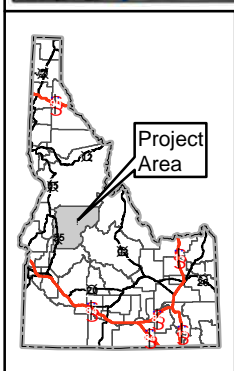
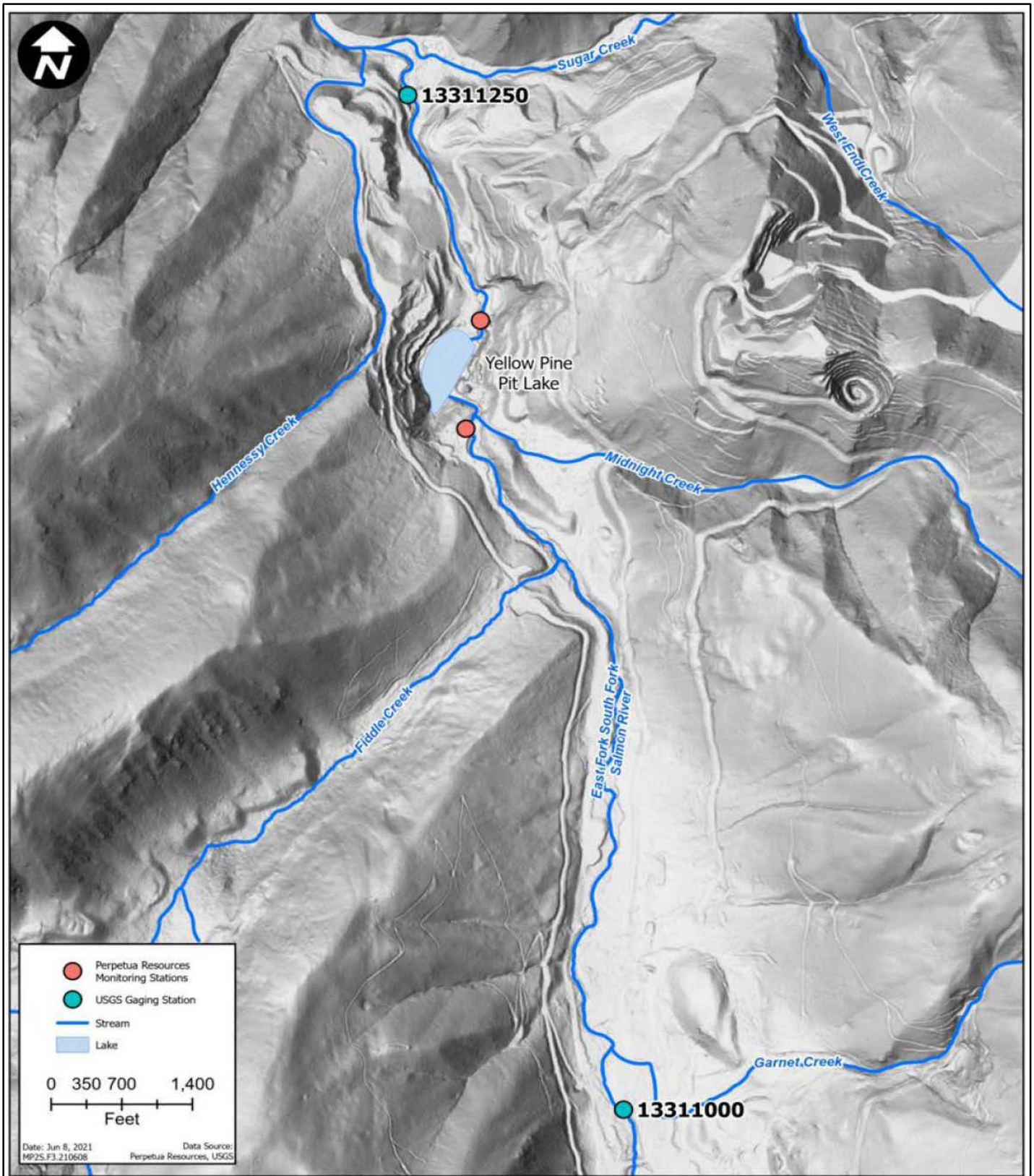
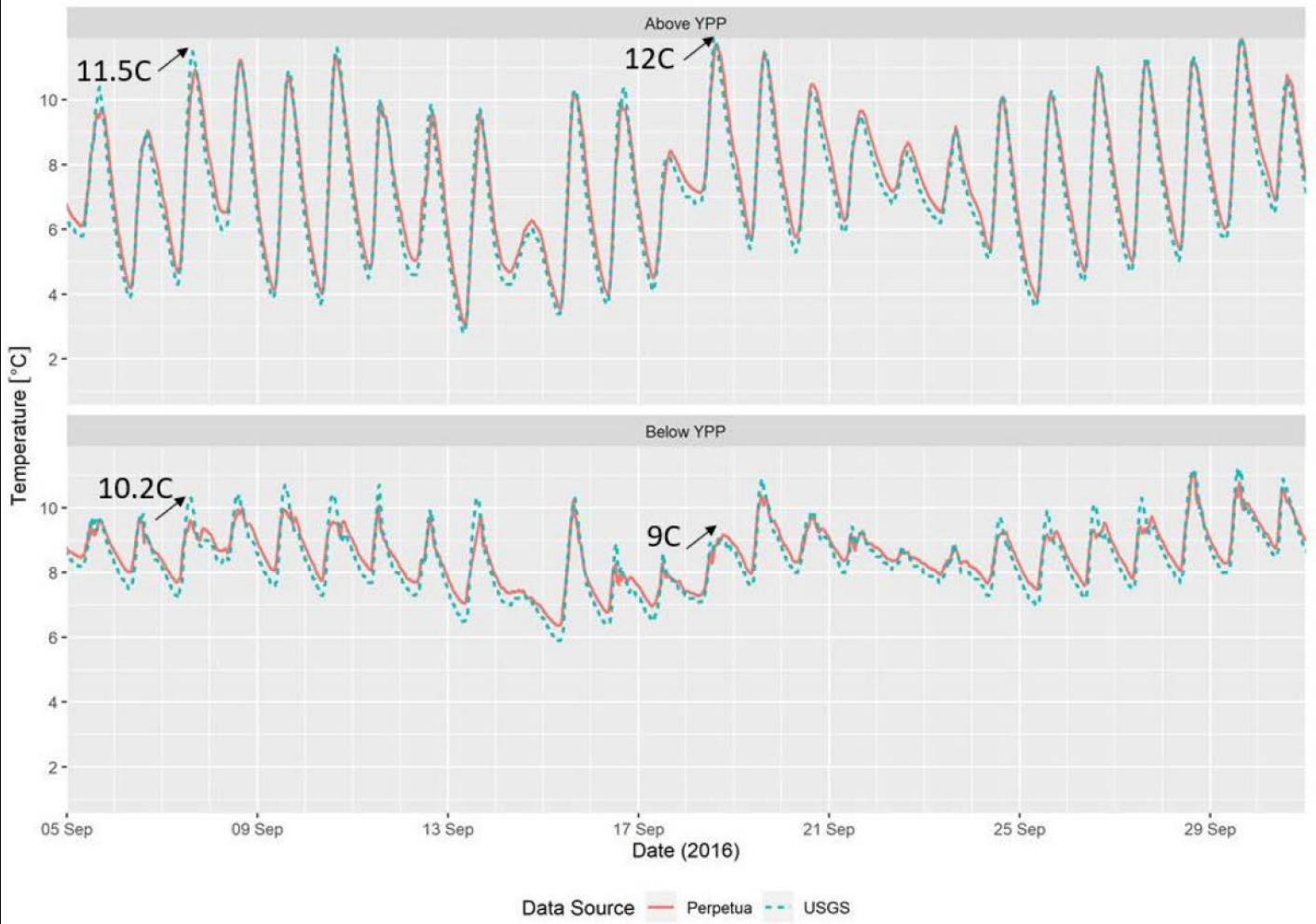


Figure 6-15
Yellow Pine Pit Lake
Temperature Observation
Locations

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021c)





USGS stations are 1.5mi upstream and 0.5mi downstream of YPP. Perpetua stations are nearer to the inlet and outlet.

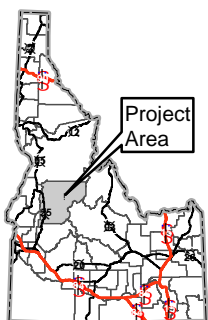


Figure 6-16
Yellow Pine Pit Lake Temperature
Observations

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2011c)



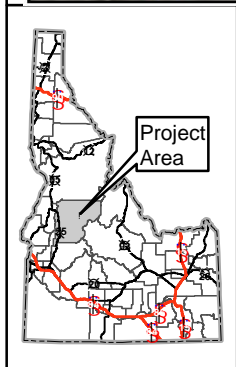
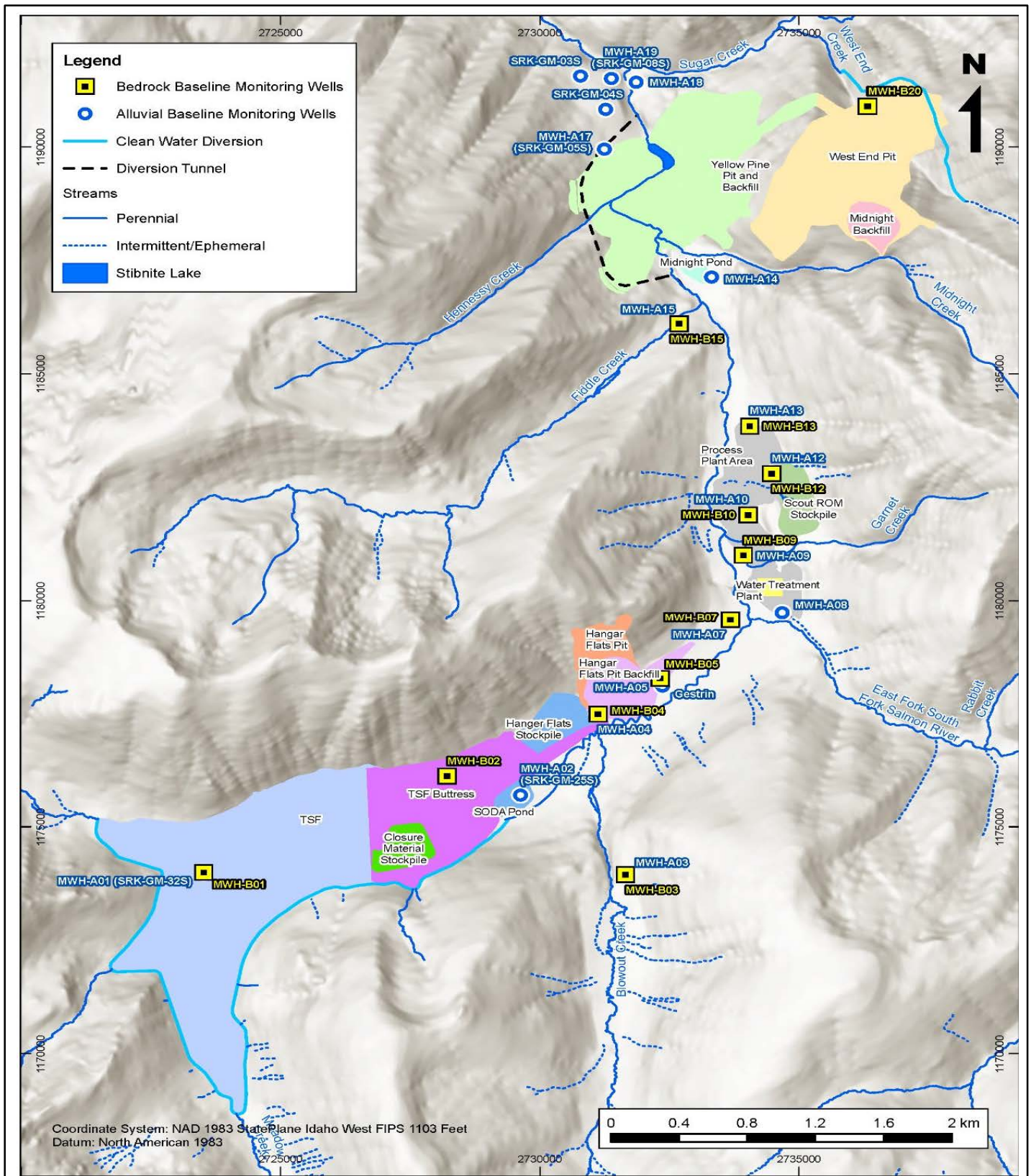


Figure 6-17
Groundwater
Chemistry Monitor
Locations

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 6-17 Average Groundwater Chemistry (2012 to 2018) for Select Alluvial and Bedrock Wells

Proposed Mine Feature			TSF	Hangar Flats Area			Hangar Flats Pit				Meadow Creek Valley		Yellow Pine Pit			Fiddle Creek Area		West End Pit Area	East Fork SF SR TSF	Upgradient
Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Alluvial aquifer (MWH-A01) ₁	Alluvial aquifer (MWH-A02) ₁	Bedrock aquifer (MWH-B02) ₁	Alluvial aquifer (MWH-A04) ₁	Bedrock aquifer (MWH-B04) ₁	Alluvial aquifer (MWH-A05) ₁	Bedrock aquifer (MWH-B05) ₁	Alluvial aquifer (MWH-A07) ₁	Bedrock aquifer (MWH-B07) ₁	Alluvial aquifer (MWH-A18) ₁	Alluvial aquifer (MWH-A19) ₁	Alluvial aquifer (MWH-A14) ₁	Alluvial aquifer (MWH-A15) ₁	Bedrock aquifer (MWH-B15) ₁	Bedrock aquifer (MWH-B20) ₁	Alluvial Aquifer (MWH-A08) ₁	Bedrock Aquifer (MWH-B01) ₁	
pH	s.u.	6.5 - 8.5*	7.46	6.9	6.67	6.62	8.86	6.62	7.04	6.09	8.15	6.19	6.34	7.64	7.09	8.39	8.12	7.04	8.56	
Alkalinity	mg/L as CaCO ₃	-	59.9	138	39.3	56.3	174	104	176	65.8	214	25.6	22.4	119	25.6	82.1	157	71.9	66	
Ag	mg/L	0.1*	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00003	<0.00002	
Al	mg/L	0.2*	0.0068	0.0046	0.054	0.0067	0.038	0.0045	0.017	0.028	0.28	0.035	0.0085	0.0052	0.0046	0.24	0.0029	0.0066	0.019	
As	mg/L	0.05	0.0064	0.0055	0.00054	1.1	0.11	1.9	0.14	0.20	0.25	0.033	4.7	0.35	0.087	0.32	0.3	0.019	0.013	
B	mg/L	-	0.01	0.01	0.011	0.013	0.051	0.023	0.018	0.012	0.031	0.0098	0.011	0.009	0.011	0.024	0.008	0.009	<0.011	
Ba	mg/L	2	0.0019	0.021	0.0029	0.01	0.64	0.033	0.049	0.018	0.019	0.017	0.046	0.016	0.017	0.041	0.048	0.045	0.0037	
Be	mg/L	0.004	<0.00002	<0.00002	0.000021	<0.00002	<0.00002	<0.00002	<0.00002	0.000027	0.000065	0.00017	0.000013	<0.00002	<0.00002	0.00005	<0.00002	<0.00002	<0.00002	
Ca	mg/L	-	18	30.7	10.4	18.1	7.69	83.5	65.4	75.6	14.5	83.9	36.5	32	5.11	15.5	34.9	19	18.8	
Cd	mg/L	0.005	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.000035	<0.00002	0.000038	0.000017	0.000023	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	
Cl	mg/L	250*	0.3	7.4	0.27	0.52	0.28	9.2	2.1	2.5	1.8	6	0.72	0.47	0.42	0.97	0.28	0.4	0.4	
Cyanide	mg/l	0.2	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	0.011	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	<0.0027	
Co	mg/L	-	0.0001	0.00099	0.00028	0.00071	0.00017	0.00188	0.00073	0.0033	0.00042	0.00025	0.00011	0.00023	0.000054	0.00069	0.00014	0.00006	0.00014	
Cr	mg/L	0.1	0.00028	0.00026	0.0002	0.00017	0.00043	0.00014	0.0003	0.00019	0.00057	0.00019	0.00028	0.00027	0.00014	0.00026	0.00027	0.00026	0.00022	
Cu	mg/L	1.3	0.00048	0.00032	0.00038	0.00094	0.00061	0.0016	0.0016	0.0014	0.0007	0.00063	0.001	0.00056	0.00013	0.00041	0.00043	0.0022	0.00035	
F	mg/L	4	0.11	0.11	0.094	0.1	0.68	0.15	0.89	0.17	3.2	0.16	0.15	0.11	0.09	0.59	0.12	0.11	0.23	
Fe (total)	mg/L	0.3*	0.134	2.8	1.7	2.1	0.23	0.21	0.37	1.3	1.7	4.3	1.1	0.38	0.23	6.93	0.061	0.2	0.16	
Hg	mg/L	0.002	5.60E-07	8.20E-06	1.40E-06	2.50E-05	8.80E-07	6.60E-05	1.50E-06	1.00E-05	1.80E-06	2.70E-06	2.00E-06	6.60E-07	7.40E-07	3.80E-06	4.30E-07	7.40E-07	5.80E-07	
K	mg/L	-	0.77	1.5	0.58	1.3	1.2	2.7	2.4	3.6	1	2	1.4	1.7	0.9	0.95	3.13	1.58	0.66	
Mg	mg/L	-	1.48	8.07	1.17	3.26	1.78	20.6	15.5	31.4	3.77	22.1	8.02	10.63	1.15	2.29	24.1	5.32	1.89	
Mn	mg/L	0.05*	0.001	2.8	0.012	1.1	0.07	2.2	0.07	0.36	0.021	0.026	0.0021	0.0039	0.0009	0.019	0.01	0.001	0.0013	
Mo	mg/L	-	0.0012	0.0023	0.0003	0.001	0.0036	0.0016	0.0048	0.0022	0.012	0.00008 9	0.00031	0.003	0.00023	0.0051	0.0045	0.00086	0.0061	
Na	mg/L	-	2.68	15.4	3.91	5.33	70	15.24	49.2	8.19	133	4.58	3.72	3.9	3.58	27.8	2.55	3.58	7	
Ni	mg/L	-	0.00021	0.00079	0.00038	0.00061	0.00026	0.0024	0.0012	0.0014	0.00054	0.0017	0.00058	0.00045	0.00017	0.00051	0.00093	0.00027	<0.0002	
P	mg/L	-	0.024	0.033	0.02	0.066	0.023	0.044	0.053	0.031	0.021	0.023	0.32	0.023	0.038	0.026	0.026	0.018	0.022	
Pb	mg/L	0.015	0.000029	0.000046	0.000055	0.000047	0.000064	0.0000 4	0.00013	0.000042	0.00023	0.000021	0.000036	0.00004	<0.00002	0.00021	0.000037	0.00012	0.000034	
Sb	mg/L	0.006	0.002	9.10E-05	0.0016	0.0013	0.00062	0.12	0.12	1.08	0.0011	0.2	0.01	0.0422	0.004	0.01	0.019	0.015	0.0044	
Se	mg/L	0.05	<0.001	<0.001	<0.001	0.00092	0.00098	0.00 076	0.00085	0.0008	0.00094	0.00078	0.0016	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
SO ₄	mg/L	250*	3.91	4.79	2.63	17.8	5.86	214	153	260	112	270	103	11.95	2.38	26.9	37.5	8.88	8.31	

Proposed Mine Feature			TSF	Hangar Flats Area			Hangar Flats Pit				Meadow Creek Valley		Yellow Pine Pit			Fiddle Creek Area		West End Pit Area	East Fork SFSR TSF	Upgradient
Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Alluvial aquifer (MWH-A01) ₁	Alluvial aquifer (MWH-A02) ₁	Bedrock aquifer (MWH-B02) ₁	Alluvial aquifer (MWH-A04) ₁	Bedrock aquifer (MWH-B04) ₁	Alluvial aquifer (MWH-A05) ₁	Bedrock aquifer (MWH-B05) ₁	Alluvial aquifer (MWH-A07) ₁	Bedrock aquifer (MWH-B07) ₁	Alluvial aquifer (MWH-A18) ₁	Alluvial aquifer (MWH-A19) ₁	Alluvial aquifer (MWH-A14) ₁	Alluvial aquifer (MWH-A15) ₁	Bedrock aquifer (MWH-B15) ₁	Bedrock aquifer (MWH-B20) ₁	Alluvial Aquifer (MWH-A08) ₁	Bedrock Aquifer (MWH-B01) ₁	
Tl	mg/L	0.002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	
V	mg/L	-	0.00031	0.00047	0.00021	0.00051	0.0003	0.00074	0.00047	0.00016	0.0009	0.00013	0.00073	0.00022	0.00044	0.0009	0.00013	0.0004	0.00033	
Zn	mg/L	5*	0.0011	0.0014	0.0015	0.0016	0.0015	0.0019	0.011	0.0039	0.0062	0.0058	0.0014	0.0015	0.001	0.0017	0.028	0.0023	0.0011	
TDS	mg/L	500*	75.4	170	60.3	103	185	434	410	465	415	448	205	144	57.9	172	198	93.8	86.4	
NO3 + NO2	mg/L as N	10	0.078	0.046	0.17	0.047	0.044	0.12	0.21	0.19	0.046	0.31	0.39	0.33	0.076	0.045	0.05	0.18	0.047	

Source: Brown and Caldwell 2019; HDR 2016; Midas Gold 2019; SRK Consulting (SRK) 2018a

¹ Represents average chemistry measured during the 2012-2018 baseline period. Concentration values represent the dissolved fraction unless otherwise noted.

² Bolded values exceed the respective Idaho Groundwater Quality Standard (IDAPA 58.01.11).

TSF = Tailings storage facility.

mg/L = milligrams per liter.

- Indicates no standard for parameter.

* Indicates secondary standard.

< = less than detection limit.

6.6.2 Constituents of Interest

The Groundwater Quality Baseline Study (HDR 2016) showed that several metals are present in mine site groundwater at concentrations that exceed the Idaho primary and secondary groundwater quality standards. The constituents exceeding applicable standards typically include antimony, arsenic, iron, and manganese in alluvial groundwater, and aluminum, antimony, arsenic, and iron in the bedrock groundwater. Therefore, these metals were selected as constituents of interest because of their potential to exceed regulatory standards and impact water and biological resources. Based on **Table 6-17**, average concentrations measured for the monitoring wells of interest are representative of the broader baseline study findings. Data presented in this table show that average concentrations of pH, aluminum, arsenic, iron, manganese, and antimony exceed the groundwater quality standards from **Table 3-1** at one or more wells.

Based on these findings, antimony and arsenic were identified as constituents of interest in groundwater. This determination is supported by the fact that groundwater quality criteria associated with antimony and arsenic were established to protect human health, whereas criteria for iron, aluminum, and manganese are based on secondary standards established to protect aesthetic and cosmetic qualities of drinking water. Mercury was not identified as a groundwater constituent of interest, because both total and dissolved mercury concentrations were consistently reported below the water quality standard in the alluvial and bedrock monitoring wells. Although certain waterways in the Stibnite Mining District have drinking water supply as a designated use (e.g., Meadow Creek, Garnet Creek, Fiddle Creek, and Midnight Creek), and Idaho groundwater quality standards apply throughout the Stibnite Mining District, there are no current, contemplated, or likely future public water supply intakes or wells in the zones at the SGP where metals levels exceed applicable standards. However, the implications of mercury concentrations in groundwater on surface water chemistry was retained as part of the impact analysis in **Section 7.0**.

Figure 6-18 illustrates the trend in dissolved antimony concentrations for groundwater monitoring locations across the mine site. During the baseline study, the fraction of antimony adsorbed onto solid particulates was found to be small, suggesting that the antimony concentration is adequately represented by the dissolved phase of this constituent (HDR 2016). The figure shows that mean dissolved antimony concentrations are generally below the 6 µg/L Idaho primary groundwater standard in the Meadow Creek valley; however, antimony concentrations increase by two to three orders of magnitude at some of the downgradient alluvial and bedrock wells, such as MWH-A05, MWH-B05, and MWH-A07. Immediately below the confluence with Meadow Creek, groundwater antimony concentrations in the lower East Fork SFSR alluvial aquifer are elevated above the primary groundwater standard but generally decrease in concentration downgradient. The baseline dissolved antimony concentrations exceed the Idaho primary groundwater standard in wells MWH-A14 and MWH-B15 upgradient of Yellow Pine pit. In the Sugar Creek valley, the average dissolved antimony concentration also is above the Idaho primary groundwater standard in bedrock well MWH-B20 near the proposed location of the West End pit.

For most samples collected during the Groundwater Quality Baseline Study (HDR 2016), 90 to 100 percent of arsenic was found to occur in the dissolved fraction. **Figure 6-19** illustrates the trend in dissolved arsenic concentrations for groundwater monitoring locations across the mine site. The figure shows that near wells MWH-A01 and MWH-A03 in the upper Meadow Creek valley, dissolved arsenic is on average higher in the bedrock aquifer than in the alluvium. This trend is reversed farther downgradient in the valley, where monitoring wells MWH-A04 and MWH-A05 have some of the highest average dissolved arsenic concentrations observed during baseline monitoring. The increase in dissolved arsenic in this area is likely due to the influence of historical mining materials.

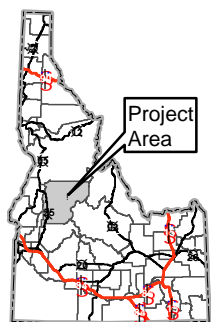
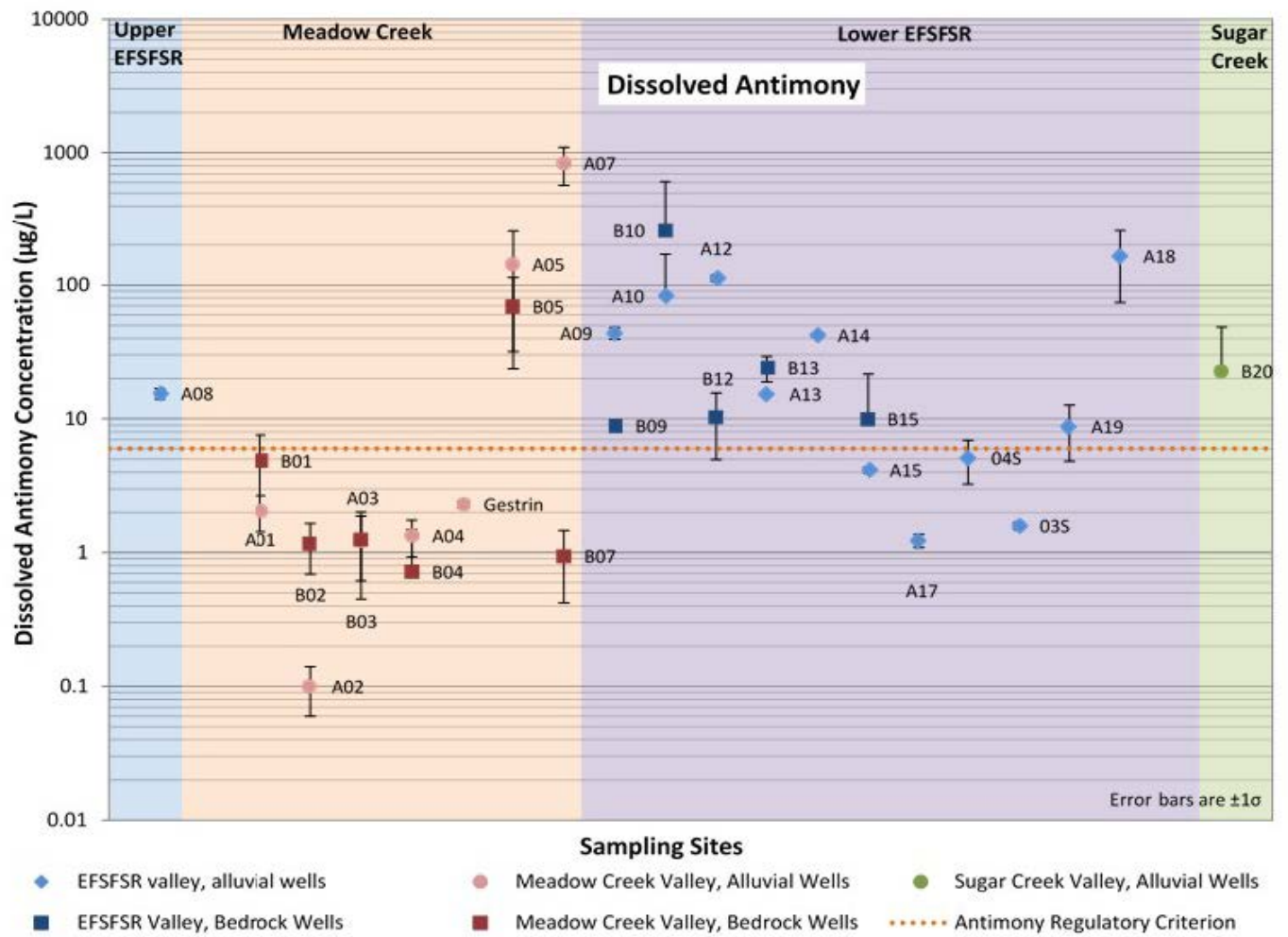


Figure 6-18
Dissolved Antimony
Concentrations in
Groundwater

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2017)



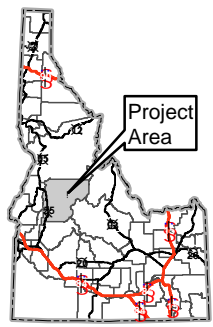
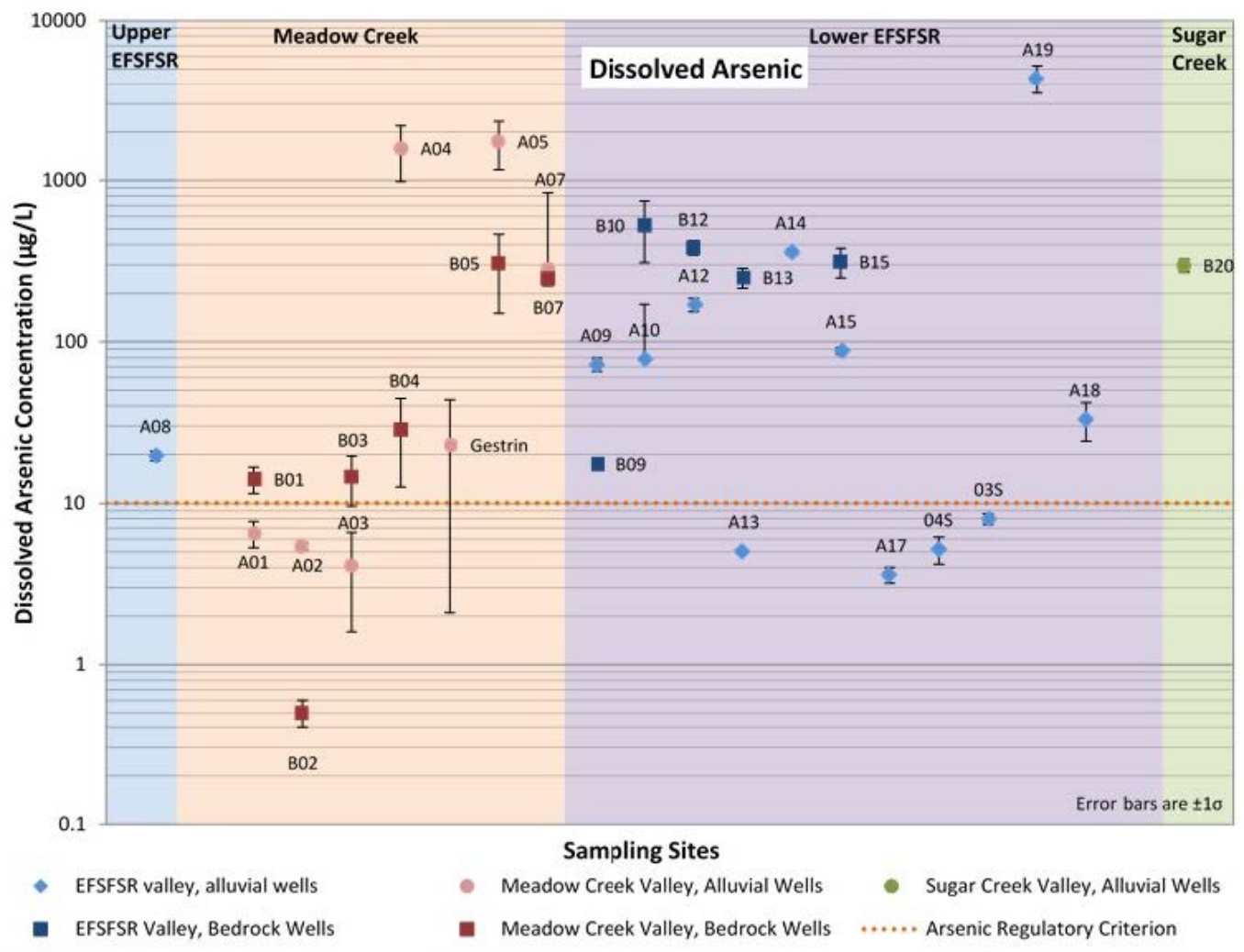


Figure 6-19
Dissolved Arsenic
Concentrations in
Groundwater

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2017)



In both the alluvial and bedrock aquifer, average dissolved groundwater arsenic concentrations were mostly above the primary groundwater standard in the lower East Fork SFSR and Sugar Creek valleys. This includes groundwater monitoring wells MWH-A14, MWH-A15, MWH-B15, and MWH-B20 near Yellow Pine pit.

Overall, dissolved concentrations of antimony and arsenic fluctuate seasonally, but to a lesser extent in bedrock wells than in alluvial wells. Concentrations are generally lower during spring and higher during the fall. This suggests that the concentrations are being diluted in springtime by freshwater recharge, but that concentrations increase during fall when groundwater levels typically approach seasonal lows.

7.0 Environmental Consequences

7.1 Impact Definitions

The impacts definitions for intensity, duration (FSH 1909.15, 152b), and context are provided in **Table 7-1**. As described in **Section 5.2**, analysis of water quality impacts utilizes a comparison of predicted analyte concentrations to regulatory standards (see **Section 3.3**). These standards are developed to be protective human and wildlife water users. Human health and wildlife implications of the predicted analyte concentrations relative to regulatory standards and existing conditions are included in analyses of public health & safety and the Fisheries and Aquatic Resources special report (Forest Service 2022c).

Table 7-1 Impact Definitions

Attribute	Term	Description
Intensity	Negligible	Impacts would result in a change in current conditions that would be too small to be physically measured using normal methods or would not be perceptible. There is no noticeable effect on the natural or baseline setting. There are no required changes in management or utilization of the resource.
Intensity	Minor	Impacts would result in a change in current conditions that would be just measurable with normal methods or barely perceptible. The change may affect individuals of a population or a small portion of a resource, but it would not result in a modification in the overall population, or the value or productivity of the resource. There are no required changes in management or utilization of the resource.
Intensity	Moderate	Impacts would result in an easily measurable change in current conditions that is readily noticeable. The change affects a large percentage of a population, or portion of a resource which may lead to modification or loss in viability, value, or productivity in the overall population or resource. There are some required changes in management or utilization of the resource.
Intensity	Major	Impacts are considered significant. Impacts would result in a large, measurable change in current conditions that is easily recognized. The change affects a majority of a resource or individuals of a population, which leads to significant modification in the overall population, or the value or productivity of the resource. This impact may not be in compliance with applicable regulatory standards or impact thresholds, requiring large changes in management or utilization of the resource.
Duration	Temporary	Impacts that are anticipated to last no longer than 1 year.
Duration	Short-Term	Impacts that are anticipated to begin and end within the first 3 years during the construction phase.

Attribute	Term	Description
Duration	Long-Term	Impacts lasting beyond 3 years to the end of mine operations and through reclamation, approximately 20 years.
Duration	Permanent	Impacts that would remain after reclamation is completed.
Context	Localized	Impacts would occur within the analysis area or the general vicinity of the Operations Area Boundary.
Context	Regional	Impacts would extend beyond the Operations Area Boundary and local area boundaries.

Intensity is the severity or levels of magnitude of an impact.

Duration is the length of time an effect would occur.

Context is the effect(s) of an action that must be analyzed within a framework, or within physical or conceptual limits.

7.2 Direct and Indirect Effects

7.2.1 No Action Alternative

Under the No Action Alternative, the Forest Service would not approve the SGP, and therefore no activities proposed on Forest Service lands would be approved as part of the EIS.

This alternative would not include any surface (open-pit) mining or ore processing to extract gold, silver, and antimony, and no underground exploration or related operations included in the proposed 2021 MMP on Forest Service lands would occur. Perpetua would continue to implement surface exploration and associated activities that have been previously approved on Forest Service lands as part of the Golden Meadows Exploration Project, per the Golden Meadows Exploration Project Plan of Operations and the Golden Meadows Exploration Project Environmental Assessment (Forest Service 2016). These approved activities include construction of several temporary roads (approximately 0.32 mile of temporary roads) to access drill sites (total of 28 drill sites), drill pad construction (total of 182 drill pads) and drilling on both Forest Service and private lands at and in the vicinity of the SGP. The continuation of approved exploration activities at the SGP by Perpetua would result in the continued use of the existing man camp, office trailers, truck maintenance shop area, potable water supply system, wastewater treatment facility, helipad and hangar, and airstrip (located primarily on patented land), which would require the continued use of diesel, gasoline, and jet fuel (approximately 141,000 gallons per calendar year) that is stored in aboveground tanks.

Perpetua would be required to continue to comply with reclamation and monitoring commitments included in the applicable Golden Meadows Exploration Project Plan of Operations and Environmental Assessment, which include reclamation of the drill pads and temporary roads by backfilling, re-contouring, and seeding using standard reclamation practices, and monitoring to ensure that sediment and stormwater BMPs are in place and effective so that soil erosion and other potential resource impacts are avoided or minimized. Additionally, Perpetua could, pursuant to development of another plan of operations, continue information collecting activities at the SGP and vicinity such as groundwater and surface water monitoring and reporting beyond which is required as part of the Golden Meadows Exploration Environmental Assessment, care and maintenance of stormwater BMPs at over 140 historical mining impact locations, and monitoring stream flow measurements from stream gages installed within creeks.

In the absence of an approved action alternative, access to public land in the area would continue as governed by law, regulation, policy, and existing and future landownership constraints.

The only geochemical indicator that would be affected by the alternative is the removal of legacy mine tailings and waste rock, which would not occur under the No Action scenario. Leaving the SODA and Bradley tailings in place would enable continued metals leaching from these sources, effectively preserving the existing mine site geochemistry while simultaneously preventing reductions in current baseline metals concentrations that exceed water quality standards.

The legacy mining wastes have contributed to elevated metals concentrations in surface water. Recent data indicate that antimony and arsenic routinely exceed surface water quality standards below the Bradley tailings (HDR 2017). Surface water mercury concentrations are above water quality standards at times and are typically above the 2 ng/L concentration determined by U.S. EPA to be protective of human health. Water quality data collected between 2012 and 2017 indicate that these constituents exceed surface water standards in 44 percent of the samples collected for dissolved and total antimony, 55 to 57 percent of the samples collected for dissolved and total arsenic, and 3 to 27 percent of the samples collected for dissolved and total mercury (Midas Gold 2019). These impacts exist despite the near-neutral surface water pH (median value of 7.41), which shows that the historical mining waste is not causing ARD. Overall, the elevated metals concentrations found in surface water would only improve with additional source removal. This removal is part of the planned Phase I scope for the Administrative Settlement Agreement and Order on Consent (ASAOC) signed in 2021 with implementation anticipated in 2022 through 2024. As such, the effects of the ASAOC are reasonably foreseeable future improvements in analyte concentrations in Meadow Creek and the East Fork SRSR associated with stream flow interaction with the historical mine waste (see **Section 7.5.2**). To the extent that surface waters recharge groundwater in these areas, there would also be a potential improvement in groundwater analyte concentrations.

Soil sampling and analysis indicate that legacy mining wastes have influenced concentrations of arsenic, antimony, and mercury in soil within the SGP. The elevated soil concentrations and continued presence of the waste material provide a pathway for these constituents to leach into groundwater. A review of arsenic, antimony, and mercury data for groundwater samples collected in the Meadow Creek valley between 2012 and 2017 (Midas Gold 2019) shows that concentrations of antimony and arsenic exceed the applicable standard in both alluvial and bedrock wells installed near the historic tailings. The average groundwater antimony concentrations in the Meadow Creek valley range up to 0.99 mg/L in the alluvium and 0.099 mg/L in the bedrock, compared to the Idaho groundwater standard of 0.006 mg/L. Average groundwater arsenic concentrations in the Meadow Creek valley are similarly elevated, ranging up to 1.96 mg/L in the alluvium and up to 0.39 mg/L in bedrock relative to the 0.050 mg/L arsenic standard. The elevated antimony and arsenic concentrations in groundwater are unlikely to improve in the future under the No Action Alternative.

Based on water quality data from the mine site seeps, sampled constituents that routinely exceed regulatory criteria in the seeps include aluminum, antimony, arsenic, cyanide, iron, manganese, and mercury (HDR 2017). Water quality data collected between 2012 and 2017 indicate that these constituents exceeded the applicable surface water standard in 42 percent of the seep samples collected for total aluminum, 85 to 88 percent of the samples collected for dissolved and total antimony, 95 percent of the samples collected for dissolved and total arsenic, 23 percent of the samples collected for total cyanide, 21 to 52 percent of the samples collected for dissolved and total iron, 39 to 48 percent of the samples collected for dissolved and total manganese, and 10 to 44 percent of the samples collected for dissolved and total mercury (Midas Gold 2019). Although removal and repurposing of the legacy mine waste would not guarantee an immediate improvement in the water quality of these seeps (unless the seeps also were removed), metals concentrations in the seeps are expected to remain largely static under the No Action Alternative unless the mine wastes were removed as part of an action such as the ASAOC.

Under the No Action Alternative, there would be no new or upgraded access roads. Current access to the area, via Johnson Creek Road and Stibnite Road, would continue to be used and would be expected to have traffic levels similar to current conditions. There would be no change to the existing condition of surface water quality related to roads.

Under the No Action Alternative, there would be no changes to the existing transmission lines and no new segment of transmission line constructed. No new communication towers would be established. As such, there would be no change to the existing condition of surface water quality related to utilities.

The SGP offsite facilities would not be constructed under this alternative. Existing facilities would likely continue to be used in a similar manner. As such, there would be no change to the existing condition of surface water quality related to off-site facilities.

7.2.2 2021 Modified Mine Plan

7.2.2.1 Water Chemistry Conceptualization

The conceptual development and modeling details associated with the quantitative forecast of water chemistry associated with the 2021 MMP are described in the Site-Wide Water Chemistry Modeling Report (SWWC, SRK 2021a). This section summarized that description as context for the ensuing effects analysis.

In summary, many water chemistry effects of the SGP originate with the mobilization of solutes from mined materials that would otherwise remain stable and in place in their native rock under the No Action scenario. Solute generated from mined materials are expected to be partially to substantively controlled by water management practices that are part of the SGP.

Mined materials under the 2021 MMP appear in the following mine facilities:

- as mined rock material in stockpiles,
- as finely ground tailings in the TSF,
- as mined rock material in the TSF Embankment and Buttress,
- as in situ rock exposed in pit walls of the Yellow Pine, Hangar Flats, and West End open pits, and
- as mined development rock material placed as backfill in the Yellow Pine, Hangar Flats and Midnight open pits.

The net effect of the solute mobilization and control measures is reflected in water chemistry associated with specific mine facilities, namely:

- seepage emerging at the ground surface from mine facilities (stockpiles, TSF, TSF Embankment, TSF Buttress),
- seepage infiltrating into the local alluvium from mine facilities (stockpiles, TSF, TSF Embankment, TSF Buttress),
- pit lake water (West End pit lake),

- interstitial water within the backfill material placed in former open pits (Yellow Pine pit, Hangar Flats pit, Midnight pit),
- groundwater affected by contact with mine-related solute mobilization, and
- surface water affected by contact with mine-related solute mobilization.

In addition to solute mobilization, the temperatures of surface waters would be affected by the proposed project as it modifies the flow and shading characteristics of the mine area which affect stream temperatures.

Water management practices are initially described in **Section 2** above and incorporated into their associated individual source conceptualizations described below.

7.2.2.2 Water Management and Water Treatment

According to the 2021 MMP (Perpetua 2021a) three water types would require management over the life of the Project (**Figure 7-1**): contact water from mine facilities, which includes dewatering water (construction through closure); consolidation water from the TSF (construction through closure which includes process water); and sanitary wastewater (construction through early closure).

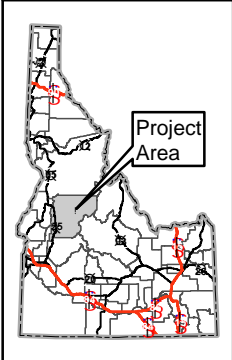
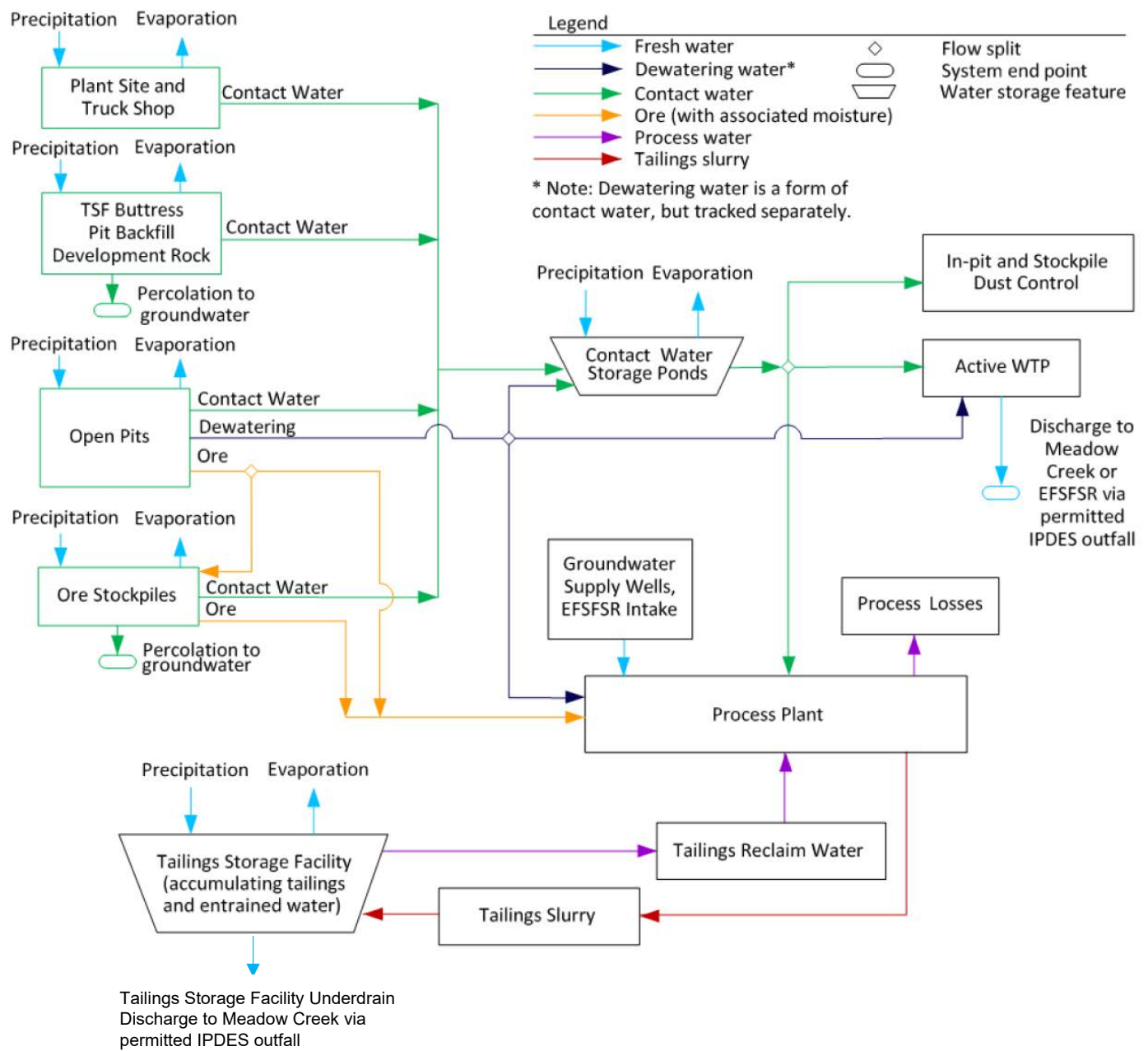
Specific sources of mining impacted water that could be expected to require treatment during operations include:

- Contact water from the dewatering of the Hangar Flats, Yellow Pine, and West End pits.
- Contact stormwater runoff from the pits, TSF buttress, Bradley Tailings, SODA, Hecla Heap, ore stockpiles, truck shop, and ore processing facility.
- Toe seepage and pop-out seepage from the TSF buttress and ore stockpiles.
- Sanitary wastewater from the worker housing facility, truck shop, ore processing facility, administrative buildings, and offsite facilities.

After mine closure and final reclamation of the TSF Buttress and pit backfill surfaces which incorporate geosynthetic liners to inhibit interaction between water resources and mined materials, contact water treatment would no longer be required; but process water treatment for the TSF would continue longer, through approximately year 40 (MGII 2020a) to account primarily for consolidation water from the TSF which would exhibit a diminishing flow rate over that period.

Contact Water Pond Chemistry

During operations, contact water from SGP facilities, and occasionally pit dewatering water, would be directed to site contact water collection ponds and subsequently directed to the water treatment plant (WTP). Inflow sources to each collection pond are provided in **Table 7-2**. Open pit dewatering water that is not directed to site contact water collection ponds would be pumped directly to the WTP.



**Figure 7-1
Project Water Management
Components**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (Brown & Caldwell 2021a)



Table 7-2 Contact Water Collection Pond Inflow Sources included in Model

Contact Water Pond	Inflow Sources	Predicted Analytes with Concentrations above the Strictest Potentially Applied Standards
Hangar Flats Pond	Hangar Flats pit Contact Water TSF Buttress Toe Seepage and Runoff Bradley Tailings Contact Water	Antimony, Arsenic, Cadmium, Copper, Fluoride, Iron, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Sulfate, Thallium, and Zinc
SODA Pond	Hangar Flats pit Contact Water TSF Buttress Toe Seepage and Runoff Bradley Tailings Contact Water	Antimony, Arsenic, Cadmium, Copper, Fluoride, Iron, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Sulfate, Thallium, and Zinc
Plant Ponds	Pit Dewatering Stockpiles	Antimony, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Selenium, and Zinc
West End Pond	West End pit Contact Water West End In-pit and Stockpile Seepage and Runoff	Antimony, Arsenic, Cadmium, Chloride, Copper, Fluoride, Lead, Manganese, Mercury, Nickel, Selenium, Silver, Sulfate, and Zinc
Midnight Pond	West End Pond Yellow Pine pit Contact Water	Antimony, Arsenic, Copper, Mercury, and Lead

Source: SRK 2021a, Appendices D1-D5

The WTP influent water quality was predicted based on water chemistries associated with each of the inflow sources listed in **Table 7-2**, mixed in their relative proportions based on the site wide water balance model, to estimate the mixed influent chemistry to the water treatment plant on a monthly timestep (SRK 2021a, Appendix D). Predicted water chemistries for individual water sources reporting to the contact water ponds are described below.

The site contact water collection ponds also gain water from direct precipitation and lose water from evaporation. However, the collection pond water quality is assumed to be characterized by the inflow sources at each timestep and are not diluted or concentrated as a result of direct precipitation or evaporation in the ponds (i.e., the pond chemistry is assumed to be equal to the mixed inflows at each timestep). This is considered appropriate since the contact water collection ponds have residence times that are smaller than each timestep.

Dewatering Water Chemistry

Forecasts for the water chemistries of the dewatering production for the Yellow Pine pit, Hangar Flats pit, and West End pit were developed based on the alluvial and bedrock monitoring wells in proximity to those locations. The relative dewatering components from the alluvium and bedrock groundwater were based on the groundwater flow model dewatering simulations (Brown and Caldwell 2021b).

For the Yellow Pine pit dewatering, water chemistry data from four alluvial wells (SRK-GM-04S, MWH-A14, MWH-A15, and MWH-A17) were utilized along with one bedrock well (MWH-15). Alluvial and

bedrock wells MWH-04A, MWH-05A, MWH-04B, and MWH-05B were used to represent previously mine-impacted groundwater chemistry that would be intercepted by early Hangar Flats pit dewatering while MWH-A01 and MWH-B02 were used to represent later time dewatering which would encounter unimpacted influent groundwater (SRK 2021a).

Water chemistry forecasts for the West End pit dewatering utilized Summer and Fall season analyses of the nearby surface water monitoring station YP-T-37 on West End Creek above the mine area. Bedrock groundwater discharge at this location is the primary source of flow except the Spring when surface water runoff contributes to flows (SRK 2021a).

An aggregate dewatering chemistry was calculated from the individual source terms on an annual basis (SRK 2021a, Appendix D6). Predicted dewatering chemistry has consistently circumneutral pH with antimony and arsenic concentrations above the strictest potentially applied water quality standards. In some instances, maximum monthly predicted concentrations of manganese (Mine Years 3, 4, and 5) and mercury (Mine Year 3) were also above the strictest potentially applied water quality standards.

In early years, average predicted arsenic concentrations were between 0.12 mg/L and 0.14 mg/L before decreasing to 0.012 mg/L in Mine Year 6. In the mid-years, dewatering is encountering unimpacted groundwater in the Hangar Flats pit area. Later year predicted arsenic concentrations returned to their initial levels after Mine Year 8. Predicted antimony concentrations exhibited a similar trend with early time dewatering concentrations between 0.014 mg/L and 0.016 mg/L. In Mine Years 4 through 6, average antimony concentrations decreased below the 0.006 mg/L standard before returning to their initial concentrations after Mine Year 8.

Ore Stockpiles

Stockpiles would be used to manage mined ore awaiting processing during project operations. There would be three short-term ore stockpiles located in the processing area near the crushing facility plus five long-term ore stockpiles located on the footprint of the TSF Buttress or the Hangar Flats pit backfill. Stormwater runoff and seepage from the ore stockpiles would be collected in runoff channels and managed as contact water.

Stockpile runoff, toe seepage, and sub-surface infiltration was evaluated by the Site-Wide Water Balance Model (Brown and Caldwell 2021a). The model utilized the volume meteoric water incident on each stockpile to develop estimates for surface runoff, toe seepage, and sub-surface infiltration over time. In summary, initial assumptions for event runoff and preferential flow were applied to the volume of incident meteoric water to get estimates for instantaneous runoff and toe seepage. The remaining water was simulated to infiltrate into the stockpile material from which it discharged from pore space storage more slowly over time in the form of toe seepage and infiltration into the subsurface under the stockpile. Details of this modeling are provided in Brown and Caldwell 2021a and SRK 2021b.

The predicted relative volumes for runoff, toe seepage, and infiltration are dependent on the assumption of the percentage of event runoff from the stockpile surface and preferential flow through the stockpile. A higher percentage assumption would lead to a greater volume of instantaneous runoff and toe seepage while a lower percentage assumption would lead to a greater volume of long-term toe seepage and subsurface infiltration. A range of assumed preferential flow percentages between 15 and 85 percent were examined as part of this analysis. The low range assumption was utilized for the prediction of stockpile water chemistry concentrations because it conservatively resulted in the greatest amount of water-rock interactions that allow metals to enter solution. A higher percentage assumption would result in relatively more near-term water flow from the pile but with lower constituent concentrations reporting to the contact

water ponds and water treatment plant. However, that volume of water would be within the design capacities of the ponds and plant (Brown and Caldwell 2021c).

Contributions of analytes leached from stockpiles to water chemistry were estimated based on a weighted-average of humidity cell test results for the lithologies expected to be present in each stockpile. The weights utilized for the calculation were based on the relative percentage of each lithologic unit. Details of the calculations are available in SRK 2021a, Appendix A.

Predicted water chemistries for the stockpiles exhibited circum-neutral pH values with antimony concentrations (0.008 mg/L to 0.016 mg/L) and arsenic concentrations (0.069 mg/L to 0.25 mg/L), both above the strictest potentially applied water quality standards. Other metal leaching concentrations were predicted to be below surface water standards with mercury concentrations between 7 ng/L and 11 ng/L (SRK 2021a, Appendix A), but above the 2 ng/L concentration calculated by the U.S. EPA.

TSF Embankment and Buttress

During the construction and early operations phases, Hangar Flats Pond will be located near the northeast toe of the TSF Buttress to provide contact water storage. Runoff and toe seepage from the TSF Buttress and remaining legacy materials in SODA would be conveyed to the Hangar Flats Pond using a series of runoff collection channels or berms, internal collections sumps, pumps, and pipelines as needed. The SODA Pond would be constructed south of the TSF Buttress to provide contact water storage for the remaining years of operations and closure, as the Hangar Flats Pond would be deconstructed as the Hangar Flats pit is mined below the valley bottom.

Operational and post-closure water quality predictions have been developed for the TSF Buttress and adjacent TSF Embankment. The general modeling approach was to quantify:

- Solute concentrations in contact waters that would run off the surface of the facility or emerge from the base and intermediate lifts of the facility, either as toe seepage, pop-out seepage or as recharge to groundwater.
- Solute concentrations in groundwater underlying the facility.

Conceptual models for the TSF Buttress and Embankment during operations and closure are shown in **Figure 7-2**. Further details regarding the TSF Buttress design and modeling can be found in Perpetua 2021a and SRK 2021a, respectively. A summary of the information follows.

At final buildout, the TSF Buttress and adjacent TSF Embankment would contain 142 million tons of material, comprising 85.5 million tons (60%) of non-PAG development rock from the Yellow Pine pit, 22 million tons (16%) of non-PAG development rock from the West End pit, 14.3 million tons (10%) of non-PAG development rock from the Hangar Flats pit, 6.4 million tons (4%) of PAG development rock, 11.7 million tons (8%) of borrow material, 1.25 million tons (0.9%) of spent ore from the Hecla Heap, 0.85 million tons (0.6%) of spent ore from the SODA, and 0.2 million tons (0.1%) mine waste placed on the former SMI on/off leach pads during the ASAOC action. Active ‘blending’ of the development rock during operations is not proposed. During operations, ore stockpiles 1, 2, 3 and 4 would be located on top of the TSF Buttress and are assumed to contribute to solute loading from the facility during the operational period only. These stockpiles are assumed to have been completely removed and processed prior to closure.

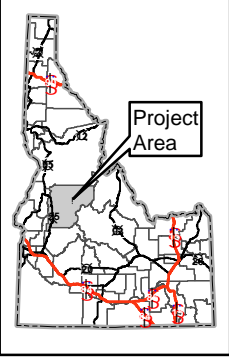
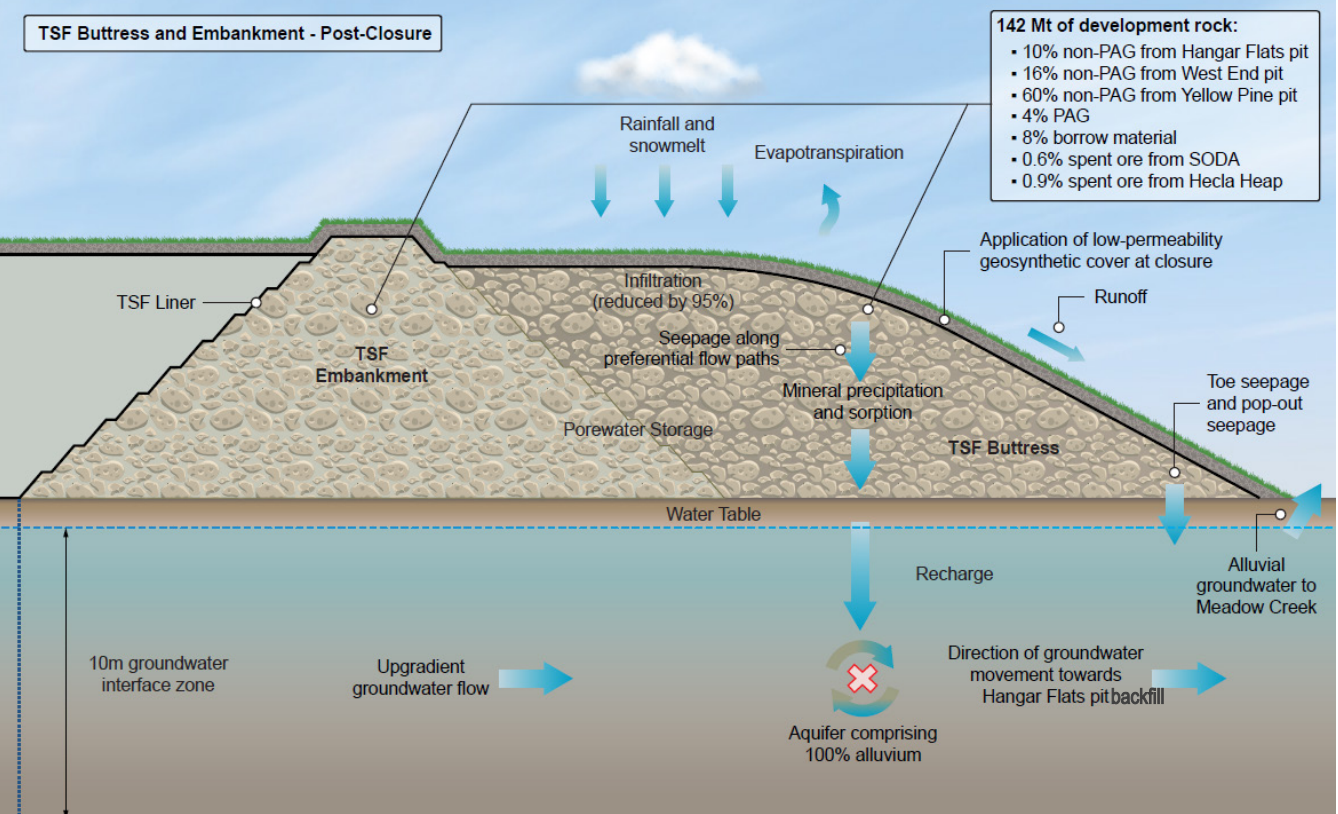
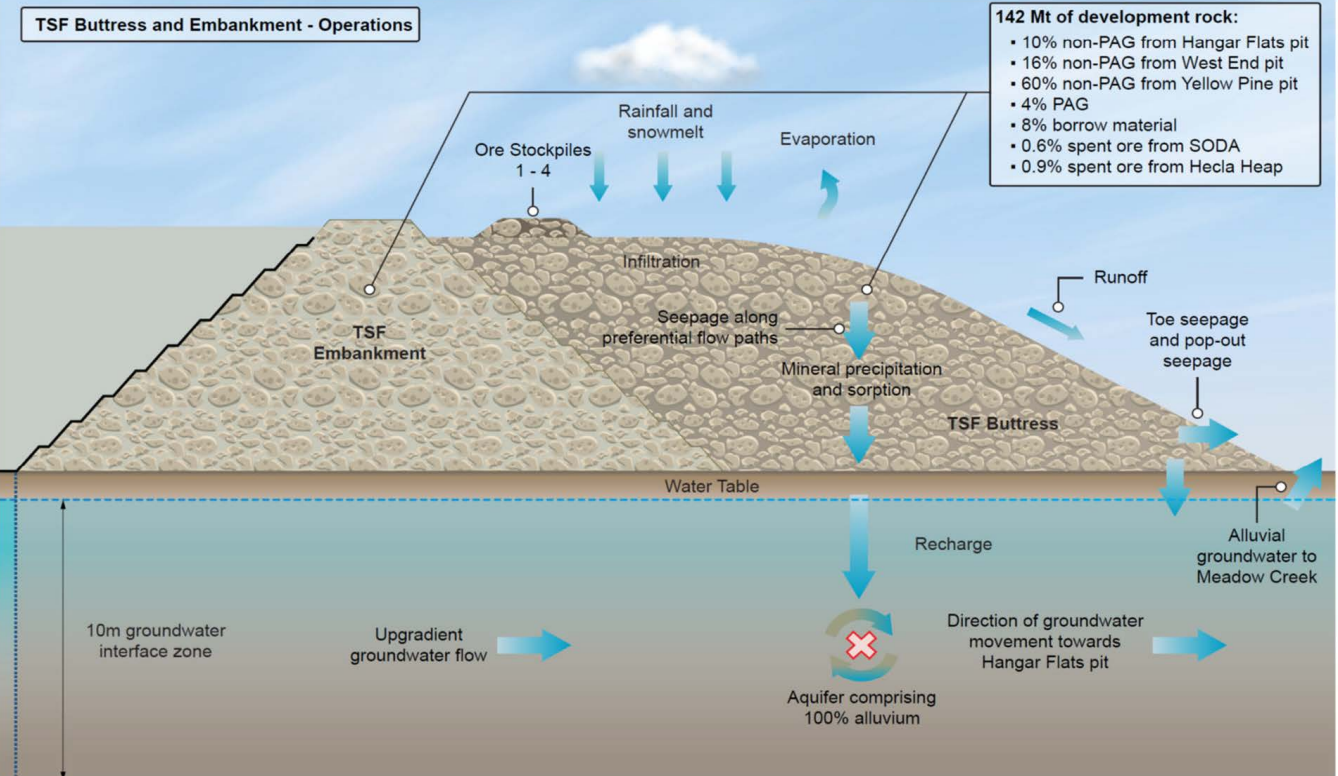


Figure 7-2
Conceptual Model for
Tailings Storage Facility
Buttress

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Representative leachate chemistries for the lithologies within the TSF Buttress and Embankment were obtained from humidity cell effluent data, scaled to field conditions. The details for the leachate chemistry calculation are described in SRK 2021a.

The primary source of contact water for material within the TSF Buttress and Embankment would be rainwater and snowmelt. Chemistry of representative rainwater was obtained from monthly monitoring carried out between 1984 and 2006 at the Smiths Ferry Meteorological Station, Valley County, Idaho, approximately 55 miles from Stibnite (NADP 2021), which is considered the best record of rainwater chemistry in the area. Any precipitation that falls on the TSF Buttress and Embankment would either run off or infiltrate the facility. Runoff waters are assumed to contact the outermost 0.3 meters (1 foot) of material within the facility. Any precipitation that infiltrates the facility would either recharge groundwater or report as toe seepage or pop-out seepage on the face of the facility (Brown and Caldwell 2021a, 2021c). As with the predicted stockpile chemistry, a lower runoff and preferential flow assumption was applied to conservatively predict water-rock interactions and resulting analyte concentrations.

Precipitation that infiltrates the facility has the potential to recharge to groundwater. This water was assumed to interact with groundwater in the uppermost 32.8 feet (10 meters) of the aquifer beneath the footprint of the facility (SRK 2021a). The aquifer below the facility consists entirely of alluvium. Any infiltration recharging to groundwater would migrate directly to the water table and no allowance for solute attenuation has been accounted for along the flow path. The residence time in the aquifer of any precipitation that infiltrates the TSF Buttress and Embankment and recharges groundwater, was assumed to be short and on the order of one month to a few months at most (SRK 2021a). The direction of groundwater flow beneath the TSF buttress and Embankment is toward the Hangar Flats pit area. Hence, water that infiltrates the facility and recharges groundwater would report there.

At closure, the TSF Embankment and Buttress would be regraded to promote positive drainage and a low permeability geosynthetic cover would be placed over the entire facility, which would be designed to limit infiltration through the underlying development rock (Perpetua 2021a). The geosynthetic cover would be overlain by an inert soil/rock layer and growth media and revegetated. Following cover placement, any toe/pop-out seepage from the facility would occur under the liner and is assumed to recharge groundwater.

Under this design and conceptualization, the predicted seepage volume from the TSF Buttress increases during the operations phase until closure of the facility and installation of the geosynthetic liner (**Figure 7-3**). Following closure, there is no longer any runoff or toe seepage from contact with the buttress materials. In the post-closure period, residual solution from the buttress materials continues to infiltration into the sub-surface and alluvial groundwater.

Predicted water chemistry associated with runoff from the TSF Buttress and Embankment has circum-neutral pH with concentrations of antimony, arsenic, copper, manganese, mercury, and thallium above the strictest potentially applied water quality standards (**Table 7-3**).

Predicted water chemistry associated with toe seepage from the TSF Buttress and Embankment has circum-neutral pH with concentrations of antimony, arsenic, cadmium, chromium, copper, fluoride, manganese, mercury, nickel, lead, selenium, silver, sulfate, thallium, zinc, and TDS above the strictest potentially applied water quality standards (**Table 7-4**).

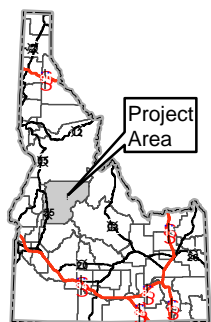
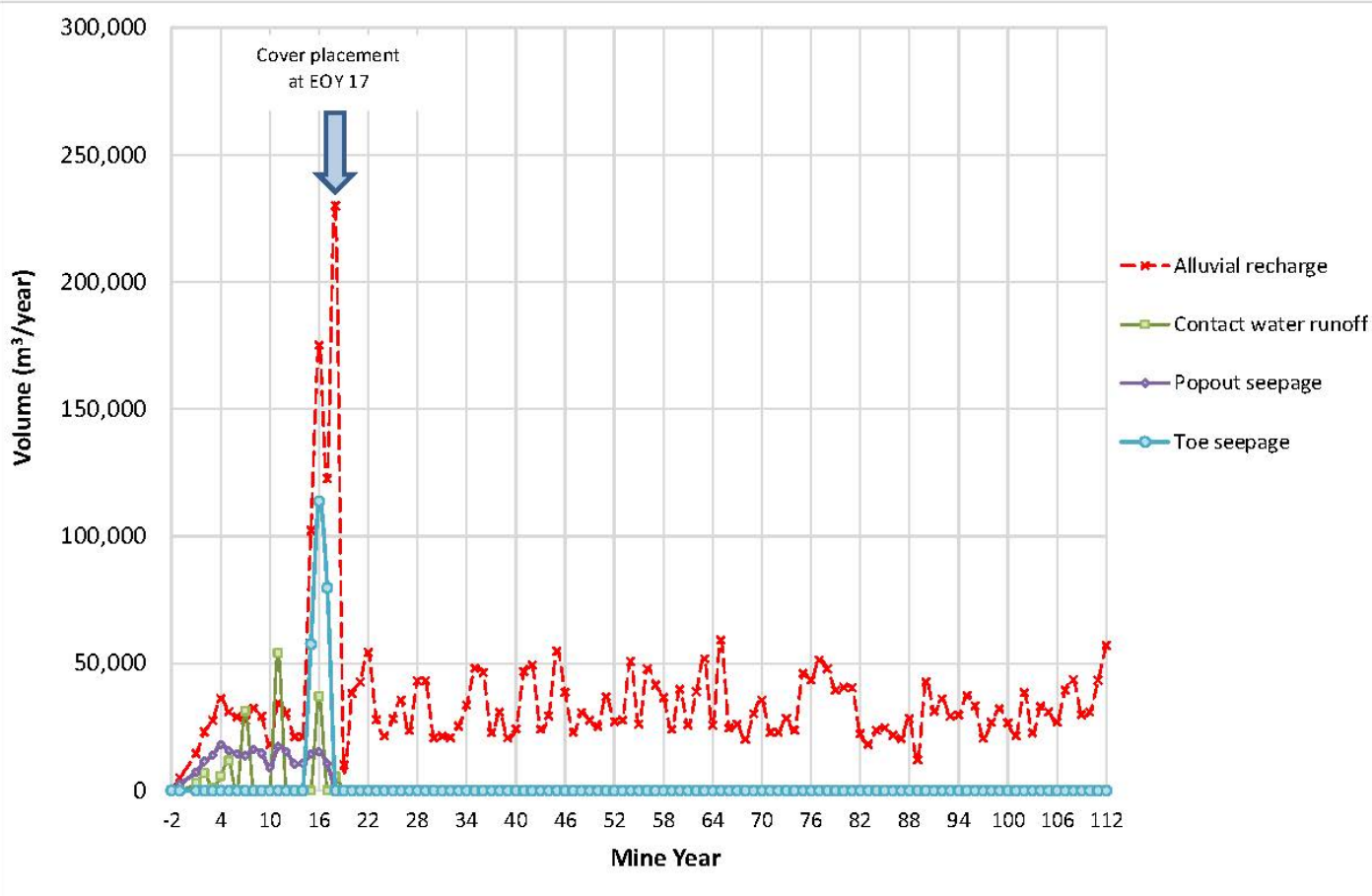


Figure 7-3
Tailings Storage Facility
Buttress Seepage Volume

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 7-3 Predicted Runoff Chemistry for the TSF Buttress and Embankment

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria*	Operations			Post-Mining Prior to Cover Placement	Post-Mining after Cover Placement
			Mine Year -2 to 12			Mine Year 13 to 18*	Mine Year 19 to 112
			Average	Minimum	Maximum	Average*	Average
pH	s.u.	6.5 - 9	7.45	6.94	7.96	7.65	No contact water runoff from TSF Buttress and Embankment post-mining
Alkalinity	mg/L as CaCO ₃	>20	13.2	3.04	32.7	15.7	
Ag	mg/L	0.0007 [†]	0.00002	5.9E-06	0.00004	0.00002	
Al	mg/L	0.05	0.0027	0.0025	0.0031	0.0025	
As	mg/L	0.01	0.14	0.029	0.34	0.14	
B	mg/L	-	0.048	0.0075	0.12	0.0557	
Ba	mg/L	2.0	0.021	0.0032	0.053	0.0251	
Be	mg/L	-	<0.001	<0.001	<0.001	<0.001	
Ca	mg/L	-	4.92	1.22	11.6	5.55	
Cd	mg/L	0.00033 [†]	0.00002	4.7E-06	0.00005	0.00003	
Cl	mg/L	230	0.69	0.20	1.59	0.83	
Co	mg/L	-	0.0002	0.000046	0.00048	0.00023	
Cr	mg/L	0.0106 ^{†††}	0.00057	0.00009	0.0013	0.00043	
Cu	mg/L	0.002 ^{††}	0.0017	0.00009	0.0041	0.0019	
F	mg/L	2.0	0.069	0.0085	0.18	0.087	
Fe	mg/L	0.3	<0.005	<0.005	<0.005	<0.005	
Hg	mg/L	0.000012	0.000013	1.6E-06	0.000032	0.000015	
K	mg/L	-	0.94	0.26	2.18	1.05	
Mg	mg/L	-	1.78	0.60	4.09	2.08	
Mn	mg/L	0.05	0.017	0.0033	0.039	0.018	
Mo	mg/L	-	0.0031	0.00025	0.0081	0.0033	
Na	mg/L	-	1.86	0.33	4.79	2.36	
Ni	mg/L	0.024 [†]	0.0015	0.00025	0.0035	0.0013	
P	mg/L	-	0.024	0.0075	0.055	0.027	
Pb	mg/L	0.0009 [†]	0.00041	0.00009	0.00098	0.00045	
Sb	mg/L	0.0052	0.065	0.018	0.15	0.071	
Se	mg/L	0.0031	0.00007	0.00002	0.00014	0.00007	

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Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria*	Operations			Post-Mining Prior to Cover Placement	Post-Mining after Cover Placement
			Mine Year -2 to 12			Mine Year 13 to 18*	Mine Year 19 to 112
			Average	Minimum	Maximum	Average*	Average
SO4	mg/L	250	7.34	1.77	17.3	8.41	
Tl	mg/L	0.000017	2.5E-06	5.4E-07	5.6E-06	2.7E-06	
V	mg/L	-	<0.01	<0.01	<0.01	<0.01	
Zn	mg/L	0.054 [†]	0.0051	0.00087	0.013	0.0057	
TDS	mg/L	500	31.8	7.89	80.0	30.1	
NO3 + NO2	mg/L as N	-	8.43	1.64	17.8	<0.01	

Source: SRK 2021a

All values are for the dissolved fraction unless otherwise noted

< Indicates parameter was consistently below analytical detection limits in the HCT effluents, and is thus not expected at detectable concentrations in the buttress toe/pop-out seepage waters

- Indicates no guideline for parameter

[†]Indicates hardness-dependent parameter. The values listed are based on the East Fork SFSR hardness of 40 mg/L as calcium carbonate, which represents the 5th percentile hardness during the driest four months at node YP-SR-10 (East Fork SFSR below Meadow Creek) between April 2012 and May 2019.

^{††} Estimated criterion based on DEQ guidance on Biotic Ligand Model and limited site-specific SGP data

^{†††} Standard is for chromium VI and is based on Water Effect Ratio

* During this period, runoff would only be generated in Mine Year 16 according to the SWWB (Perpetua 2021). Therefore, only a single prediction (rather than a range) is provided for each parameter

Indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria

Table 7-4 Predicted Toe/Pop-out Seepage Chemistry for the TSF Buttress and Embankment

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria*	Operations			Post-Mining Prior to Cover Placement			Post-Mining after Cover Placement
			Mine Year -2 to 12			Mine Year 13 to 18			Mine Year 19 to 112
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average
pH	s.u.	6.5 - 9	8.39	8.35	8.61	8.42	8.41	8.44	Post-mining the application of a low permeability geosynthetic cover to the TSF Buttress and Embankment means any toe/pop-out seepage would report to groundwater
Alkalinity	mg/L as CaCO ₃	>20	107	92.2	192	114	110	117	
Ag	mg/L	0.0007 [†]	0.00098	0.00071	0.0037	0.00077	0.00074	0.00079	
Al	mg/L	0.05	0.0044	0.0041	0.0059	0.0045	0.0044	0.0046	
As	mg/L	0.01	6.23	3.37	22.4	6.09	5.98	6.21	
B	mg/L	-	1.71	0.83	3.64	2.12	2.03	2.21	
Ba	mg/L	2.0	0.0081	0.0067	0.011	0.0066	0.0065	0.0068	
Be	mg/L	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Ca	mg/L	-	26.8	10.2	29.9	24.3	23.3	25.4	
Cd	mg/L	0.00033 [†]	0.00092	0.00054	0.0024	0.00094	0.00093	0.00095	
Cl	mg/L	230	21.1	11.2	30.1	27.6	26.2	29.1	
Co	mg/L	-	0.0072	0.0047	0.010	0.0088	0.0084	0.0092	
Cr	mg/L	0.0106 ^{†††}	0.017	0.0050	0.024	0.023	0.023	0.024	
Cu	mg/L	0.002 ^{††}	0.004	0.004	0.004	0.004	0.004	0.004	
F	mg/L	2.0	2.27	0.97	3.60	3.18	3.02	3.34	
Fe	mg/L	0.3	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Hg	mg/L	0.000012	0.00041	<0.000006	0.00055	0.00057	0.00055	0.00059	
K	mg/L	-	36.4	24.6	76.3	39.3	37.8	41.0	
Mg	mg/L	-	57.2	39.5	91.3	69.4	65.6	73.3	
Mn	mg/L	0.05	0.24	0.094	0.27	0.22	0.21	0.23	
Mo	mg/L	-	0.091	0.029	0.14	0.14	0.14	0.14	
Na	mg/L	-	54.3	22.6	75.9	82.0	77.7	86.5	
Ni	mg/L	0.024 [†]	0.047	0.012	0.065	0.063	0.062	0.064	
P	mg/L	-	1.17	0.89	3.05	1.04	1.01	1.08	
Pb	mg/L	0.0009 [†]	0.015	0.0091	0.028	0.017	0.017	0.018	
Sb	mg/L	0.0052	2.83	1.89	7.19	2.78	2.69	2.89	

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Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria*	Operations			Post-Mining Prior to Cover Placement			Post-Mining after Cover Placement
			Mine Year -2 to 12			Mine Year 13 to 18			Mine Year 19 to 112
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Se	mg/L	0.0031	0.0046	0.0026	0.024	0.0028	0.0027	0.0029	
SO ₄	mg/L	250	240	143	296	309	296	322	
Tl	mg/L	0.000017	0.00009	0.00005	0.00010	0.00010	0.00010	0.00011	
V	mg/L	-	0.0100	0.010	0.010	0.010	0.010	0.010	
Zn	mg/L	0.054 [†]	0.16	0.082	0.21	0.22	0.21	0.23	
TDS	mg/L	500	573	414	943	639	617	663	
NO ₃ + NO ₂	mg/L as N	-	70.7	20.8	298	16.3	13.5	19.4	

Source: SRK 2021a

All values are for the dissolved fraction unless otherwise noted

< Indicates parameter was consistently below analytical detection limits in the HCT effluents, and is thus not expected at detectable concentrations in the buttress toe/pop-out seepage waters

- Indicates no guideline for parameter

[†]Indicates hardness-dependent parameter. The values listed are based on the East Fork SFSR hardness of 40 mg/L as calcium carbonate, which represents the 5th percentile hardness during the driest four months at node YP-SR-10 (East Fork SFSR below Meadow Creek) between April 2012 and May 2019.

^{††} Estimated criterion based on DEQ guidance on Biotic Ligand Model and limited site-specific SGP data

^{†††} Standard is for chromium VI and is based on Water Effect Ratio

Indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria

Both the runoff and the seepage from the facility report to a contact water pond and then to the water treatment plant. Sub-surface infiltration from the TSF Embankment and Buttress was modeled to mix with the alluvial groundwater under the facility footprint, resulting in a groundwater chemistry that has circum-neutral pH with antimony and arsenic concentrations above the strictest potentially applied water quality standards (**Table 7-5** and **Figure 7-4**). After the end of operations, predicted groundwater analyte concentrations decrease slightly as TSF Embankment and Buttress seepage is collected on surface. Upon placement of the geosynthetic cover, seepage to the ground surface is inhibited and residual water within the TSF Embankment and Buttress infiltrates, contributing to slightly higher groundwater concentrations. Other constituent concentrations are below standards for groundwater. However, because the alluvial groundwater in the system contributes discharge to surface water flows, it is worth noting that predicted long-term mercury (10 ng/L) and copper concentrations (0.002 mg/L) are increased relative to existing conditions but remain below the most stringent potentially applicable criteria.

Tailings Storage Facility (TSF)

Operational and post-closure water quality predictions have been developed for the TSF (SRK 2021a). The general modeling approach was to quantify:

- Solute concentrations in waters that could potentially seep through defects in the liner, both during operations and post-closure.
- Solute concentrations in groundwater underlying the TSF.
- Solute concentrations in consolidation water emerging at the surface of the TSF after operations end.
- Post-closure solute concentrations in commingled surface water runoff from the covered TSF surface. The model assumes this water consists of a mixture of run-on to the TSF, runoff, consolidation water and minor seepage through the TSF cover that may contact the upper surface of the tailings.

The conceptual model for the TSF is presented in **Figure 7-5**, illustrating the TSF water chemistry conditions during operations, closure prior to cover placement, and post-closure following cover placement (SRK 2021a). This conceptual model is based on Perpetua 2021a and is summarized below

Tailings generated by the Project would be deposited in a fully lined facility with an engineered rockfill dam and development rock buttress. The composite liner system inhibits process-related fluids from exiting the facility and mixing with surface water and groundwater. A drainage removal system of perforated pipes would be installed in the basin before the liner was constructed to collect and drain groundwater out from under the liner. Another drainage system of perforated pipes would be installed on top of the liner before tailings were discharged into the TSF. These upper drains are intended to reduce the hydraulic head on top of the liner system.

During operations, the TSF would store tailings solids, water entrained within the tailings, and free water atop the tailings (supernatant pool). Approximately 120 million tons of tailings solids would be stored in the TSF at full buildout, including approximately 115 million tons of ground ore, plus approximately 5 million tons of lime, ground limestone and gypsum resulting from the neutralization of oxidized sulfides. Water collected in or falling on the surface of the TSF would drain to the supernatant pool on top of the tailings and be recycled, along with tailings consolidation water, for use in ore processing. There would be no runoff from the TSF discharged to Meadow Creek during operations, as any precipitation that falls within the facility footprint would be contained within the facility and managed within the process circuit.

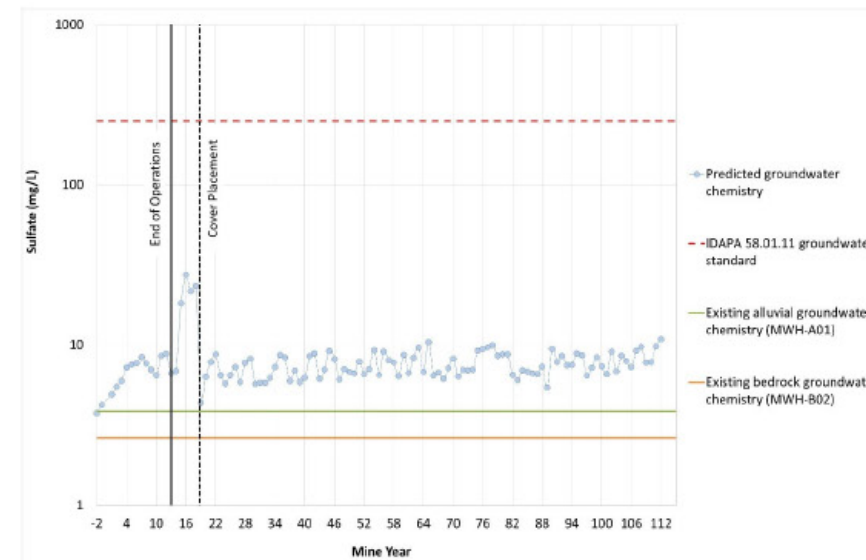
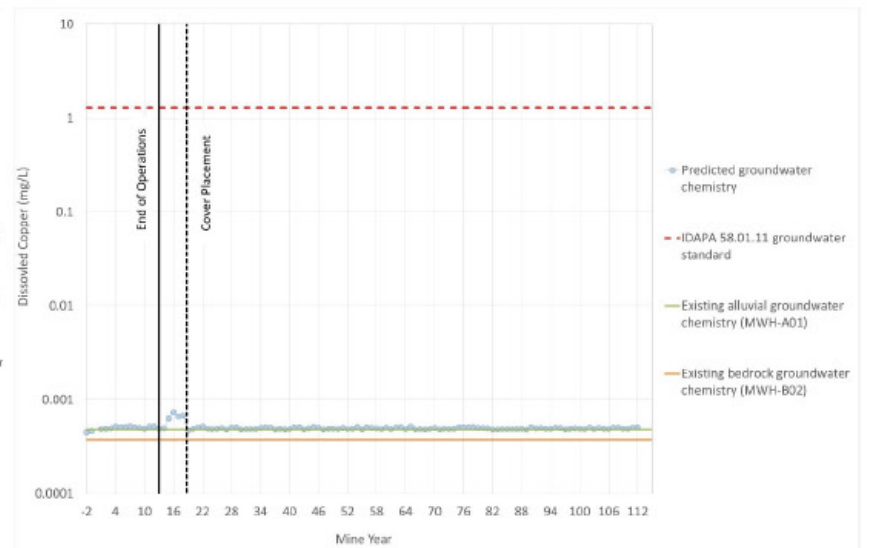
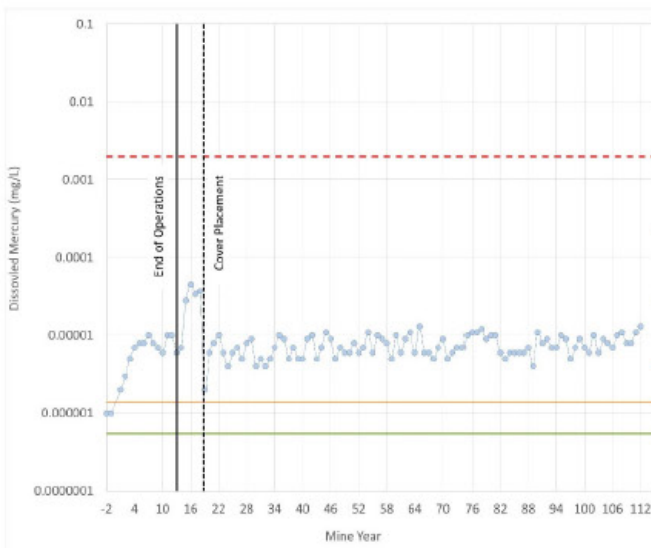
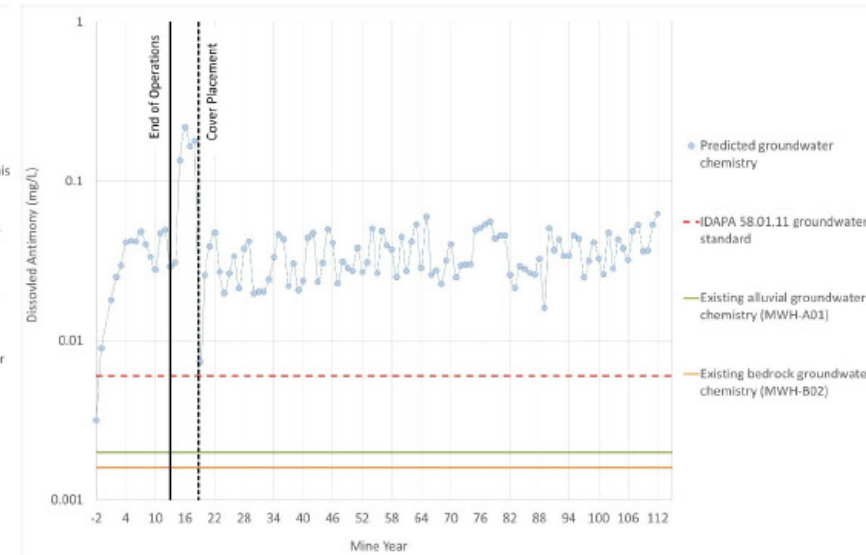
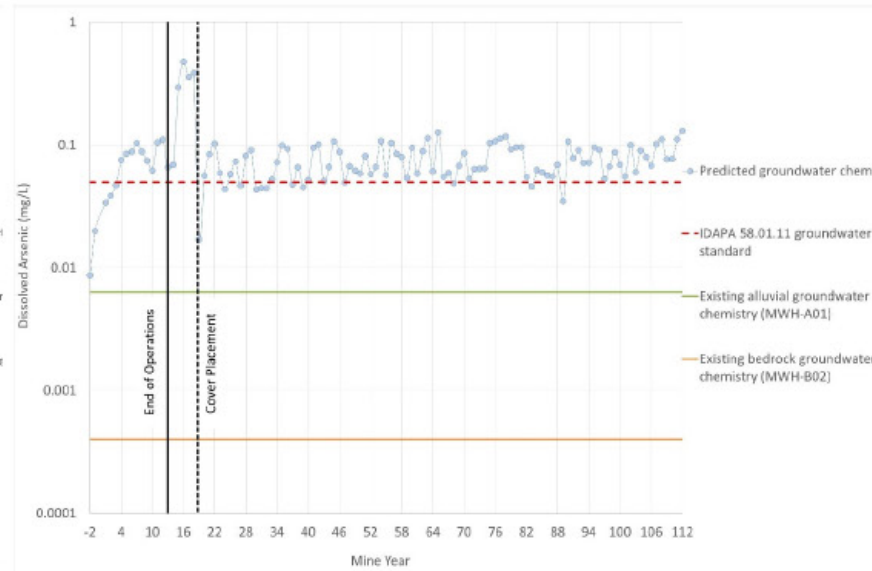
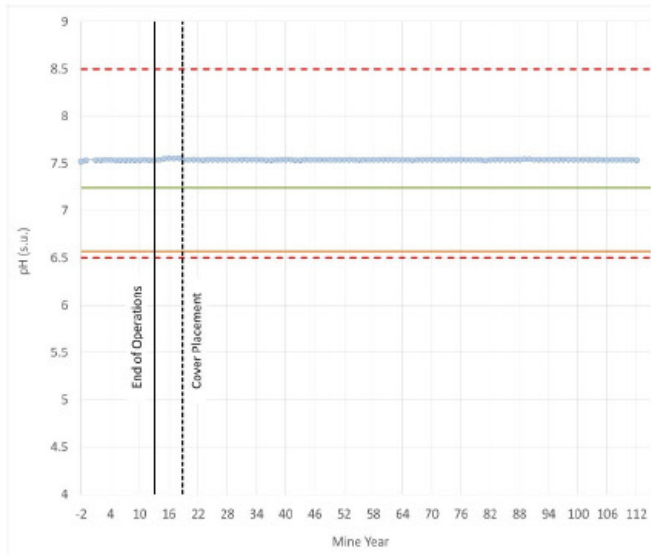
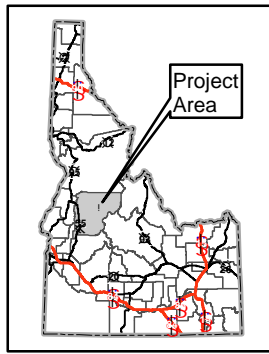
Table 7-5 Predicted Groundwater Chemistry under the TSF Buttress and Embankment

Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Existing alluvial groundwater chemistry under facility (MWH-A01)	Existing bedrock groundwater chemistry under facility (MWH-B02)	Operations			Post-Mining Prior to Cover Placement			Post-Mining after Cover Placement		
					Mine Year -2 to 12			Mine Year 13 to 18			Mine Year 19 to 112		
					Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
pH	mg/L	6.5 - 8.5*	7.24	6.57	7.53	7.52	7.54	7.55	7.53	7.56	7.54	7.53	7.55
Total Alkalinity	mg/L as CaCO ₃	-	59.5	38.7	55.9	54.1	56.6	58.2	55.7	59.9	56.7	55.7	57.4
Ag	mg/L	0.1*	9.6E-06	9.4E-06	0.00002	0.00001	0.00002	0.00004	0.00002	0.00007	0.00002	0.00001	0.00003
Al	mg/L	0.2*	0.0065	0.051	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
As	mg/L	0.05	0.0063	0.00040	0.067	0.0087	0.11	0.28	0.066	0.48	0.075	0.017	0.131
B	mg/L	-	0.0072	0.0074	0.027	0.0080	0.043	0.10	0.028	0.17	0.033	0.011	0.054
Ba	mg/L	2	0.0020	0.0028	0.0022	0.0022	0.0023	0.0023	0.0022	0.0025	0.0022	0.0021	0.0022
Be	mg/L	0.004	9.2E-06	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Ca	mg/L	-	17.8	10.2	16.4	15.8	16.6	16.7	16.3	16.9	16.6	16.2	16.9
Cd	mg/L	0.005	9.6E-06	0.00002	0.00002	0.00001	0.00003	0.00005	0.00002	0.00008	0.00002	0.00001	0.00003
Cl	mg/L	250*	0.30	0.27	0.55	0.30	0.75	1.52	0.55	2.43	0.66	0.35	1.02
Co	mg/L	-	0.00010	0.00026	0.00022	0.00015	0.00028	0.0005	0.0002	0.0008	0.0002	0.0001	0.0003
Cr	mg/L	0.1	0.00029	0.00020	0.00051	0.00027	0.00069	0.0013	0.00051	0.0020	0.00051	0.00032	0.0007
Cu	mg/L	1.3	0.00048	0.00038	0.0005	0.0005	0.0005	0.0006	0.0005	0.0007	0.0005	0.0005	0.0005
F	mg/L	4	0.076	0.074	0.11	0.083	0.13	0.22	0.11	0.32	0.12	0.08	0.15
Fe	mg/L	0.3*	0.012	0.055	0.00163	0.00159	0.0018	0.00154	0.00149	0.00165	0.00158	0.00151	0.0017
Hg	mg/L	0.002	5.5E-07	1.4E-06	6.1E-06	1.0E-06	0.00001	0.00003	6.0E-06	0.00005	7.6E-06	2.0E-06	1.3E-05
K	mg/L	-	0.77	0.57	1.13	0.72	1.37	2.46	1.10	3.73	1.21	0.81	1.62
Mg	mg/L	-	1.47	1.16	2.08	1.42	2.53	4.48	2.06	6.72	2.34	1.57	3.19
Mn	mg/L	0.05*	0.00080	0.011	0.0059	0.0035	0.0076	0.012	0.0050	0.020	0.0044	0.0027	0.0061
Mo	mg/L	-	0.0012	0.00029	0.0023	0.0012	0.0035	0.0074	0.0025	0.012	0.0027	0.0014	0.0040
Na	mg/L	-	2.66	3.87	3.65	3.12	4.30	6.51	3.74	9.14	3.96	3.06	4.95
Ni	mg/L	-	0.00019	0.00035	0.00084	0.00023	0.0013	0.0	0.0	0.0	0.0	0.0	0.0
P	mg/L	-	0.017	0.014	0.028	0.017	0.034	0.1	0.0	0.1	0.0	0.0	0.0
Pb	mg/L	0.015	2.4E-05	5.2E-05	0.00021	3.7E-05	0.00033	0.00081	0.00020	0.0014	0.00024	0.00006	0.00041
Sb	mg/L	0.006	0.0020	0.0016	0.033	0.0032	0.050	0.126	0.029	0.22	0.035	0.007	0.063
Se	mg/L	0.05	0.00050	0.00049	0.00053	0.00050	0.00054	0.00054	0.00053	0.00054	0.00054	0.00050	0.00068
SO ₄	mg/L	250*	3.86	2.62	6.70	3.76	8.81	17.4	6.65	27.4	7.55	4.35	10.85
Tl	mg/L	0.002	0.00001	9.3E-06	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001
V	mg/L	-	0.00031	0.00019	0.00028	0.00028	0.00029	0.00028	0.00027	0.00029	0.00029	0.00028	0.00030
Zn	mg/L	5*	0.00087	0.0014	0.0031	0.0011	0.0047	0.011	0.0032	0.018	0.0036	0.0014	0.0059
TDS	mg/L	500*	63.1	42.6	65.2	58.3	68.8	85.4	64.7	104	67.0	61.3	72.5
NO ₂ + NO ₃	mg/L as N	10	0.49	0.62	1.07	0.59	1.56	1.17	0.70	1.68	0.61	0.54	0.71

All values are for the dissolved fraction unless otherwise noted.

- Indicates no guideline for parameter; * Indicates secondary groundwater standard.

Shading indicates value is greater than Idaho Groundwater Quality Standard (IDAPA 58.01.11).

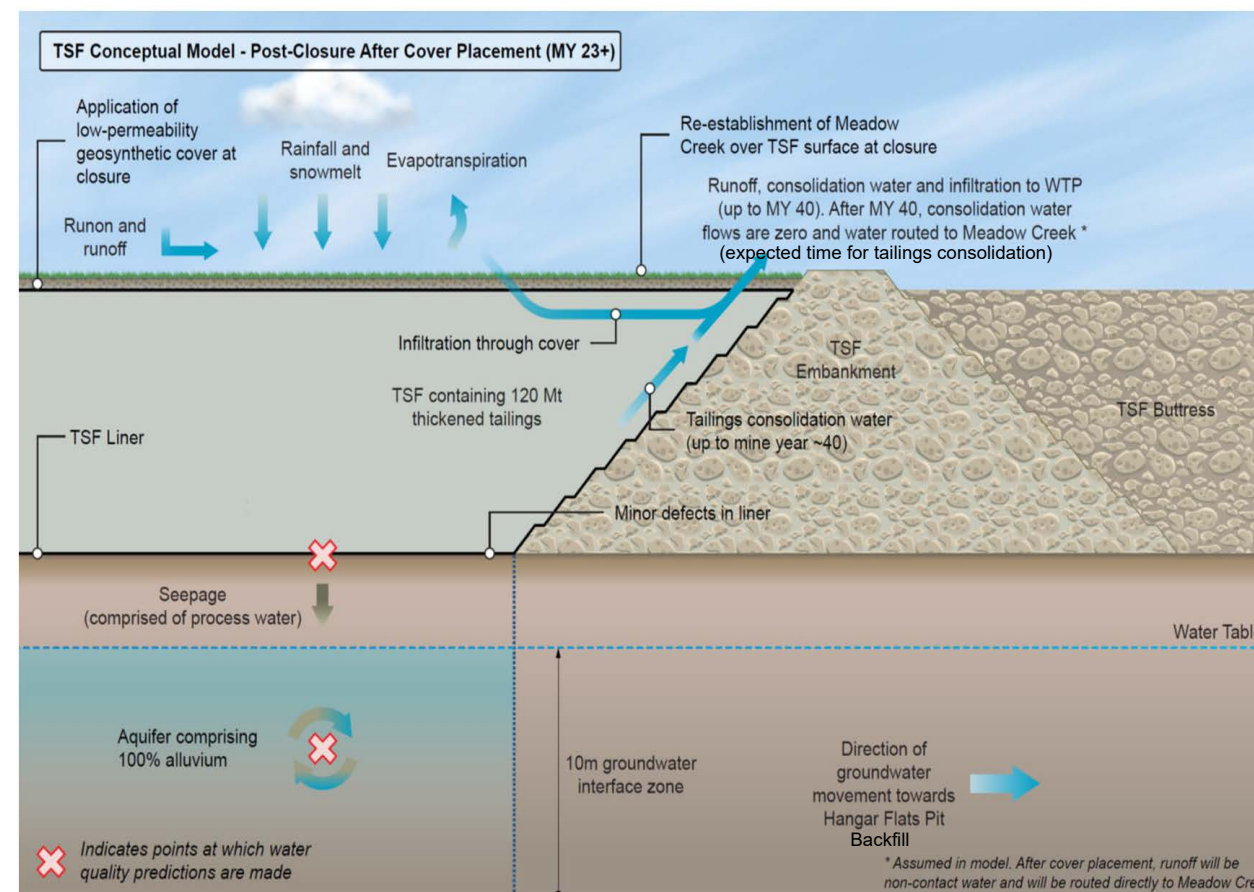
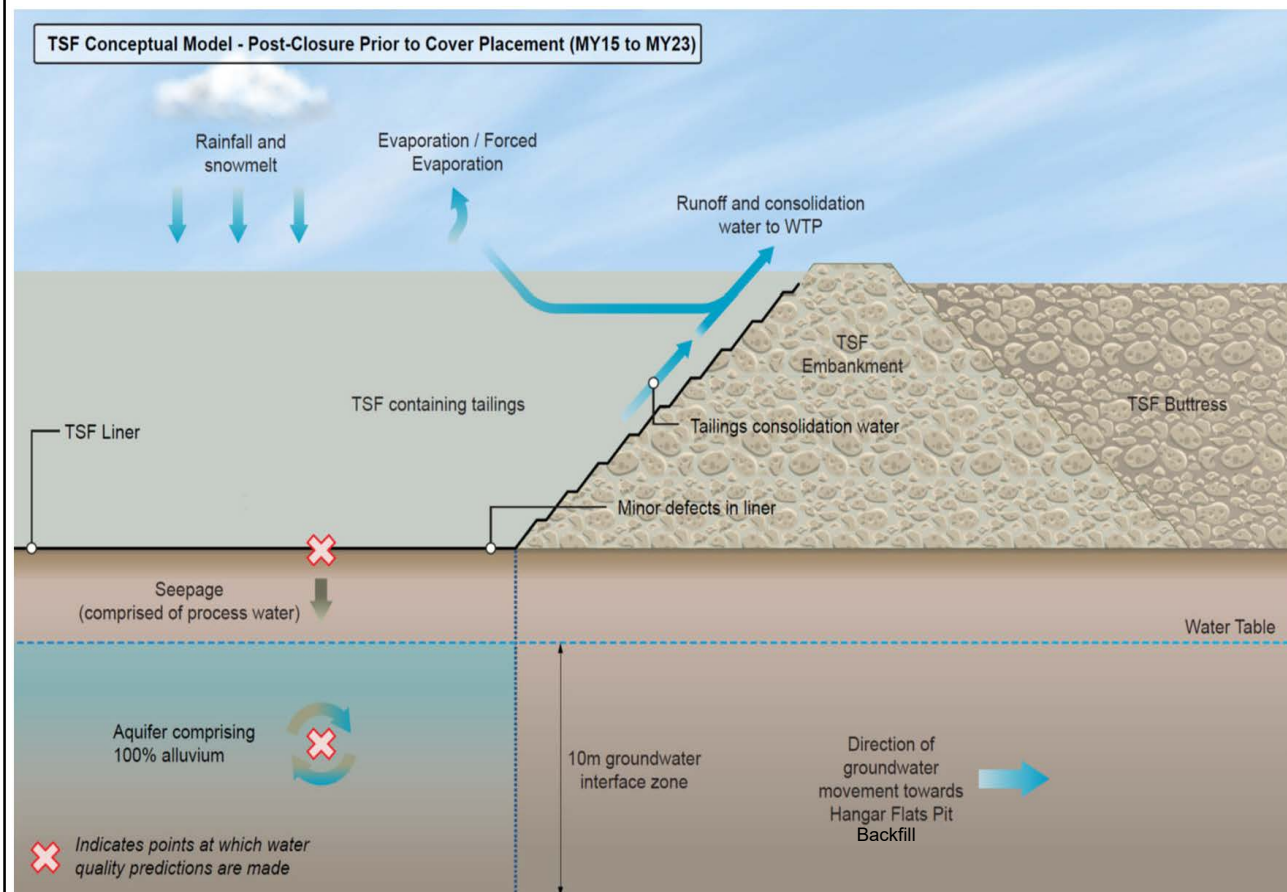
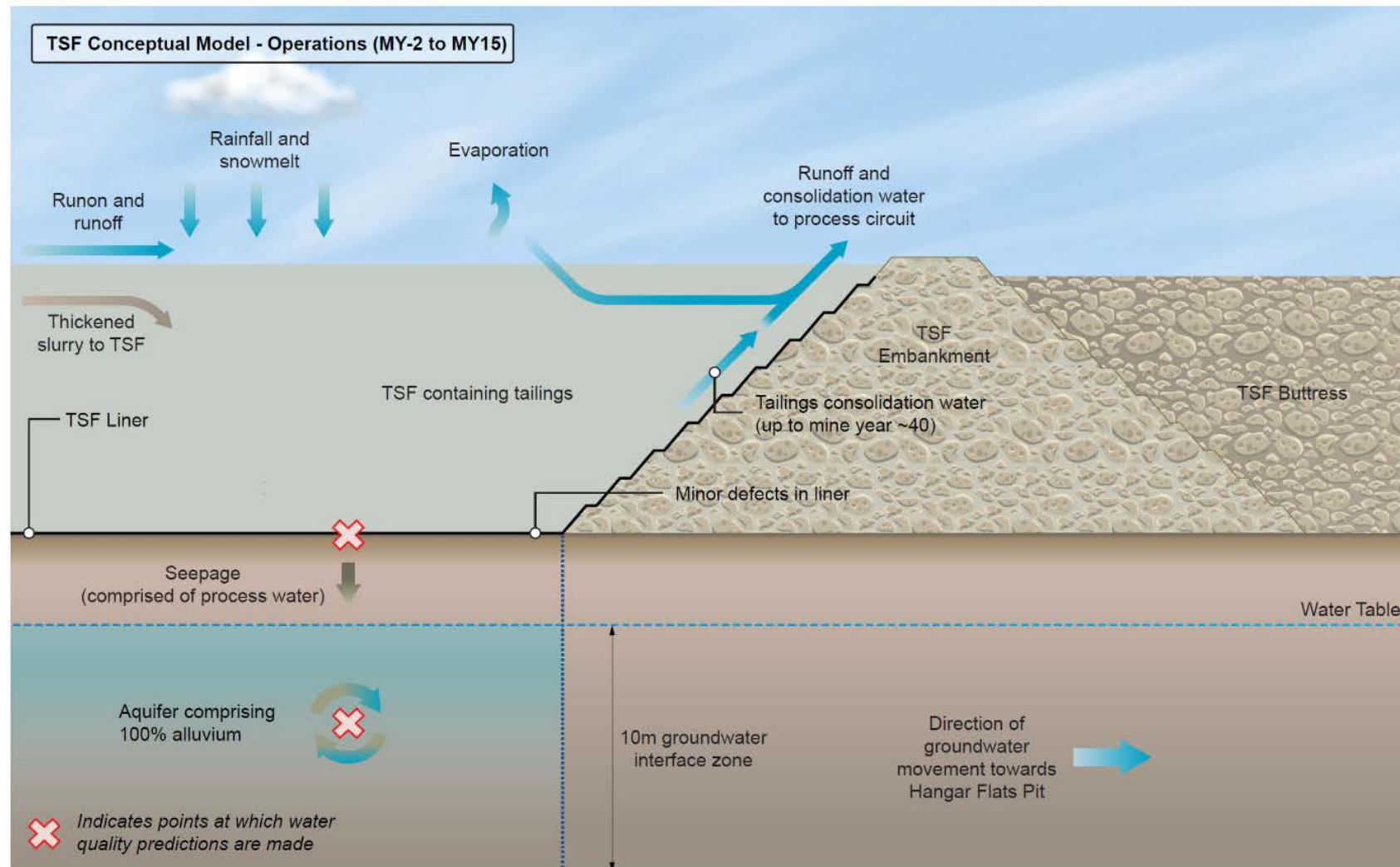
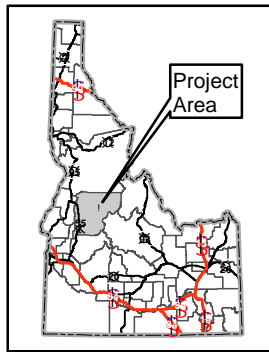


**Figure 7-4
Predicted Tailings Storage
Facility Buttress Seepage
Chemistry**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2021)





**Figure 7-5
Conceptual Model
Tailings Storage Facility**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2021)



During operations, pore water released from the tailings during consolidation would report to the supernatant pool or to the over-liner drains, and from there be collected and pumped either to the supernatant pool or directly to the reclaim system.

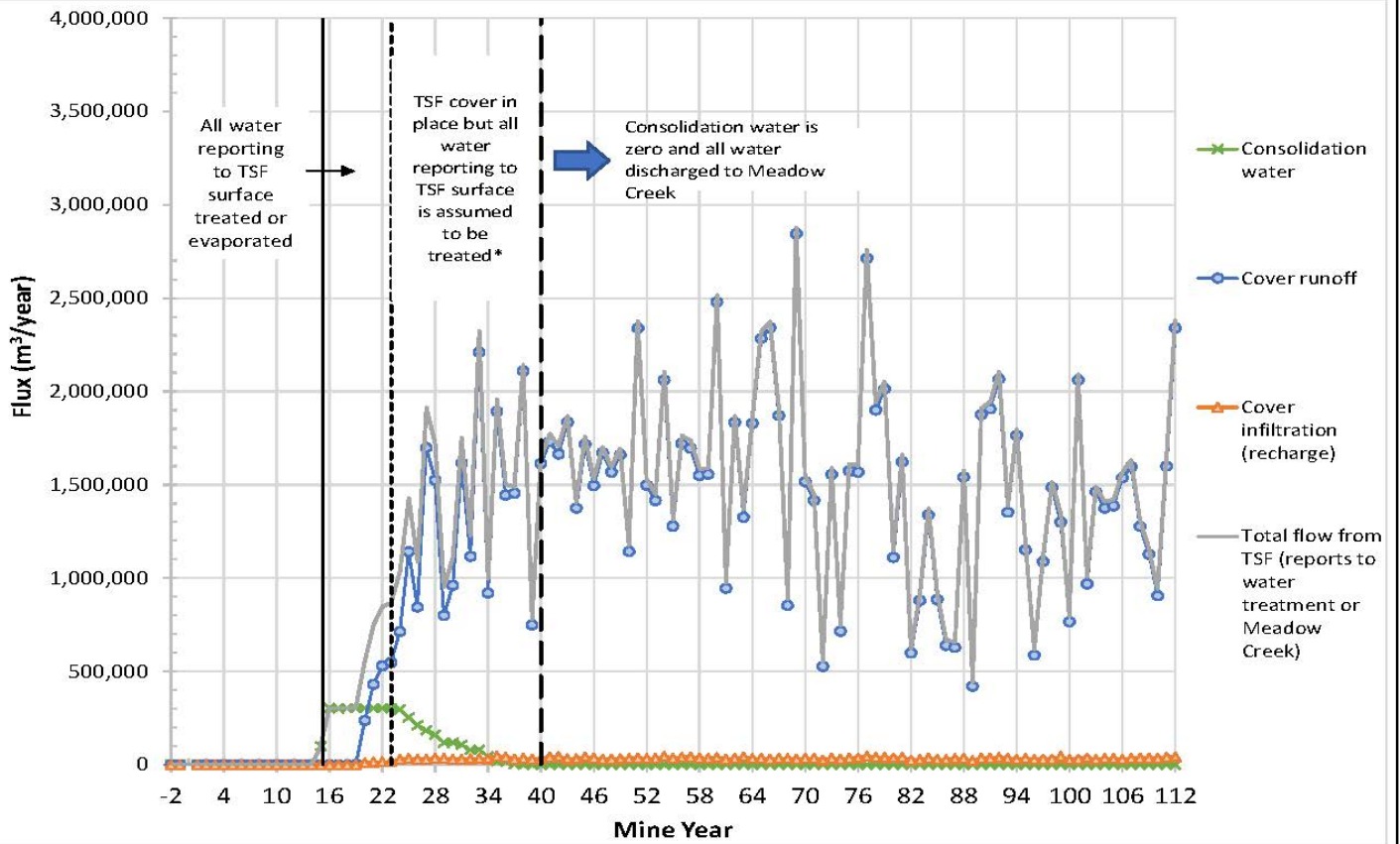
At closure, the TSF facility would be graded and contoured, and a low permeability geosynthetic cover would be placed on top of the tailings. The reclamation would require approximately nine years after ore processing operations cease to allow sufficient tailings consolidation, drainage, and drying to reclaim the facility surface and install the restored Meadow Creek stream channel across the facility (Perpetua 2021a). The application of a low permeability geosynthetic cover would reduce infiltration into the TSF solids by at least 95%. Minor infiltration through the cover may contact the upper portion (0.01 meters) of the underlying tailings, and this contact water would mix with consolidation water.

Consolidation of the tailings would continue after cover placement and surface reclamation, at gradually declining rates, and this consolidation water would be withdrawn from beneath the geosynthetic cover using a combination of wells, wicks, and/or gravel drains (that would convey water to a sump with an extraction well), and routed to water treatment. The rates of consolidation water withdrawal along with cover infiltration and runoff were predicted as part of the Site-Wide Water Balance modeling effort (Brown and Caldwell 2021a) and are depicted in **Figure 7-6**. The predicted time for tailings consolidation and collection of consolidation water is expected to be until year 40.

Despite the best practice design, there could be minor seepage from manufacturing defects and other openings in the basal TSF liner. It is assumed that there would be minor seepage from defects in the TSF liner, which would ultimately infiltrate to groundwater. This solution would interact with groundwater in the uppermost 32.8 feet (10 meters) of the alluvial aquifer beneath the footprint of the facility. Groundwater below the facility would flow toward the backfilled Hangar Flats pit.

Details of the tailings water chemistry prediction are included in SRK 2021a and summarized below.

Metallurgical testing provided an opportunity to collect samples representative of tailings material and process water that were used in the assessment of operational and post-closure tailings geochemistry (**Table 7-6**).



Note: Treatment of all water reporting to the TSF following placement of the cover is a simplifying assumption used in the SWWC model. In reality, only the consolidation water will be treated and all other TSF surface water will be routed to Meadow Creek after cover placement

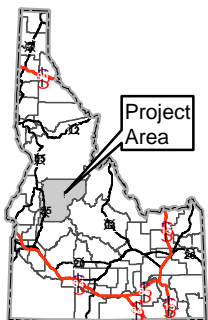


Figure 7-6
Tailings Storage Facility
Seepage Volume

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 7-6 Details of Tailings Composite Samples

Composite ID	Material	Time Period (Mine Year)	Proportion of Total Tailings ¹	Proportion of Last 3 Years Production ¹	HCT Test Duration used in Source Term	Total S (%) ²	Sulfide S (%) ²	NPR ²	As (mg/kg) ²	Sb (mg/kg) ²
HCT-4331 SB100 CON 10 PP HCT	Concurrent Mining of Yellow Pine (85%) and Hangar Flats (15%)	1 - 7	32%	0%	77	1.25	0.060	19	3,150	0.026
HCT-4331 CON 5 COMBINED TAILS	Late YP Production	4 - 7	21%	18%	77	0.66	0.090	8.9	2,280	0.0027
HCT-4331 CON 11 COMBINED TAILS	West End Sulfide	11 - 12	11%	12%	77	1.84	0.69	9.9	2,870	0.017
HCT-4331 CON 12 COMBINED TAILS	Concurrent Mining of West End (50%) and Hangar Flats (50%)	6 - 10	6%	3%	77	1.04	0.11	38	1,580	0.026
HCT-4331 5197 CN-170/D1 HCT	West End Oxide	-1 - 12	30%	67%	77	0.29	0.090	58	1,040	0.0063

¹ AECOM 2020b

² SRK 2021a

For the purpose of the TSF geochemical model, it is assumed that pore water within the TSF primarily comprises process water chemistry. Representative process water chemistry data were obtained from HCT tailings decant solution collected as part of the metallurgical test work program (**Table 6-6**).

Leaching of tailings materials post-closure following the dissipation of pore water would yield a water chemistry as characterized by the SPLP testing discussed in **Section 6.2** above.

The predicted post-closure TSF water chemistry is presented in **Table 7-7** and is summarized in **Figure 7-7** for key constituents of concern (arsenic, antimony, mercury, sulfate, pH, and copper). During the early closure period and prior to cover placement (between Mine Years 15 and 23), TSF surface water chemistry would be dominated by tailings consolidation water expelled from the tailings solids. During this period, several constituent concentrations are predicted to be above the strictest potentially applicable water quality standards, including arsenic, antimony, fluoride, mercury, manganese, silver, sulfate, thallium, total cyanide, and WAD cyanide. These waters would be collected and routed to the treatment plant and would not be discharged to Meadow Creek prior to treatment.

When tailings are sufficiently consolidated to allow equipment to access the TSF surface around Mine Year 23, a geosynthetic cover would be placed over the tailings to reduce meteoric water contact with tailings material and infiltration into the TSF. During and following cover placement, tailings would continue to consolidate and produce water. Constituent concentrations in TSF surface waters decrease between Mine Years 15 and 40 as the volume of consolidation water declines (**Figure 7-7**). Through this period (approximately 40 years), TSF surface water would be routed to the water treatment plant before discharge to Meadow Creek.

From Mine Year 41 onwards, it is expected that consolidation would be complete and pore water drainage from the tailings would cease (Brown and Caldwell 2021c). Thereafter, TSF surface waters would then be comprised of a mixture of runoff and runoff from the TSF cover, in addition to infiltration through defects in the cover that would contact the uppermost surface of the tailings then mix with other interstitial waters within the cover. During this period, TSF surface waters are predicted to be slightly acidic (pH 5.7 to 5.8) and pH and alkalinity are below the strictest potentially applicable surface water quality standard. This reflects the naturally acidic pH of rainwater rather than the tailings geochemistry. The tailings geochemical characterization test work demonstrates that the tailings material is non-acid generating (SRK 2021c). Annual average concentrations of all other parameters in TSF surface waters are predicted to be below the strictest potentially applicable surface water quality standards from Mine Year 41 onwards.

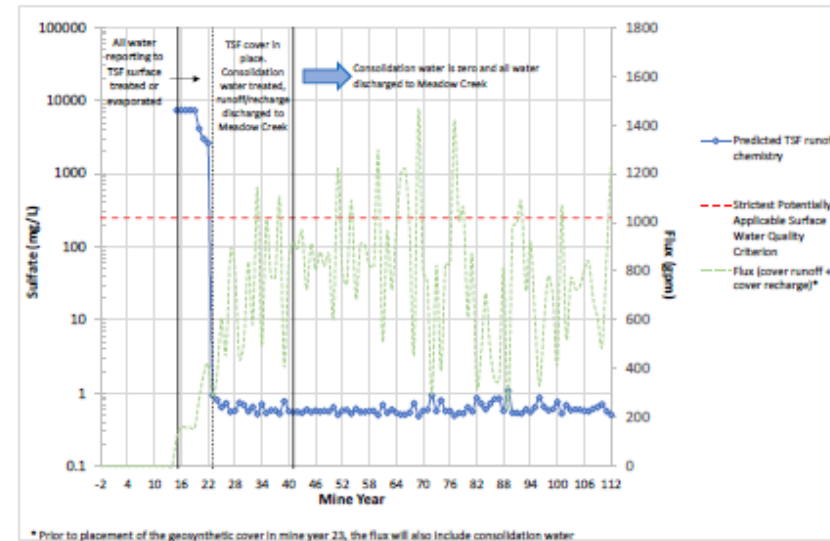
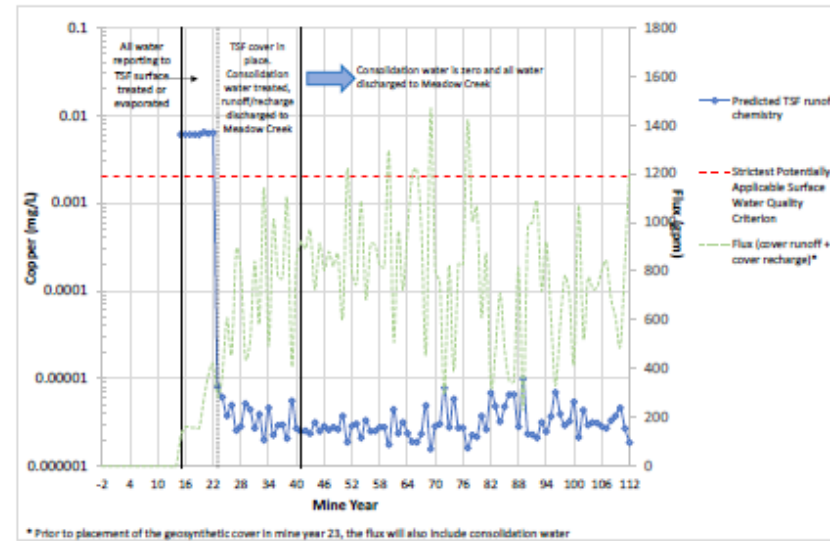
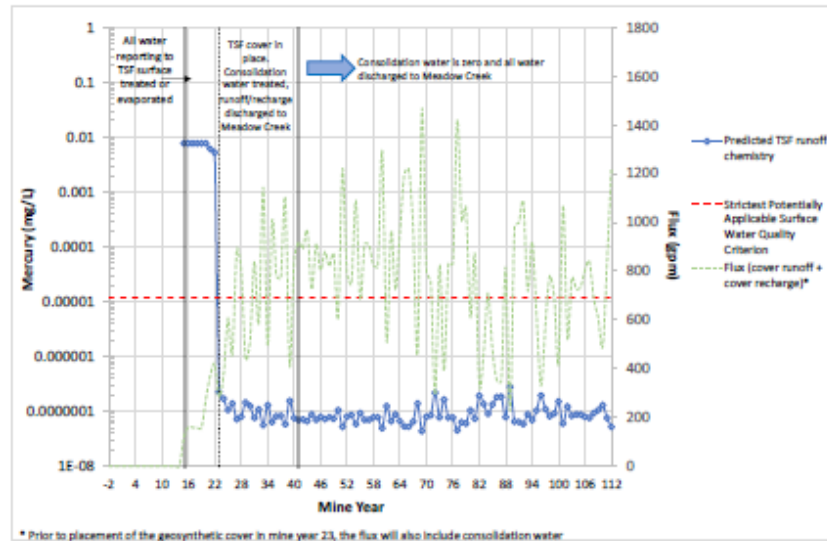
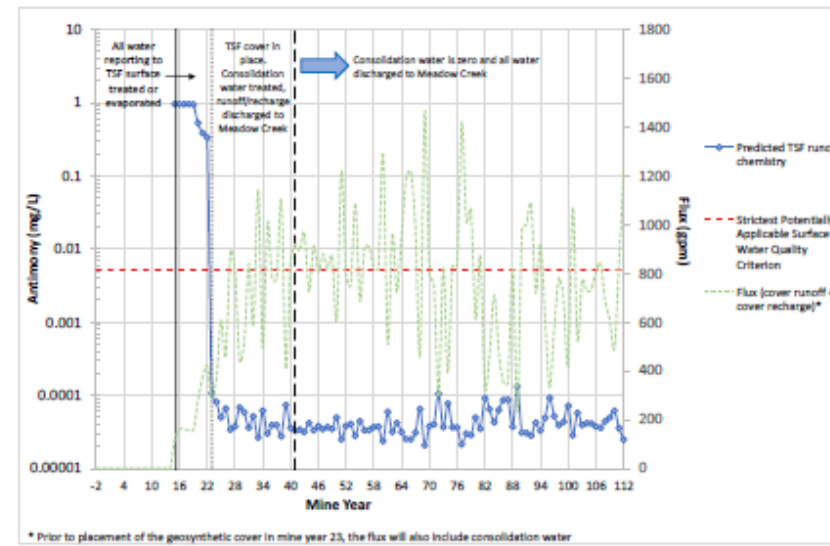
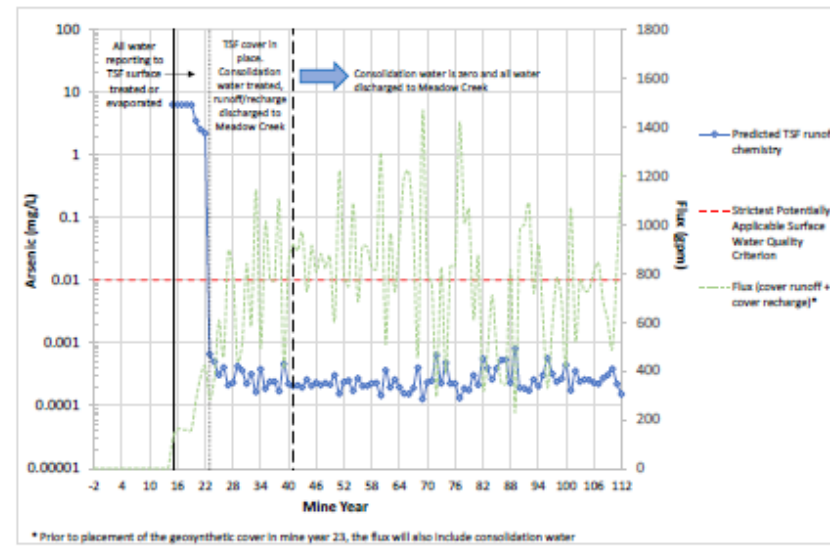
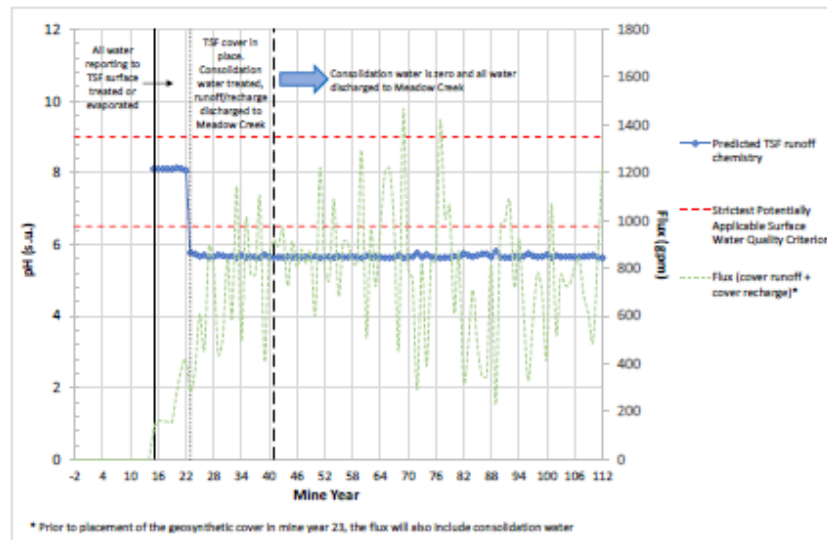
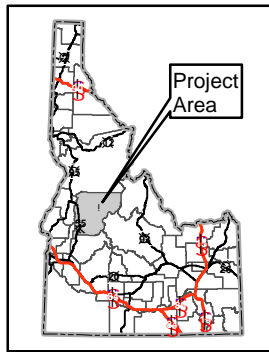


Figure 7-7
Predicted Tailings Storage
Facility Seepage Chemistry

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 7-7 Predicted TSF Surface Water Chemistry

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria	Operations Mine Year -2 to 12			Post-Mining during Active Treatment and Prior to Cover Placement* Mine Year 15** to 22			Post-Mining during Active Treatment and After Cover Placement Mine Year 23 to 40			Post-Mining no Water Treatment Mine Year 41 to 112			
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	
pH	mg/L	6.5 - 9	No surface water runoff from TSF during operations				8.11	8.07	8.14	5.68***	5.63***	5.77***	5.66***	5.62***	5.81***
Total Alkalinity	mg/L as CaCO ₃	>20		66.9	53.9	70.2	0.056***	0.029***	0.11***	0.048***	0.022***	0.14***			
Ag	mg/L	0.0007†		0.0043	0.0019	0.0055	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			
Al	mg/L	0.05		0.00014	0.00003	0.00022	0.00009	0.00005	0.00014	0.00008	0.00004	0.00017			
As	mg/L	0.01		4.99	2.21	6.35	0.00032	0.00016	0.00066	0.00027	0.00013	0.00081			
B	mg/L	-		0.00006	0.00004	0.00010	0.00003	0.00001	0.00005	0.00002	0.00001	0.00007			
Ba	mg/L	2		0.0014	0.0012	0.0018	0.00001	0.00001	0.00003	0.00001	5.1E-06	0.00003			
Be	mg/L	-		<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008			
Ca	mg/L	-		281	147	341	0.24	0.20	0.32	0.23	0.19	0.36			
Cd	mg/L	0.00033†		0.00027	0.00012	0.00034	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005			
Cl	mg/L	230		45.3	20.0	57.6	0.10	0.100	0.10	0.10	0.10	0.10			
Co	mg/L	-		0.00003	0.00002	0.00005	0.00001	0.00001	0.00003	0.00001	5.4E-06	0.00003			
Cr	mg/L	0.0106†††		1.7E-06	1.1E-06	2.9E-06	7.7E-07	4.0E-07	1.6E-06	6.6E-07	3.1E-07	2.0E-06			
Cu	mg/L	0.002††		0.0061	0.0060	0.0064	3.9E-06	2.0E-06	8.1E-06	3.3E-06	1.6E-06	0.00001			
F	mg/L	2		3.40	1.95	3.98	0.00024	0.00012	0.00049	0.00020	9.5E-05	0.00061			
Fe	mg/L	0.3		1.4E-06	6.8E-09	1.9E-06	1.9E-07	1.0E-07	3.1E-07	1.8E-07	7.3E-08	3.2E-07			
Hg	mg/L	0.000012		0.0072	0.0053	0.0077	1.1E-07	5.6E-08	2.3E-07	9.4E-08	4.4E-08	2.8E-07			
K	mg/L	-		88.9	39.4	113	0.040	0.038	0.045	0.039	0.037	0.048			
Mg	mg/L	-		182	80.6	232	0.22	0.21	0.23	0.22	0.21	0.23			
Mn	mg/L	0.05		0.22	0.099	0.29	0.00002	0.00001	0.00005	0.00002	9.7E-06	0.00006			
Mo	mg/L	-		0.15	0.064	0.19	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			
Na	mg/L	-		2499	1100	3181	0.16	0.15	0.20	0.16	0.14	0.22			
Ni	mg/L	0.024†		<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008			
P	mg/L	-		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
Pb	mg/L	0.0009†		2.9E-07	1.8E-07	4.9E-07	1.3E-07	6.7E-08	2.7E-07	1.1E-07	5.2E-08	3.3E-07			
Sb	mg/L	0.0052		0.75	0.33	0.96	0.00005	0.00003	0.00011	0.00004	0.00002	0.00013			
Se	mg/L	0.0031	7.4E-07	7.4E-07	7.4E-07	3.5E-07	1.9E-07	7.4E-07	1.6E-07	1.0E-07	2.8E-07				
SO ₄	mg/L	250	5830	2607	7392	0.65	0.52	0.94	0.61	0.49	1.08				
Tl	mg/L	0.000017	0.0020	0.00086	0.0025	1.2E-07	6.2E-08	2.5E-07	1.0E-07	4.8E-08	3.1E-07				
V	mg/L	-	0.00002	0.00001	0.00003	7.3E-06	3.8E-06	0.00002	6.3E-06	2.9E-06	0.00002				
Zn	mg/L	0.054†	6.9E-06	4.3E-06	0.00001	3.1E-06	1.6E-06	6.4E-06	2.7E-06	1.3E-06	8.0E-06				
NO ₂ + NO ₃	mg/L as N	-	6.96	3.07	8.85	0.00004	0.00002	0.00008	0.00003	0.00001	0.00009				
TDS	mg/L	500	8976	4032	11371	1.44	1.23	1.91	1.38	1.18	2.12				

All values are for the dissolved fraction unless otherwise noted. Shading indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria

* TSF surface water is assumed to report to water treatment in Mine Years 15 (when processing of stockpiled ore ends) through 40.

** During Mine Years 13 and 14, open pit mining would have ended, but stockpiled ore would be processed with water reporting to the TSF surface being recycled.

*** The pH and alkalinity reflect the naturally acidity of rainwater (pH 5.2) rather than the tailings geochemistry which is non-acid-generating.

< Indicates parameter was consistently below analytical detection limits in the geochemical testing and is thus not expected at detectable concentrations in the TSF surface waters.

- Indicates no guideline for parameter.

† Indicates hardness-dependent parameter. Calculated based on 100 mg/L total hardness and water effect ratio of 1.

†† Estimated criterion based on DEQ guidance on Biotic Ligand Model and limited site-specific SGP data.

††† Standard is for chromium VI and is based on Water Effect Ratio.

As described above, despite application of best practices, there is a potential for the tailings facility basal liner to develop small-scale leaks through which tailings solution could enter the subsurface and infiltrate to local alluvial groundwater. Leakage estimates have been developed for each year of operations based on the water elevation and maximum head for each year. The calculated liner leakage estimates are provided in **Table 7-8**.

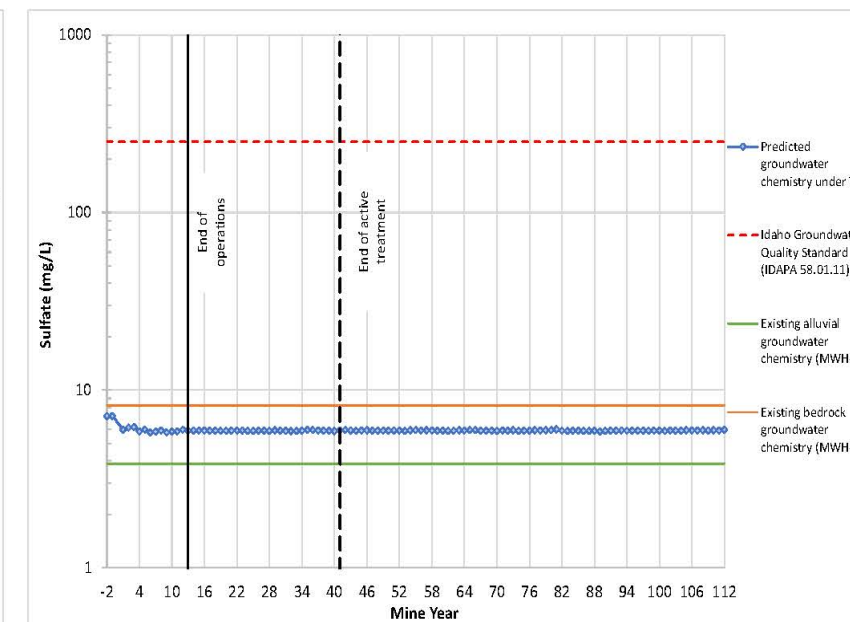
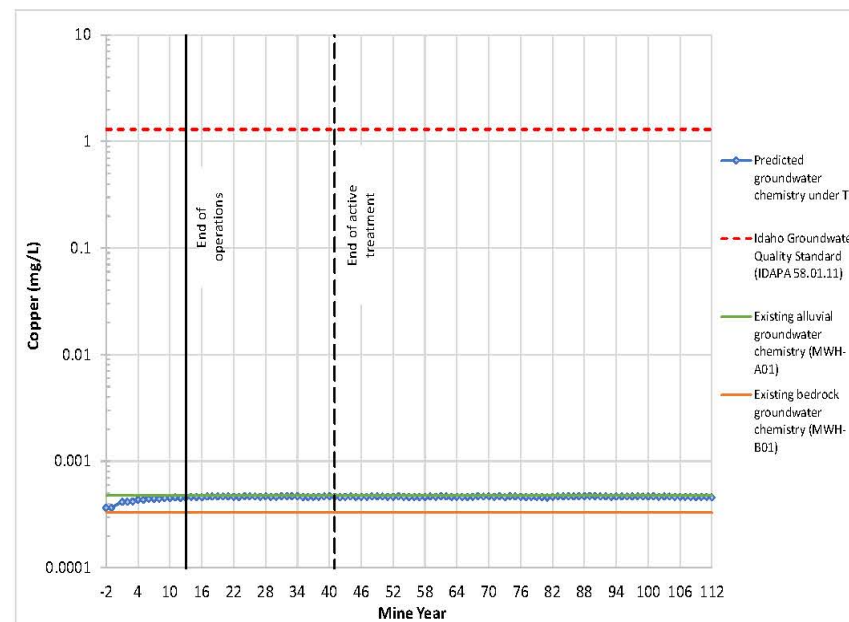
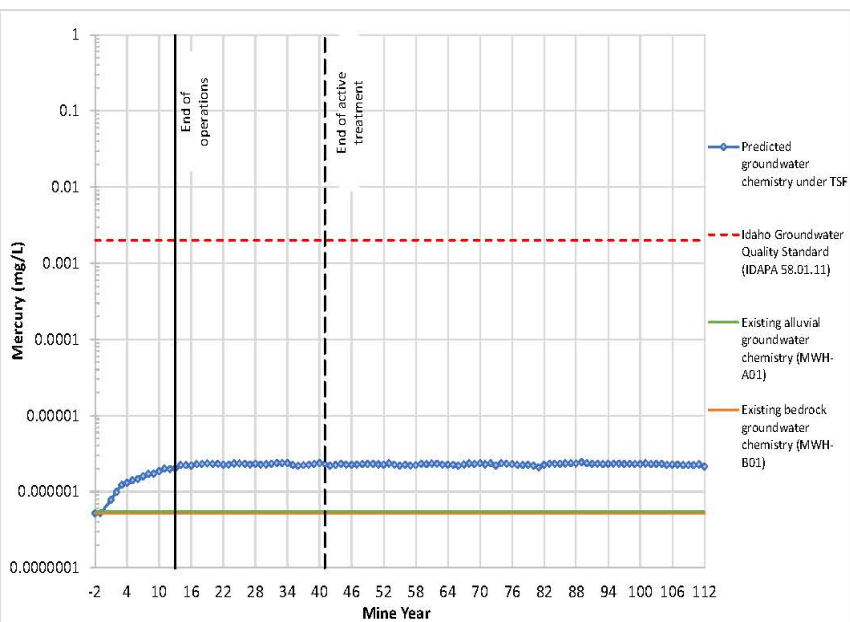
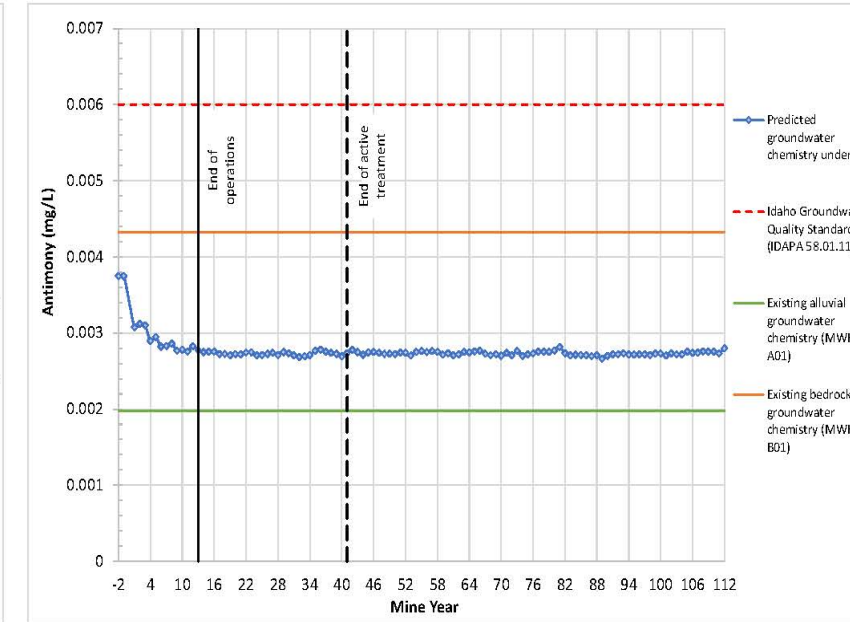
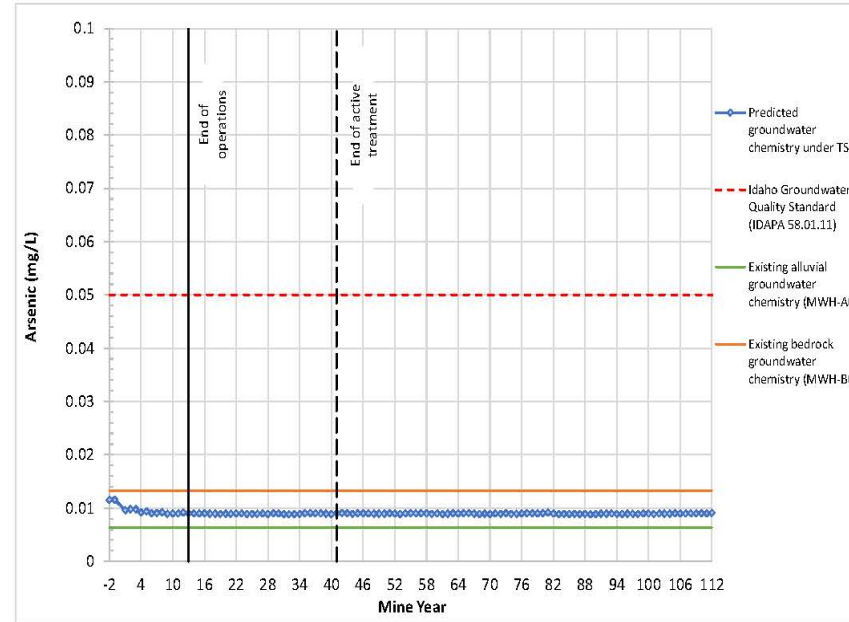
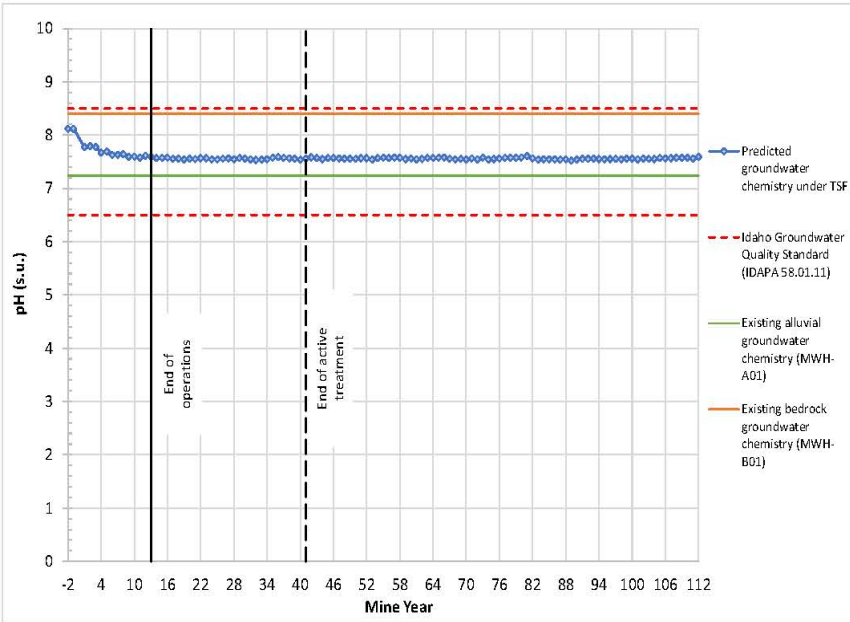
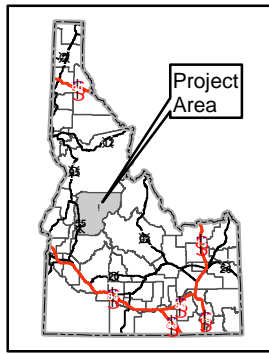
Table 7-8 TSF Liner Leakage Estimates (Tierra Group, 2020)

Mine Year	Tailings Elevation (m)	Area (m²)	Maximum Head on Liner (m)	Liner Leakage (m³/year)
1	2,063	292,076	42	34.3
2	2,080	433,328	59	64.8
3	2,092	532,579	71	96.5
4	2,102	608,787	82	130
5	2,110	691,655	89	158
6	2,116	749,533	96	186
7	2,122	830,742	101	212
8	2,127	874,224	106	241
9	2,132	955,724	111	267
10	2,136	1,000,833	115	294
11	2,140	1,105,979	119	320
12	2,144	1,152,603	123	345
13	2,147	1,202,752	127	372
14	2,151	1,255,297	130	402

Following operations and into closure, liner leakage decreasing from the Mine Year 14 rate down to near zero is assumed to occur until Mine Year 41 when tailing consolidation is expected to be complete and very minor pore water would drain from the tailings.

The predicted groundwater chemistry underlying the TSF after the TSF leakage is mixed with the upper portion of the alluvial aquifer is presented in **Table 7-9** and time series plots for the key constituents of interest are presented on **Figure 7-8**. These figures show predicted groundwater quality for the operational and post-closure period compared to IDAPA 58.01.11 groundwater quality standards and existing alluvial aquifer groundwater quality in the TSF area (MWH-A01 and MWH-B01).

The results demonstrate that all constituents are predicted to be below IDAPA 58.01.11 groundwater quality standards in groundwater underlying the future TSF. Predicted groundwater quality under the facility is very similar to existing groundwater chemistry for both operational and post-closure conditions. Furthermore, no significant increases in concentration are predicted as a result of the TSF, which relates to the very low expected seepage volumes from the facility (Tierra Group, 2020).



**Figure 7-8
Predicted Groundwater
Chemistry Underlying the
Tailings Storage Facility**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2021)



Table 7-9 Predicted Groundwater Chemistry Underlying the TSF

Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Existing alluvial groundwater chemistry under facility (MWH-A01)	Existing bedrock groundwater chemistry under facility (MWH-B01)	Operations			Post-Mining during Active Treatment			Post-Mining no Water Treatment		
					Mine Year -2 to 12			Mine Year 13 to 40			Mine Year 41 to 112		
					Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
pH	mg/L	6.5 - 8.5*	7.24	8.40	7.73	7.58	8.12	7.56	7.53	7.59	7.56	7.52	7.61
Total Alkalinity	mg/L as CaCO ₃	-	59.5	66.1	62.3	61.4	64.5	61.3	61.2	61.5	61.3	61.1	61.6
Ag	mg/L	0.1*	9.6E-06	9.8E-06	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Al	mg/L	0.2*	0.0065	0.017	0.011	0.0096	0.014	0.0094	0.0092	0.0096	0.0094	0.0090	0.0098
As	mg/L	0.05	0.0063	0.013	0.0096	0.0089	0.012	0.0090	0.0088	0.0091	0.0090	0.0088	0.0092
B	mg/L	-	0.0072	0.0088	0.0079	0.0077	0.0084	0.0077	0.0076	0.0077	0.0077	0.0076	0.0077
Ba	mg/L	2	0.0020	0.0036	0.0027	0.0025	0.0032	0.0024	0.0024	0.0025	0.0024	0.0024	0.0025
Be	mg/L	0.004	0.000009	0.000012	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Ca	mg/L	-	17.8	18.9	18.3	18.2	18.7	18.2	18.1	18.2	18.2	18.1	18.2
Cd	mg/L	0.005	0.000010	0.000012	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Cl	mg/L	250*	0.30	0.39	0.34	0.33	0.37	0.33	0.33	0.33	0.33	0.33	0.33
Co	mg/L	-	0.00010	0.00013	0.00011	0.00011	0.00012	0.00011	0.00011	0.00011	0.00011	0.00011	0.00011
Cr	mg/L	0.1	0.00029	0.00026	0.00028	0.00027	0.00028	0.00028	0.00028	0.00029	0.00028	0.00028	0.00029
Cu	mg/L	1.3	0.00048	0.00033	0.00043	0.00037	0.00046	0.00047	0.00046	0.00047	0.00046	0.00046	0.00047
F	mg/L	4	0.076	0.22	0.14	0.12	0.19	0.12	0.11	0.12	0.12	0.11	0.12
Fe	mg/L	0.3*	0.012	0.024	0.017	0.015	0.021	0.015	0.015	0.015	0.015	0.015	0.016
Hg	mg/L	0.002	0.0000005	0.0000005	0.0000014	0.0000005	0.0000020	0.0000023	0.0000020	0.0000024	0.0000023	0.0000021	0.0000024
K	mg/L	-	0.77	0.67	0.73	0.69	0.75	0.75	0.75	0.76	0.75	0.75	0.76
Mg	mg/L	-	1.47	1.89	1.66	1.62	1.79	1.61	1.61	1.62	1.61	1.60	1.63
Mn	mg/L	0.05*	0.00080	0.0011	0.00094	0.00091	0.0010	0.00091	0.00091	0.00092	0.00092	0.00091	0.00092
Mo	mg/L	-	0.0012	0.0060	0.0033	0.0027	0.0049	0.0026	0.0025	0.0027	0.0026	0.0024	0.0028
Na	mg/L	-	2.66	6.88	4.61	4.20	5.84	4.18	4.11	4.26	4.19	4.07	4.32
Ni	mg/L	-	0.00019	0.00022	0.00020	0.00020	0.00021	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
P	mg/L	-	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
Pb	mg/L	0.015	0.00002	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003	0.00003
Sb	mg/L	0.006	0.0020	0.0043	0.0030	0.0028	0.0037	0.0027	0.0027	0.0028	0.0027	0.0027	0.0028
Se	mg/L	0.05	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050
SO ₄	mg/L	250*	3.86	8.23	6.12	5.78	7.16	5.93	5.88	5.98	5.93	5.85	6.01
Tl	mg/L	0.002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
V	mg/L	-	0.00031	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032	0.00032
Zn	mg/L	5*	0.00087	0.0014	0.0011	0.0010	0.0013	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
NO ₂ + NO ₃	mg/L as N	10	0.49	0.81	0.62	0.58	0.73	0.58	0.57	0.59	0.58	0.57	0.59
TDS	mg/L	500*	63.1	76.9	69.4	68.1	73.5	68.0	67.8	68.3	68.0	67.6	68.4

All values are for the dissolved fraction unless otherwise noted

- Indicates no guideline for parameter; * Indicates secondary groundwater standard.

Shading indicates value is greater than Idaho Groundwater Quality Standard (IDAPA 58.01.11)

Water Treatment

The mine-affected waters described above that report to the ground surface would be subject to consumptive use in ore processing with any water production above consumptive use subject to water treatment and discharge. To summarize, these mine-affected waters include:

- dewatering production,
- waters collected in contact water ponds,
- stockpile runoff and toe seepage,
- TSF Buttress runoff and toe seepage, and
- post-closure TSF facility solutions.

Waters infiltrating into the subsurface under the mine facilities would mix with alluvial groundwater and are not subject to water treatment except in instances where alluvial groundwater is subsequently pumped for mine dewatering.

The Site-Wide Water Balance model (Brown and Caldwell 2021a) provides a forecast for the volumes of water that would require water treatment for the operating and post closure time-periods (**Figure 7-9**). A principal driver for predicting water treatment rates would be uncertainty in future precipitation rates and their effect on contact water. A 120-year precipitation record was utilized to develop percentile estimates for meteoric inputs to the water balance (5th through 95th percentile ranges) which are displayed on **Figure 7-9**. Initially, the volumes of water destined for water treatment would be less than 500 gpm because dewatering and seepage rates from newly constructed facilities would be ramping up at the same time that consumptive use demand for processing needs would be at its largest and hence, consuming contact water as a supply. Over time, water treatment volumes would increase through about Mine Year 6 to approximately 2,000 gpm as dewatering production and seepage rates would constitute a higher percentage of diversion for process water in those years, displacing contact water as a source. Differences in actual versus predicted dewatering rates would have limited effect on water treatment needs because diversion from industrial supply wells or surface waters would be reduced to offset any increase dewatering production (Forest Service 2022a). Following Mine Year 6, predicted dewatering rates would decline removing most of the need for water treatment as water recycling would be needed to meet consumptive use demands, except during seasonal runoff periods when contact water volumes would increase. Any short-term volumes in excess of the water treatment capacity (i.e., following a large storm event) would result in water storage within the TSF and/or contact water ponds.

In the closure and post-closure periods, beginning in Mine Year 15, volume of mine-affected waters requiring water treatment would range seasonally up to approximately 1,000 gpm until geosynthetic cover installations (planned to commence in Mine Year 19) could be completed in Mine Year 23 to prevent mixing of surface water runoff and contact waters with consolidation water. Once the cover installations are in effect, volumes consisting of residual seepage and TSF consolidation water would continue to be treated but would decrease from approximately 200 gpm down to very minor, unmeasurable flow as the tailings solids consolidate and stop emitting water (**Figure 7-9**).

Predicted maximum analyte concentrations were developed for water treatment plant influent on an annual basis for the construction, operations, and post-closure periods (Brown and Caldwell 2021c and SRK 2021a). In addition to influent flow rates, the maximum influent concentrations are relevant to the selection and design of the water treatment system and are summarized in **Table 7-10**.

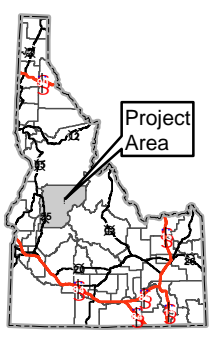
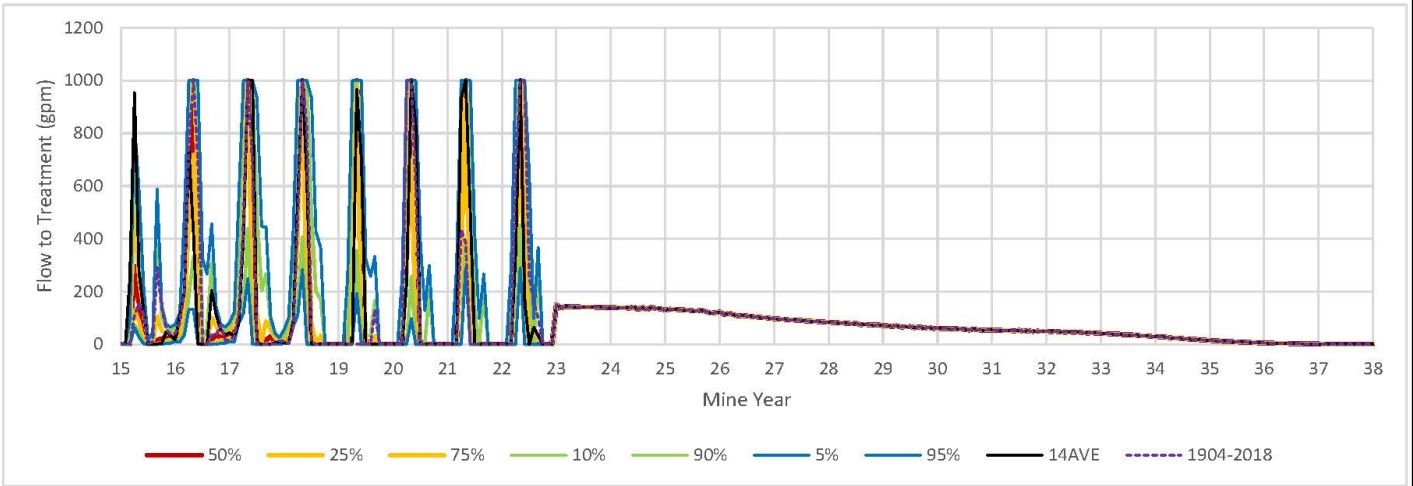
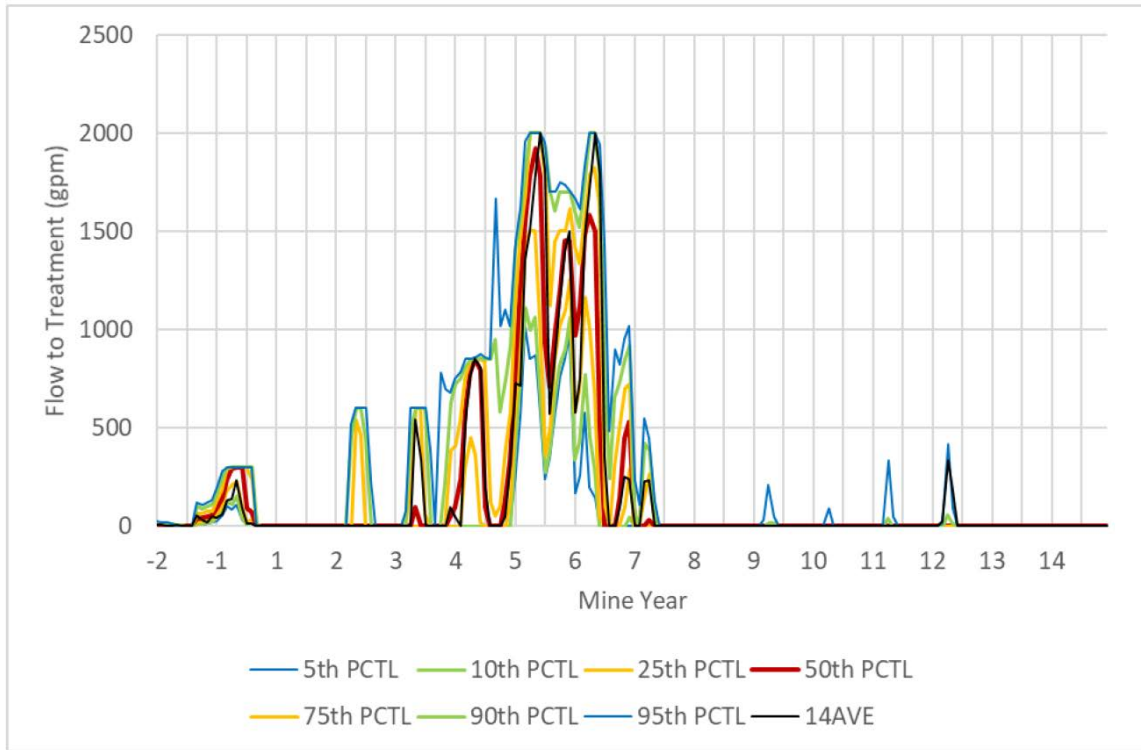


Figure 7-9
Predicted Water Treatment Volumes
Stibnite Gold Project
Stibnite, ID
Data Sources: (Brown & Caldwell 2021a)



Table 7-10 Predicted Maximum Concentrations in Water Treatment Plant Influent

Parameter	Units	Construction	Operations	Post-Closure
pH (range)	s.u.	6.9 – 7.6	8.1 – 8.5	8.0 – 8.4
Alkalinity	mg/L as CaCO ₃	233	159	155
Silver	mg/L	0.005	0.0012	0.0055
Aluminum	mg/L	0.01	0.01	<0.01
Arsenic	mg/L	30.08	6.43	6.35
Boron	mg/L	4.89	2.34	0.53
Barium	mg/L	0.01	0.04	0.11
Beryllium	mg/L	0.001	0.001	0.001
Calcium	mg/L	14	22	422
Cadmium	mg/L	0.0032	0.0015	0.00035
Chloride	mg/L	40	34	58
Cobalt	mg/L	0.01	0.01	<0.01
Chromium	mg/L	0.01	0.03	<0.01
Fluoride	mg/L	4.8	4.0	5.6
Iron	mg/L	<0.01	0.12	<0.01
Mercury	mg/L	0.0003	0.0006	0.0151
Potassium	mg/L	103	41	113
Magnesium	mg/L	123	76	232
Manganese	mg/L	0.11	0.27	0.29
Molybdenum	mg/L	0.02	0.21	0.019
Sodium	mg/L	96	131	3,181
Nickel	mg/L	0.01	0.1	0.01
Phosphorus	mg/L	4.1	1.7	0.25
Lead	mg/L	0.037	0.019	0.004
Antimony	mg/L	8.51	2.37	0.96
Selenium	mg/L	0.004	0.003	0.001
Sulfate	mg/L	331	323	7,508
Thallium	mg/L	0.0003	0.0001	0.0025
Vanadium	mg/L	0.01	0.01	0.01
Zinc	mg/L	0.198	0.241	0.055
Nitrate/Nitrite	mg/L as N	401	38	9
Ammonia	mg/L as N	<0.3	<0.3	<0.3
Cyanide, Total	mg/L	-	-	0.119
Cyanide, WAD	mg/L	-	-	0.073
TDS	mg/L	-	-	11,371

Source: Brown and Caldwell 2021c

The differences in major ion composition of water treatment influent in the post-closure period are due to the routing of TSF water inventory and tailings consolidation water from the facility for treatment.

To meet applicable discharge standards, the target post-treatment concentrations for analytes were identified for the water treatment plant design (**Table 7-11**).

Table 7-11 Target Post-Water Treatment Plant Effluent Analyte Concentrations

Parameter	Units	Treatment Objective ¹
pH (range)	s.u.	6.9 – 9.0
Silver	mg/L	0.0007
Arsenic	mg/L	0.01
Cadmium	mg/L	0.00033
Chromium (III)	mg/L	0.035
Chromium (IV)	mg/L	0.0106
Mercury	mg/L	0.000012
Nickel	mg/L	0.024
Lead	mg/L	0.0009
Antimony	mg/L	0.0052
Sulfate	mg/L	250
Thallium	mg/L	0.005
Zinc	mg/L	0.054
Nitrate/Nitrite	mg/L as N	10
Ammonia	mg/L as N	2.1
Cyanide, Total	mg/L	0.0052
Cyanide, WAD	mg/L	0.0039
TDS	mg/L	500

¹Treatment objectives are equivalent to the strictest potentially applied water quality standard
Source: Brown and Caldwell 2021c

During colder months (October through April), the temperature of treated water is estimated to be 7.3°C (Brown and Caldwell 2021c). During the operational period Mine Years 4 through 6 when water treatment plant discharge is between seven and 55 percent of the Meadow Creek flow, the discharge would increase stream temperature in Meadow Creek by one to three degrees Celsius. During warmer months, retention times for contact water in ponds would be up to 34 days resulting in warmer water treatment plant feeds with the potential to increase Meadow Creek temperatures downstream of the treatment plant outfall by up to 2.5°C. However, warmer water treatment plant discharge temperatures would be offset by the cooling effect of the piped diversion of Meadow Creek around the TSF with the net effect of water treatment expected to be less than 0.25°C (Brown and Caldwell 2021c).

Brown and Caldwell (2021c) performed an assessment of the viability of potentially applicable water treatment technologies to the predicted maximum influent water chemistry and identified the following technologies to incorporate into the proposed project design for the construction, operational, and post-closure periods.

Temporary treatment systems would be employed during the construction period until the project's water treatment plant would be constructed and commissioned. These temporary systems would utilize trailer-mounted or skid-mounted equipment packages containing membrane treatment and/or iron coprecipitation systems that can be set up with limited lead time. **Figure 7-10** illustrates the construction period water treatment flowsheet.

Figure 7-11 illustrates the operational period water treatment plan flowsheet with a design capacity of 2,000 gpm. For the operational period water chemistry, a treatment process consisting of sodium

hypochlorite oxidation, two-stage iron coprecipitation, and solids separation with contingent mercury precipitation via organic sulfide precipitant addition between iron precipitation stages was selected. Influent waters would be stored in lined storage ponds for flow equalization and pumped into the water treatment plant. This operational water treatment generally targets dissolved nitrate, metals, and oxyanions in influent solution, primarily arsenic and antimony. Addition of the mercury-sequestering precipitant is included as a contingency for the design to account for uncertainties regarding the effectiveness of iron coprecipitation in reducing dissolved mercury and methylmercury concentrations to levels below applicable receiving stream standards. Residual solids from the treatment plant would be placed in the TSF.

Under an IPDES permit, the water treatment plant effluent would be directed to Meadow Creek at a location upstream of the Hangar Flats pit when flow augmentation is required and otherwise to the East Fork SFSR for the remainder of operations (i.e., when Hangar Flats groundwater pumping results in decreased Meadow Creek baseflow). For predicting surface water chemistry incorporating the effects of treated effluent, the minimum of the predicted water treatment plant influent analyte concentrations or the target effluent concentrations was used. Constituents that do not have a target effluent concentration were assumed to be unaffected by the treatment process.

For the post-closure period, the water treatment process would need to be augmented to treat cyanide, sulfate, and TDS concentrations that would be derived from the remaining inventory of TSF process solutions and tailings consolidation seepage (**Figure 7-12**). The first-stage iron coprecipitation would be modified to include gypsum precipitation to reduce sulfate concentrations to approximately 1,800 mg/L, the sulfate concentration associated with gypsum saturation of influent water. The second-stage iron coprecipitation would then be converted to ettringite precipitation which would reduce sulfate and TDS concentrations to the target levels for treatment plant effluent. Cyanide would be treated using a two-stage alkaline oxidation process that converts cyanide to carbon dioxide, nitrogen gas, and water. Treatment plant residual solids would be placed in the TSF until its cover was completed, and thereafter dewatered and disposed of in a landfill constructed above the TSF cover.

At the start of closure, water treatment plant effluent would be discharged to the East Fork SFSR until the cover of the TSF is completed (approximately nine years to allow for tailings consolidation, cover installation, and stream channel restoration). Once the TSF cover is completed, the treatment plant and discharge would be relocated to Meadow Creek, nearer the TSF, for the duration of its operation (approximately Mine Year 40).

The effects of capture, treatment, and discharge of mine-impacted waters on surface water chemistry would be minor, long-term, and localized.

Sanitary Wastewater Treatment

The worker housing facility, administration building, warehouse, maintenance shops, and underground exploration surface facility would produce sanitary wastewater. Wastewater from the administration building, warehouse, maintenance shops, and underground facility would be collected in tanks for transport to a sanitary wastewater treatment plant equipped with a septage receiving system located near the worker housing facility. The sanitary wastewater treatment plant would consist of a package plant containing a membrane bioreactor or equivalent system to treat wastewater to applicable discharge requirements. The volume of wastewater influent would depend on the number of personnel working on site and is expected to be approximately 50,000 gallons per day during the construction period and 25,000 gallons per day during operations (Brown and Caldwell 2021c).

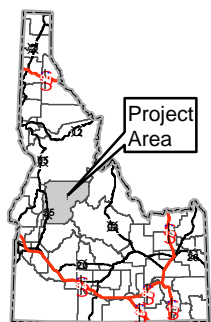
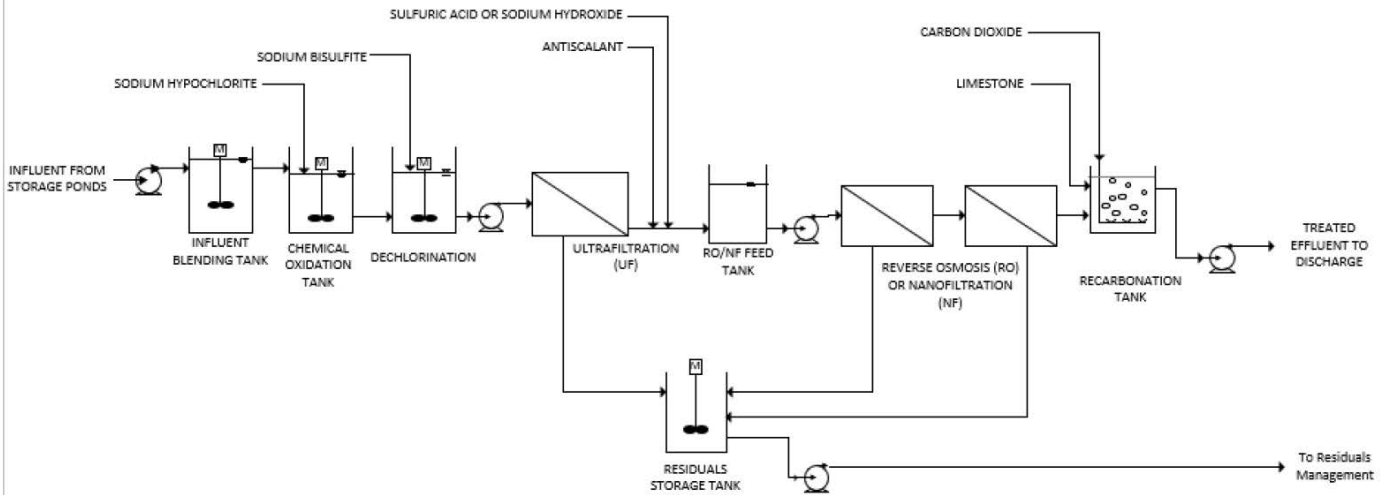


Figure 7-10
Construction Period Water
Treatment Plant Flowsheet

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021a)



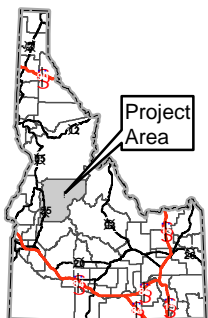
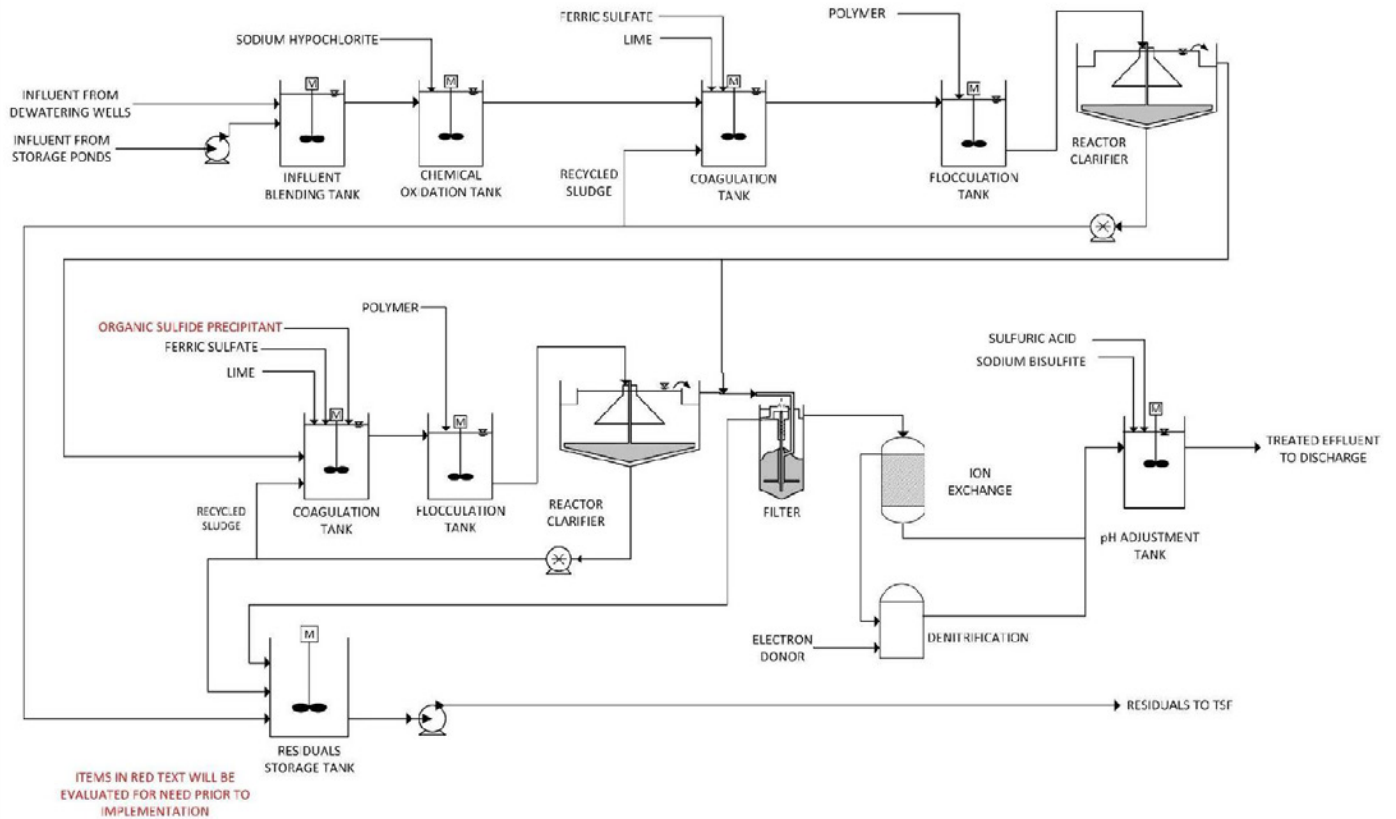


Figure 7-11
Operational Water
Treatment Plant Flowsheet

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021a)



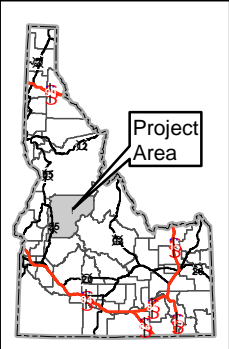
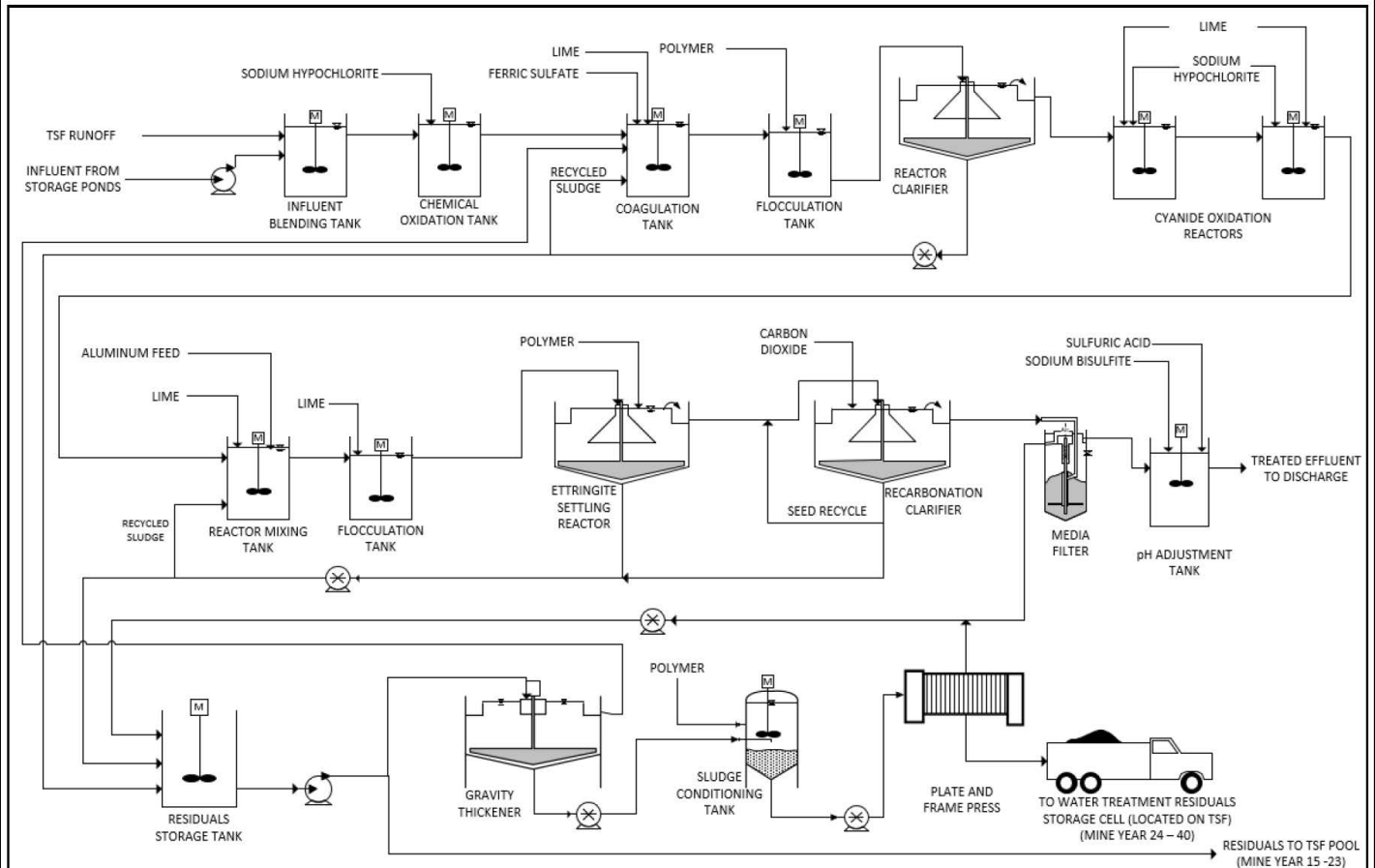


Figure 7-12
Closure Period Water
Treatment Plant Flowsheet

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021a)



Wastewater treatment plant effluent would be discharged to the East Fork SFSR at an IPDES permitted location near the worker housing facility. Treatment residuals would be dewatered and transported to a permitted, off-site landfill for disposal.

The effects of sanitary wastewater treatment and discharge would be minor, long-term, and localized.

IPDES Permits and Cyanidation Permit

The State of Idaho has regulatory authority over its Idaho Pollution Discharge Elimination System (IPDES) process. The SGP would need permits issued by the IDEQ to discharge treated water from its water treatment plant and sanitary wastewater treatment plant. Under the IPDES program, IDEQ would establish specific discharge limits for constituents of interest plus monitoring and reporting requirements for the system based on its regulatory criteria.

The SGP would also need a Cyanidation Permit issued by IDEQ to allow the use of cyanide in its ore processing. Under this permit, IDEQ would institute permit obligations regarding the handling and containment of process solutions as well as responses to upset conditions. In addition, the permit would also contain requirements for the ultimate treatment and disposal of process water. The descriptions of handling TSF water in this specialist report are consistent with the requirements of the Cyanidation Permit regulations.

This analysis of water quality utilizes the predicted water chemistries for water treatment plant discharges as developed by SRK (2021a) and Brown and Caldwell (2021c). Additional limits and requirements associated with the IPDES and Cyanidation Permit have not been determined at the time of this analysis and are therefore not incorporated.

7.2.2.3 West End Pit Lake Chemistry

During mine operations, the West End pit is expected to be relatively dry, and limited water from stormwater runoff and passive groundwater inflows would pond within the pit sump. At the end of open pit mine operations, dewatering would cease, diversions would be breached, and a pit lake would ultimately form in the pit. A conceptual geochemical model (**Figure 7-13**) has been developed for the West End pit lake from a review of the hydrologic model (Brown and Caldwell 2021b).

During the operational period, highwall runoff, bedrock seepage and runoff from undisturbed ground would report to the pit sump as part of the pit dewatering system. Once dewatering ceases, the West End pit lake would begin to fill slowly until attaining a maximum volume of approximately 2,700 acre-feet and a surface elevation of 6,663 feet amsl 57 years from the start of filling. Thereafter, the lake volume and surface elevation would vary at slightly lower levels as meteoric inflows varied in relation to outflows to bedrock groundwater. The final pit lake surface elevations are predicted to be more than six feet below the level where outflow from the pit lake to surface water would be anticipated (**Figure 7-14**).

Bedrock groundwater inflow and pit wall runoff are the main contributors to early pit lake filling. After infilling for approximately 11 years, direct precipitation on the pit lake surface would become equivalent to pit wall runoff, while groundwater inflow declines (**Figure 7-14**).

Solute loading into the pit lake would come from groundwater and pit wall runoff. These waters would pick up additional solute loading from fractures in the pit walls and talus remaining on pit benches. Representative leachate chemistry for the pit wall rock and talus are obtained from humidity cell tests of West End pit samples, scaled to field conditions.

The pit lake model predicts the lake chemistry under well-mixed, annual average conditions. SPLNT modeling (Brown and Caldwell 2019b) demonstrated that the lake is likely to experience seasonal stratification, turning over each spring and fall. Summer stratification would be more pronounced, with the epilimnion being warmer than the hypolimnion. During winter, the temperature gradient would be smaller and in the opposite direction, with ice cover supporting stratification by preventing wind mixing. During spring and fall mixing, water quality is likely to be generally similar throughout the water column.

The USGS code PHREEQC was used to perform a quantitative prediction of future West End pit lake water chemistry based on equilibrium of influent precipitation, groundwater, and rock leachate chemistries in equilibrium with solid phase minerals that act as solubility controls for dissolved constituents in aqueous systems (Table 7-12).

Table 7-12 Equilibrium Phases Used for PHREEQC Water Chemistry Models

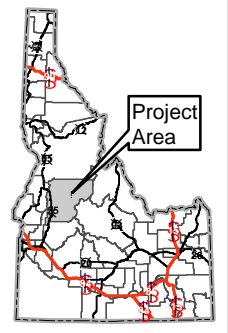
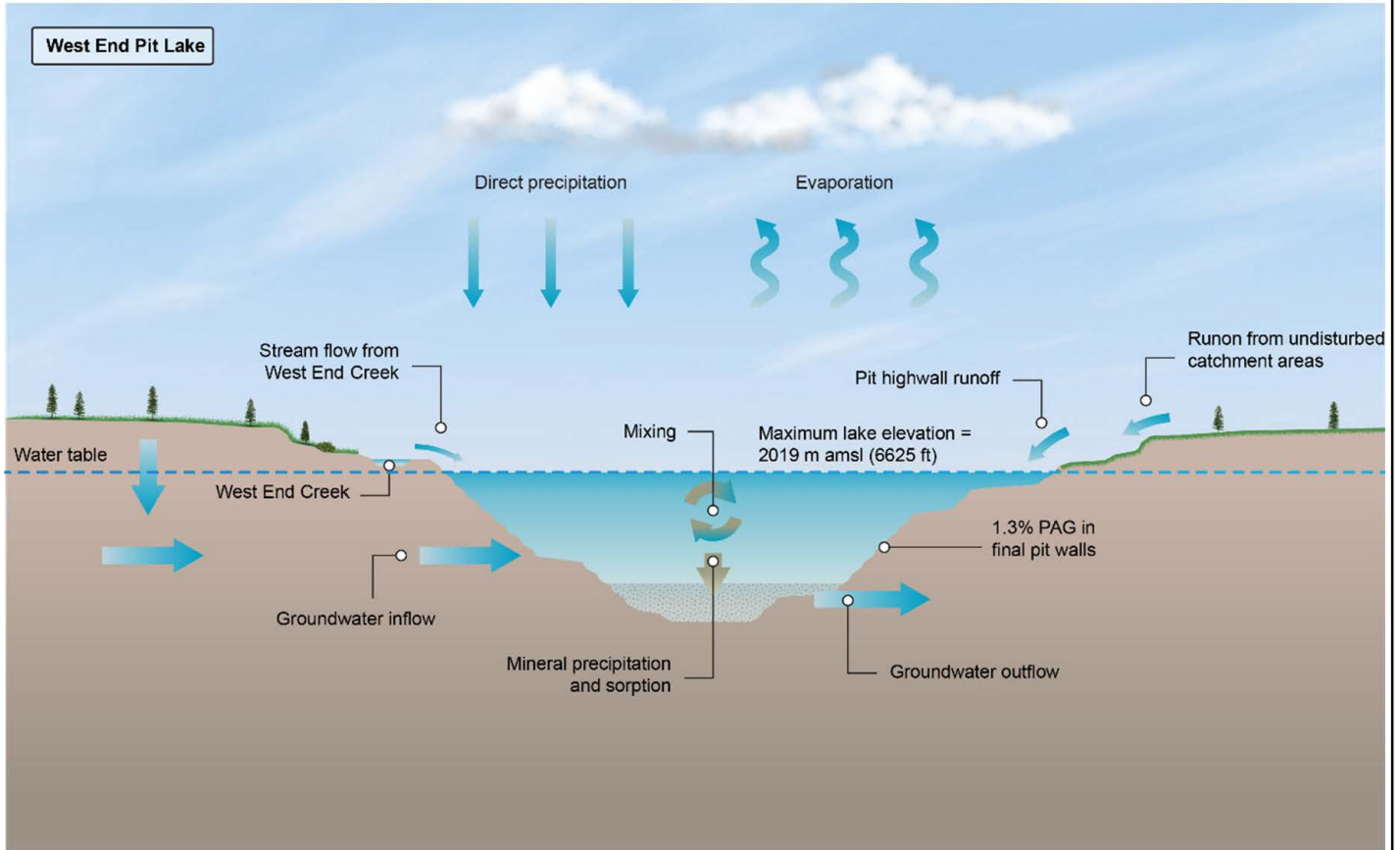
Mineral Phases Allowed to Form in PHREEQC	Ideal Mineral Formula	Rationale for Inclusion in Facility Models
Barite	BaSO ₄	Primary mineralogic control on barium (Eary 1999). Close to saturation in initial model runs.
Calcite	CaCO ₃	Mineral observed in Project area (M3 2020; SRK 2021a). Primary mineralogic control on calcium at alkaline pH (Eary 1999).
Goethite	FeOOH	Primary mineralogic control on iron chemistry and on the sorption of trace elements. Thermodynamic properties well defined (Dzombak and Morel 1990). Mineral observed in the Project area (SRK 2021a).
Fluorite	CaF ₂	Primary mineralogic control on fluoride at neutral to alkaline pH (Eary 1999).
Gibbsite	Al(OH) ₃	Primary mineralogic control on aluminium at neutral to alkaline pH (Eary 1999).
Gypsum	CaSO ₄ .2H ₂ O	Mineral observed in Project area (SRK 2021a). Primary mineralogic control on sulfate (Eary 1999).
Hg metal(l)	Hg	Close to saturation in initial model runs.
Malachite	Cu ₂ (CO ₃)(OH) ₂	Primary mineralogic control on copper at alkaline pH (Eary 1999).
Rhodochrosite	MnCO ₃	Primary mineralogic control on manganese at alkaline pH (Eary 1999). Close to saturation in initial model runs.
Senarmontite	Sb ₂ O ₃	Mineral observed in the Project area (SRK 2021a).

Source: SRK 2021a

The pit lake is expected to turn over seasonally and remain in an oxidizing redox condition. Further details for the pit lake chemistry prediction are available in Site-Wide Water Chemistry Report (SRK 2021a).

Predicted West End pit lake water chemistry exhibits circumneutral pH conditions with TDS concentrations below 130 mg/L. Constituent concentrations are generally below the strictest potentially applied water quality standards except for antimony, arsenic, and mercury concentrations that exceed those values throughout the operating and closure period (Table 7-13 and Figure 7-15). Concentrations of copper and lead are predicted to exceed the strictest potentially applied water quality standards during pit dewatering operations, when produced water is routed for consumptive use and water treatment but decrease below those levels during as the lake fills.

West End Pit Lake



**Figure 7-13
Conceptual Model -
West End Pit Lake**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2021)



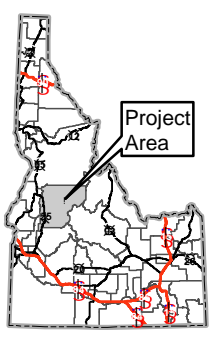
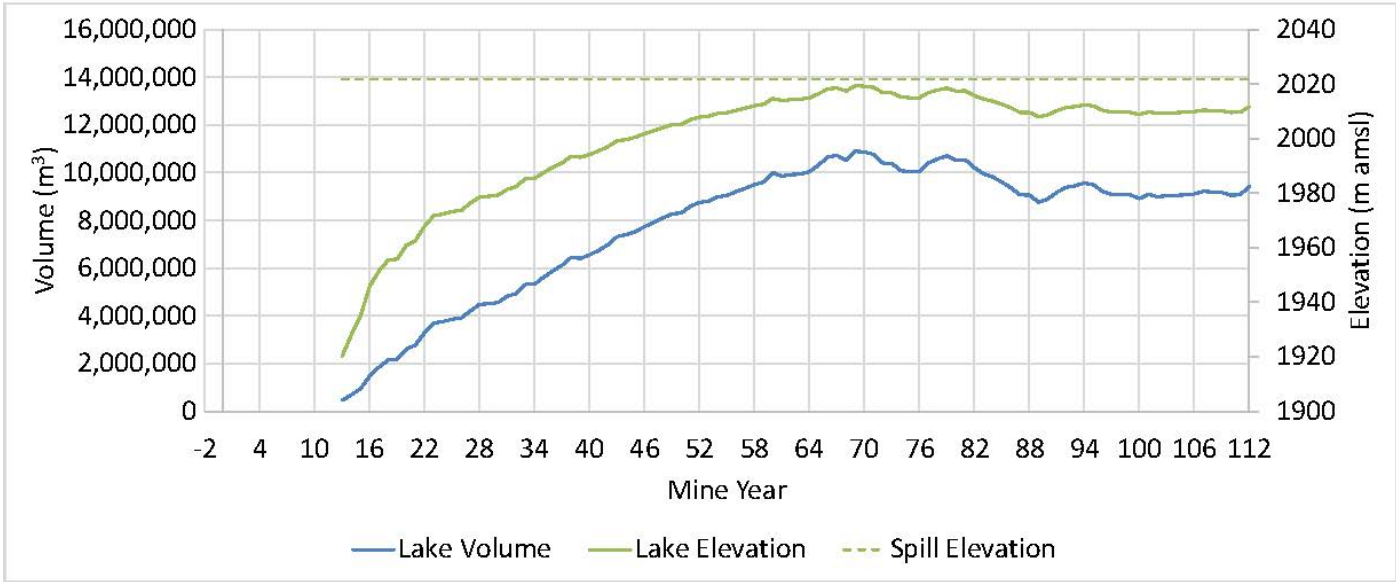
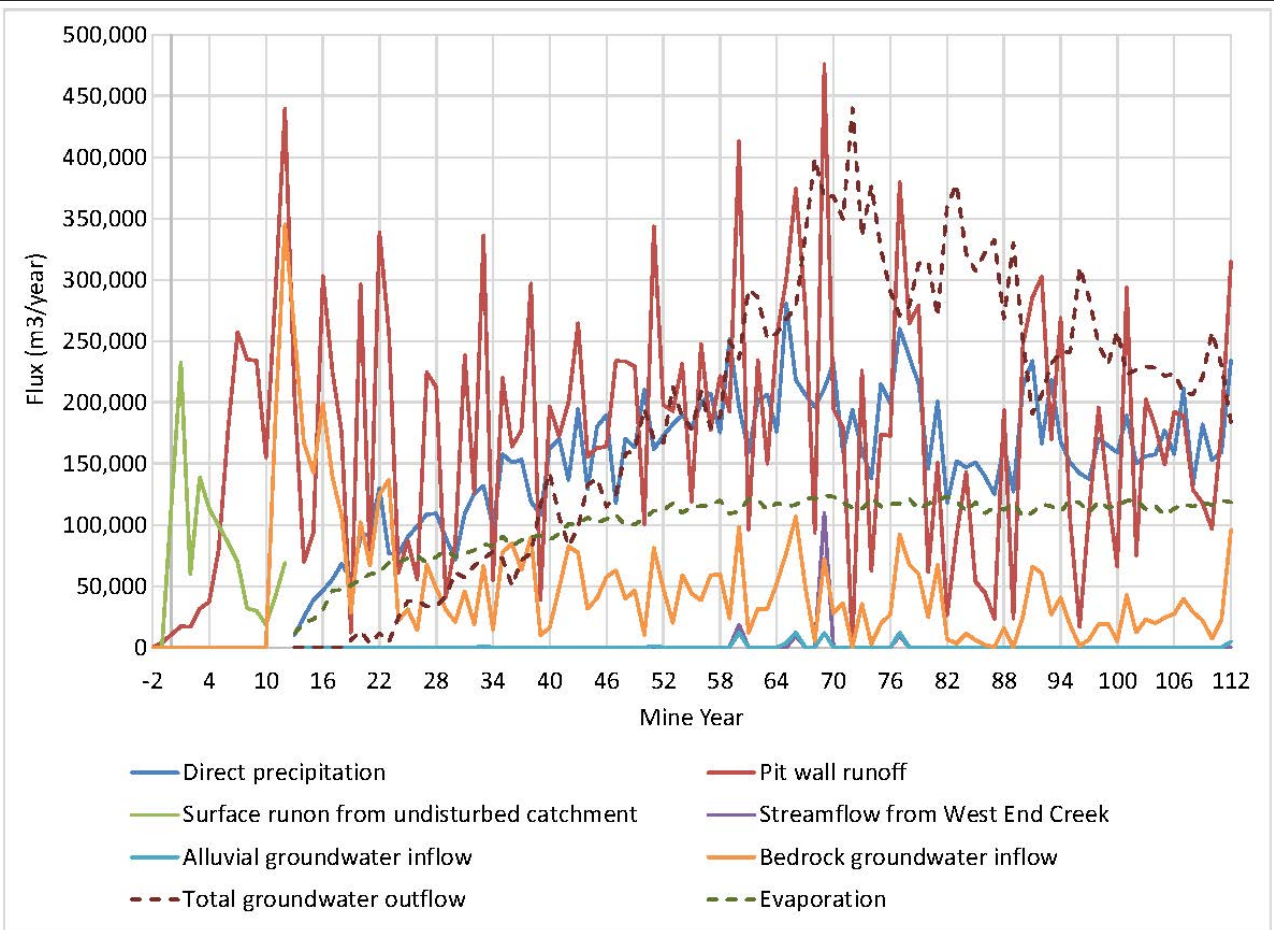
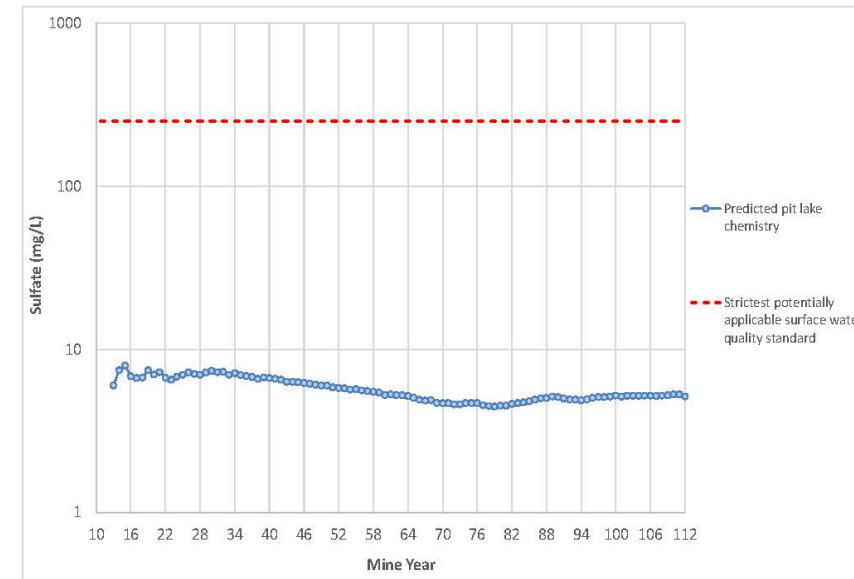
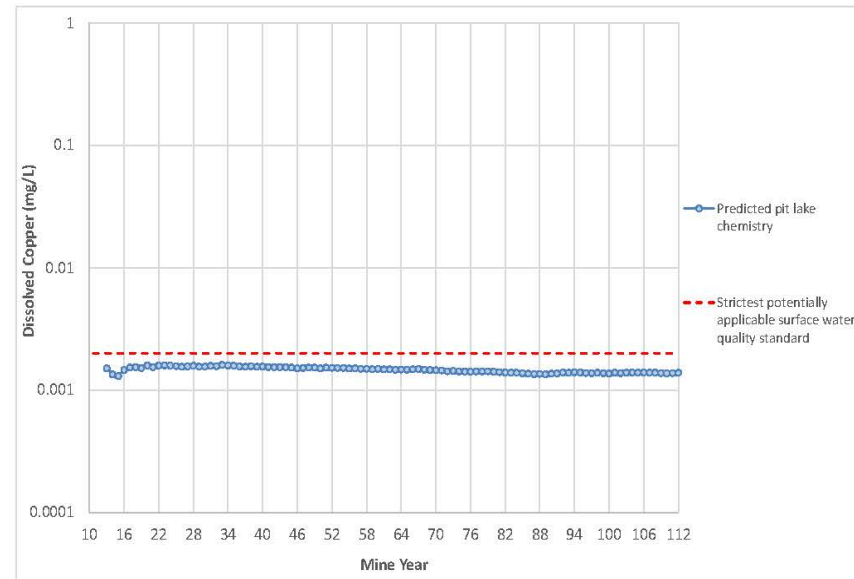
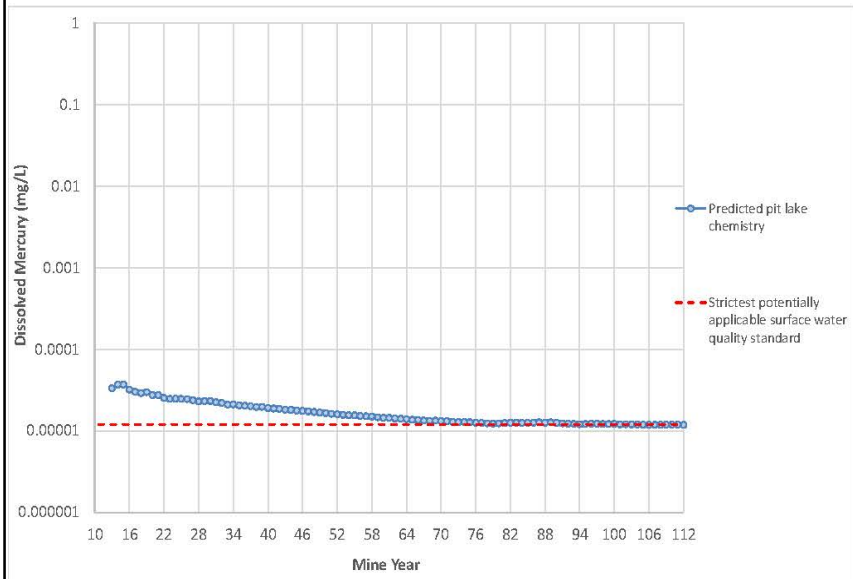
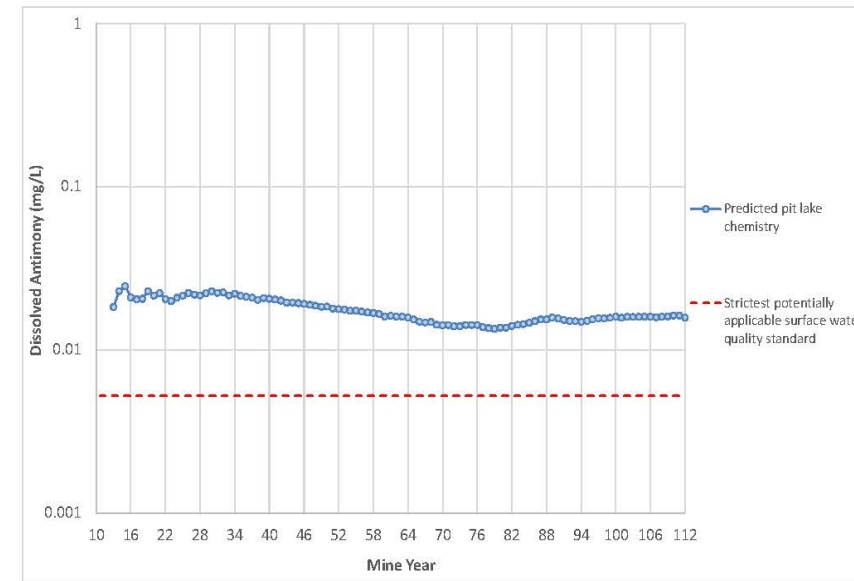
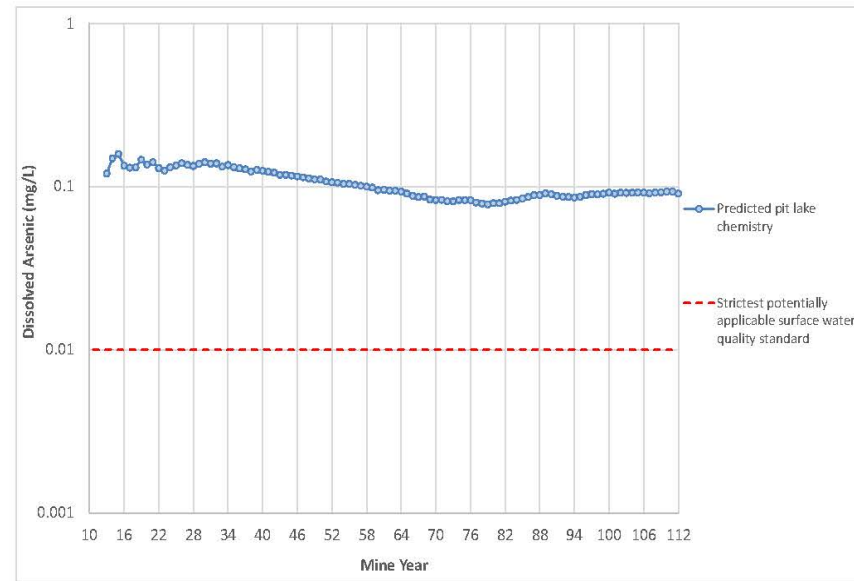
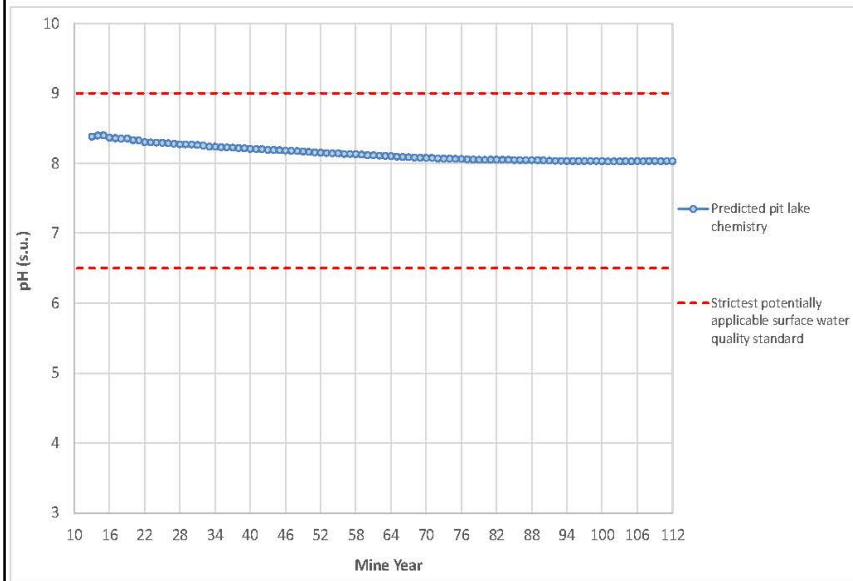
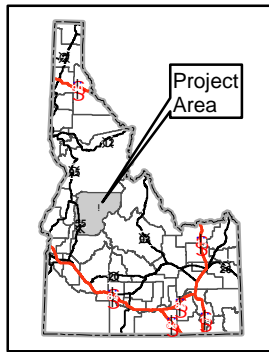


Figure 7-14
West End Pit Lake Inflows

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)





**Figure 7-15
Predicted West End Pit
Lake Chemistry**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2021)



Table 7-13 Summary of Results for West End Pit Sump and Pit Lake Geochemical Model

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Standard*	Mine Year (pit sump until year 12; pit lake year 13+)						
			4	6	10	13	25	50	100
pH	s.u.	6.5 to 9.0	7.95	8.33	8.57	8.4	8.3	8.2	8.0
Alkalinity	mg/L as CaCO ₃	>20	16.5	40.4	74	89	71	53	40
Ag	mg/L	0.0007 [†]	<0.00002	<0.00002	0.0000208	<0.00002	<0.00002	<0.00002	<0.00002
Al	mg/L	0.05	<0.002	0.0032	0.0051	0.0037	0.0033	0.0028	0.0023
As	mg/L	0.01	0.050	0.12	0.31	0.11	0.13	0.11	0.09
B	mg/L	--	0.044	0.11	0.27	0.1	0.12	0.1	0.088
Ba	mg/L	2	0.006	0.016	0.040	0.024	0.019	0.017	0.013
Be	mg/L	--	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Ca	mg/L	--	3.87	9.16	11.3	19	15	12	8.4
Cd	mg/L	0.00033 [†]	<0.00002	0.000035	0.00009	0.000036	0.00004	0.000032	0.000026
Cl	mg/L	230	<0.4	0.44	0.97	0.45	0.51	0.46	0.43
Co	mg/L	--	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Cr	mg/L	0.0106 ^{†††}	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cu	mg/L	0.002 ^{††}	0.00074	0.0020	0.0027	0.0014	0.0015	0.0015	0.0013
F	mg/L	2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fe	mg/L	0.3	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hg	mg/L	0.000012	3.62E-06	8.77E-06	0.000022	0.000033	0.000025	0.000017	0.000013
K	mg/L	--	0.56	1.31	3.30	1.8	1.8	1.5	1.3
Mg	mg/L	--	2.25	5.41	13.8	10	9.2	6.8	5.4
Mn	mg/L	0.05	0.0019	0.0046	0.012	0.0047	0.0053	0.0048	0.004
Mo	mg/L	--	<0.00005	<0.00005	<0.00005	0.000058	<0.00005	<0.00005	<0.00005
Na	mg/L	--	0.44	0.883	2.06	0.93	1.1	0.95	0.86
Ni	mg/L	0.024 [†]	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
P	mg/L	--	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Pb	mg/L	0.0009 [†]	0.00033	0.00081	0.0021	0.00073	0.00091	0.00077	0.00066
Sb	mg/L	0.0052	0.0075	0.0182	0.047	0.018	0.021	0.018	0.016
Se	mg/L	0.0031	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Stibnite Gold Project, Water Quality Specialist Report

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Standard*	Mine Year (pit sump until year 12; pit lake year 13+)						
			4	6	10	13	25	50	100
SO ₄	mg/L	250	2.73	6.09	15	5.8	6.9	5.9	5.1
Tl	mg/L	0.000017	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
V	mg/L	--	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zn	mg/L	0.054 †	0.0023	0.0056	0.0143	0.0053	0.0064	0.0054	0.0046
TDS	mg/L	500	26.7	64.0	121	130	110	81	61
NO ₃ + NO ₂	mg/L as N	--	0.239	0.445	0.354	0.23	0.13	0.075	<0.05

All values are for the dissolved fraction unless otherwise noted

-- Indicates no guideline for parameter

† Indicates hardness-dependent parameter. The values listed are based on the East Fork SFSR hardness of 40 mg/L as calcium carbonate, which represents the 5th percentile hardness during the driest four months at node YP-SR-10 (East Fork SFSR below Meadow Creek) between April 2012 and May 2019.

†† Estimated criterion based on DEQ guidance on Biotic Ligand Model and limited site-specific SGP data

††† Standard is for chromium VI and is based on Water Effect Ratio

Shading indicates value is greater than the strictest potentially applicable surface water quality standard

7.2.2.4 Midnight, Yellow Pine, and Hangar Flats Pit Backfills

Operational and post-closure water quality predictions have been developed for the Midnight, Yellow Pine, and Hangar Flats pits, which would be backfilled with development rock once the active mining phase is concluded in each pit. Predictions have been developed for sump chemistry for their mining periods and backfill porewater chemistry once backfill placement begins. During mine operations, active dewatering would keep the Yellow Pine and Hangar Flats and Yellow Pine pits dry and limited water would pond within pit sumps. The Midnight area pit is located above groundwater level, so would not require dewatering. The development rock backfill for the Midnight pit is to be sourced mostly from West End pit, with quantities from the West End pit and Yellow Pine pit in the Hangar Flats backfill, and from the Yellow Pine and Hangar Flats pits in the Yellow Pine backfill (**Table 6-1**). At the end of open pit mining and backfilling operations, dewatering would cease and the water table would rebound, partially flooding the backfill material within the Hangar Flats pit (84% inundation in Mine Year 8) and Yellow Pine pit (62% inundation in Mine Year 12). Midnight pit backfill would be mounded at closure to promote runoff and the highwall and backfill material would be unsaturated.

In order to develop estimates of future porewater chemistry within the pit backfill, conceptual geochemical models have been developed for the three pit backfills (**Figure 7-16**). Solute loading within the backfilled pits would come from the development rock backfill and from any talus remaining on the pit benches. There would be additional solute loading from groundwater (in the cases of Hangar Flats pit and Yellow Pine pit) and direct precipitation that contacts exposed pit walls and backfill. These waters would pick up additional solute loading from fractures in the pit walls.

Representative leachate chemistry for the non-PAG and PAG pit wall rock, talus and backfill material were obtained from humidity cell data associated with the backfill material and scaled to field conditions. The anticipated lithologies represented in the backfill material are summarized in **Figure 7-17**. The Yellow Pine pit is backfilled from Mine Year 5 through year 11, with the Hangar Flats pit backfilled in Mine Years 6 and 7, and the Midnight pit backfilled in Mine Year 8. The conceptual models developed for each backfilled pit provide the basis for the development of quantitative predictive calculations using the USGS code PHREEQC.

A low permeability geosynthetic cover would be placed over the Hangar Flats and Yellow Pine pit backfills at closure. These covers are assumed to be 95 percent effective for inhibiting infiltration of meteoric waters from the ground surface into the backfill. A geosynthetic cover would not be placed on the Midnight Area pit backfill. Following installation of the covers, the Hangar Flats pit would be revegetated and the diversion of Meadow Creek around the area would remain permanently. The East Fork SFSR stream channel would be restored above the Yellow Pine backfill cover along with the development of the Stibnite Lake feature. The restored streams, vegetation, and any wetland/riparian areas formed above the backfill covers would not interact with the development rock or groundwater below the covers. Predicted recharge and groundwater inflow rates into the backfills under this closure scenario were determined from the site hydrogeologic model and water balance (**Figure 7-18**). Influent water would inundate approximately 84 percent of backfill material in the Hangar Flats (it and 62 percent of backfill material in the Yellow Pine pit with recovered water levels more than 50 feet below the covers and local surface water. Further details of the modeling are available in Brown and Caldwell 2021c and SRK 2021a.

Porewater in an unsaturated condition within the Midnight pit backfill is predicted to have alkaline pH with concentrations of antimony, arsenic, manganese, lead, sulfate, and TDS above groundwater standards (**Table 7-14** and **Figure 7-19**). Surface grading and revegetation of the backfill would limit the potential for porewater within the Midnight pit backfill to infiltrate to local bedrock groundwater.

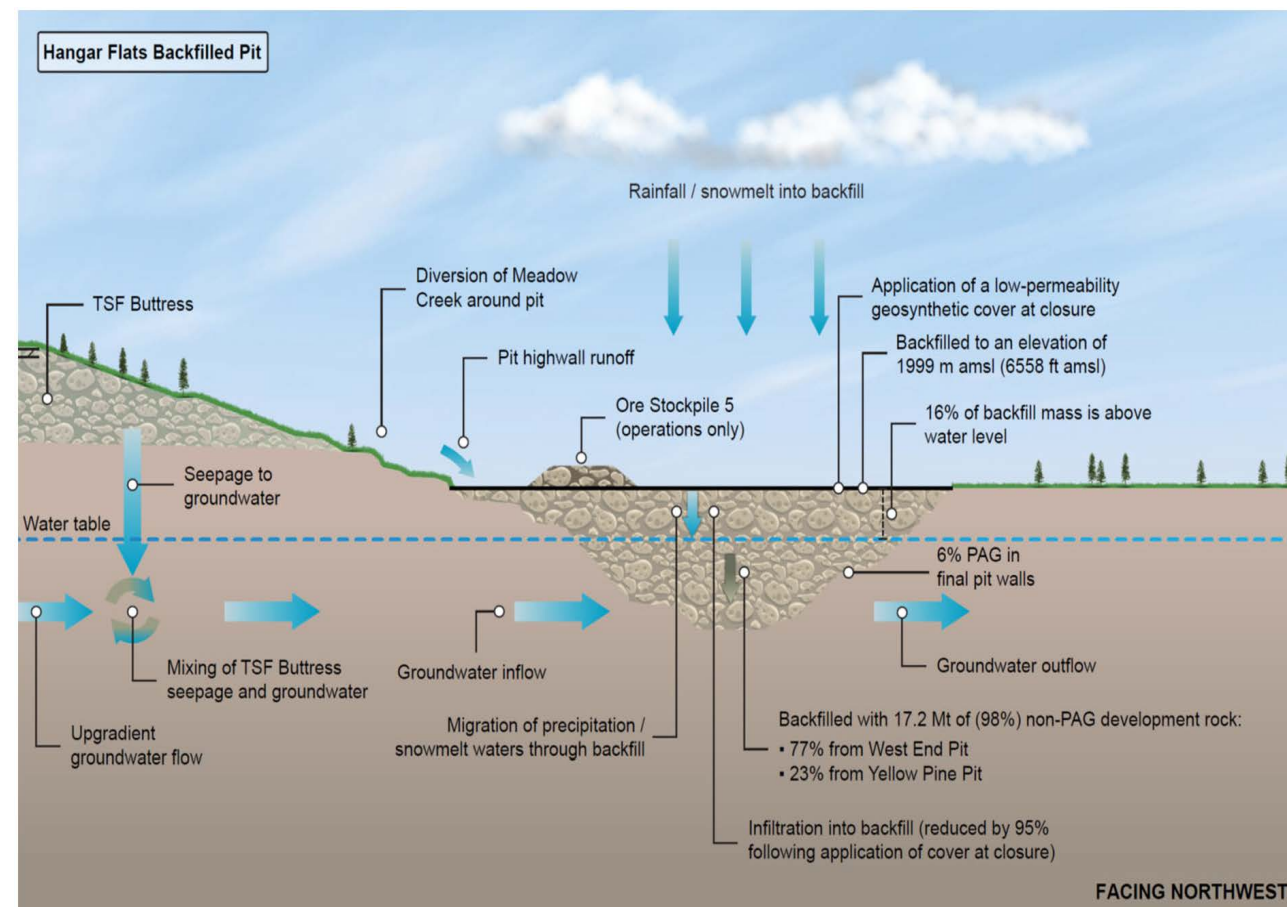
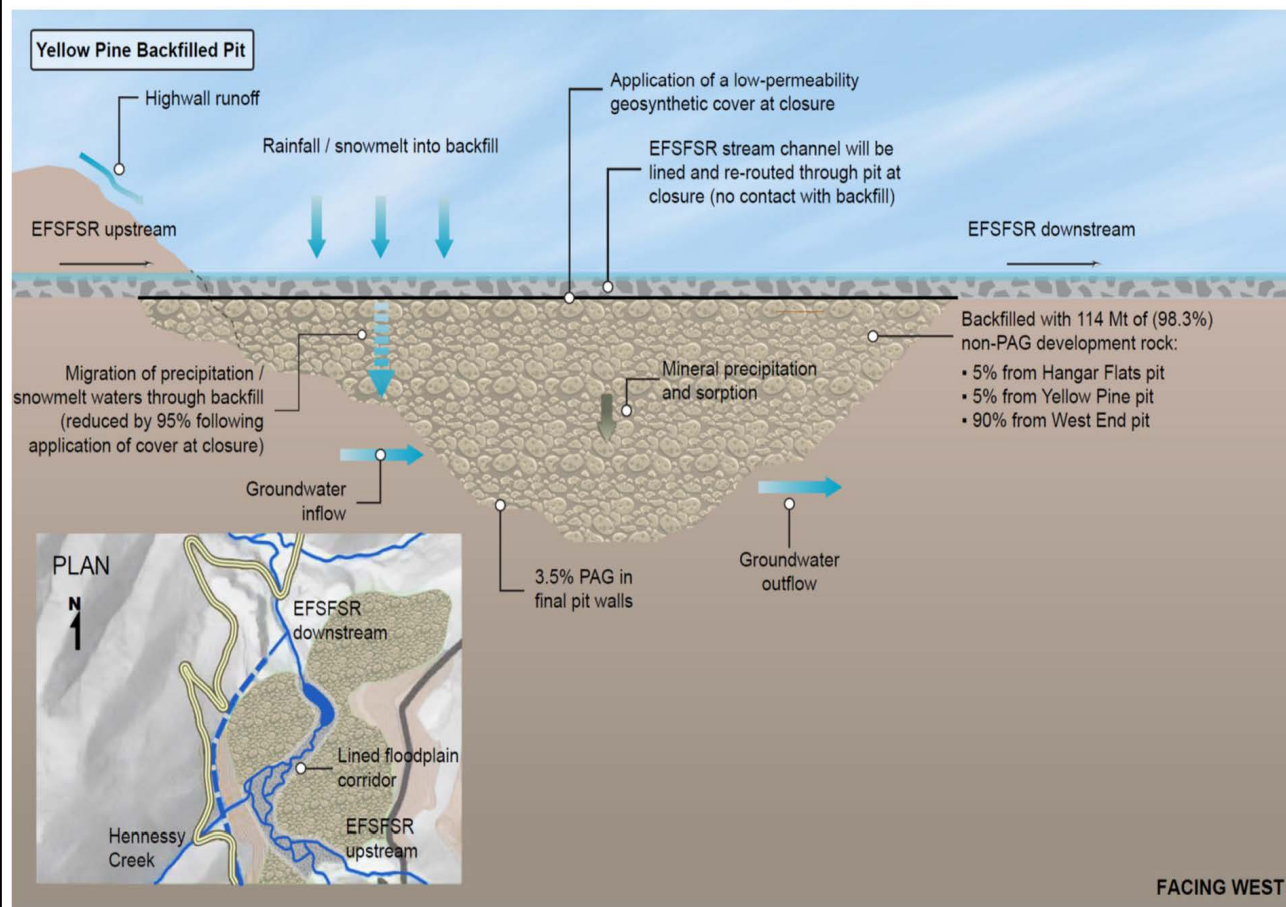
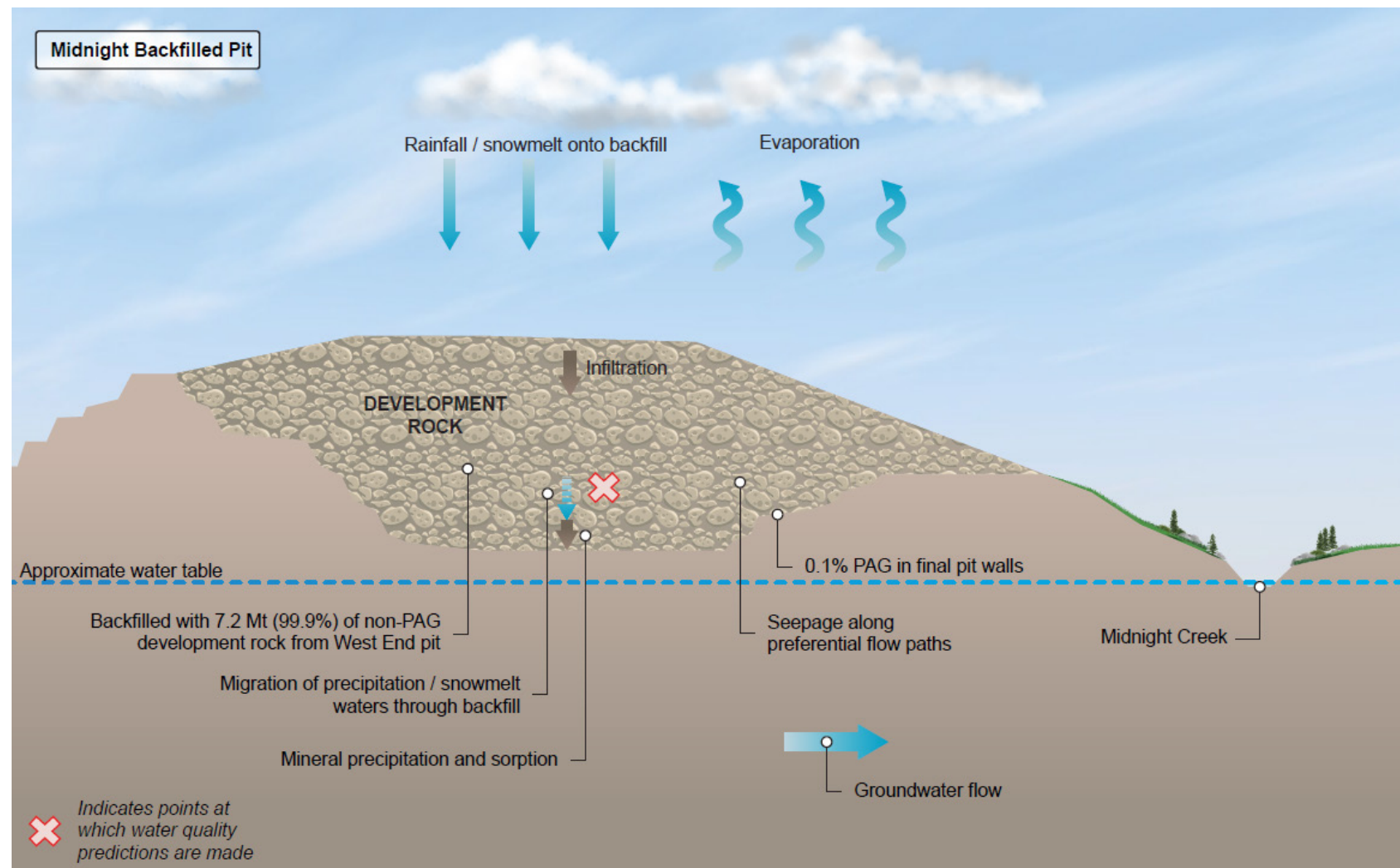
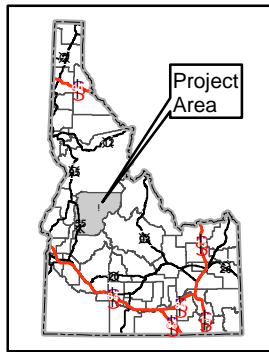
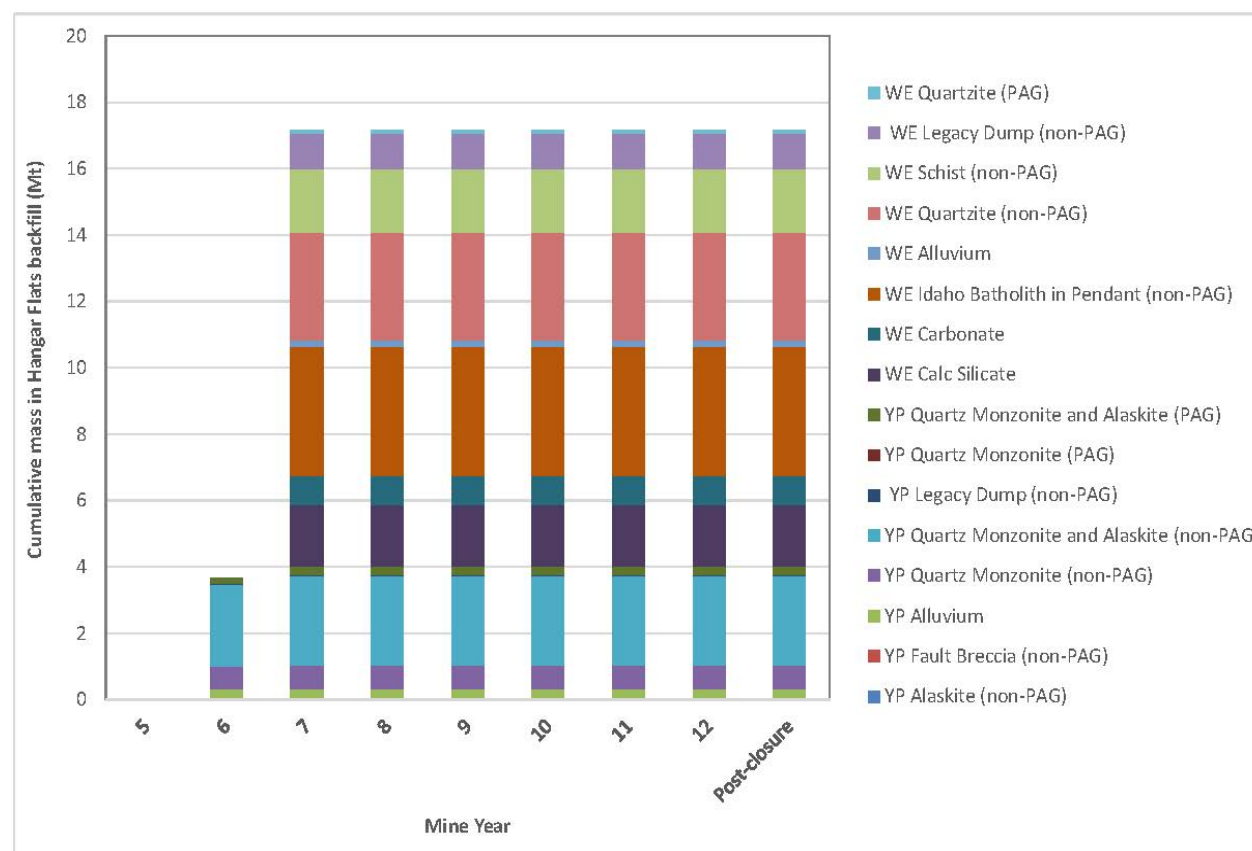
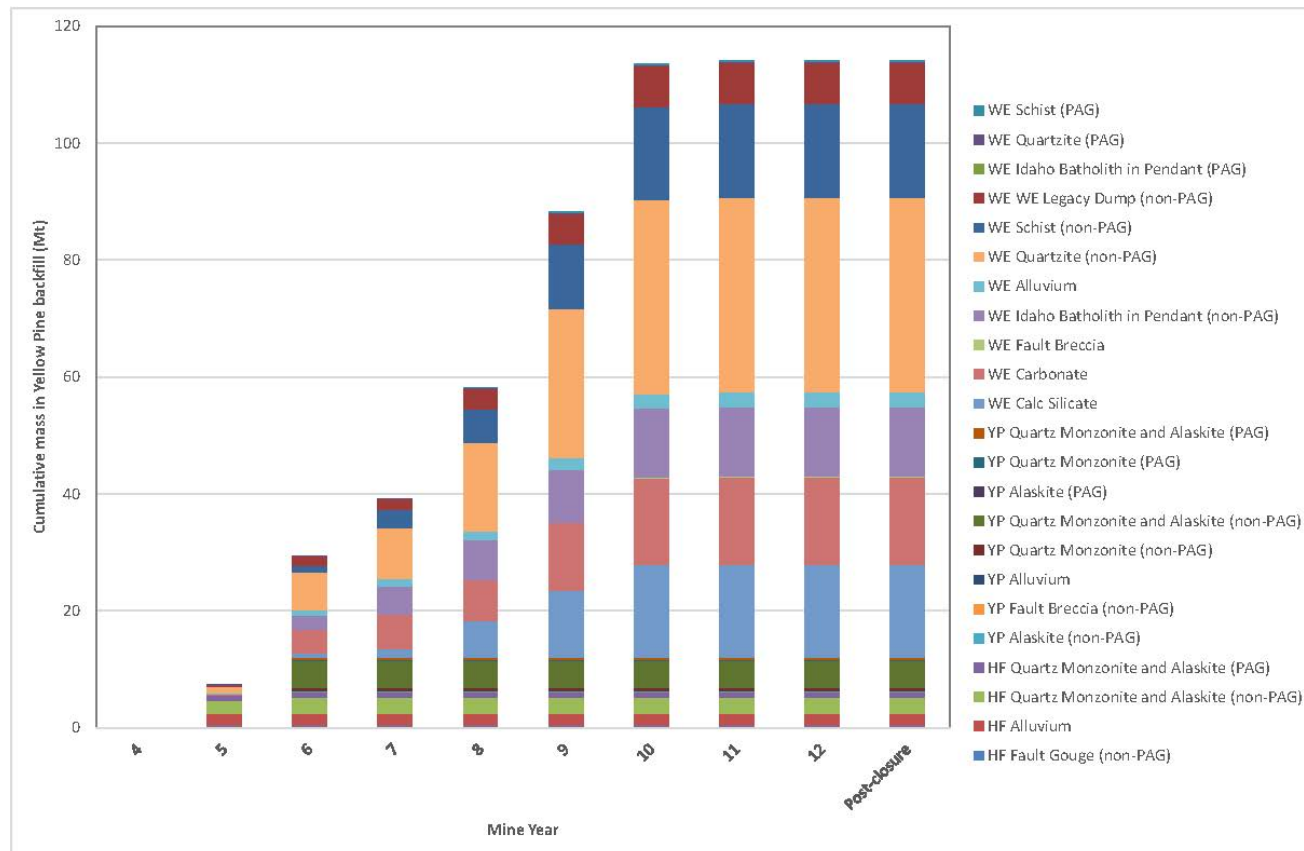
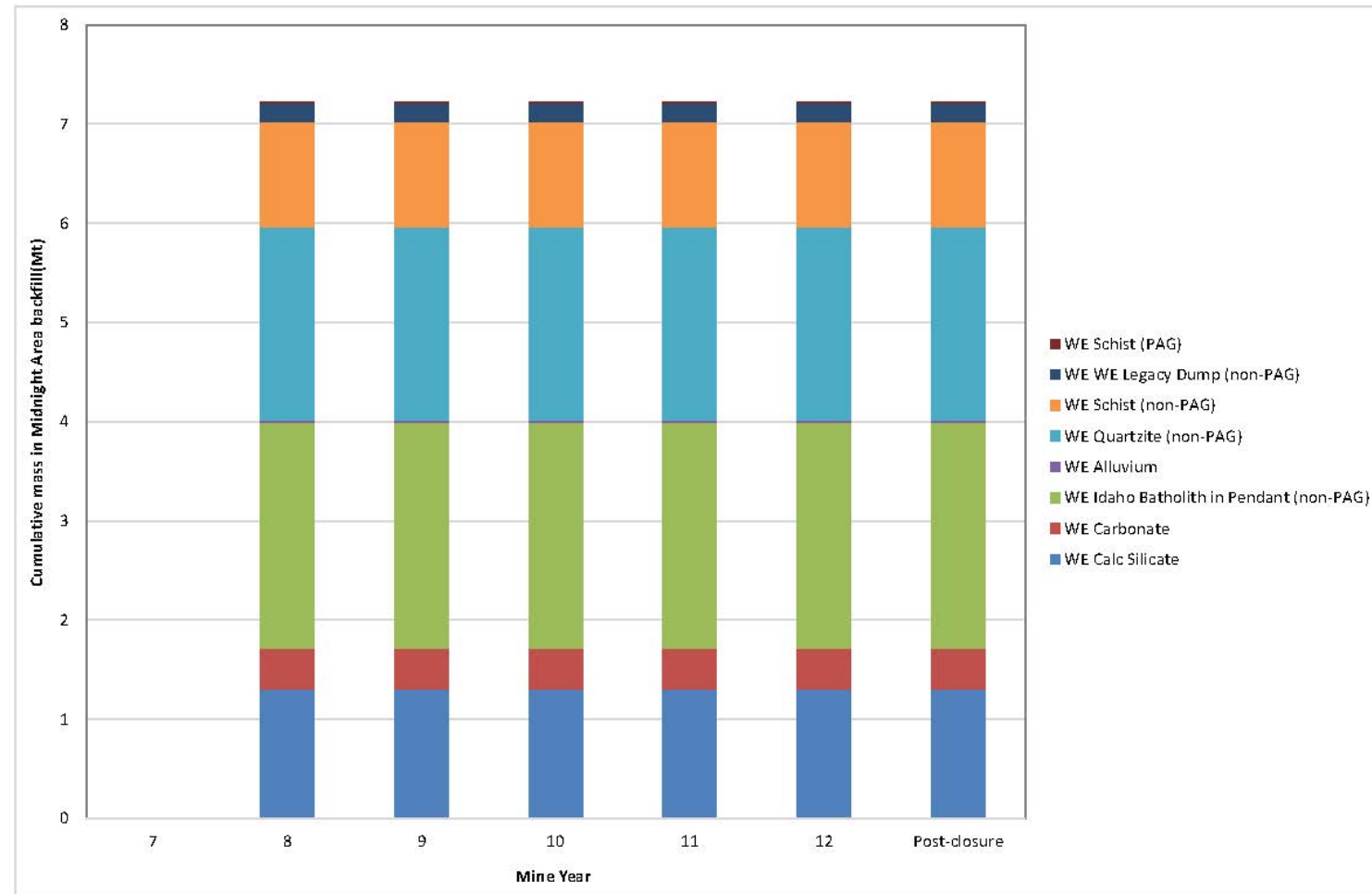
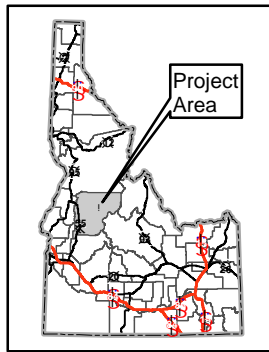


Figure 7-16
Conceptual Model -
Pit Backfills

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)





**Figure 7-17
Pit Backfill Composition**

**Stibnite Gold Project
Stibnite, ID**

Data Sources: (SRK 2021)



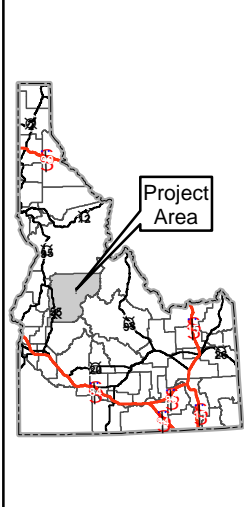
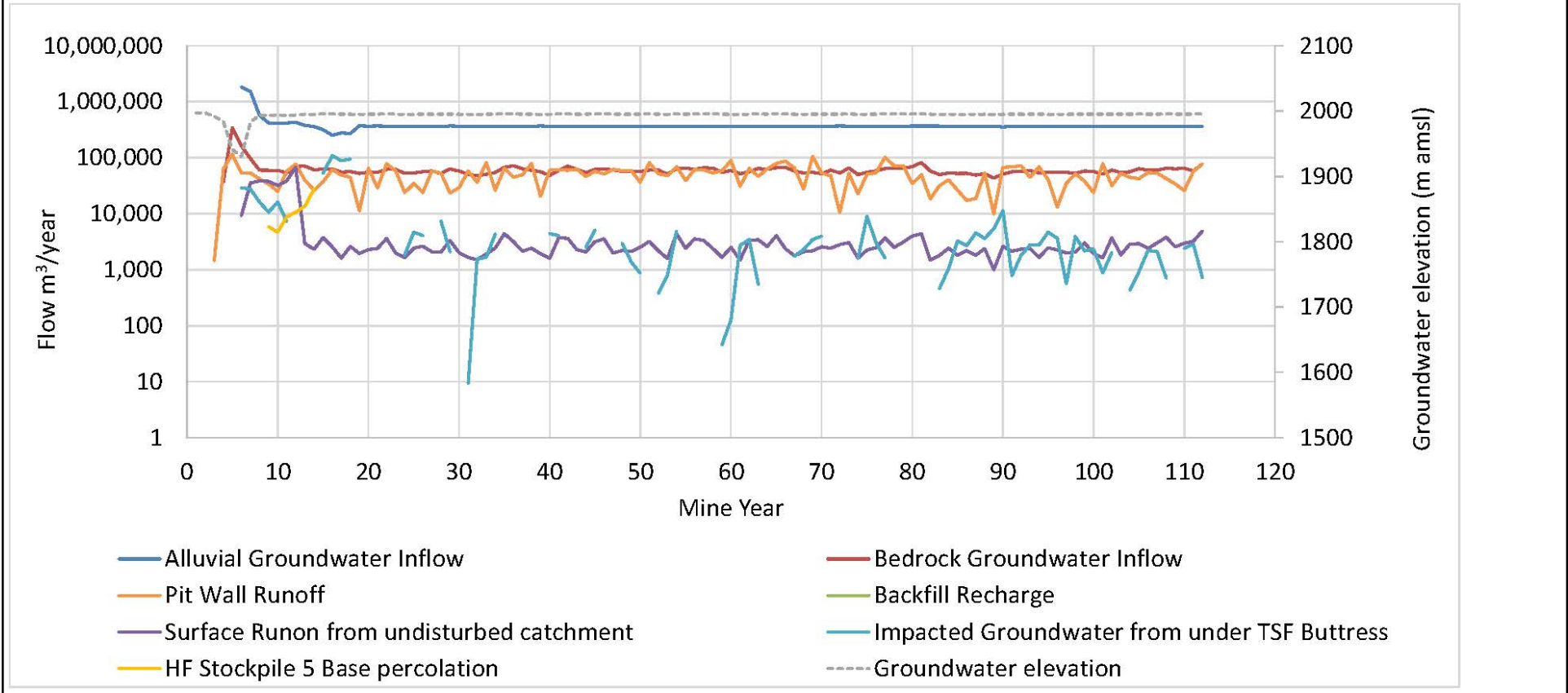
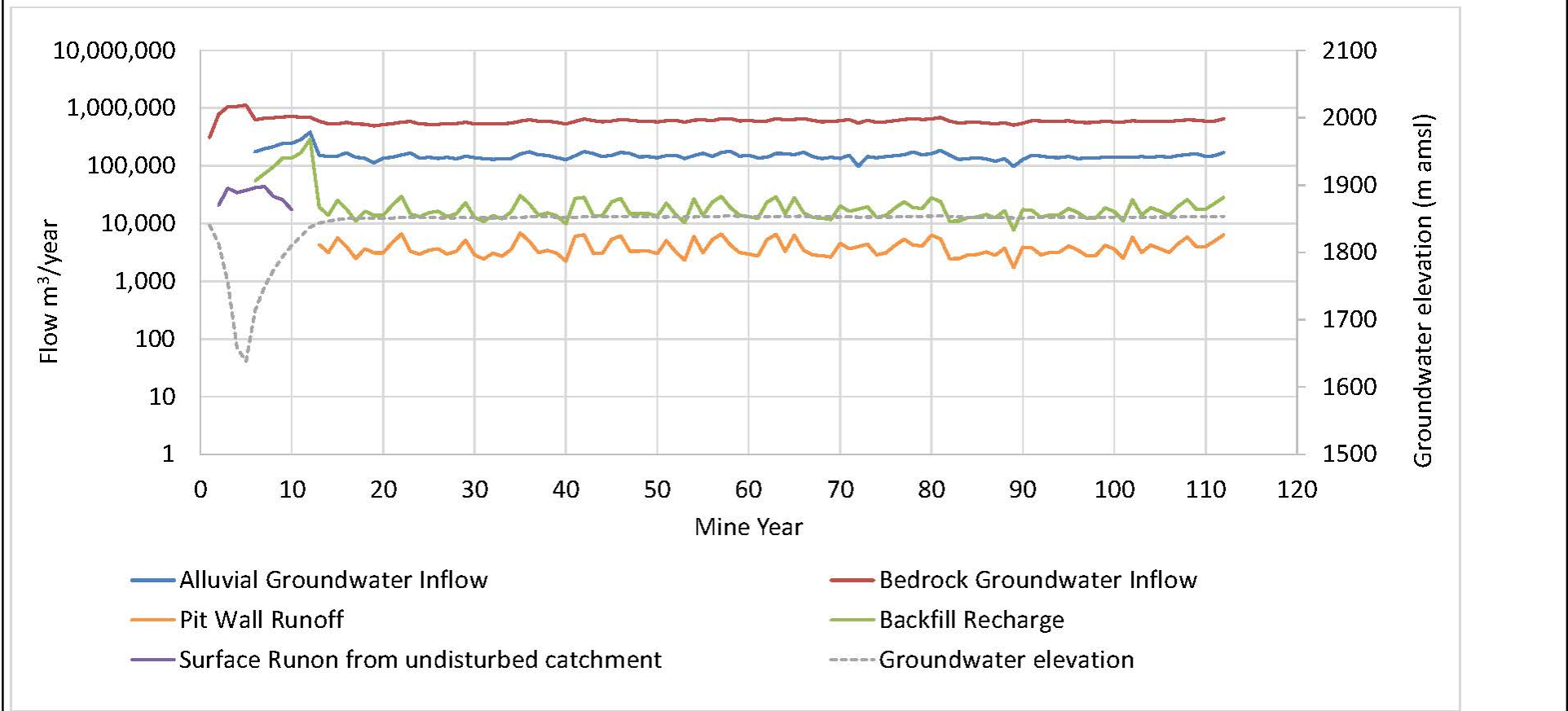
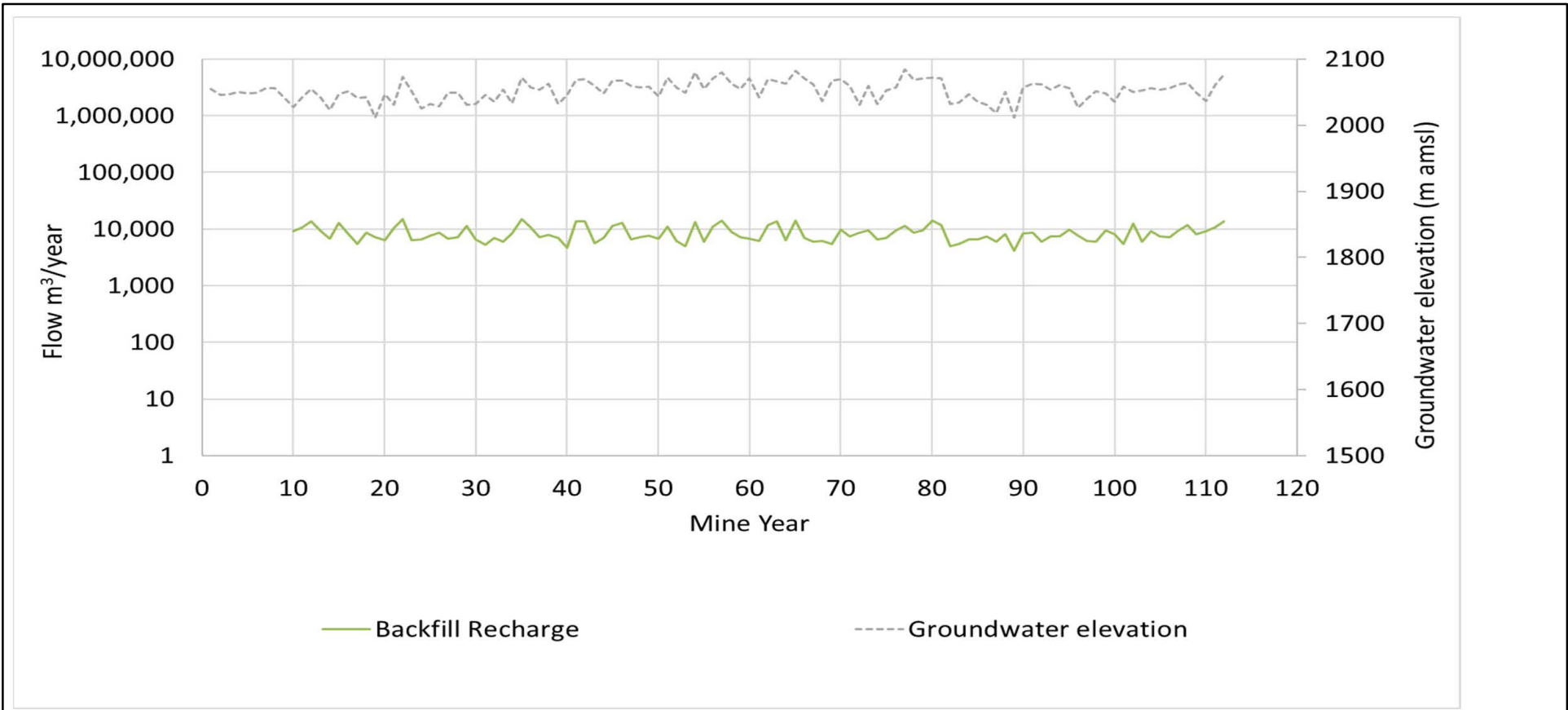
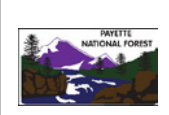


Figure 7-18
Predicted Pit Backfill Inflows

Stibnite Gold Project
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Data Sources: (SRK 2021)



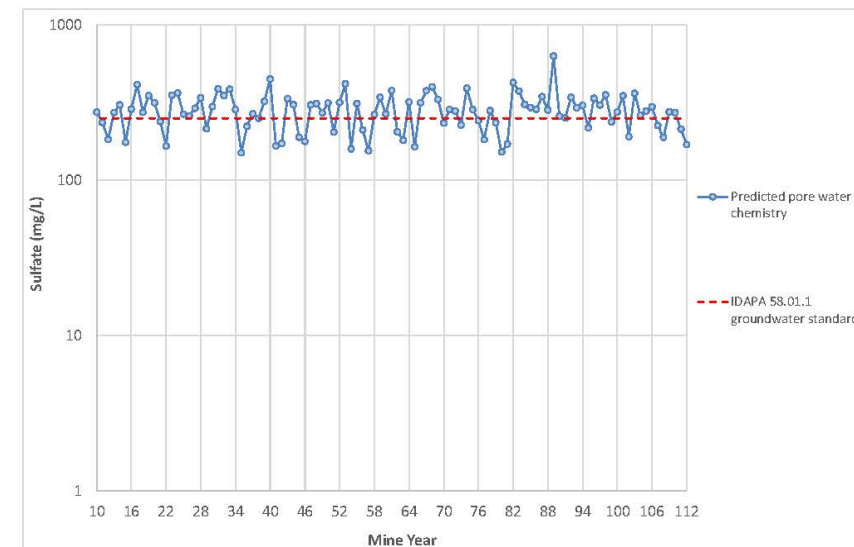
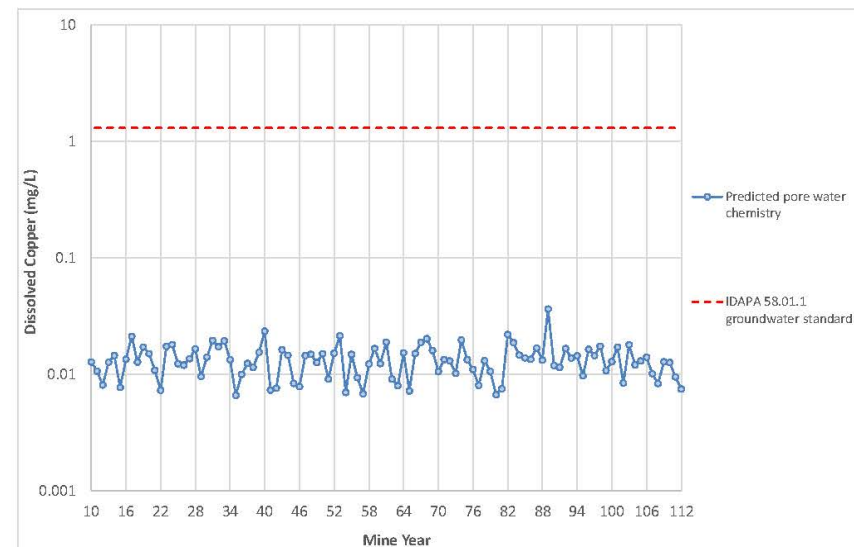
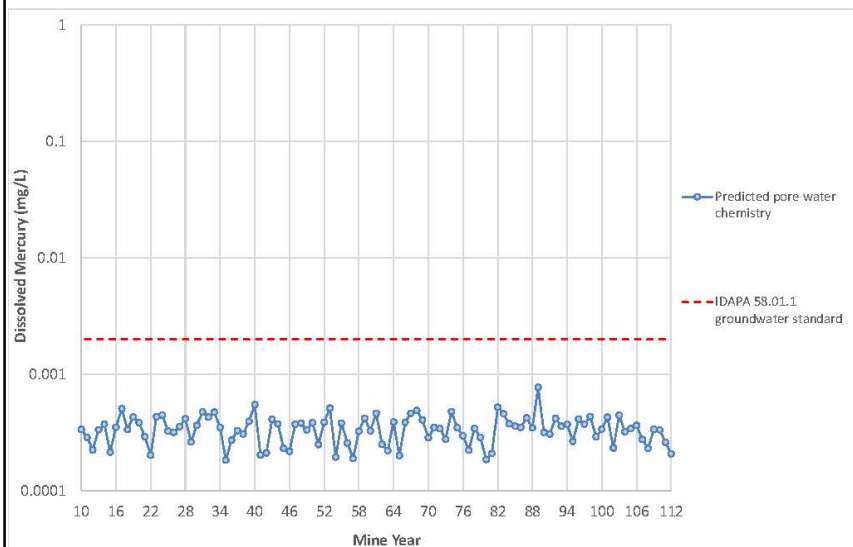
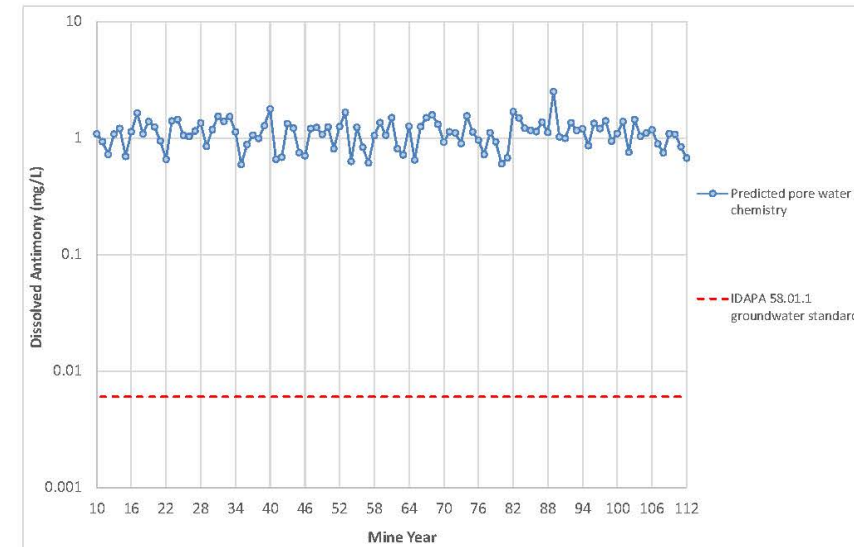
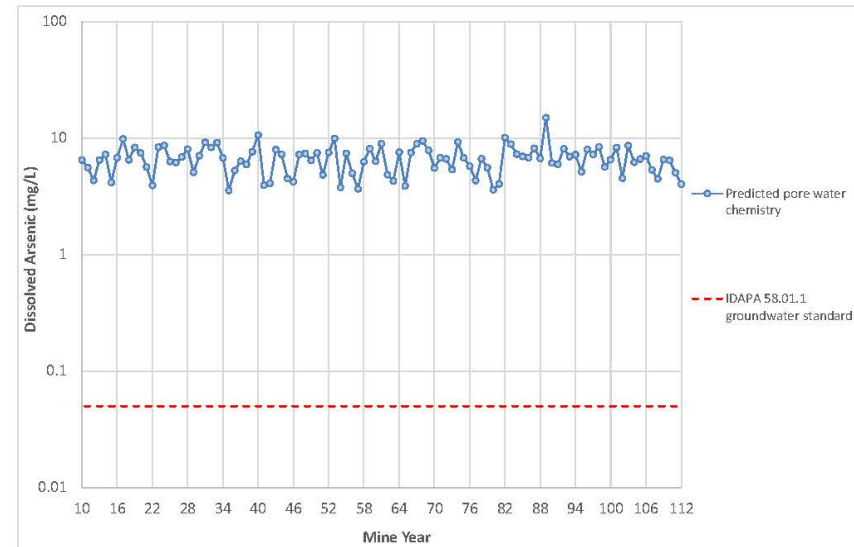
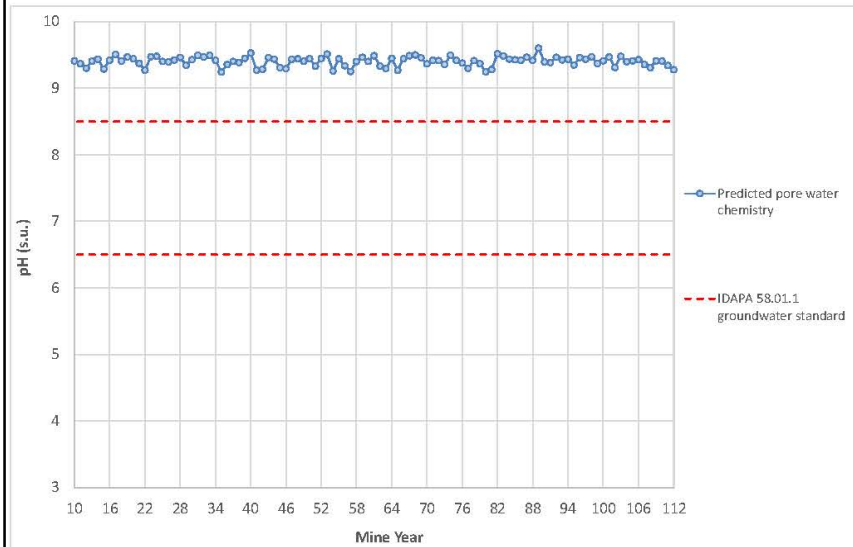
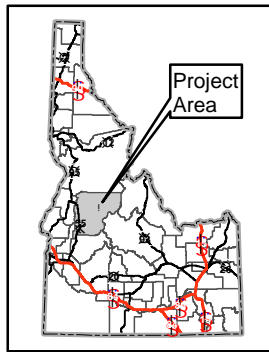


Figure 7-19
Predicted Midnight Pit
Backfill Porewater Chemistry

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 7-14 Predicted Porewater Chemistry for Midnight Pit Backfill

Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Mine Year				
			10	12	25	50	100
pH	s.u.	6.5 - 8.5*	8.4	8.4	8.4	8.4	8.4
Alkalinity	mg/L as CaCO ₃	-	110	110	110	110	110
Ag	mg/L	0.1*	0.00009	0.00006	0.00009	0.00011	0.00009
Al	mg/L	0.2*	0.004	0.005	0.004	0.004	0.004
As	mg/L	0.05	6.5	4.3	6.3	7.5	6.5
B	mg/L	-	4.0	2.7	3.9	4.6	4.0
Ba	mg/L	2	0.007	0.010	0.007	0.007	0.007
Be	mg/L	0.004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Ca	mg/L	-	24	19	24	27	25
Cd	mg/L	0.005	0.0014	0.00093	0.0014	0.0016	0.0014
Cl	mg/L	250*	6.4	4.3	6.2	7.3	6.4
Co	mg/L	-	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Cr	mg/L	0.1	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cu	mg/L	1.3	0.004	0.004	0.004	0.004	0.004
F	mg/L	4	<0.2	<0.2	<0.2	<0.2	<0.2
Fe	mg/L	0.3*	<0.02	<0.02	<0.02	<0.02	<0.02
Hg	mg/L	0.002	0.00034	0.00022	0.00033	0.00038	0.00034
K	mg/L	-	59	39	57	68	59
Mg	mg/L	-	61	49	60	66	61
Mn	mg/L	0.05*	0.22	0.17	0.22	0.24	0.22
Mo	mg/L	-	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Na	mg/L	-	32	22	31	37	32
Ni	mg/L	-	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
P	mg/L	-	0.13	0.089	0.13	0.15	0.13
Pb	mg/L	0.015	0.043	0.029	0.042	0.050	0.044
Sb	mg/L	0.006	1.1	0.7	1.1	1.2	1.1
Se	mg/L	0.05	<0.001	<0.001	<0.001	<0.001	<0.001
SO ₄	mg/L	250*	270	180	270	310	280
Tl	mg/L	0.002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
V	mg/L	-	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zn	mg/L	5*	0.33	0.22	0.32	0.38	0.33
TDS	mg/L	500*	580	440	570	640	580
NO ₃ + NO ₂	mg/L as N	10	<0.05	<0.05	<0.05	<0.05	<0.05

All values are for the dissolved fraction unless stated otherwise

Shading indicates greater than Idaho Groundwater Quality Standard (IDAPA 58.01.11)

* Indicates secondary guideline; - Indicates no standard for parameter

The water chemistry in the inundated backfill within the Yellow Pine pit is predicted to have circumneutral pH with TDS below 180 mg/L. Antimony and arsenic concentrations are predicted to be above groundwater quality standards (**Table 7-15** and **Figure 7-20**). Predicted mercury concentrations range from 30 ng/L in early years following inundation down to 9 ng/L after approximately 40 years. These mercury concentrations are below groundwater standards but notable because of the potential for groundwater discharge to surface waters.

Table 7-15 Predicted Post-Closure Porewater Chemistry for Yellow Pine Pit Backfill

Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Mine Year						
			13	14	15	20	25	50	100
pH	s.u.	6.5 - 8.5*	8.1	8.1	8.1	8.1	8.1	8.0	8.0
Alkalinity	mg/L as CaCO ₃	-	96	94	93	88	84	79	79
Ag	mg/L	0.1*	0.000027	0.000026	0.000025	0.000021	<0.00002	<0.00002	<0.00002
Al	mg/L	0.2*	0.0032	0.0031	0.0031	0.0031	0.003	0.003	0.003
As	mg/L	0.05	0.58	0.56	0.54	0.47	0.42	0.34	0.34
B	mg/L	-	0.24	0.22	0.21	0.16	0.13	0.076	0.075
Ba	mg/L	2	0.032	0.033	0.033	0.033	0.033	0.034	0.034
Be	mg/L	0.004	0.000031	0.000032	0.000032	0.000033	0.000033	0.000034	0.000035
Ca	mg/L	-	13	13	14	14	14	15	15
Cd	mg/L	0.005	0.000099	0.000093	0.000087	0.000068	0.000056	0.000036	0.000036
Cl	mg/L	250*	1.9	1.8	1.8	1.5	1.3	1.1	1.1
Co	mg/L	-	0.00056	0.00055	0.00055	0.00054	0.00053	0.00051	0.00053
Cr	mg/L	0.1	0.00093	0.00088	0.00084	0.00069	0.00059	0.00042	0.00043
Cu	mg/L	1.3	0.00087	0.00084	0.00081	0.0007	0.00064	0.00053	0.00052
F	mg/L	4	0.53	0.52	0.51	0.49	0.47	0.45	0.46
Fe	mg/L	0.3*	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hg	mg/L	0.002	0.00003	0.000028	0.000026	0.00002	0.000016	0.0000094	0.0000095
K	mg/L	-	3.5	3.3	3.2	2.6	2.3	1.7	1.7
Mg	mg/L	-	12	12	11	8.9	7.5	5.4	5.3
Mn	mg/L	0.05*	0.018	0.018	0.018	0.017	0.017	0.017	0.017
Mo	mg/L	-	0.0097	0.0093	0.0088	0.0074	0.0064	0.005	0.005
Na	mg/L	-	23	23	23	22	22	21	21
Ni	mg/L	-	0.0025	0.0024	0.0022	0.0018	0.0014	0.00088	0.0009

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Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Mine Year						
			13	14	15	20	25	50	100
P	mg/L	-	0.046	0.045	0.043	<0.04	<0.04	<0.04	<0.04
Pb	mg/L	0.015	0.0018	0.0017	0.0016	0.0012	0.00098	0.00059	0.00059
Sb	mg/L	0.006	0.05	0.048	0.045	0.037	0.031	0.021	0.021
Se	mg/L	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO ₄	mg/L	250*	33	32	31	28	26	24	24
Tl	mg/L	0.002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
V	mg/L	-	0.00059	0.0006	0.0006	0.00062	0.00063	0.00065	0.00066
Zn	mg/L	5*	0.017	0.016	0.015	0.011	0.0089	0.0053	0.0053
TDS	mg/L	500*	180	180	180	170	160	150	150
NO ₃ + NO ₂	mg/L as N	10	0.18	0.18	0.19	0.2	0.21	0.21	0.21

All values are for the dissolved fraction unless stated otherwise

Shading indicates greater than Idaho Groundwater Quality Standard (IDAPA 58.01.11)

* Indicates secondary guideline

- Indicates no standard for parameter

The water chemistry in the inundated backfill within the Hangar Flats pit is predicted to have circumneutral pH with TDS below 120 mg/L. Antimony and arsenic concentrations are predicted to be above groundwater quality standards (**Table 7-16** and **Figure 7-21**). Predicted mercury concentrations range from 5 ng/L in early years following inundation down to 2 ng/L after approximately 20 years. These mercury concentrations are less than groundwater standards but notable because of the potential for groundwater discharge and contribute constituents to surface waters.

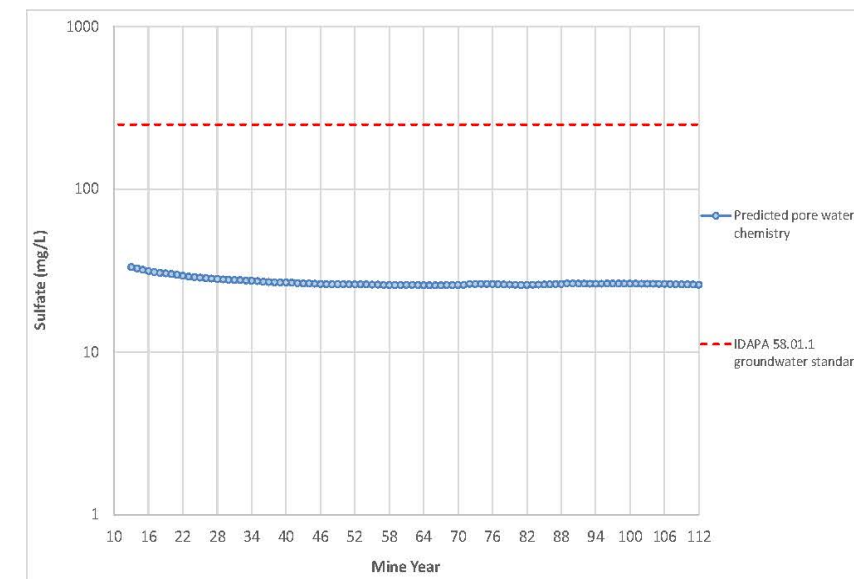
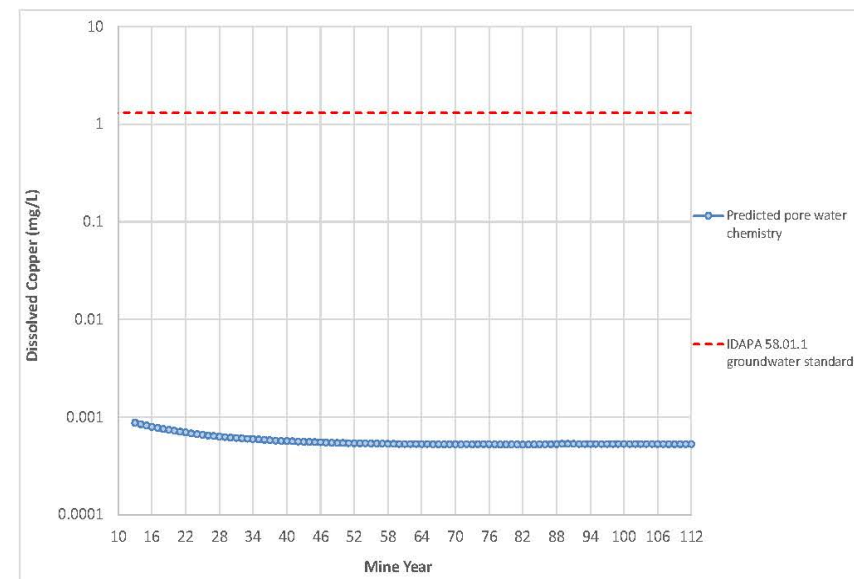
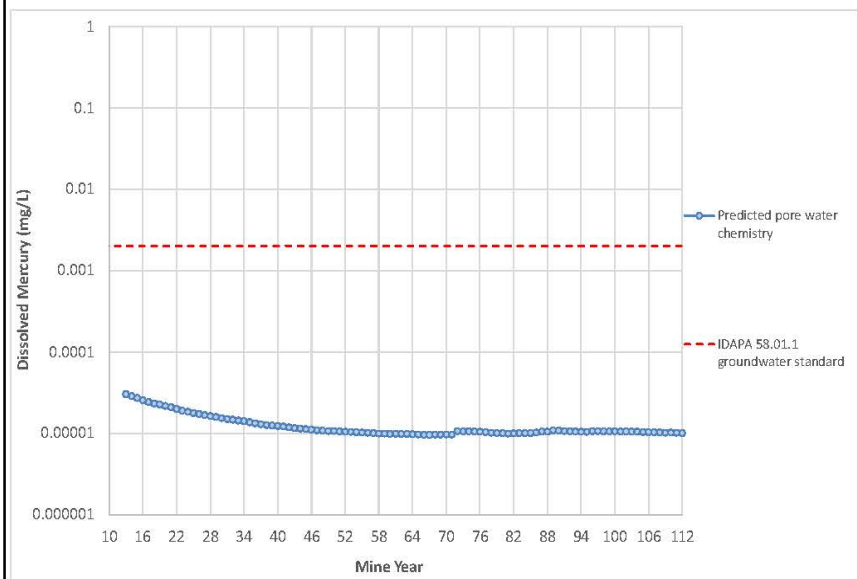
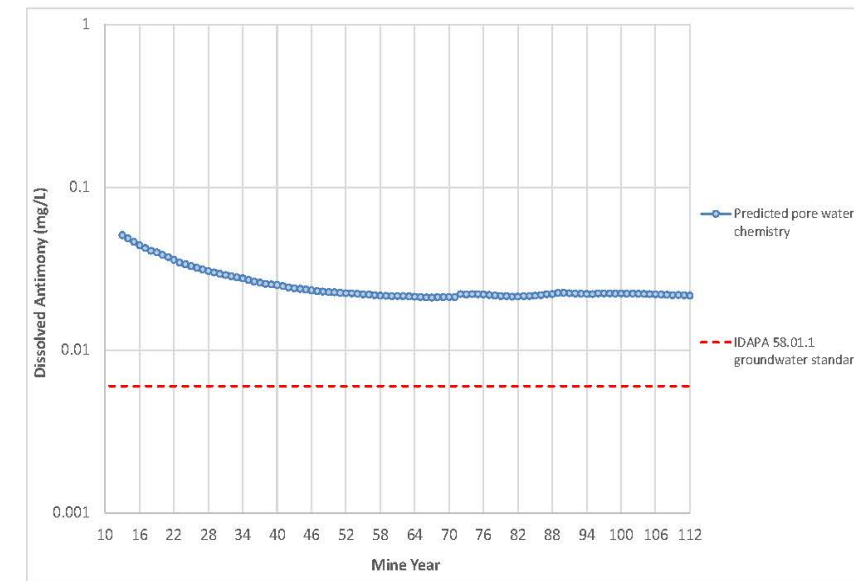
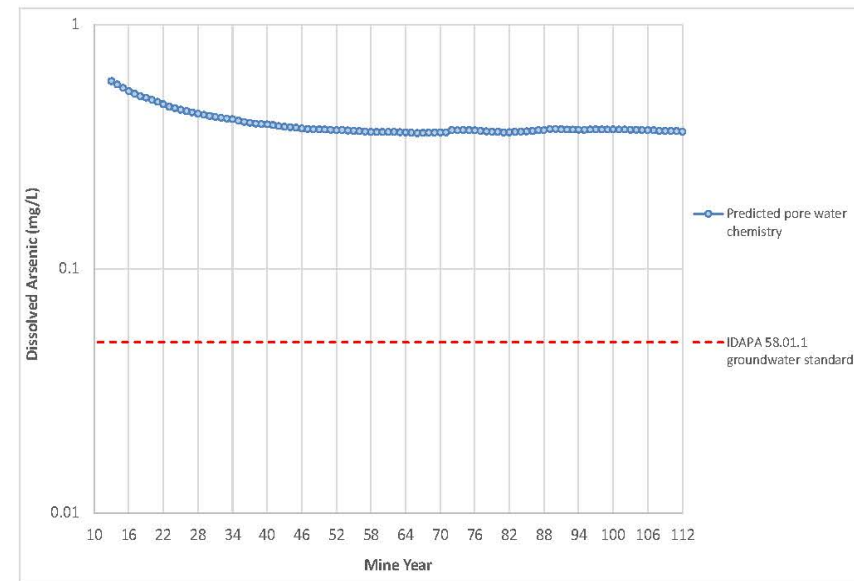
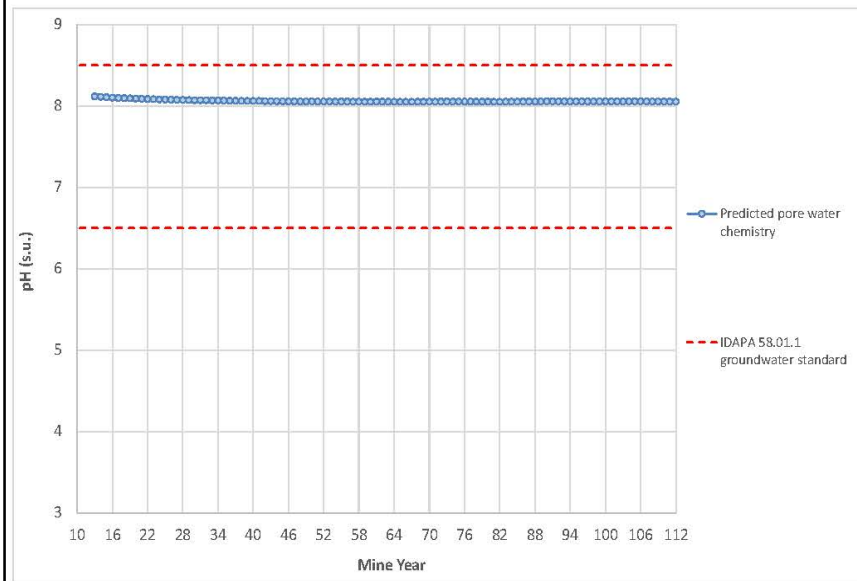
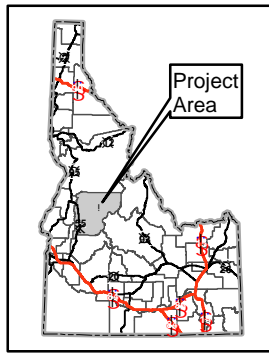


Figure 7-20
Predicted Yellow Pine Pit
Backfill Porewater Chemistry

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Stibnite, ID

Data Sources: (SRK 2021)



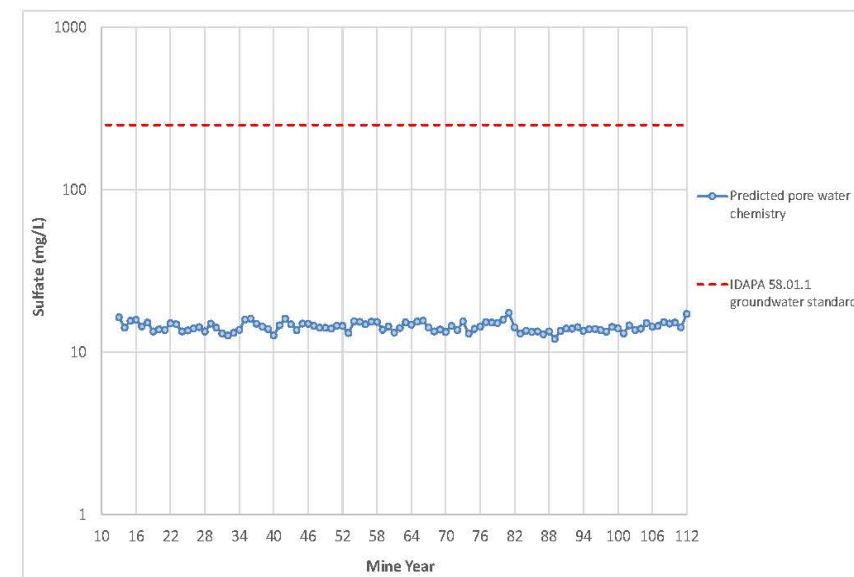
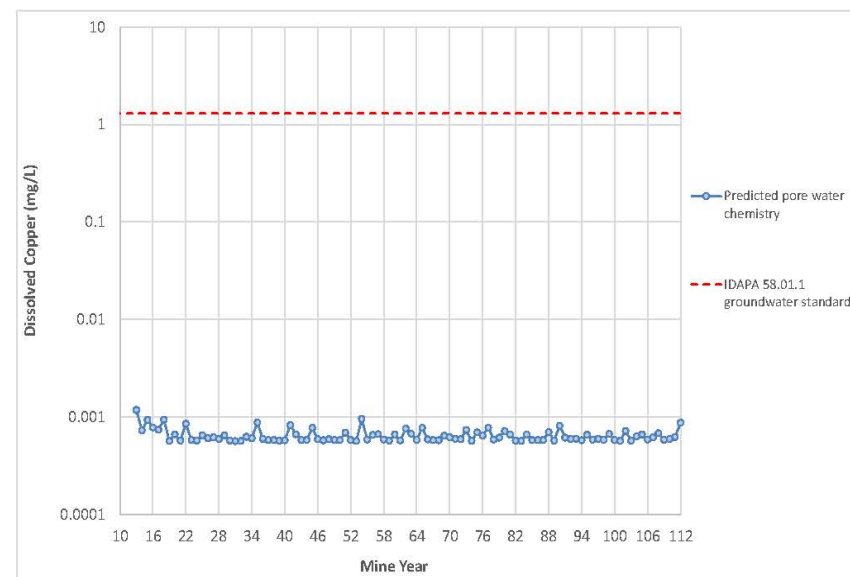
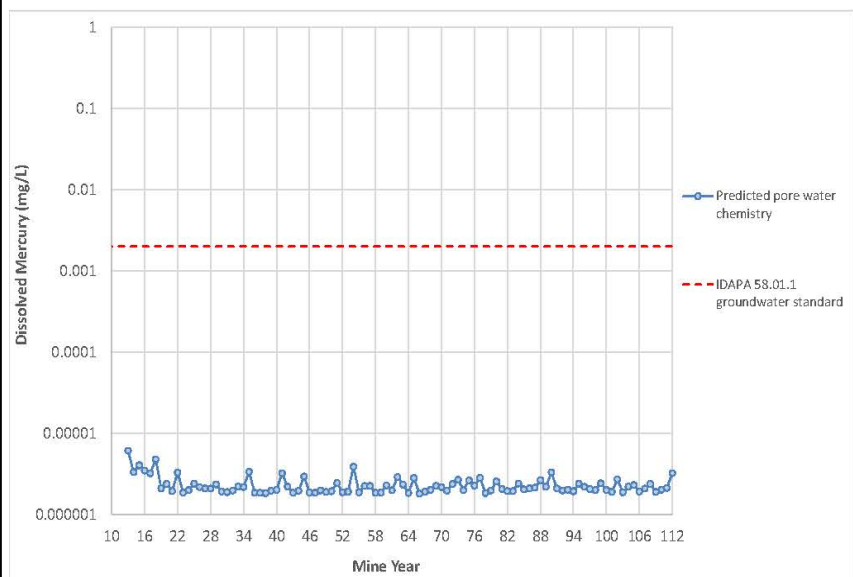
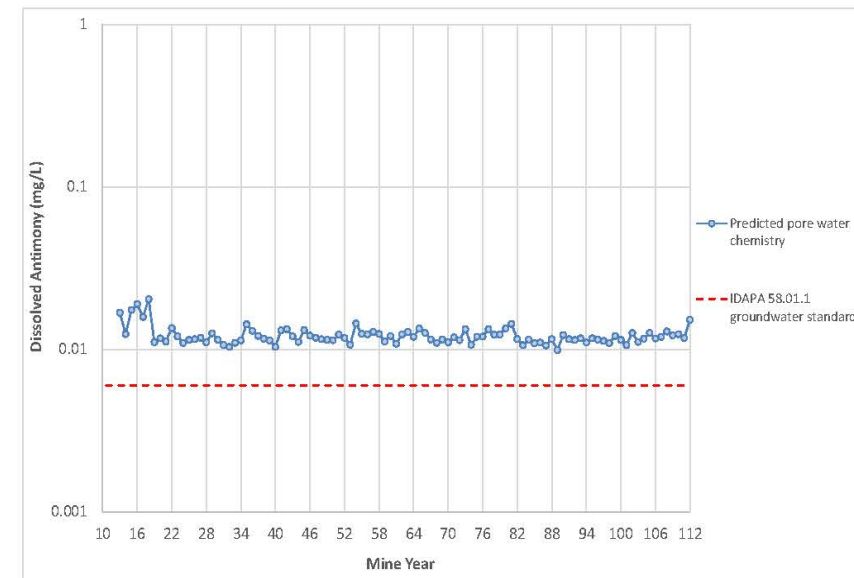
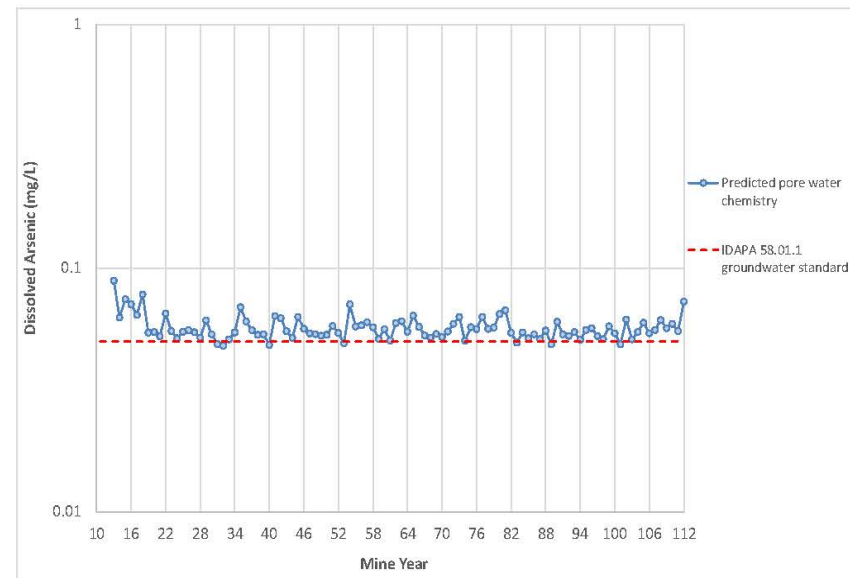
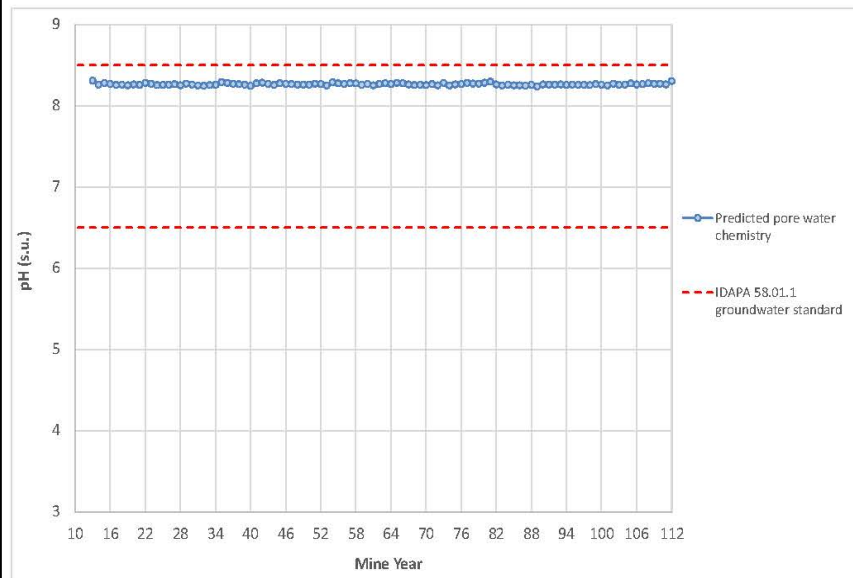
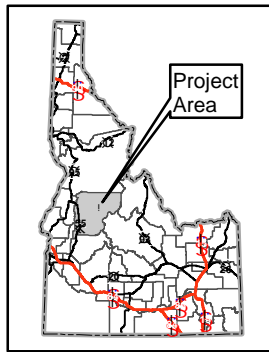


Figure 7-21
Predicted Hanger Flats Pit
Backfill Porewater Chemistry

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 7-16 Predicted Post-Closure Porewater Chemistry for Hangar Flats Pit Backfill

Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Mine Year						
			13	14	15	20	25	50	100
pH	s.u.	6.5 - 8.5*	8.3	8.2	8.3	8.2	8.2	8.2	8.2
Alkalinity	mg/L as CaCO ₃	-	69	63	66	63	63	63	63
Ag	mg/L	0.1*	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Al	mg/L	0.2*	0.0037	0.0035	0.0036	0.0035	0.0035	0.0035	0.0035
As	mg/L	0.05	0.072	0.051	0.095	0.045	0.045	0.043	0.044
B	mg/L	-	0.031	<0.02	0.034	<0.02	<0.02	<0.02	<0.02
Ba	mg/L	2	0.0050	0.0045	0.0043	0.0039	0.0038	0.0039	0.0038
Be	mg/L	0.004	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Ca	mg/L	-	21	19	20	20	20	20	20
Cd	mg/L	0.005	0.000023	<0.00002	0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Cl	mg/L	250*	0.51	0.45	0.62	0.41	0.42	0.41	0.41
Co	mg/L	-	0.00015	0.00014	0.00021	0.00014	0.00014	0.00014	0.00015
Cr	mg/L	0.1	0.0006	0.00057	0.00050	0.00033	0.00034	0.00033	0.00033
Cu	mg/L	1.3	0.0010	0.00068	0.00080	0.00063	0.00062	0.00056	0.00055
F	mg/L	4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Fe	mg/L	0.3*	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Hg	mg/L	0.002	0.0000050	0.0000028	0.0000066	0.0000020	0.0000020	0.0000016	0.0000017
K	mg/L	-	1.1	0.95	1.3	0.96	0.95	0.93	0.94
Mg	mg/L	-	3.30	2.6	3.2	2.5	2.5	2.4	2.4
Mn	mg/L	0.05*	0.0093	0.0072	0.010	0.0069	0.0068	0.0070	0.0069
Mo	mg/L	-	0.0017	0.0016	0.0026	0.0016	0.0016	0.0016	0.0016
Na	mg/L	-	9.9	8.8	9.9	8.7	8.6	8.9	8.9
Ni	mg/L	-	0.00043	0.00033	0.00083	0.00032	0.00035	0.00033	0.00034
P	mg/L	-	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Pb	mg/L	0.015	0.00022	0.00012	0.00025	0.000097	0.000096	0.000079	0.000080
Sb	mg/L	0.006	0.014	0.010	0.030	0.0097	0.0097	0.0095	0.0095
Se	mg/L	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
SO ₄	mg/L	250*	14	12	15	12	12	12	12

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Parameter	Units	Idaho Groundwater Quality Standard (IDAPA 58.01.11)	Mine Year						
			13	14	15	20	25	50	100
Tl	mg/L	0.002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
V	mg/L	-	0.00031	0.00030	0.00031	0.00032	0.00032	0.00032	0.00032
Zn	mg/L	5*	0.0033	0.0023	0.0038	0.0019	0.0019	0.0018	0.0018
TDS	mg/L	500*	120	110	120	110	110	110	110
NO ₃ + NO ₂	mg/L as N	10	0.43	0.42	0.55	0.45	0.45	0.45	0.45

All values are for the dissolved fraction unless stated otherwise

Shading indicates greater than Idaho Groundwater Quality Standard (IDAPA 58.01.11)

* Indicates secondary guideline

- Indicates no standard for parameter

7.2.2.5 Groundwater Chemistry

Project effects on groundwater chemistry would be related to infiltration of leachate from the TSF, TSF Embankment and Buttress, stockpiles, and the Midnight pit backfill plus groundwater interaction with the inundated backfill within the Yellow Pine and Hangar Flats pits and groundwater outflow from the West End pit lake. In addition, accidental releases of fuels, lubricants, coolants, hydraulic fluid, and other chemicals could impact groundwater quality if not effectively addressed via designed containments and spill responses.

Effects of TSF, TSF Embankment and Buttress, and stockpiles leachate infiltration on receiving alluvial groundwater were summarized in **Figures 7-4** and **7-8**. Limited infiltration from the lined TSF results in minor changes to groundwater analyte concentrations under the TSF that do not result in exceedances of groundwater quality standards. Infiltration from the unlined TSF Buttress is predicted to have a more notable effect on groundwater analyte concentrations. Specifically, mixing of infiltrated leachate with previously unimpacted alluvial groundwater is predicted to increase antimony and arsenic groundwater concentrations above existing conditions and groundwater standards. However, infiltrating leachate would result in little change to the antimony and arsenic concentrations in currently impacted alluvial groundwater.

Where the local groundwater has not been previously impacted, the groundwater interactions with inundated backfill pore water and the West End pit lake would have the potential to increase groundwater concentrations for antimony and arsenic to levels above groundwater standards. Where the local groundwater is previously impacted, these groundwater interactions would have little influence on antimony and arsenic concentrations.

To assess the mixing and movement of dissolved constituents in groundwater, a particle tracking analysis was conducted using the site hydrogeologic model (Brown and Caldwell 2021b). Flow paths from origin locations within the TSF Buttress footprint and pit backfills were tracked over a period simulating 100 years following the end of dewatering operations and the particles were mapped at their final destinations over this time frame (**Figure 7-22**). The tracking analyses indicated that these destinations were typically surface stream segments in Meadow Creek, the East Fork SFSR, or Sugar Creek. Flow from the TSF Buttress footprint and the Hangar Flats backfill is predicted to be in an easterly to northeasterly direction toward the Meadow Creek area. The presence of a lined diversion channel for Meadow Creek inhibited discharge of groundwater to surface water along the length of the diversion. Groundwater discharge was predicted to occur primarily in Meadow Creek past the end of the lined diversion and prior to its confluence with the East Fork SFSR. Discharge of groundwater from these origin areas to the East Fork SFSR below the Meadow Creek confluence is predicted to occur to lesser extent than above the confluence. The effects of groundwater discharge on surface water chemistry are incorporated into the predicted analyte concentrations in surface water (**Section 7.2.2.6**).

Most of the groundwater movement from origin locations within the Yellow Pine pit backfill concludes as surface water discharge to the East Fork SFSR below the Yellow Pine pit area. However, approximately 10 percent of the groundwater flow discharges to surface water in Sugar Creek (**Figure 7-22**). Twenty-five percent of groundwater outflow from the West End pit lake discharges as surface water in West End Creek with the remainder discharging as surface water in Sugar Creek.

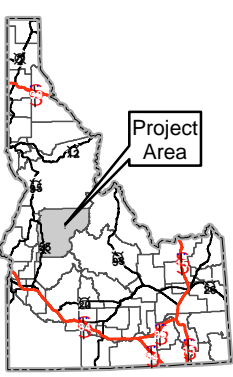
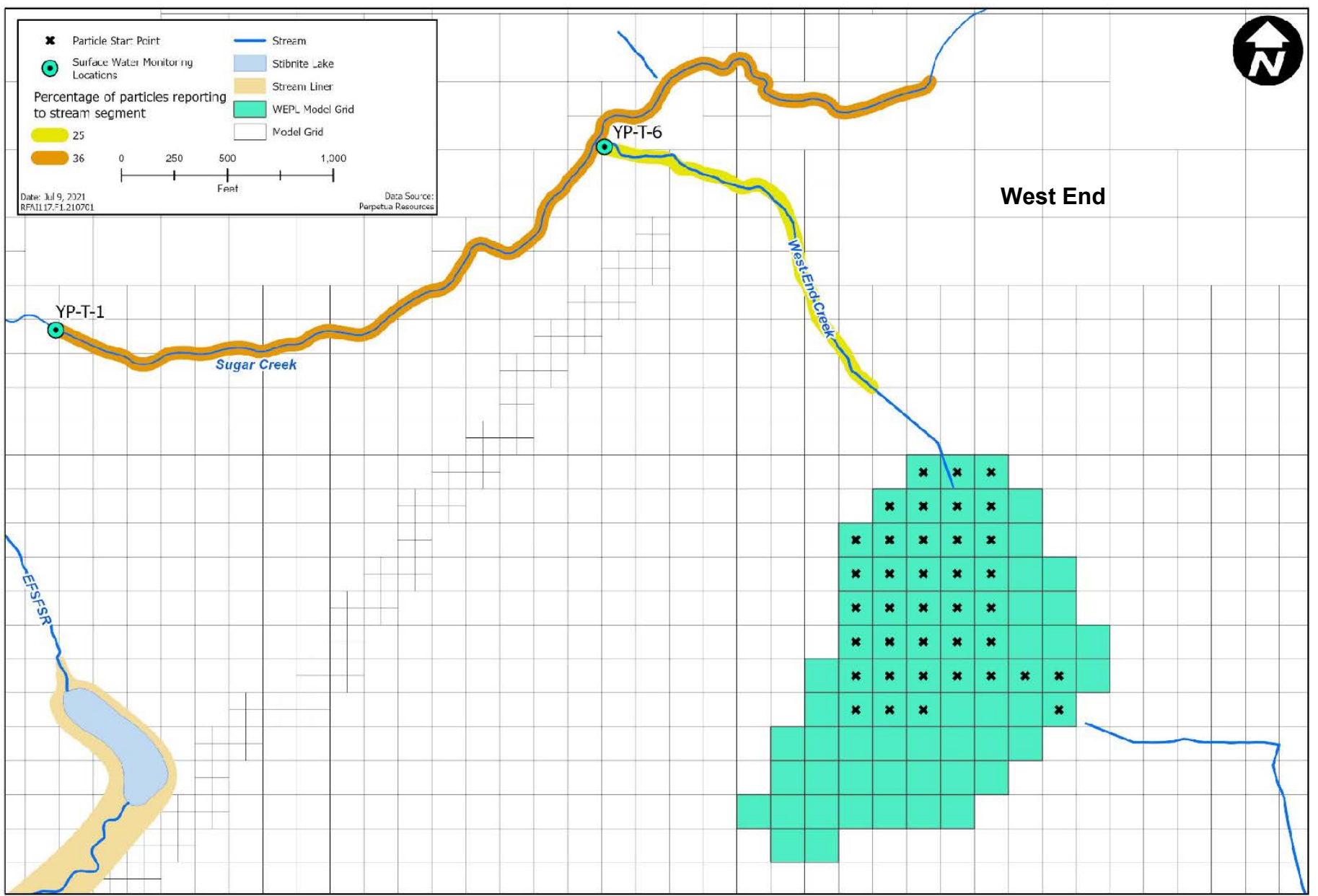
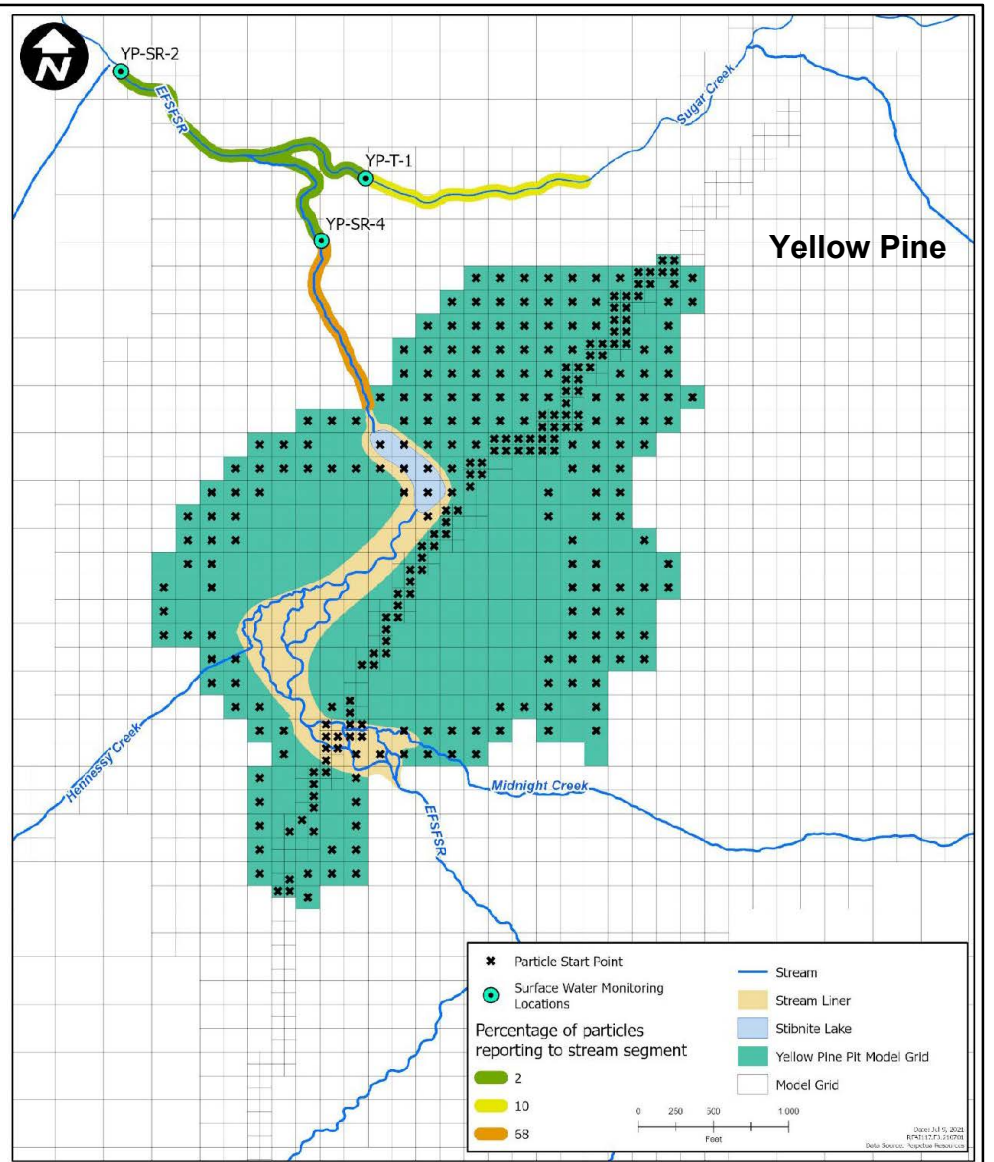
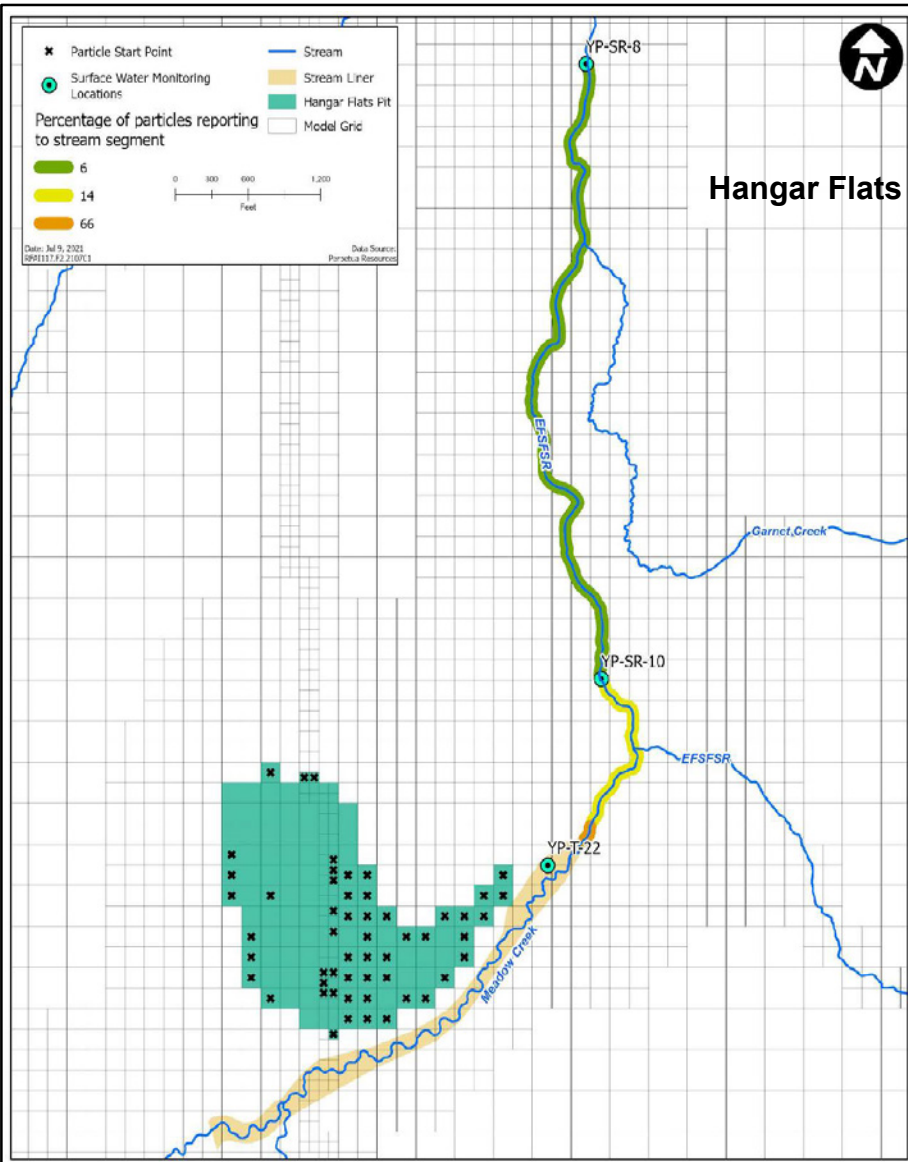


Figure 7-22
Predicted Groundwater Discharge to Surface Water

Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2020)



Existing groundwater monitoring data near the confluence of Meadow Creek and the East Fork SFSR exhibit antimony and arsenic concentrations above groundwater standards (**Figures 6-17 and 6-18**), indicating the mixture of leachate with these waters would result in little change to groundwater concentrations relative to standards. This is also the case with groundwater concentrations with the Sugar Creek drainage. Groundwater monitoring below the existing Yellow Pine pit indicates that there are zones of groundwater to the west of the East Fork SFSR channel (e.g., around MWH-A17 and SRK-GM-04S) where antimony and arsenic concentrations are below groundwater standards. Approximately two percent of the groundwater particles originating from the Yellow Pine pit backfill are predicted to reach those groundwater areas which could observe an associated increase in groundwater antimony and arsenic concentrations.

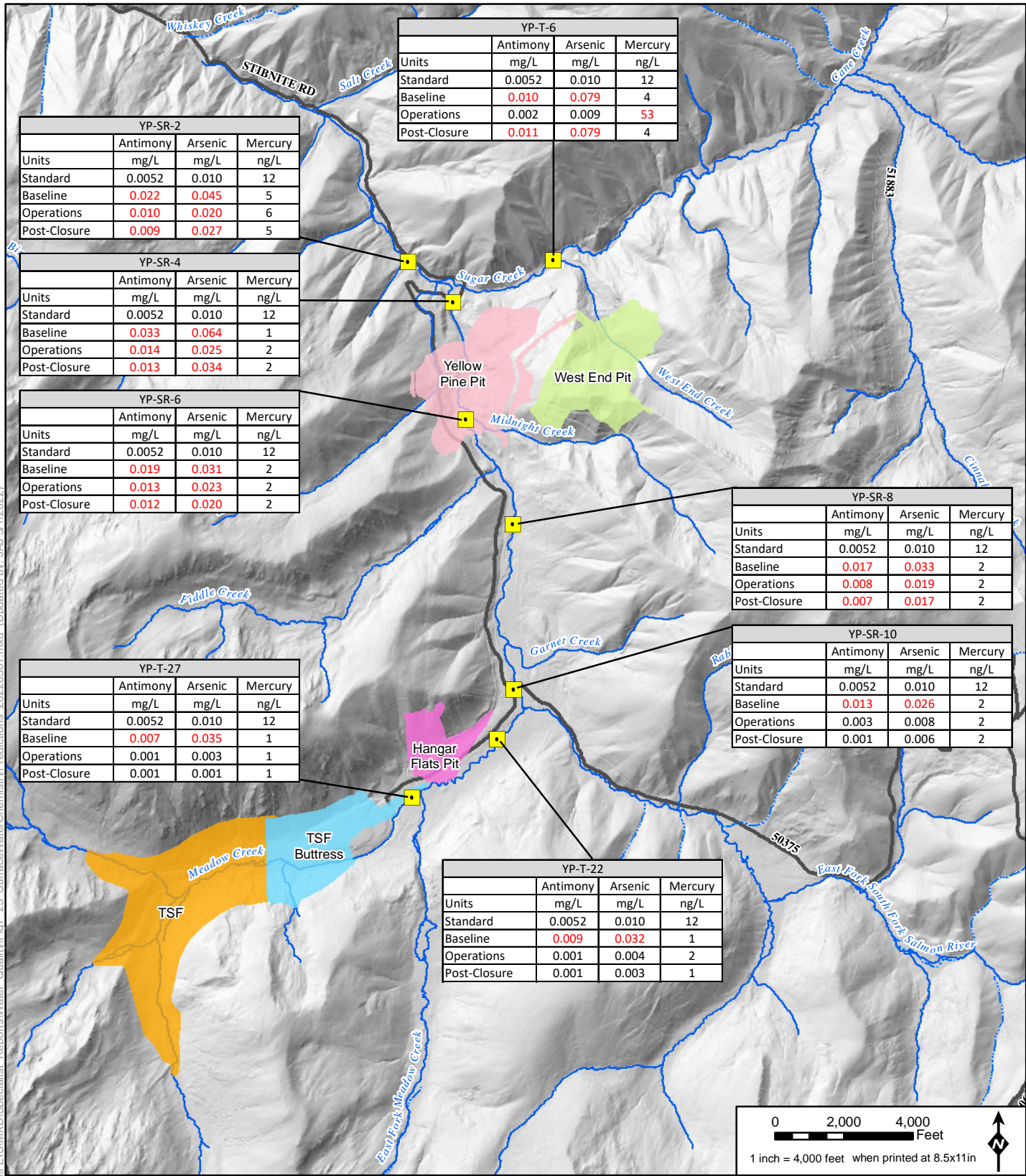
The effects of the infiltration of leachate from the TSF, TSF Buttress, stockpiles and Midnight pit backfill, groundwater interaction with the Yellow Pine and Hangar Flats pit backfills, and West End pit lake on groundwater chemistry would be minor to major depending on the existing condition of receiving groundwater, permanent, and localized. Major effects would be limited to the groundwater area (i.e., around MWH-A17 and SRK-GM-04S) where antimony and arsenic concentrations are below groundwater standards. The effects of groundwater discharge on surface water chemistry are incorporated into the predicted analyte concentrations in surface water in the following section.

7.2.2.6 Surface Water Chemistry

The results of the individual facility water chemistry models for the TSF, TSF Buttress, the backfilled Hangar Flats, Yellow Pine and Midnight pits, West End pit lake, and WTP effluent water quality were incorporated into a site-wide water chemistry (SWWC) model to provide an overall prediction of surface water concentrations in Meadow Creek, the East Fork SFSR, West End Creek and Sugar Creek (SRK 2021a). The water chemistry models were coupled with surface and groundwater flow predictions from the site-wide water balance and hydrogeological model (Brown and Caldwell 2021a, 2021b). The SWWC model quantifies surface water analyte concentrations at a series of nine prediction nodes downgradient of the mine facilities (**Figure 7-23**).

Constituent leaching from haul roads and access roads by meteoric and snowmelt runoff was evaluated using the site-wide water balance to estimate flows and humidity cell data to estimate runoff water chemistry. Details of the assessment can be found in SRK 2021a. Leachate chemistry from road surface materials is predicted have circumneutral pH with analyte concentrations below surface water standards. Use of chemical additives for dust control on roadways is not expected to add constituents to surface water. Dust control products, such as magnesium chloride, lignin sulfonate, or other appropriate and environmentally acceptable products, to further enhance dust control at the site would be incorporated. The Forest Service would require that where haul roads pass within 25 feet (slope distance) of surface water, dust abatement would only be applied to a 10-foot swath down the centerline of the road. The rate and quantity of application would be regulated to ensure the chemical is absorbed before leaving the road surface. Therefore, effects of haul roads and access roads were not incorporated into the water chemistry modeling but were incorporated into the analysis of sediments and hazardous materials.

Document Path: U:\20372\198103_data\gis_cad\fig7-23_SurfaceWaterChemistryPredictions_20220301.mxd (Updated by: JAL 3/1/2022)



YP-SR-2			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.022	0.045	5
Operations	0.010	0.020	6
Post-Closure	0.009	0.027	5

YP-T-6			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.010	0.079	4
Operations	0.002	0.009	53
Post-Closure	0.011	0.079	4

YP-SR-4			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.033	0.064	1
Operations	0.014	0.025	2
Post-Closure	0.013	0.034	2

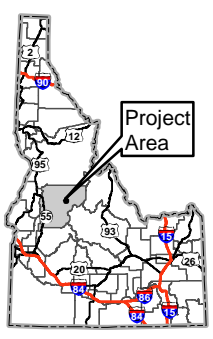
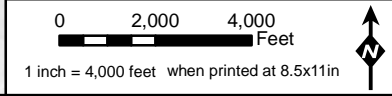
YP-SR-6			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.019	0.031	2
Operations	0.013	0.023	2
Post-Closure	0.012	0.020	2

YP-SR-8			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.017	0.033	2
Operations	0.008	0.019	2
Post-Closure	0.007	0.017	2

YP-T-27			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.007	0.035	1
Operations	0.001	0.003	1
Post-Closure	0.001	0.001	1

YP-SR-10			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.013	0.026	2
Operations	0.003	0.008	2
Post-Closure	0.001	0.006	2

YP-T-22			
	Antimony	Arsenic	Mercury
Units	mg/L	mg/L	ng/L
Standard	0.0052	0.010	12
Baseline	0.009	0.032	1
Operations	0.001	0.004	2
Post-Closure	0.001	0.003	1



- LEGEND**
- Prediction Node
 - Project Components ***
 - SGP Features**
 - Hangar Flats Pit
 - TSF
 - TSF Buttress
 - West End Pit
 - Yellow Pine Pit
 - Other Features**
 - Road
 - Intermittent Stream
 - Perennial Stream

Figure 7-23
Locations for Surface Water
Chemistry Predictions
Stibnite Gold Project
Stibnite, ID

Base Layer: Midas Hillshade Raster 10m
Other Data Sources: Perpetua; Boise National Forest; Payette National Forest



*Mine Site components are associated with 2021 MMP

Construction and operation of the Burntlog Maintenance Facility and the SGLF would have the potential for increased runoff, erosion, sedimentation (as a result of vegetation removal and excavation of soil, rock, and sediment) and fuel and/or material discharge to nearby waterbodies during operations (if not properly stored or contained). However, design features proposed by Perpetua (**Table 2-3**), prominent regulatory and Forest Plan requirements required by the Forest Service (**Table 2-2**), and permit stipulations from state and federal agencies (including BMPs, sanitary wastewater, and SPCC Plan) would control runoff, erosion, sedimentation, and the potential for discharges. Therefore, effects of the Burntlog Maintenance Facility and the SGLF were considered to be negligible to surface water quality analysis.

Predicted water chemistry at the assessment nodes was determined by mixing the predicted mine-impacted water chemistry originated from the modeled project facilities with catchment runoff. Catchment runoff is the proportion of surface water flow derived from meteoric and snow melt runoff. Catchment runoff would consist of runoff from the disturbed ground associated with historical mine facilities and undisturbed native ground. The percentage of disturbed ground within the catchment of each prediction node is summarized in **Table 7-17**. Runoff from disturbed and undisturbed ground was assigned water chemistries associated with observed concentrations in water chemistry samples from the area. Additional details for this surface water chemistry modeling can be found in SRK 2021a.

Table 7-17 Summary of Disturbed Catchment Percentages

Assessment Node	Watercourse	Disturbed Catchment (% of total catchment)*
YP-T-27	Meadow Creek	0.3
YP-T-22	Meadow Creek	0.4
YP-SR-10	East Fork SFSR	3.0
YP-SR-8	East Fork SFSR	0.9
YP-SR-6	East Fork SFSR	0.8
YP-SR-4	East Fork SFSR	1.5
YP-T-1	Sugar Creek	0.1
YP-SR-2	East Fork SFSR	0.01

*The proportions are not cumulative and are calculated using the disturbed area downstream of upstream assessment locations
Source: SRK 2021a

For predicting future surface water concentrations, disturbance associated with the SODA/Bradley tailings and Hecla Heap was not incorporated because those facilities are proposed to be reclaimed during operations. Conversely, reclamation of the Bradley dumps is not included in the model because that reclamation is not part of the 2021 MMP. Therefore, leachate from the Bradley dumps was incorporated in the model, and recharge estimates were assumed to remain the same as existing conditions during operations and post-operations.

To minimize the volumes of contact water encountering project disturbance and requiring treatment, the project would divert upstream non-contact water to prevent it from interacting with SGP facilities during operations. **Table 7-18** provides a summary of the non-contact diversion channels that are considered in the SWWC model. At closure, the diversion channels would be decommissioned, and non-contact water would follow its natural drainage pathways.

Table 7-18 Summary of Diversion Channels included in the Surface Water Chemistry Model

Diversion Channel	Description
North Diversion	Diverts non-contact runoff from the north of the TSF and TSF Buttress to Meadow Creek
South Diversion	Diverts Meadow Creek and its tributaries from the south and west of the TSF around the TSF
Hennessy Diversion	Diverts water from Hennessy Creek away from the Yellow Pine pit to Fiddle Creek
Midnight Diversion	Diverts Midnight Creek away from the Yellow Pine pit to the East Fork SFSR
West End Diversion	Diverts upper West End Creek around the West End pit
East Fork SFSR Tunnel	Diverts the East Fork SFSR around the Yellow Pine pit downstream of YP-SR-6 to upstream of YP-SR-4

Source: SRK 2021a

Predicted surface water concentrations at node YP-T-22 on Meadow Creek downstream of the TSF and TSF Buttress are lower for most analytes compared to existing conditions (**Figure 7-24** and **Table 7-19**). This prediction is related to the removal of historical unlined mine waste disposal areas from the Meadow Creek drainage and the construction of lined and covered facilities as part of the project. The exception to the reduced analyte concentrations are mercury concentrations which exhibit some variability during the operational and early closure periods attributable to predicted variations in effluent chemistry from the water treatment plant. Predicted long-term surface water mercury concentrations are comparable to the existing conditions at the location. Mercury concentrations remain below the most stringent applicable water quality standard under existing conditions and throughout the construction, operating and post-closure periods.

Immediately downstream of the Yellow Pine pit on the East Fork SFSR at node YP-SR-4 (above the confluence with Sugar Creek), predicted surface water chemistry is similar to existing conditions with some variability in predicted antimony, arsenic, and mercury concentrations during the operating and initial closure period (**Figure 7-25** and **Table 7-20**). Compared to existing conditions, predicted surface water antimony concentrations are lower during the operating period due to the removal of unlined legacy mine wastes then increase slightly post-closure to a concentration below existing conditions as discharging groundwater chemistry is modified by interaction with the Yellow Pine pit backfill. Similarly, predicted arsenic concentrations decrease relative to existing conditions during the operating period then recover to a concentration below existing conditions in the post-closure period. Lastly, predicted mercury concentrations are slightly higher than existing conditions during the operating period due to variability in predicted effluent chemistry from the water treatment plant, then return to concentrations slightly higher than existing conditions post-closure. However, mercury concentrations remain below the most stringent applicable water quality standard under existing conditions and throughout the construction, operating and post-closure periods.

Immediately downstream of the West End pit on West End Creek at node YP-T-6 (above the confluence with Sugar Creek), predicted surface water chemistry is modified by diversion of West End Creek around the pit area and predicted operational period water chemistry is based on observed analyte concentrations in West End Creek above the pit area (**Figure 7-25** and **Table 7-21**). Compared to existing conditions, predicted surface water antimony concentrations are lower during the operating period due to the creek diversion then return to existing conditions during the closure period as a result of West End pit lake chemistry effects on surface water and groundwater. Similarly, predicted arsenic concentrations decrease relative to existing conditions during the operating period then recover to existing conditions in the post-closure period. Lastly, predicted mercury concentrations are an order of magnitude higher than existing conditions during the operating period due to the observed upper West End Creek concentrations, then return to existing conditions post-closure. During operations, mercury concentrations are greater than the most stringent applicable water quality standard because the surface water in upper West End Creek is above the standard under existing conditions. Post-closure mercury concentrations return to a level below the most stringent applicable water quality standard.

Downstream of the project on the East Fork SFSR at node YP-SR-2 (below the confluence with Sugar Creek), predicted surface water chemistry is largely unchanged from existing conditions with some variability in predicted antimony, arsenic, and mercury concentrations during the operating and initial closure period (**Figure 7-27** and **Table 7-22**). Compared to existing conditions, predicted surface water antimony concentrations are lower during the operating period due to the removal of unlined legacy mine wastes then increase slightly post-closure to a concentration below existing conditions as recovering groundwater levels result in increased discharge to surface water. Similarly, predicted arsenic concentrations decrease relative to existing conditions during the operating period then recover to a concentration comparable to existing conditions in the post-closure period. Lastly, predicted mercury concentrations are slightly higher than existing conditions during the operating period due to variability in predicted effluent chemistry from the water treatment plant, then return to concentrations comparable to existing conditions post-closure. However, mercury concentrations remain below the most stringent applicable water quality standard under existing conditions and throughout the construction, operating and post-closure periods.

During operations, West End Creek would be diverted around the operations associated with the West End pit. Under existing conditions West End Creek has antimony and arsenic concentrations above stream surface water standards. Existing mercury concentrations in West End Creek are greater than standards above the West End pit area (approximately 50 ng/L) and less than standards below the pit area (approximately 4 ng/L). This suggests that a naturally occurring mechanism reduces mercury concentrations in the creek between the sample locations upstream and downstream of the pit area.

Diversion of West End Creek around the pit area during operations has the potential to affect the naturally occurring reduction in mercury concentrations, allowing higher upstream concentrations to appear in the downstream segment. Therefore, water chemistry forecasting conservatively utilizes the higher mercury concentrations from upstream of the pit area in assessing West End Creek and downstream mercury concentrations (SRK 2021a). However, predicted downstream mercury concentrations remain lower than surface water standards.

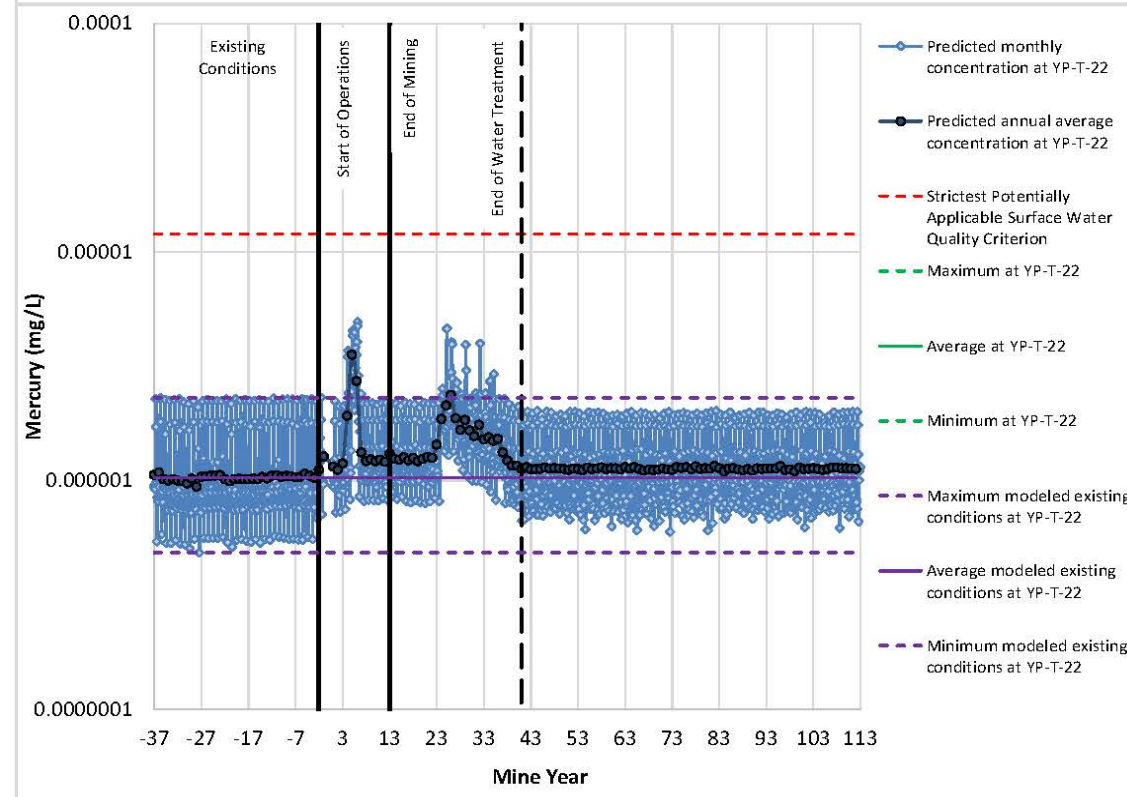
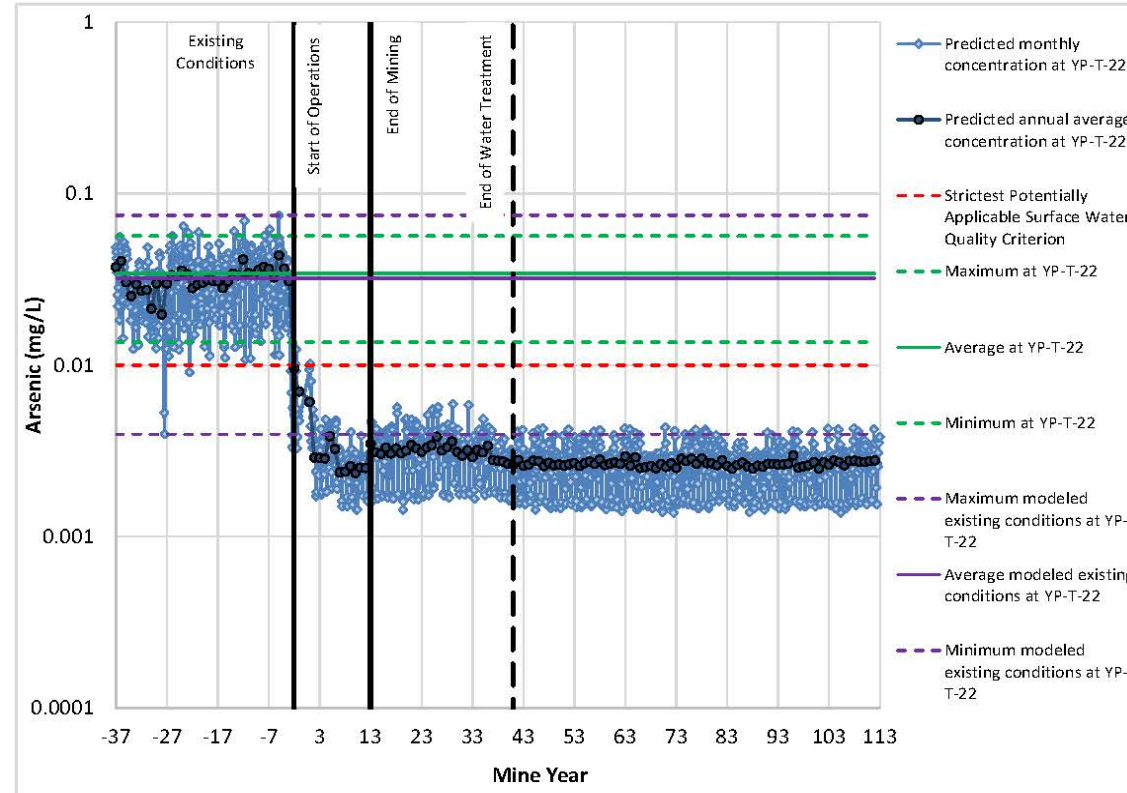
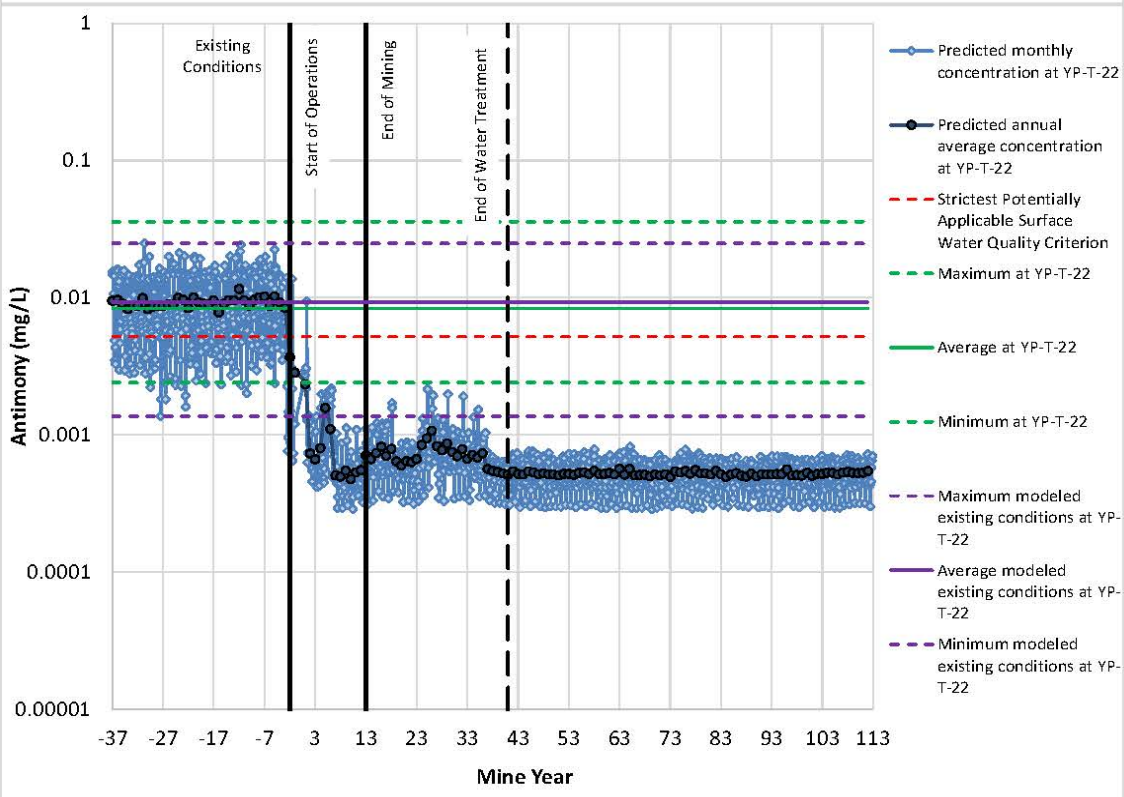
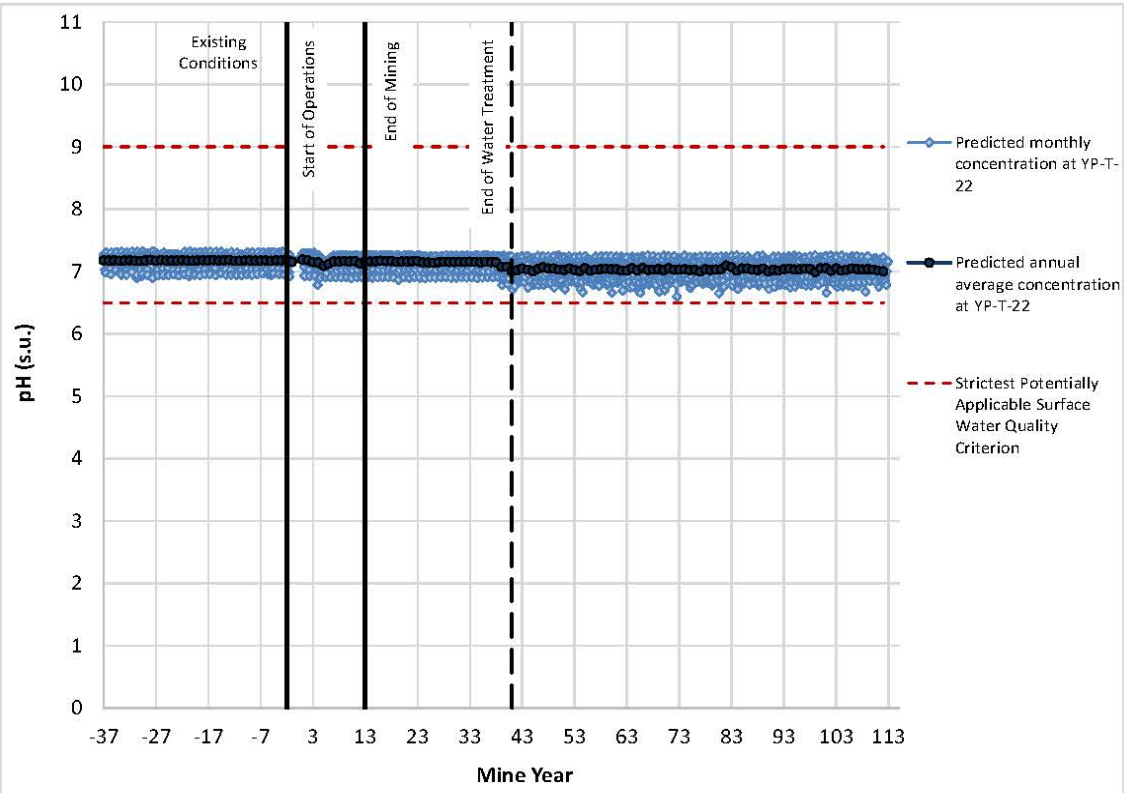
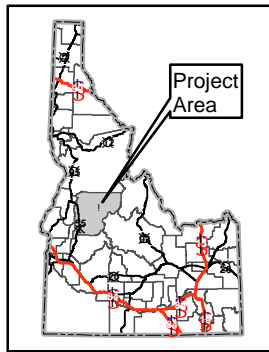
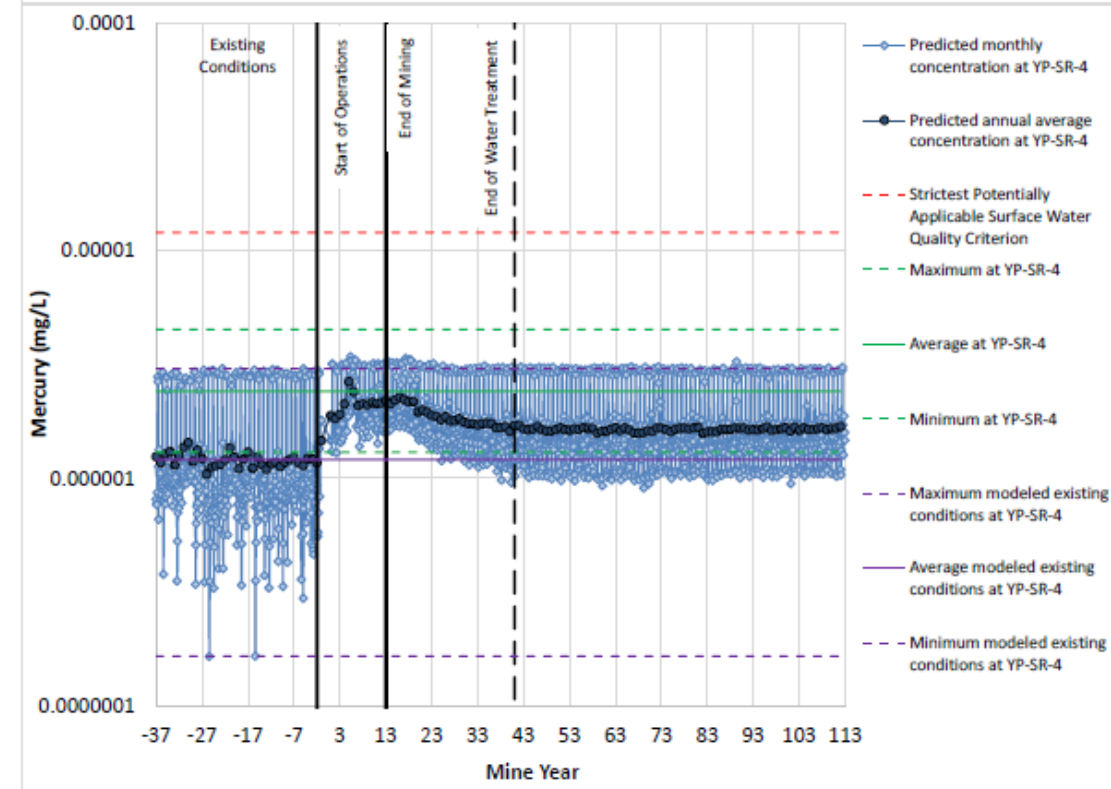
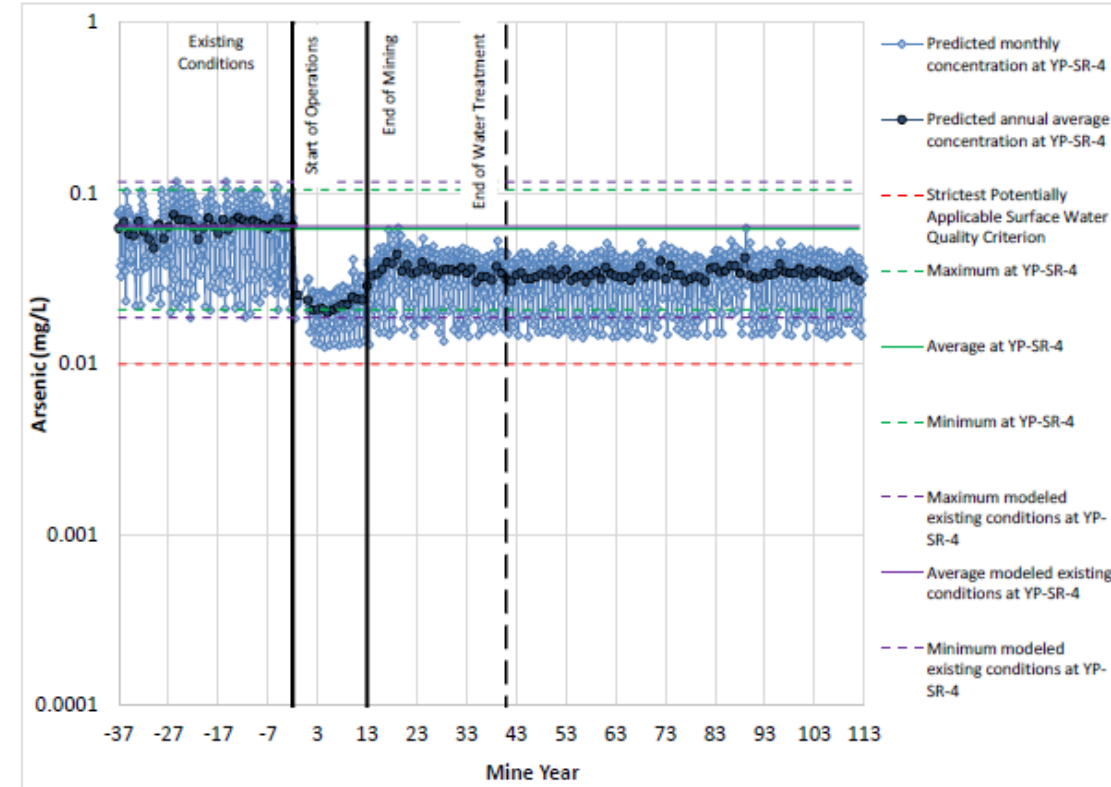
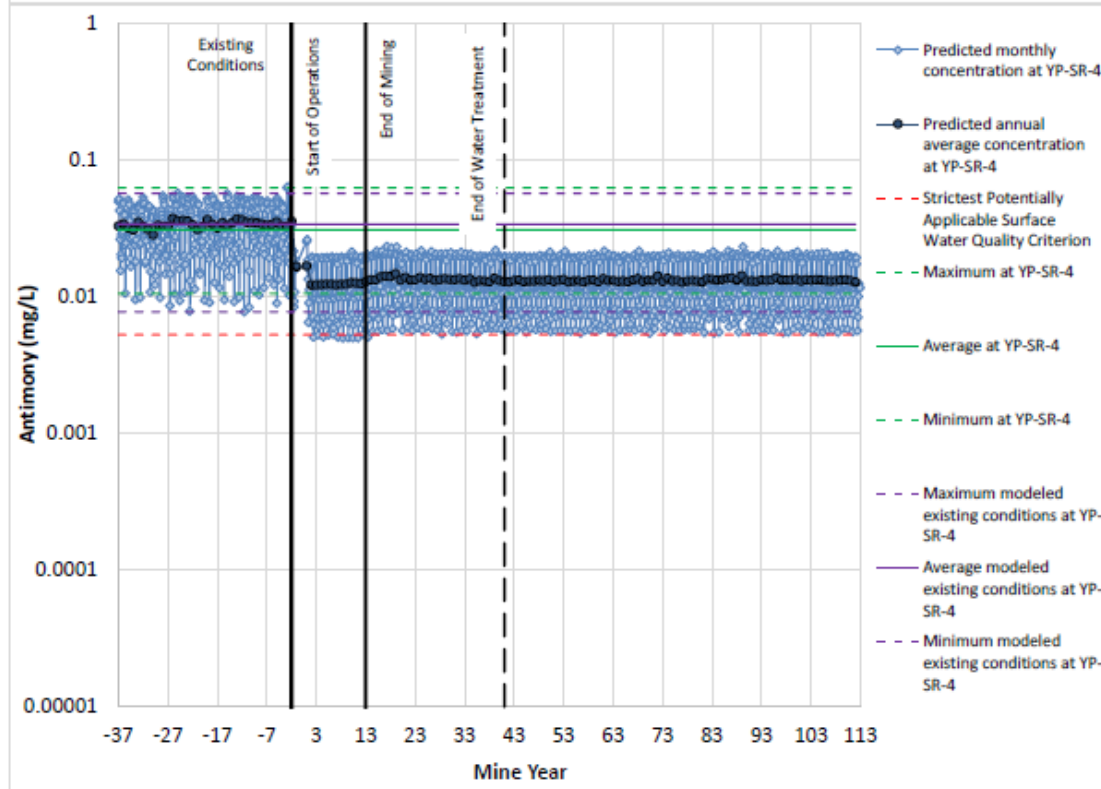
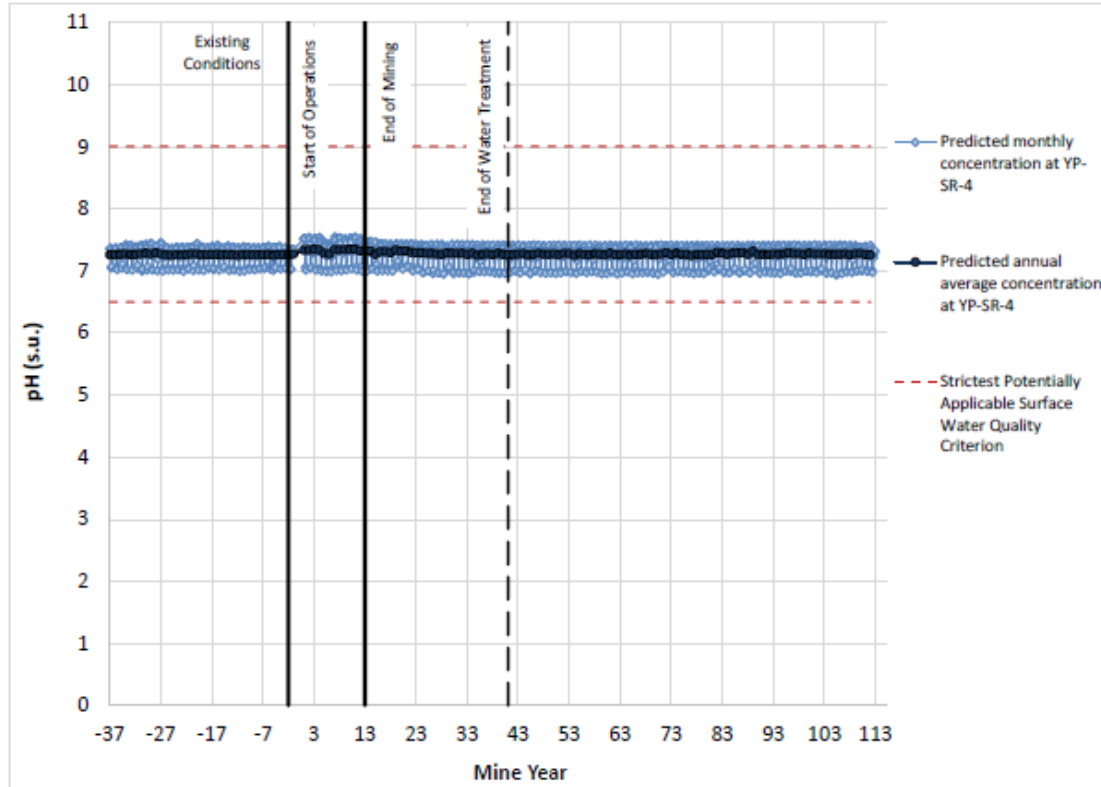
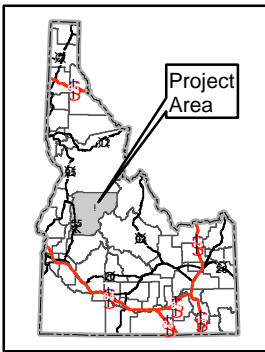


Figure 7-24
Predicted Surface Water
Chemistry Downstream of
the Tailings Storage Facility
and Buttruss (YP-T-22)

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)





**Figure 7-25
Predicted Surface
Water Chemistry
Downstream of Yellow
Pine Pit (YP-SR-4)
Stibnite Gold Project**

Data Sources: (SRK 2021)



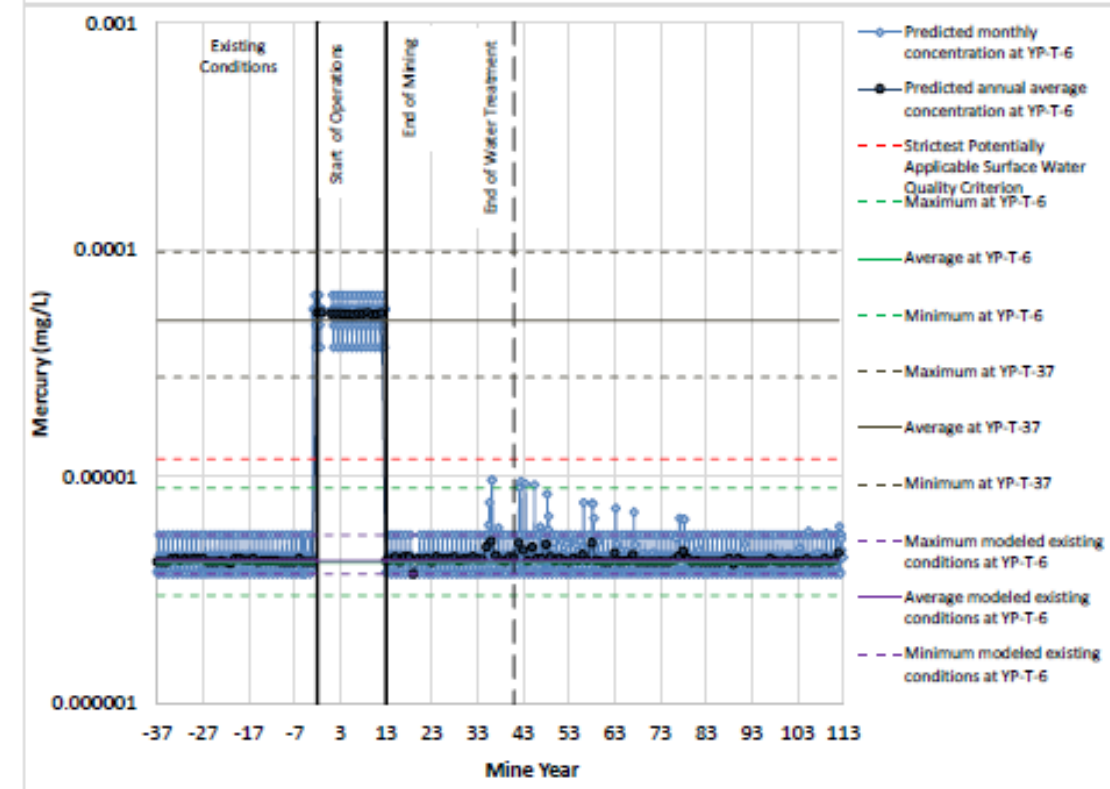
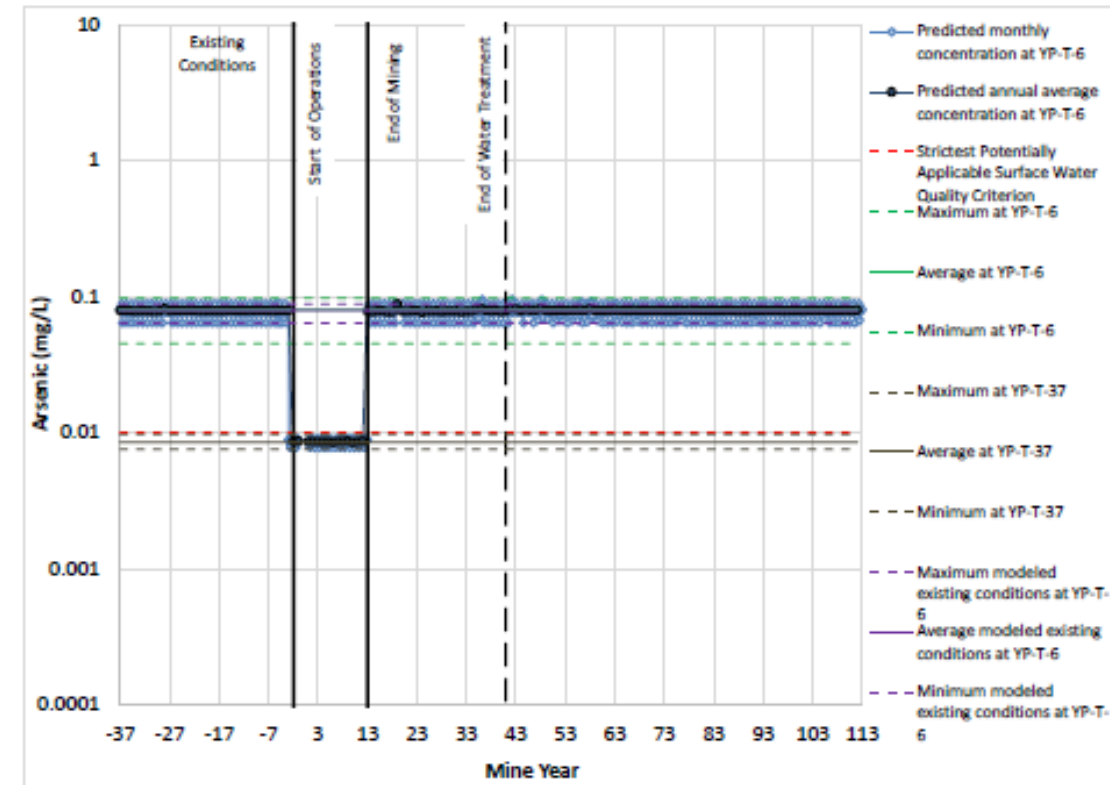
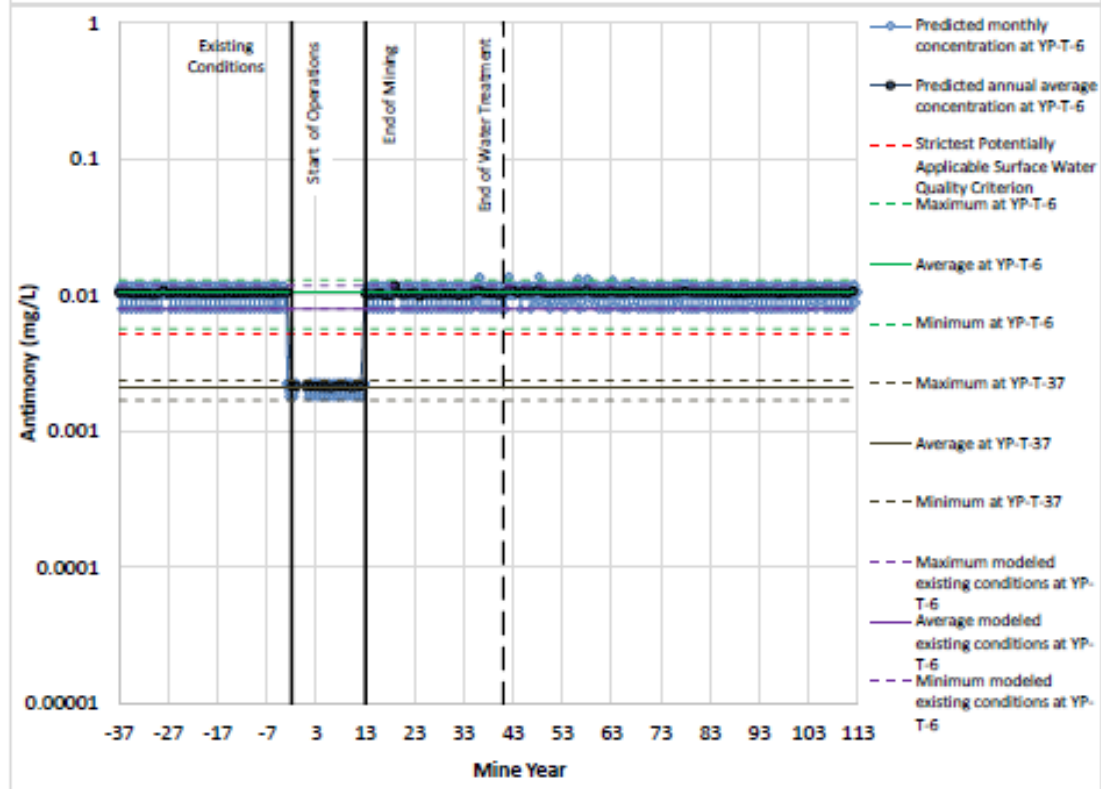
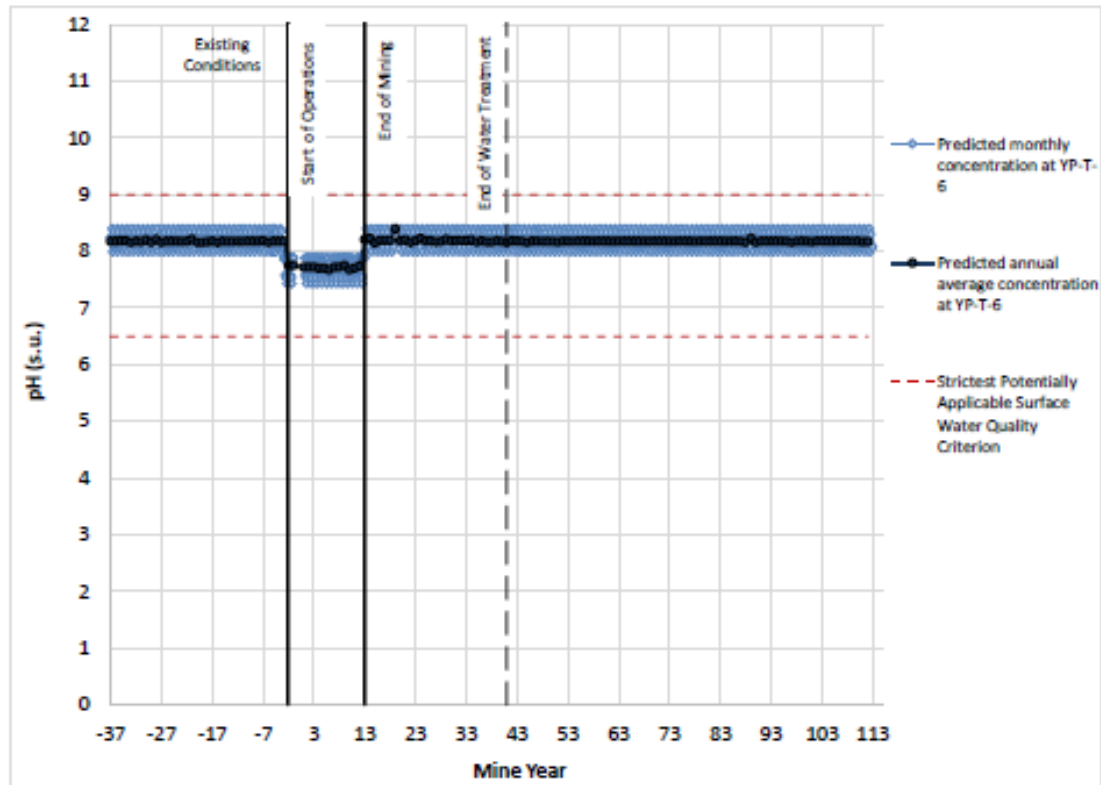
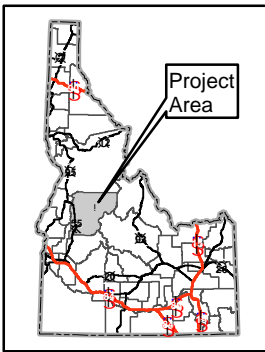


Figure 7-26
Predicted Surface
Water Chemistry
Downstream of West
End Pit (YP-T-6)
Stibnite Gold Project

Data Sources: (SRK 2021)



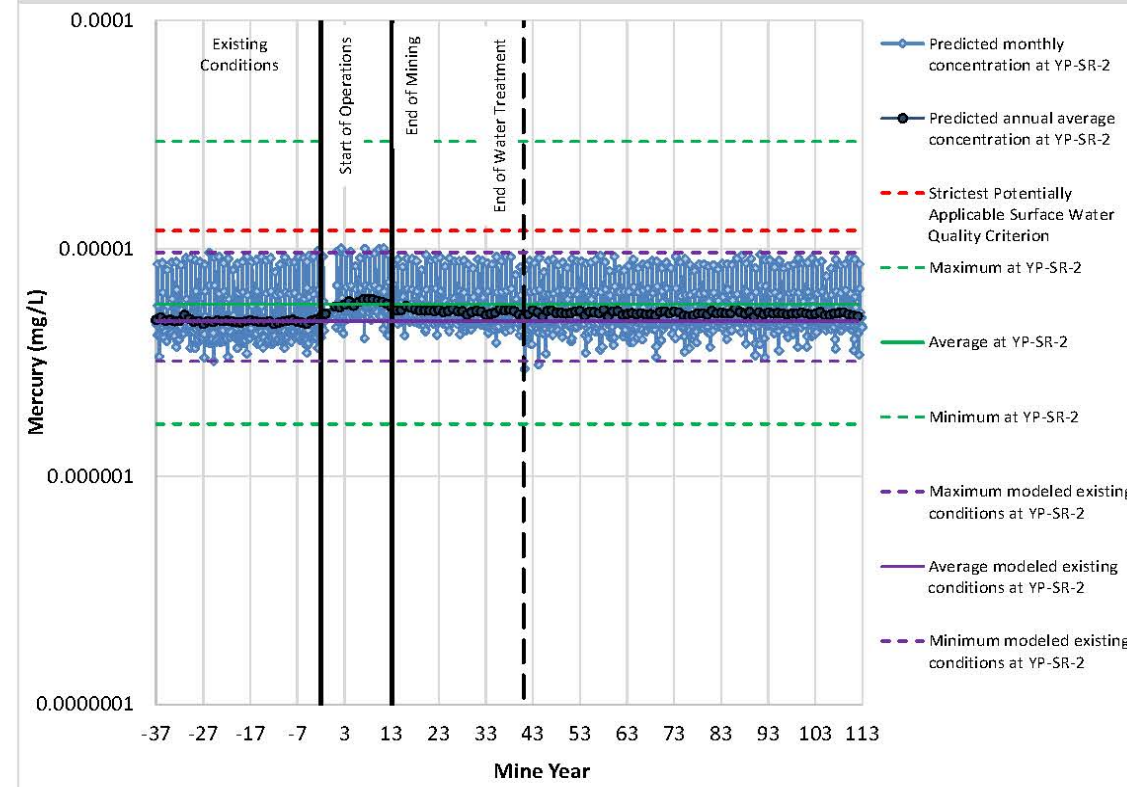
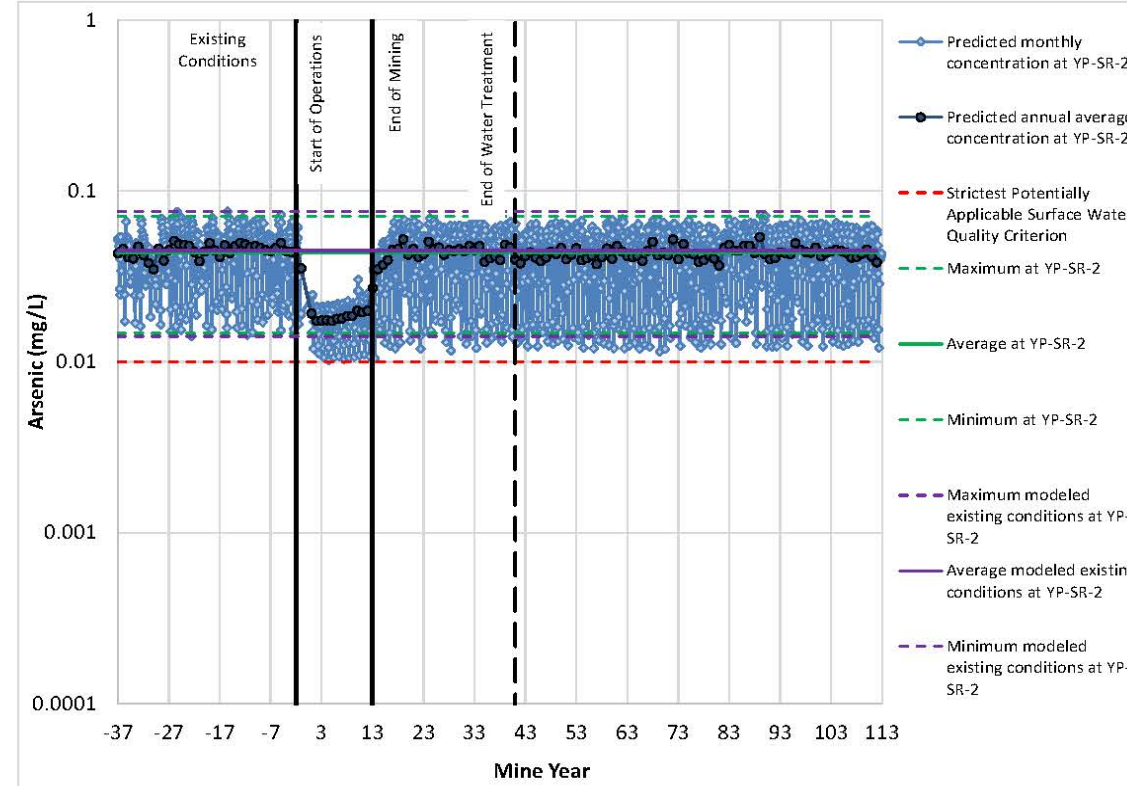
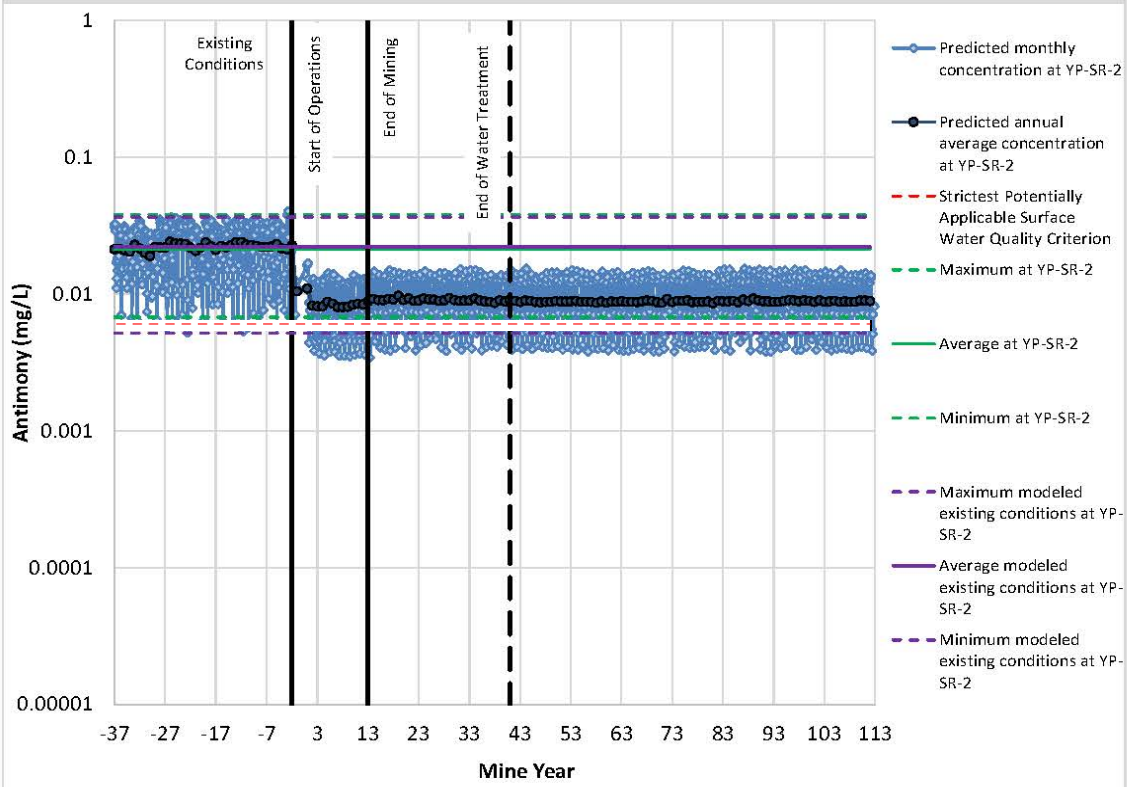
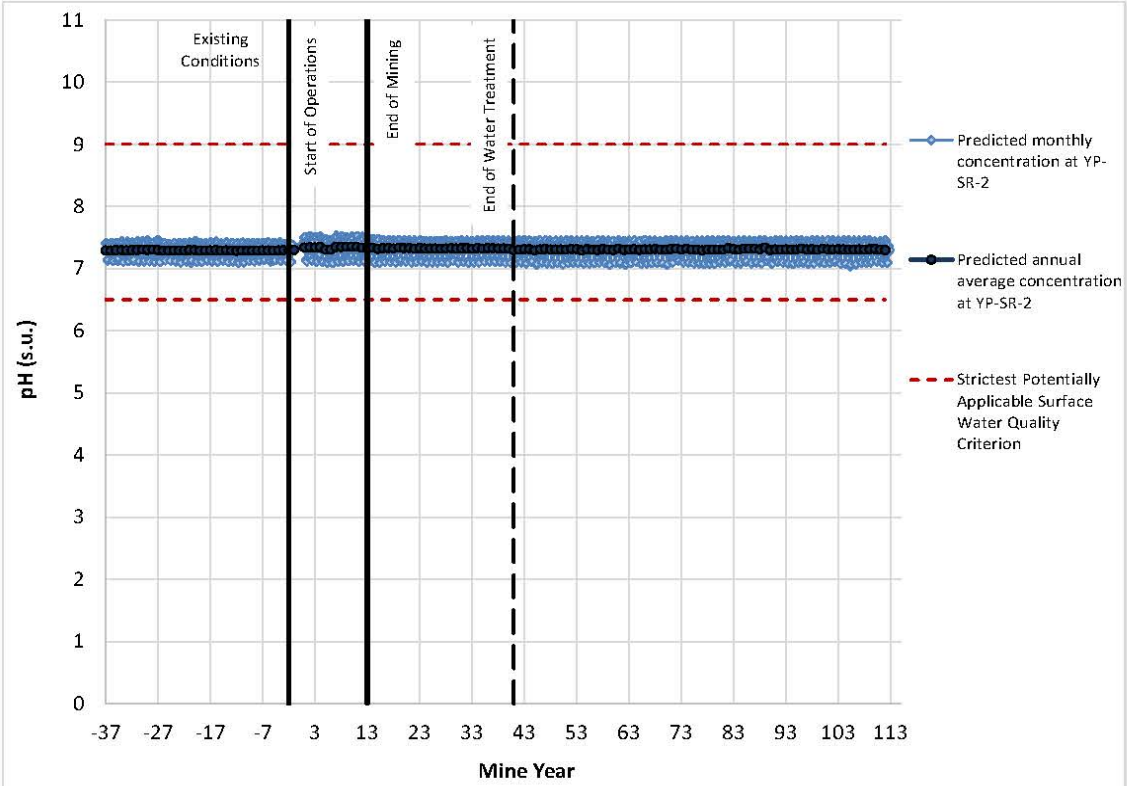
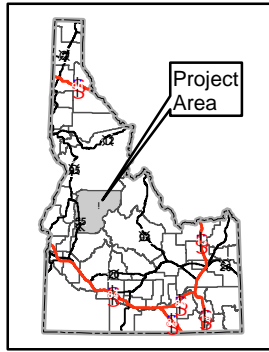


Figure 7-27
Predicted Surface Water
Chemistry Downstream of
the Stibnite Mine Area
(YP-SR-2)

Stibnite Gold Project
Stibnite, ID

Data Sources: (SRK 2021)



Table 7-19 Summary of Predicted Concentrations at YP-T-22

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria	Existing Conditions Mine Year -37 to -3			Open Pit Mining Mine Year -2 to 12			Post-Mining during Water Treatment Mine Year 13 to 40			Post-Mining no Water Treatment Mine Year 41 to 112		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
pH	mg/L	6.5 - 9	7.2	6.9	7.3	7.2	6.9	7.3	7.1	6.6	7.3	7.0	6.6	7.3
Total Alkalinity	mg/L	>20	46	24	58	34	18	48	33	18	42	31	18	39
Ag	mg/L	0.0007	0.00001	0.0000099	0.000011	0.000012	0.0000099	0.000048	0.000018	0.000010	0.00004	0.000019	0.00001	0.000042
Al	mg/L	0.05	0.011	0.006	0.026	0.012	0.0069	0.027	0.012	0.0062	0.027	0.011	0.0061	0.025
As	mg/L	0.01	0.032	0.004	0.075	0.0038	0.0014	0.018	0.003	0.0012	0.0134	0.0025	0.0012	0.0037
B	mg/L	-	0.01	0.0074	0.012	0.016	0.0082	0.09	0.016	0.008	0.045	0.011	0.0065	0.012
Ba	mg/L	2.0	0.0048	0.0026	0.0068	0.0058	0.0039	0.012	0.0061	0.003	0.0126	0.0048	0.003	0.0067
Be	mg/L	-	0.0000096	0.0000091	0.00001	0.000011	0.0000088	0.000025	0.000063	0.0000099	0.000343	0.000016	0.00001	0.000035
Ca	mg/L	-	14	6.3	18	9.5	5.2	14	8.7	4.5	12	8.1	4.5	11
Cd	mg/L	0.00033	0.0000097	0.0000094	0.000011	0.000011	0.0000096	0.000033	0.000012	0.0000095	0.000024	0.000014	0.00001	0.000024
Cl	mg/L	230	2.3	0.24	5.4	0.34	0.16	2.1	0.2	0.15	0.3	0.19	0.14	0.25
Co	mg/L	-	0.00018	0.000021	0.0004	0.000052	0.00001	0.00042	0.000509	0.00001	0.003352	0.000019	0.00001	0.000028
Cr	mg/L	0.0106	0.0002	0.00013	0.00028	0.0002	0.00010	0.001	0.00025	0.000089	0.00082	0.00014	0.000074	0.00029
Cu	mg/L	0.002	0.00034	0.00016	0.002	0.00028	0.00018	0.0013	0.00029	0.00014	0.00067	0.00022	0.00013	0.00029
F	mg/L	2.0	0.11	0.085	0.15	0.14	0.095	0.24	0.13	0.085	0.15	0.12	0.078	0.15
Fe	mg/L	0.3	0.053	0.0095	0.14	0.014	0.0083	0.027	0.014	0.0081	0.02	0.012	0.008	0.017
Hg	mg/L	0.000012	0.000001	0.00000048	0.0000023	0.0000015	0.00000068	0.0000049	0.0000012	0.00000059	0.0000023	0.0000011	0.00000057	0.000002
K	mg/L	-	0.97	0.55	1.4	0.75	0.5	2.9	0.6	0.47	0.8	0.62	0.46	0.74
Mg	mg/L	-	2.1	1.0	3.1	1.7	0.88	4.5	1.5	0.8	2	1.4	0.79	1.8
Mn	mg/L	0.05	0.024	0.001	0.056	0.0032	0.001	0.017	0.0019	0.00073	0.005	0.0014	0.00072	0.002
Mo	mg/L	-	0.0011	0.00059	0.0014	0.0011	0.00053	0.0083	0.0019	0.00053	0.008	0.0026	0.00095	0.0079
Na	mg/L	-	2.7	1.5	3.8	2.3	1.4	6.4	2	1.3	4	1.8	1.3	2.1
Ni	mg/L	0.024	0.00018	0.00011	0.00022	0.00026	0.0001	0.0027	0.0008	0.0001	0.0033	0.00084	0.00014	0.003
P	mg/L	-	0.02	0.012	0.025	0.021	0.015	0.12	0.048	0.017	0.185	0.026	0.018	0.047
Pb	mg/L	0.0009	0.000018	0.0000097	0.00011	0.000032	0.00001	0.00034	0.000022	0.0000093	0.000071	0.000012	0.0000083	0.000017
Sb	mg/L	0.0052	0.0092	0.0014	0.025	0.0012	0.00029	0.014	0.00074	0.00029	0.0056	0.00055	0.00029	0.00102
Se	mg/L	0.0031	0.0005	0.0005	0.00051	0.0005	0.00038	0.00061	0.0005	0.00032	0.00067	0.00046	0.00032	0.0005
SO ₄	mg/L	250	6.3	2.1	12	3.6	1.4	12	3.2	1.4	7	2.6	1.4	3.7
Tl	mg/L	0.000017	0.00001	0.00001	0.000011	0.00001	0.0000077	0.000011	0.00001	0.0000065	0.000012	0.0000096	0.0000064	0.000011
V	mg/L	-	0.00022	0.00015	0.00029	0.00021	0.00015	0.00034	0.00067	0.0001	0.00351	0.00018	0.0001	0.00027
Zn	mg/L	0.054	0.00081	0.00046	0.0018	0.001	0.00048	0.0067	0.00115	0.00038	0.0039	0.00063	0.00034	0.0018
TDS	mg/L	500	57	27	80	40	21	82	37	20	51	34	20	43
NO ₂ + NO ₃	mg/L as N	-	0.5	0.32	0.58	0.7	0.3	11	0.44	0.26	0.58	0.42	0.25	0.56

Source: SRK 2021a

Average, minimum and maximum values are calculated based on the monthly predicted concentrations over the indicated time period.

Shading indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria.

Table 7-20 Summary of Predicted Concentrations at YP-SR-4

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria	Existing Conditions Mine Year -37 to -3			Open Pit Mining Mine Year -2 to 12			Post-Mining during Water Treatment Mine Year 13 to 40			Post-Mining no Water Treatment Mine Year 41 to 112		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
pH	mg/L	6.5 - 9	7.3	7.0	7.5	7.3	7.0	7.5	7.3	7.0	7.5	7.3	6.9	7.4
Total Alkalinity	mg/L	>20	45	26	60	51	24	68	46	24	65	44	24	60
Ag	mg/L	0.0007	0.00001	0.0000098	0.000011	0.00001	0.0000063	0.000012	0.000011	0.0000063	0.000031	0.00001	0.0000057	0.000017
Al	mg/L	0.05	0.0091	0.0066	0.019	0.0086	0.004	0.019	0.0074	0.0043	0.02	0.007	0.0039	0.019
As	mg/L	0.01	0.064	0.019	0.12	0.025	0.013	0.097	0.035	0.013	0.063	0.034	0.014	0.06
B	mg/L	-	0.011	0.0096	0.012	0.013	0.0065	0.029	0.014	0.009	0.043	0.011	0.009	0.023
Ba	mg/L	2.0	0.014	0.006	0.021	0.0093	0.0055	0.019	0.0083	0.0053	0.013	0.008	0.0053	0.01
Be	mg/L	-	0.000012	0.00001	0.000015	0.00001	0.0000085	0.000014	0.000022	0.0000095	0.000083	0.000012	0.00001	0.000017
Ca	mg/L	-	15	6.7	18	13	6.3	17	10	5.9	16	10	5.9	15
Cd	mg/L	0.00033	0.00001	0.0000098	0.000011	0.000011	0.0000059	0.000018	0.000011	0.0000075	0.000023	0.00001	0.0000068	0.000015
Cl	mg/L	230	0.8	0.29	1.2	0.32	0.17	0.85	0.45	0.17	0.8	0.45	0.18	0.7
Co	mg/L	-	0.000096	0.000027	0.0002	0.000081	0.000015	0.00029	0.000174	0.000015	0.00085	0.000064	0.000013	0.00015
Cr	mg/L	0.0106	0.0002	0.00015	0.00029	0.00022	0.00011	0.00048	0.0002	0.00013	0.00045	0.00016	0.00012	0.00031
Cu	mg/L	0.002	0.00034	0.00021	0.0014	0.00034	0.00017	0.0012	0.0003	0.00017	0.00093	0.00027	0.00017	0.00083
F	mg/L	2.0	0.11	0.092	0.15	0.12	0.053	0.16	0.1	0.079	0.17	0.1	0.074	0.15
Fe	mg/L	0.3	0.027	0.013	0.041	0.015	0.01	0.027	0.014	0.0105	0.016	0.013	0.0109	0.015
Hg	mg/L	0.000012	0.0000012	0.00000017	0.000003	0.000002	0.00000046	0.0000034	0.0000019	0.000001	0.0000034	0.0000016	0.00000091	0.0000033
K	mg/L	-	0.92	0.58	1.1	0.9	0.56	1.3	0.76	0.55	1.4	0.72	0.55	1.0
Mg	mg/L	-	3.8	1.3	4.8	3.3	1.3	5.0	2.7	1.3	5	2.5	1.3	4.2
Mn	mg/L	0.05	0.022	0.0043	0.044	0.0043	0.00083	0.05	0.0053	0.0009	0.011	0.0054	0.00092	0.012
Mo	mg/L	-	0.00093	0.00052	0.0015	0.0013	0.00062	0.0037	0.0014	0.00061	0.007	0.0014	0.00088	0.0031
Na	mg/L	-	2.7	1.5	3.5	2.5	1.4	4.5	2.5	1.4	8	2.3	1.4	3.0
Ni	mg/L	0.024	0.00027	0.00011	0.0004	0.00032	0.00011	0.0012	0.00042	0.00011	0.00106	0.0004	0.00021	0.001
P	mg/L	-	0.028	0.018	0.039	0.02	0.014	0.036	0.024	0.014	0.054	0.019	0.013	0.028
Pb	mg/L	0.0009	0.000018	0.000011	0.00008	0.000034	0.00001	0.00014	0.000055	0.000013	0.0002	0.00004	0.000011	0.00018
Sb	mg/L	0.0052	0.033	0.0077	0.056	0.014	0.0049	0.063	0.013	0.005	0.023	0.013	0.0054	0.023
Se	mg/L	0.0031	0.0005	0.00049	0.00051	0.00049	0.00025	0.00051	0.00039	0.00029	0.00051	0.00038	0.00026	0.00049
SO ₄	mg/L	250	16	2.5	32	5.7	1.7	26	6.8	1.7	17	6.5	1.8	9.9
Tl	mg/L	0.000017	0.000012	0.00001	0.000013	0.000011	0.0000056	0.000014	0.0000085	0.0000063	0.000013	0.0000083	0.0000058	0.000013
V	mg/L	-	0.00017	0.00014	0.00022	0.00017	0.000127	0.00021	0.00027	0.00013	0.00087	0.00016	0.00013	0.00021
Zn	mg/L	0.054	0.0014	0.00065	0.0018	0.0011	0.00054	0.0031	0.0012	0.00064	0.0042	0.001	0.00061	0.002
TDS	mg/L	500	67	29	97	57	26	98	52	26	88	50	26	71
NO ₂ + NO ₃	mg/L as N	-	0.42	0.27	0.62	0.6	0.32	2.3	0.44	0.36	0.65	0.43	0.35	0.56

Source: SRK 2021a

Average, minimum and maximum values are calculated based on the monthly predicted concentrations over the indicated time period.

Shading indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria.

Table 7-21 Summary of Predicted Concentrations at YP-T-6

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria	Existing Conditions Mine Year -37 to -3			Open Pit Mining Mine Year -2 to 12			Post-Mining during Water Treatment Mine Year 13 to 40			Post-Mining no Water Treatment Mine Year 41 to 112		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
pH	mg/L	6.5 - 9	8.2	8.0	8.4	7.7	7.4	7.9	8.2	8.0	8.4	8.2	8.0	8.4
Total Alkalinity	mg/L	>20	122	105	126	123	108	126	121	105	126	122	101	126
Ag	mg/L	0.0007	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.000011	0.00001	0.000010	0.000011
Al	mg/L	0.05	0.0022	0.0013	0.005	0.0033	0.0014	0.004	0.0024	0.0013	0.005	0.0022	0.0013	0.005
As	mg/L	0.01	0.079	0.064	0.088	0.0086	0.0078	0.0089	0.079	0.064	0.094	0.079	0.064	0.095
B	mg/L	-	0.012	0.011	0.013	0.013	0.011	0.015	0.013	0.011	0.04	0.013	0.011	0.042
Ba	mg/L	2.0	0.017	0.016	0.02	0.016	0.014	0.018	0.018	0.016	0.02	0.017	0.015	0.02
Be	mg/L	-	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.000010	0.0000085	0.00001	0.0000099	0.0000078	0.00001
Ca	mg/L	-	42	38	54	31	28	34	43	34	54	42	32	54
Cd	mg/L	0.00033	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.000018	0.00001	0.00001	0.000018
Cl	mg/L	230	0.2	0.19	0.21	0.18	0.15	0.19	0.2	0.19	0.28	0.2	0.19	0.29
Co	mg/L	-	0.000032	0.00001	0.00005	0.000015	0.00001	0.000023	0.000029	0.00001	0.00005	0.000033	0.00001	0.00005
Cr	mg/L	0.0106	0.00022	0.0001	0.00037	0.00033	0.00029	0.00048	0.00022	0.0001	0.00037	0.00022	0.000092	0.00037
Cu	mg/L	0.002	0.00025	0.00015	0.0005	0.00013	0.00011	0.00017	0.00026	0.00015	0.00057	0.00026	0.00015	0.00057
F	mg/L	2.0	0.13	0.11	0.17	0.14	0.11	0.17	0.14	0.11	0.17	0.13	0.099	0.17
Fe	mg/L	0.3	0.01	0.0093	0.012	0.011	0.01	0.014	0.01	0.007	0.012	0.01	0.007	0.012
Hg	mg/L	0.000012	0.0000043	0.0000037	0.0000056	0.000053	0.000037	0.000063	0.000044	0.0000037	0.0000097	0.000043	0.0000037	0.0000095
K	mg/L	-	1.9	1.7	2.3	1.1	0.85	1.1	1.9	1.7	2.3	1.9	1.6	2.3
Mg	mg/L	-	17	15	22	10	9.0	11	18	15	22	17	14	22
Mn	mg/L	0.05	0.00074	0.0005	0.00081	0.00093	0.00053	0.0013	0.00074	0.0005	0.0018	0.00078	0.0005	0.002
Mo	mg/L	-	0.0017	0.0015	0.0019	0.00009	0.00005	0.00012	0.0017	0.0013	0.0019	0.0017	0.0012	0.0019
Na	mg/L	-	1.1	0.91	1.3	0.34	0.32	0.36	1.1	0.91	1.3	1.1	0.9	1.3
Ni	mg/L	0.024	0.00035	0.00025	0.00052	0.00016	0.0001	0.00027	0.00033	0.00024	0.00052	0.00035	0.0002	0.00052
P	mg/L	-	0.019	0.017	0.022	0.018	0.016	0.023	0.019	0.017	0.022	0.019	0.017	0.022
Pb	mg/L	0.0009	0.000013	0.00001	0.000028	0.00001	0.00001	0.000013	0.000017	0.00001	0.00024	0.000019	0.00001	0.00025
Sb	mg/L	0.0052	0.01	0.0079	0.012	0.0021	0.0018	0.0022	0.01	0.0079	0.014	0.011	0.0079	0.014
Se	mg/L	0.0031	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00043	0.0005	0.0005	0.00039	0.0005
SO ₄	mg/L	250	55	38	94	0.82	0.65	0.9	56	36	94	54	30	94
Tl	mg/L	0.000017	0.000012	0.00001	0.000014	0.000011	0.00001	0.000013	0.000011	0.0000095	0.000014	0.000012	0.0000083	0.000014
V	mg/L	-	0.00021	0.0001	0.00023	0.00019	0.00017	0.00025	0.0002	0.0001	0.00023	0.00021	0.0001	0.00023
Zn	mg/L	0.054	0.00059	0.00048	0.00085	0.00056	0.00044	0.0008	0.00063	0.00048	0.002	0.00062	0.00048	0.0021
TDS	mg/L	500	192	158	250	119	105	129	194	152	251	191	140	251
NO ₂ + NO ₃	mg/L as N	-	0.69	0.53	0.89	1.0	0.28	6.0	0.69	0.5	0.89	0.69	0.43	0.89

Source: SRK 2021a

Average, minimum and maximum values are calculated based on the monthly predicted concentrations over the indicated time period.

Shading indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria.

Table 7-22 Summary of Predicted Concentrations at YP-SR-2

Parameter	Units	Strictest Potentially Applicable Surface Water Quality Criteria	Existing Conditions Mine Year -37 to -3			Open Pit Mining Mine Year -2 to 12			Post-Mining during Water Treatment Mine Year 13 to 40			Post-Mining no Water Treatment Mine Year 41 to 112		
			Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
pH	mg/L	6.5 - 9	7.3	7.1	7.5	7.3	7.1	7.5	7.3	7.0	7.5	7.3	7.0	7.5
Total Alkalinity	mg/L	>20	49	29	60	53	27	64	49	27	63	49	27	60
Ag	mg/L	0.0007	0.00001	0.0000099	0.000011	0.00001	0.0000077	0.000012	0.000011	0.0000077	0.000023	0.00001	0.0000074	0.000015
Al	mg/L	0.05	0.0079	0.0051	0.017	0.0075	0.0048	0.017	0.0068	0.004	0.017	0.0065	0.0038	0.017
As	mg/L	0.01	0.045	0.014	0.076	0.02	0.01	0.066	0.028	0.01	0.045	0.027	0.011	0.047
B	mg/L	-	0.012	0.0098	0.017	0.013	0.009	0.024	0.014	0.01	0.032	0.012	0.01	0.021
Ba	mg/L	2.0	0.013	0.0067	0.018	0.011	0.0061	0.017	0.0098	0.0058	0.013	0.0096	0.0058	0.011
Be	mg/L	-	0.000011	0.00001	0.000013	0.00001	0.0000091	0.000012	0.000018	0.0000097	0.000059	0.000011	0.00001	0.000015
Ca	mg/L	-	16	8.3	18	15	7.7	17	13	7.2	17	12	7.3	16
Cd	mg/L	0.00033	0.00001	0.0000099	0.00001	0.000011	0.0000075	0.000016	0.000011	0.0000086	0.000018	0.00001	0.0000082	0.000013
Cl	mg/L	230	0.58	0.25	0.87	0.28	0.17	0.61	0.36	0.17	0.6	0.36	0.17	0.51
Co	mg/L	-	0.000072	0.00002	0.00014	0.00006	0.000013	0.00021	0.000122	0.000013	0.00058	0.000051	0.000012	0.00013
Cr	mg/L	0.0106	0.00017	0.00014	0.00023	0.00018	0.00012	0.00037	0.00017	0.00013	0.00033	0.00015	0.00012	0.00025
Cu	mg/L	0.002	0.00032	0.00023	0.00098	0.00031	0.0002	0.00077	0.00029	0.0002	0.00064	0.00028	0.0002	0.0006
F	mg/L	2.0	0.12	0.11	0.15	0.13	0.086	0.16	0.12	0.1	0.16	0.11	0.09	0.15
Fe	mg/L	0.3	0.021	0.012	0.029	0.014	0.011	0.021	0.013	0.01	0.015	0.013	0.011	0.015
Hg	mg/L	0.000012	0.0000048	0.0000032	0.0000096	0.0000057	0.0000037	0.00001	0.0000052	0.0000032	0.0000093	0.0000052	0.000003	0.0000094
K	mg/L	-	0.87	0.57	1.0	0.85	0.56	1.1	0.77	0.55	1.2	0.75	0.55	0.96
Mg	mg/L	-	3.7	1.6	4.4	3.3	1.5	4.5	2.9	1.4	4	2.9	1.5	4.1
Mn	mg/L	0.05	0.014	0.0028	0.028	0.0031	0.00073	0.032	0.0038	0.00077	0.008	0.0038	0.00077	0.0085
Mo	mg/L	-	0.00099	0.00059	0.0014	0.0012	0.00058	0.0027	0.0013	0.00059	0.0049	0.0013	0.00079	0.0027
Na	mg/L	-	2.6	1.5	3.2	2.4	1.5	3.9	2.5	1.5	6	2.3	1.5	2.9
Ni	mg/L	0.024	0.00025	0.00011	0.00035	0.00028	0.00011	0.0009	0.00035	0.00011	0.00087	0.00033	0.00018	0.00084
P	mg/L	-	0.024	0.018	0.031	0.02	0.015	0.03	0.022	0.015	0.042	0.019	0.015	0.026
Pb	mg/L	0.0009	0.000018	0.000011	0.000056	0.000028	0.000011	0.0001	0.000043	0.000021	0.00014	0.000035	0.00002	0.00013
Sb	mg/L	0.0052	0.022	0.0052	0.037	0.0097	0.0035	0.041	0.0095	0.0034	0.016	0.0093	0.0038	0.016
Se	mg/L	0.0031	0.0005	0.00049	0.00051	0.00049	0.00035	0.0005	0.00043	0.00036	0.00051	0.00042	0.00035	0.00049
SO ₄	mg/L	250	14	3.2	23	6.7	2.3	20	7.3	2.4	15	7.1	2.5	9.8
Tl	mg/L	0.000017	0.000012	0.00001	0.000014	0.000011	0.0000091	0.000014	0.00001	0.0000088	0.000013	0.00001	0.0000087	0.000013
V	mg/L	-	0.00016	0.00014	0.00019	0.00016	0.00013	0.0002	0.00022	0.00013	0.00062	0.00015	0.00013	0.00018
Zn	mg/L	0.054	0.0011	0.00064	0.0014	0.00093	0.00057	0.0023	0.001	0.00063	0.0029	0.00086	0.0006	0.0015
TDS	mg/L	500	67	33	87	61	31	88	57	30	82	56	30	71
NO ₂ + NO ₃	mg/L as N	-	0.49	0.32	0.71	0.6	0.31	1.7	0.5	0.34	0.72	0.49	0.33	0.72

Source: SRK 2021a

Average, minimum and maximum values are calculated based on the monthly predicted concentrations over the indicated time period.

Shading indicates value is greater than Strictest Potentially Applicable Surface Water Quality Criteria.

During the construction, operations, and post-closure periods, predicted water chemistry in Sugar Creek differs very little from baseline conditions (SRK 2021a). A slight predicted decrease in antimony concentrations (0.004 mg/L to 0.003 mg/L), a slight predicted increase in arsenic concentrations (0.013 mg/L to 0.014 mg/L), and a slight predicted increase in mercury concentrations (6 ng/L to 8 ng/L) are predicted in association with the closure of the Bailey Tunnel and the removal of its contributions to Sugar Creek chemistry plus the arrival of groundwater outflow from the West End pit lake in the post-closure period (SRK 2021a). Existing upstream contributions from Cinnabar Creek, a tributary to Sugar Creek, would continue to exert control on predicted Sugar Creek mercury concentrations in the operational and post-closure periods.

Effects of the project on surface water concentrations are expected to be negligible relative to applicable standards and calculated human health criteria, permanent, and localized. Effects of chemistry changes on fish and human health are described in **Sections 4.12.2** and **4.18.2**, respectively.

Organic Carbon

Sewage from the planned worker housing facility would be managed via a wastewater treatment plant that would discharge via a surface water outfall directly to the East Fork SFSR. A package plant consisting of a membrane bioreactor or equivalent system would treat the sanitary wastewater to meet applicable IPDES permit standards, and effluent would be discharged in an acceptable manner as approved by the permit. Sewage effluent systems would have waste containment and runoff control structures to prevent escape of untreated waste to the East Fork SFSR. The discharge volume from the wastewater treatment plant would vary between the mine construction, operation, and closure and reclamation periods, depending on the number of workers present at the SGP. However, the overall discharge rate from the plant is expected to be small relative to ambient flow in the East Fork SFSR (Brown and Caldwell 2020).

Surface water quality changes resulting from the wastewater treatment plant discharge have not been calculated through modeling exercises. Qualitatively, operation of the wastewater treatment plant would incrementally increase organic carbon mass loading rates in the Headwater East Fork SFSR subwatershed. But the overall impact on organic carbon concentrations in the river are expected to be low given the small volume of wastewater effluent relative to average streamflow, and the planned adherence to IPDES permit limits for the treated water discharge.

Effects of the SGP on organic carbon in surface water are expected to be minor, long-term, and localized. An incremental increase in organic carbon content due to wastewater effluent (as described above) would yield an incremental increase in methylation potential (see below).

Aerial Deposition

Air emissions from the project have the potential to contribute metals to the ground surface via wet and dry deposition that have the potential to affect surface water chemistry. Most of these contributions would be in the form of particulate matter, but a portion of the local aerial deposition of mercury may also occur in elemental form. Total mercury emissions from the project are predicted to be approximately 13.6 pounds of mercury per year.

Actual local mercury deposition rates from project emissions depend on the fractions of particulate versus gaseous mercury emissions. Particulate emissions generally deposit on the ground surface nearer to their source while gaseous emissions tend to deposit farther from the source or potentially become part of global atmospheric mercury burden.

Ratios of stream mercury loads to atmospheric mercury deposition rates have been reported in watersheds affected by gold and silver mining (Domagalski et al. 2016). The effects of aerial mercury deposition on stream loads are variable based on watershed area, mineralization present, land development, rainfall, and soil adsorption characteristics. In smaller watersheds hosting precious metal mining, total mercury stream loads are higher relative to the mass associated with aerial deposition with erodible sediments contributing relatively more to the stream load. Contributions from aerial deposition appear in stream loads over time as deposited mercury retained in soils is re-mobilized by local precipitation.

Therefore, aerial deposition would have a minor to moderate, long-term effect on particulate mercury loads in streams within the project area watershed, depending on the annual precipitation conditions.

Methylmercury

Predictive modeling indicates that mine facilities and water treatment would contribute dissolved mercury to surface waters primarily during the operating and early post-closure periods. These contributions are expected to increase the total mercury concentrations in surface waters compared to baseline conditions during those periods, while remaining below stream surface water standard values. Increases in total mercury may also result in increased methylmercury concentrations. There are many factors that affect methylmercury formation as methylation efficiency is influenced by pH, sulfate, total organic carbon, bacteria activity, and wetland abundance (**Figure 7-28**). An incremental increase in organic carbon content due to wastewater effluent (as described above) would yield an incremental increase in methylation potential.

A ratio method to estimate methylmercury concentrations from predicted total mercury concentrations was applied per the approach and data collection by Holloway et al. (2017) that showed methylmercury concentrations were up to two percent of total mercury concentrations in samples from Sugar Creek and the East Fork SFSR. For Meadow Creek, the East Fork SFSR, and Sugar Creek, predicted total mercury concentrations varied up to 5 ng/L compared to existing conditions which ranged between 2.5 ng/L and 159 ng/L. Application of the methylation ratio to 5 ng/L would result in a predicted increase of methylmercury concentrations up to 0.1 ng/L for these surface waters. If upstream total mercury concentrations in West End Creek persist to downstream areas of the creek due to its diversion around the West End pit area, application of the methylation ratio would indicate a potential increase of methylmercury concentrations up to 0.9 ng/L in that portion of West End Creek.

Sediment

Surface disturbance caused by the project would cause erosion of soil and overburden material. These eroded sediments could in turn affect surface water quality if the sediment is blown or washed into adjacent streams. Erosion and sedimentation effects on surface water quality are indicated primarily by changes in turbidity and total suspended solids in the receiving waters such as historical sediment effects on the SFSR. Predictions of these water quality indicators were not included in the surface water chemistry modeling. As such, changes in turbidity and total suspended solids have been qualitatively assessed using best available data and consideration of proposed management strategies for the SGP.

Proposed activities at the SGP would result in some erosion and sedimentation within Meadow Creek, Sugar Creek, and the East Fork SFSR during active surface material disturbance associated with mine construction, operations, reclamation, and closure, with the greatest potential for in-stream impacts occurring during times of higher overland flow. The effect to surface water quality as a result of sedimentation and erosion would be limited by applicable mitigation strategies and control techniques, by the limited duration of surface disturbing activities, and by the adaptability of the receiving environment

(as indicated by the typically low baseline levels of total suspended solids and turbidity with seasonally variable spikes at times of higher overland flow).

Another SGP component that could increase stream sediment loads is draining the current Yellow Pine pit lake in preparation for mining. Perpetua would limit the potential for sedimentation impacts by following conditions in the Dewatering Practices section of their current Multi-Sector General Permit, or the Multi-Sector General Permit that is in place at the time (Brown and Caldwell 2020). During mine construction, the Yellow Pine pit would be drained after the East Fork SFSR has been diverted around the pit lake, and the lake stage would be allowed to passively drop to the lake outlet elevation. The remaining water in the lake would then be withdrawn near the shoreline or from a floating intake managed to prevent disturbance of bottom sediments, thereby minimizing turbidity in the lake and in the discharged water. Water removed from the lake would be pumped downstream without treatment except for turbidity controls as needed. After the pit lake level is sufficiently below the outlet elevation, the nearly empty pit would be used for storm water management during pre-stripping of the pit highwalls. When complete drainage of the pit is necessary for mining, any water remaining in the pit bottom would be managed as contact water (i.e., either be used for construction purposes, transferred to the TSF for future use in ore processing, or contained in contact water ponds). By managing the Yellow Pine pit in this manner, excess sediment loading in the East Fork SFSR could effectively be prevented.

Surface water quality also could be impacted during construction, operations, closure, and reclamation by fugitive dust from vehicles and heavy equipment that settles into adjacent water bodies. Reduction of these potential impacts would be achieved through fugitive dust control at the SGP. In dry months, Perpetua would spray water on mine haul roads as necessary to mitigate dust emissions in compliance with state and Forest Service requirements.

The extent of sedimentation effects from erosion and fugitive dust would be concentrated at the SGP; however, due to the nature of sediment transport by streams, the geographic extent of the impact could extend farther downstream in the East Fork SFSR depending on site- and event-specific factors. The duration for traffic-related dust and erosion/sedimentation would last throughout the mine construction, operations, and post closure periods; however, the potential for these effects would be incrementally reduced during closure and reclamation due to reduced activity at the SGP and stabilization of disturbed areas.

Construction and use of roads can accelerate erosion and sediment delivery to streams and have been identified as the primary contributor of sediments to stream channels in managed watersheds (Trombulak and Frissell 2000). Roads are often chronic sources of sediment delivery from cut-slopes, ditch- lines, and running surfaces, and act as potential sites for accelerated mass movements (e.g., mud slides). Roads can also intercept subsurface flows, concentrate surface flows in ditch lines and through culverts and bridges, and act as direct conduits for sediment delivery to stream channels (Beschta 1978). The minimum road culvert size for mining projects in Idaho is 18-inch diameter (IDAPA 20.03.02.140.05.c).

The access roads used under the 2021 MMP would cross 71 different named and unnamed streams, as inventoried in **Table 7-23**.

Table 7-23 Access Road Stream Crossings

Road/Component	Route/Access	Number of Crossings ¹	Stream Names
Warm Lake Road (CR 10-579)	Johnson Creek Route & Burntlog Route	16	Alpine Creek Beaver Creek [combined biota/habitat bioassessments (COLD)] Big Creek Deep Creek Little Creek Little Pearsol Creek Pearsol Creek South Fork Salmon River [water temperature (SS), sedimentation (COLD)] Warm Lake Creek [water temperature (SS)] 7 Unnamed creeks
Johnson Creek Road (CR 10-413)	Johnson Creek Route	16	Bear Creek Coffee Creek Ditch Creek Halfway Creek Hanson Creek Johnson Creek [water temperature (SS)] Lunch Creek Moose Creek Olson Creek Park Creek Pid Creek Riordan Creek Rustican Creek Sheep Creek Trapper Creek Trout Creek
McCall-Stibnite Road (CR 50-412)	Johnson Creek Route	11	3 Unnamed creeks Double A Creek East Fork SFSR [arsenic (DWS), arsenic (SCR)] Profile Creek [water temperature (SS)] Tamarack Creek Salt Creek Sugar Creek [mercury (COLD), arsenic (SCR)] Vibika Creek Whiskey Creek
Johnson Creek Road (CR 10-413)	Burntlog Route	21	Burntlog Creek East Fork Burntlog Creek East Fork SFSR Johnson Creek Landmark Creek [water temperature (SS)] Peanut Creek Rabbit Creek Riordan Creek Trapper Creek Unnamed creeks (12)

Road/Component	Route/Access	Number of Crossings ¹	Stream Names
Cabin Creek Groomed OSV Route (FR 467)	Cabin Creek Groomed OSV Route	7	Cabin Creek [water temperature (SS)] Lunch Creek [water temperature (SS)] Pid Creek [water temperature (SS)] Park Creek [water temperature (SS)] Sheep Creek [water temperature (SS)] Trout Creek [water temperature (SS)] Warm Lake Creek

Source: IDEQ 2020a

Any 303(d) listings in brackets

¹ The number of crossings listed for each road segment/route is for individual streams; in some cases, the road/route segment may cross one or more streams at multiple locations.

COLD = cold water aquatic life

CR = County Road

DWS = domestic water supply

FR = National Forest System Road

SCR = secondary contact recreation

SS = salmonid spawning

During the construction phase (approximately 2 to 3 years), the SGP would be accessed via Warm Lake Road (CR 10-579 and then the Johnson Creek Route (Johnson Creek Road [CR 10-413] and McCall-Stibnite [CR 50-412] Road), which would cross 43 of the 71 streams listed in **Table 7-23**. In addition to these stream crossings, the Johnson Creek Route is located in close proximity to streams (i.e., within 100 feet) for 6.5 miles or 18 percent of its 36-mile length. A total of 45 heavy vehicles and 20 light vehicles are anticipated on average per day (year-round) during construction, for an annual average daily trip (AADT) total of 65 round trips utilizing the Johnson Creek Route.

During the Burntlog Route construction including bridge and culvert installations, the potential exists for increased runoff, erosion, and sedimentation as a result of localized vegetation removal and excavation of soil, rock, and sediment, which could result in increased sediment load in streams. Expected permit stipulations from the Idaho Department of Water Resources (IDWR) and IDEQ would ensure that streambank vegetation would be protected except where its removal is absolutely necessary; that new cut or fill slopes not protected with some form of riprap would be seeded and planted with native vegetation to prevent erosion; use of temporary erosion and sediment control best management practices (BMPs) associated with a stormwater pollution prevention plan; and that all activities would be conducted in accordance with Idaho environmental anti-degradation policies, including IDEQ water quality regulations and applicable federal regulations.

For stream crossings, Perpetua would replace existing, or install new, culverts or bridges at crossings along the Johnson Creek (CR 10-579), McCall-Stibnite (CR 50-412), and Burnt Log (FR 447) roads. Existing bridges and culverts along Warm Lake Road would remain. If not properly designed, constructed, and maintained, culverts and bridges could constrict natural streamflow leading to an increase in water velocity at the downstream end of the structure. This could lead to stream bank and/or streambed erosion, and/or excessive erosion at the structure. Erosion of the streambed and/or banks could result in downstream sedimentation, a change in the morphology of the stream, and/or a change to the aquatic habitat. If a structure does not allow for adequate flow, water could pool excessively on the upstream side. As such, stream crossings associated with access roads would be designed to minimize potential impacts on surface water hydrology, water quality, and fish passage. The Forest Service would require stream crossings to be designed to accommodate a 100-year flood recurrence interval, unless site-

specific analysis using calculated risk tools, or another method determines a more appropriate recurrence interval.

Utilities associated with the project (existing transmission line upgrades and structure work, right-of-way (ROW) clearing, new transmission line, and transmission line access roads) would cross 37 different streams, as inventoried in **Table 7-24**.

Of the 37 streams that would be crossed, 26 would be related to the upgrade of existing Idaho Power Company (IPCo) transmission lines, where the existing transmission line ROW crosses various streams. The existing transmission line would be upgraded from 69 kilovolts (kV) to 138 kV service, which would require removing vegetation to widen the ROW corridor and replacing existing power poles with taller structures. Structure work would result in some ground disturbance at or near five streams. Use of the transmission line access road to facilitate year- round maintenance of the line also would result in disturbance at three stream crossings. Additionally, Perpetua would construct a new 8.5-mile, 138-kV transmission line from the Johnson Creek substation to a new substation at the SGP. The new transmission line corridor would require vegetation clearing along the ROW (intersecting three streams).

Table 7-24 Utility Stream Crossings

Component	Number of Intersects ¹	Stream Names
Upgraded Transmission Line	26	Alpine Creek Bear Creek Beaver Creek [combined biota/habitat bioassessments (COLD)] Big Creek Boulder Creek [total phosphorus (COLD, sedimentation (COLD), flow regime alterations (COLD), temperature (COLD)] Cabin Creek [water temperature (SS)] Coffee Creek Deep Creek Ditch Creek Halfway Creek Hanson Creek Hargrave Creek Hot Spring Creek [total phosphorus (COLD)] Johnson Creek [water temperature (SS)] Lake Fork [low flow alterations (COLD)] Little Creek Little Pearsol Creek Moose Creek Olson Creek Pearsol Creek Rustican Creek South Fork Salmon River [water temperature (SS), sedimentation (COLD)] Trapper Creek Trout Creek [water temperature (SS)] Warm Lake Creek [water temperature (SS)] Willow Creek [total phosphorus (COLD)]

Component	Number of Intersects¹	Stream Names
Structure Work for Upgraded Transmission Line	5	Beaver Creek [combined biota/habitat bioassessments (COLD)] Big Creek Hot Spring Creek [total phosphorus (COLD)] Pearsol Creek Willow Creek [total phosphorus (COLD)]
Transmission Line Access Road	3	Big Creek Cabin Creek [water temperature (SS)] Unnamed Creek
New Transmission Line	3	No Man's Creek Riordan Creek Unnamed Creek

Source: IDEQ 2020a

Any 303(d) or TMDL listings in brackets

¹ The number of intersects listed for each component is for individual streams; in some cases, the utility-related component may intersect one or more streams at multiple locations.

COLD = cold water aquatic life

SS = salmonid spawning

During transmission line upgrades and new transmission line construction, the potential exists for increased runoff, erosion, and sedimentation as a result of vegetation removal within the ROW, and the localized excavation of soil, rock, and sediment for structure work and/or ROW access roads. Expected permit stipulations from IDWR and IDEQ would be similar to the examples provided above for access roads and would ensure the use of erosion and sediment control BMPs associated with a stormwater pollution prevention plan. All activities would be conducted in accordance with Idaho environmental anti-degradation policies, including IDEQ water quality regulations and applicable federal regulations. It is important to note that ROW vegetation clearing would be for the purpose of maintaining low height during operations and would not entail clearing and grubbing to bare soil. Consequently, the vegetation root structure within soils would be retained, reducing erosion concerns.

Based on the type of vegetation removal, the localized and discontinuous ground disturbance for structure footings and ROW access roads, and permit-related requirements including use of BMPs, the potential for transmission line-related erosion and sedimentation would be minimal (i.e., limited to periods of substantial overland flow). The duration of erosion/sedimentation potential would occur from the time new transmission line is constructed until it is reclaimed at the end of mine closure and reclamation (approximately 25 years). The upgrades to IPCo's existing transmission line corridor would be permanent. Due to the nature of sediment transport by streams, the geographic extent of increased sedimentation could be hundreds of feet to miles, but it is expected that effects would be limited to within the subwatersheds of the analysis area.

During the mining and ore processing operations phase (approximately 15 years), SGP access would use the same existing Warm Lake Road (CR 10-579) and then the Burntlog Route (upgraded portions of Burnt Log Road [FR 477] and new road portions connecting to Meadow Creek Lookout Road [FR 51290]), which would cross 37 of the 71 streams (**Table 7-23**). The Burntlog Route alignment would be located within 100 feet of streams for approximately 1.69 miles or four percent of its 38.2-mile length. A total of 49 heavy vehicles and 19 light vehicles are anticipated on average per day (year-round) during operations, for an AADT total of 68 round trips utilizing the Burntlog Route. Additionally, public access along the Cabin Creek groomed over snow vehicle (OSV) route during operations would include a total of 7 stream crossings.

For operation and use of the Burntlog Route, the potential for sedimentation would be reduced using standard erosion control measures, such as silt fencing, ditch checks, and other measures, which would be installed and maintained to minimize the potential for erosion and sedimentation. Numerous small (15- to 60-inch) drainage culverts would be installed along the Burntlog Route to reduce rutting and shunt water out of ditches and off the road prism, which would serve to reduce erosion from the road into streams. Perpetua would maintain a hardened road surface with gravel surfacing to promote an efficient and useable all-weather road (Perpetua 2021e, Travel Management Plan).

Additionally, Perpetua would be required to comply with specific design requirements as part of the IDWR Stream Channel Alteration Permit, such as line of approach, minimum bridge clearance and minimum culvert size per length, and anchoring on steep slopes. Bridges and culverts would be maintained to allow proper drainage and limit sediment delivery to area streams.

Based on permit-related design requirements, use of BMPs, and required maintenance activities, the potential for access road-related erosion and sedimentation would be minimal (limited to periods of substantial overland flow, such as from very large rainfall events). The duration for this erosion/sedimentation potential would last throughout the entire period of use of the Burntlog Route (approximately 25 years) until it is reclaimed. Due to the nature of sediment transport by streams, the geographic extent of the impact could be hundreds of feet to miles, depending on many site- and event-specific factors, but it is expected that effects would be limited to within the subwatersheds of the analysis area.

During winter months, the Burntlog Route would be plowed for snow removal and sanded for winter driving safety. When practicable, snow would be removed down to the gravel, however, a snow-packed road surface could develop during the winter months. When snow-packed surfaces occur, sand/gravel would be applied to prevent vehicle slide offs. To protect surface water, snow removal standards or performance would include depositing snow and ice away from stream channels; maintaining appropriate snow floor depth to protect the roadway; clearly marking culverts and stream crossings; and no use of ice and snow removal chemicals.

It also should be noted that use of the Burntlog Route (in-lieu of the existing roads along the Johnson Creek Route) could lower sedimentation impacts by reducing the number of stream crossings (37 versus 43 crossings) and eliminating travel along and adjacent to Johnson Creek and the East Fork SFSR, as Johnson Creek and McCall-Stibnite roads follow and have multiple crossings of these two waterbodies.

During the closure and reclamation phase, traffic along the Burntlog Route would be reduced to a total of 13 heavy vehicles and 12 light vehicles on average per day (year-round), for an AADT total of 25 round trips.

Overall, based on identified maintenance activities, design features proposed by Perpetua, environmental protection measures required by the Forest Service, and permit stipulations from state and federal agencies, traffic-related dust and erosion/sedimentation would be within the normal range of properly maintained forest roads. The duration for traffic-related dust and erosion/sedimentation would last throughout the entire period of use of Burntlog Route (approximately 25 years) until it is successfully reclaimed; however, the potential for these effects would be incrementally reduced during closure and reclamation (when AADT would be reduced from 68 to 25 round trips). Due to the nature of airborne dust and sediment transport by streams, the geographic extent of the impact could be hundreds of feet to miles, depending on many site- and event-specific factors, but it is expected that effects would be limited to within the subwatersheds of the analysis area.

The effects of the SGP on sedimentation are expected to be moderate, long-term, and localized.

Fuels and Hazardous Chemicals

There is the potential for spills to occur along access roads as fuel and other materials are trucked to and from the SGP. If a spill were to occur at a stream crossing or near a stream, surface water could be impacted. Discussion of very low probability scenarios for a large release (tanker truck or concentrate truck rollover), and more probable scenarios involving small releases, is provided in the SGP Access and Transportation Specialist Report (Forest Service 2022d). Overall, environmental protection measures required by the Forest Service (**Table 2-1**), design features proposed by Perpetua (**Table 2-2**), and permit stipulations and regulatory requirements from state and federal agencies (including use of U.S. Department of Transportation [USDOT]-certified containers and USDOT-registered transporters) would reduce the risk of spills and ensure that effective response is provided should a spill occur.

The combination of the proposed environmental protection practices and committed design measures would minimize the risk of accidental releases during the transportation, storage, management, and use of hazardous materials. Spills of fuels, oil or chemicals at the SGP would be retained in the secondary containment areas and cleaned up without release to the environment. At the SGP the most likely releases to the environment would be rare, small-scale spills of fuel or hydraulic oil from mobile mining equipment that would be quickly contained and cleaned up by SGP personnel leaving de minimis residuals. Spills from transportation of fuel, oil or chemicals along the proposed transportation routes beyond the SGLF (Burntlog or Johnson Creek roads) would be unlikely due to the receiving operations for chemicals at the SGLF and traffic controls exerted along the access roads for fuel to mitigate risks associated with travel on unpaved roads with steep grades. It would be more likely that spills of bulk liquids transported to the SGP (fuel, oil, acids) could be the result of accidents on the public highways. Perpetua is coordinating with local communities to address their potential needs for responding to accidents involving fuels and hazardous materials.

The overall environmental impacts from the reasonably foreseeable releases of hazardous materials under the 2021 MMP are considered to be localized, temporary, and minor to moderate depending on the type of material releases and the location of the spill.

7.2.2.7 Surface Water Temperature

Water temperature affects biological activity of aquatic organisms as well as the solubility of dissolved oxygen in stream waters. Thermal criteria describe thresholds and frequencies that aquatic species can tolerate without suffering adverse effects and are often specified for different seasons and life stages. The most commonly used metrics include the maximum weekly maximum temperature during the Summer and Fall seasons. This section describes the predicted temperatures resulting from construction, operation, and closure of the SGP. The companion SGP Fisheries and Aquatic Species Specialist Report (Forest Service 2022c) evaluates the impacts of these predicted stream temperatures on fish species.

Under the 2021 MMP, changes to stream flow, groundwater-surface water interactions, and stream shading have the potential to affect stream temperatures. Surface water tends to warm when streams become shallower, receive smaller amounts of groundwater discharge, or receive more direct sunlight due to removal of riparian vegetation. Effluent from permitted discharges also can affect stream temperature. Predictions of future stream temperatures were generated by Brown and Caldwell (2021) using a surface water temperature model. Forecasting future water temperatures over the post-closure period involves uncertainty associated with the performance and durability of implemented surface water restoration features (e.g., restored stream channels, Stibnite Lake feature), riparian planting, and closure water

management plus broader climatic conditions. Model uncertainty and sensitivity is described further in **Section 7.3**, with approaches to mitigate forecasting and implementation uncertainty discussed in **Section 7.4**. This section describes the model results associated with the effective and durable implementation of the closure design and riparian plantings.

The temperature modeling scenario accounts for the following aspects of the SGP surface water management:

- Lining of some channels (preventing exchange with groundwater),
- Mining and vegetation removal (altering shade and topography),
- Dewatering pits (lowering of the groundwater table with subsequent reductions to stream flow rates in some reaches), and
- Permitted discharge of treated water or non-contact water to surface water.

This stream temperature description focuses on comparing predicted future temperatures to existing temperature conditions. Additional details regarding the modeling can be located in Brown and Caldwell 2021f, 2021g. The long-term post-closure results presented depend on the successful implementation of two reclamation features that contribute to controlling the temperature of stream flows in the project area:

- 1) establishment of 18-foot-wide vegetation zones consisting of willow, spruce, and other riparian species that effectively shade stream flows in the restored and native stream channels in the mine area (Brown and Caldwell 2021g), and
- 2) development of the lined Stibnite Lake lacustrine feature above the cover of the Yellow Pine pit backfill to moderate maximum stream temperatures

Improvements to stream shading were introduced into the stream restoration and closure programs in recognition of the significant affect solar radiation has on stream flow temperatures. Focused riparian re-vegetation efforts are supported by overall site re-vegetation and closure planning that reclaims disturbance in the vicinity of the stream channels. The relationship between shade addition or removal on stream temperatures has been observed in multiple locations in the northwest United States (Brown and Caldwell 2021g).

During operations, predicted maximum stream temperatures in the Yellow Pine pit area increase relative to existing conditions due in part to the removal of the pit lake there which acts to dampen diurnal variability of the water temperatures. Development of the Stibnite Lake feature to mimic the thermal characteristics of the existing pit lake would restore that dampening effect and promote the return of water temperatures toward existing conditions (Brown and Caldwell 2021f). The magnitude of stream flow temperature decreases related to shading varies with the recovery time of riparian vegetation and the effectiveness of its cover in inhibiting warming by solar radiation directly on the stream water. **Table 7-25** summarizes the predicted stream water temperatures based on designed effectiveness of riparian recovery. Temperature effects for riparian recovery less than design are described in **Section 7.3**.

Table 7-25 Highest Simulated Temperatures (°C) across Mine Years for Surface Water Areas

Area	Simulated Daily Temperature Statistic	No Action	EOY6	EOY12	EOY18	EOY27	EOY52	EOY112	Maximum Increase from No Action
Upper East Fork SFSR (above Meadow Creek)	Summer Max:	13.7	13.8	13.8	13.8	13.8	13.8	13.8	0.1
	Fall Max:	11.1	11.0	11.0	11.0	11.0	11.0	11.0	-
	Summer Avg:	10.3	10.2	10.3	10.3	10.3	10.3	10.3	-
	Fall Avg:	8.8	8.8	8.9	8.8	8.9	8.8	8.9	0.1
Meadow Creek above East Fork Meadow Creek	Summer Max:	17.9	14.6	14.6	14.6	24.5	19.9	16.9	6.6
	Fall Max:	15.1	12.2	11.5	11.5	17.9	14.1	12.4	2.8
	Summer Avg:	12.7	11.2	11.2	11.2	15.0	13.2	12.4	2.3
	Fall Avg:	10.4	9.1	9.1	9.4	11.1	10.2	9.7	0.7
Meadow Creek below East Fork Meadow Creek	Summer Max:	19.8	17.2	16.8	16.7	18.5	16.6	15.3	-
	Fall Max:	16.2	15.9	13.7	13.3	13.9	12.4	11.6	-
	Summer Avg:	13.4	12.4	12.1	12.1	13.9	12.8	12.2	0.5
	Fall Avg:	10.8	10.2	9.9	10.0	10.7	9.9	9.6	-
Middle East Fork SFSR (between Meadow and Fiddle Creeks)	Summer Max:	17.4	16.2	15.8	16.0	16.4	15.3	14.8	-
	Fall Max:	14.0	13.6	12.7	12.7	12.6	12.0	11.8	-
	Summer Avg:	12.3	11.7	11.5	11.6	12.4	11.8	11.5	-
	Fall Avg:	9.9	9.5	9.4	9.5	9.8	9.4	9.3	-
Fiddle Creek	Summer Max:	11.5	11.9	11.5	11.6	11.9	11.6	11.6	0.4
	Fall Max:	10.1	10.4	10.3	10.3	10.6	10.4	10.3	0.5
	Summer Avg:	9.5	9.7	9.6	9.5	9.7	9.6	9.6	0.2
	Fall Avg:	8.3	8.3	8.3	8.2	8.4	8.3	8.3	0.1
Lower East Fork SFSR (between Fiddle and Sugar Creek)	Summer Max:	17.4	16.1	18.1	18.3	17.7	16.4	16.0	0.9
	Fall Max:	14.0	13.3	14.7	14.1	13.4	12.6	12.4	0.7
	Summer Avg:	13.5	11.6	13.7	13.8	13.9	13.3	13.1	0.4
	Fall Avg:	10.6	9.4	10.3	10.2	10.3	9.9	9.8	-
West End Creek	Summer Max:	12.9	21.7	19.1	20.9	20.6	16.8	16.8	8.0
	Fall Max:	11.0	17.1	17.3	16.2	16.2	13.2	13.2	6.3
	Summer Avg:	11.1	13.7	12.7	16.8	16.8	16.8	16.8	5.9
	Fall Avg:	9.6	10.4	10.3	13.2	13.2	13.2	13.2	3.6
Lower Sugar Creek	Summer Max:	15.4	15.7	15.6	15.7	15.5	15.5	15.4	0.3
	Fall Max:	12.2	12.3	12.3	12.2	12.2	12.2	12.2	0.1
	Summer Avg:	10.7	10.8	10.7	10.8	10.8	10.7	10.7	0.1
	Fall Avg:	9.1	9.1	9.1	9.1	9.1	9.1	9.1	-
East Fork SFSR downstream of Sugar Creek	Summer Max:	14.9	15.9	15.0	15.1	15.0	14.7	14.5	1.0
	Fall Max:	11.9	12.5	11.6	11.6	11.6	11.3	11.3	0.6
	Summer Avg:	13.0	11.3	13.1	13.2	13.3	12.9	12.7	0.3
	Fall Avg:	10.3	9.2	10.1	10.0	10.1	9.8	9.7	-

Source: Brown and Caldwell 2021f

°C = degree Celsius

Avg = average

EOY = end of year

Figures 7-29 through **7-36** summarize the predicted maximum weekly summer condition, average weekly summer condition, maximum weekly fall condition, and average weekly fall temperatures for stream reaches of Meadow Creek, the East Fork SFSR, West End Creek, and Sugar Creek throughout the SGP that approximate (but are not identical to) the ten surface water chemistry assessment nodes discussed above. In the figures, predicted temperature statistics are compared to existing conditions and standards utilized by the Forest Service. Additional comparisons to Idaho standards and reference values can be located in Brown and Caldwell 2021f. The effects of these temperatures on fish and aquatic resources are included in the evaluation of those resources in the SGP Fish and Aquatic Resources Specialist Report (Forest Service 2022c).

In Meadow Creek above the confluence with the East Fork SFSR (**Figures 7-29** through **7-32**), predicted water temperatures are cooler than existing conditions during the operating period. These cooler temperatures are attributable to the diversion of Meadow Creek around mine facilities in diversion channels and/or pipelines where the stream flow is less exposed to the warming influence of solar radiation. Upon closure, Meadow Creek would be routed into restored stream channels on top of the covered TSF. Initially during the post-closure period, the residence time of surface flow in the low-gradient sinuous restored stream channel would allow warming of temperatures above existing conditions and standards.

Following closure, predicted temperatures between the TSF and the confluence of Meadow Creek and East Fork Meadow Creek (Blowout Creek) decrease as a net effect of increases in riparian shading plus recovery of groundwater discharge and surface water inflow. Under baseline conditions, this portion of Meadow Creek is a zone of groundwater discharge (Brown and Caldwell 2017). Groundwater production by dewatering and industrial supply wells lowers water levels and groundwater discharge to surface water during operations. In addition, underdrain flow from the TSF is intercepted during operations. During closure, flows from cooler temperature groundwater discharge and underdrains increase in this area and riparian shading reduces the warming effect of solar radiation, resulting in lower predicted stream temperatures over time. Uncertainties in the predicted cooling effects of groundwater discharge and riparian shading are discussed further in **Section 7.3**.

Predicted temperatures above the confluence of Meadow Creek and the East Fork SFSR are predicted to be comparable to the existing condition within approximately 10 years after reclamation and then continue to cool over time. On the Meadow Creek segment atop the reclaimed TSF, temperature reductions would occur more slowly remaining warmer than existing conditions after 100 years. Predicted timing of temperature reductions is subject to the uncertainty in the forecasting the implementation and durability of the stream restoration and riparian planting (see **Section 7.3**)

In the East Fork SFSR (**Figures 7-29** through **7-32**), predicted water temperatures above the Yellow Pine pit area are cooler than existing conditions throughout the operations and closure periods as surface water diversions during operations and stream restoration plus riparian plantings reduce the solar radiation incident to surface flow. In the Yellow Pine pit area and downstream, maximum temperatures are higher than existing conditions while average temperatures are lower than existing conditions due to the removal of the pit lake's moderating effect on maximum stream temperatures. In the post-closure period, development of the Stibnite Lake feature is predicted to reduce maximum temperatures to approximately the level of existing conditions with an associated increase in average temperatures to within one-half degree Celsius of existing conditions. Uncertainty in post-closure temperature predictions is discussed further in **Section 7.3**.

Several sizes of lake features ranging from 30 to 100 percent of the existing surface area and 40 to 100 percent of the existing volume of the Yellow Pine pit were evaluated. A design lake feature elongated

along the direction of stream flow with the same depth of the Yellow Pine pit lake (i.e., approximately 30 feet) and 55 percent of its surface area was selected based on results from GLM modeling. Residence times for the existing Yellow Pine pit (2.6 to 3.6 days) and proposed Stibnite Lake feature (1.5 to 2.0 days) are both short. These short residence times allow for mixing of incoming stream flow with the approximately 16 million gallons of lake water to reduce diurnal fluctuations while increasing average temperatures (Brown and Caldwell 2021g). The reductions in maximum temperature and increases in average temperature were incorporated into the water temperature predictions (see **Table 7-25** and **Figures 7-29** through **7-32**). Without the effects of the lacustrine feature, downstream maximum and average temperatures would be essentially the same as upstream maximum and average temperatures. These effects were incorporated into the impacts analyses on fisheries (Forest Service 2022c). Achievement of these predicted temperatures would depend on the effective and durable installation of the Stibnite Lake feature.

Durability of the Stibnite Lake feature would be partially dependent on effective control of sediment upstream of its location which could deposit and alter the restored stream and lacustrine features. As an initial step, the unstable slopes in lower Blowout Creek, which represent the largest single source of sediment in the subwatershed, would be stabilized during the construction period. During operations and closure, sediment would be managed under the facilities stormwater management plan followed by a reclamation program incorporating upland stabilization and revegetation measures. Restored stream channels designs include stabilizing features such as meadows and step pools which are low slope, unconfined reaches that would inhibit sediment transport downstream. The effectiveness of these measures would be assessed under the site Environmental Monitoring and Management Program to identify and address excessive and/or unexpected areas of erosion and sediment generation.

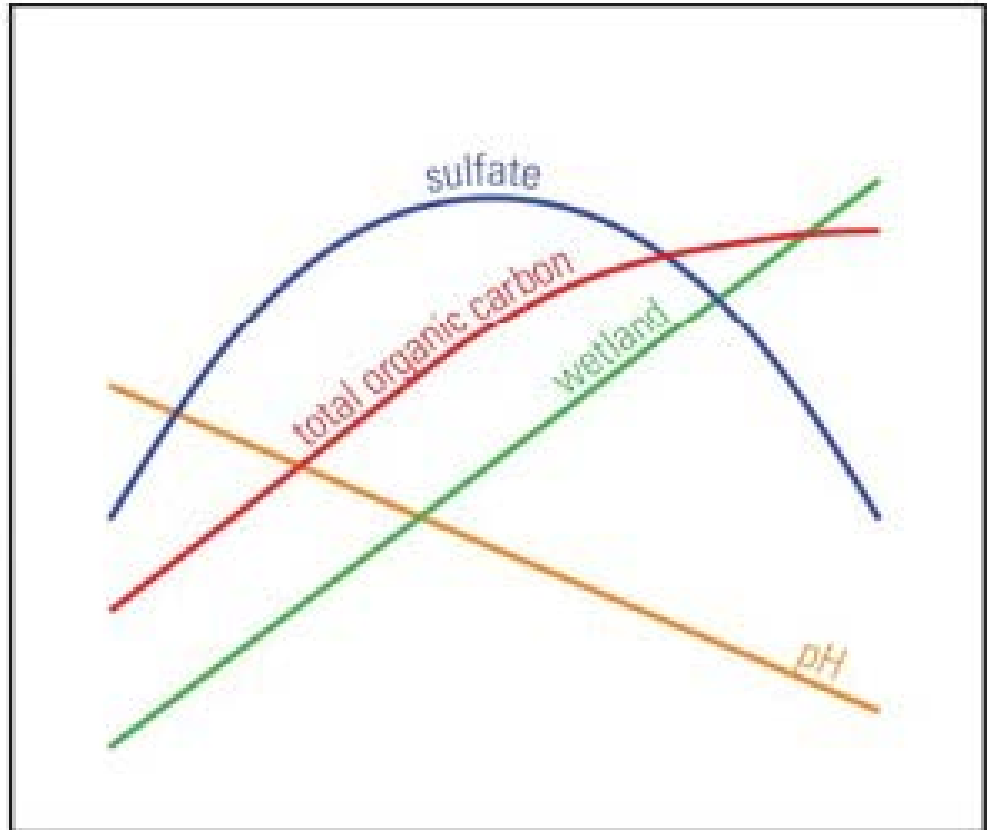
Uncertainties in the predicted cooling effects of the Lake Stibnite lacustrine feature are discussed further in **Section 7.3**.

West End Creek flows are predicted to warm during the operating period as ground disturbance and dewatering pumping reduce cooling influences of vegetation shading and groundwater discharge (**Figures 7-33** through **7-36**). Formation of the West End pit lake acts permanently raise temperatures compared to existing conditions in the stream segment immediately below that area which receives discharges of groundwater that has interacted with the pit lake. However, these increased temperatures in West End Creek have little influence on predicted temperatures in Sugar Creek between its confluence with West End Creek and above its confluence with the East Fork SFSR.

The limited disturbance associated with the growth media stockpile in the Fiddle Creek drainage associated has little effect on predicted Fiddle Creek temperatures above its confluence with the East Fork SFSR (**Figures 7-33** through **7-36**).

Low-----High

Methylmercury in water



Environmental characteristic

Low-----High

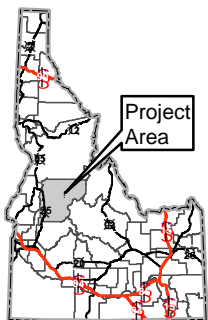


Figure 7-28
Relationships between Surface
Water Characteristics and
Mercury Methylation

Stibnite Gold Project
Stibnite, ID

Data Sources: (USGS 2015)



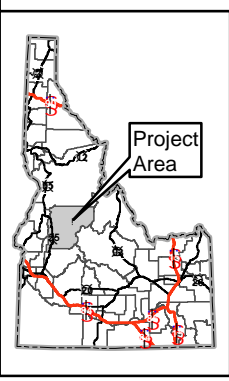
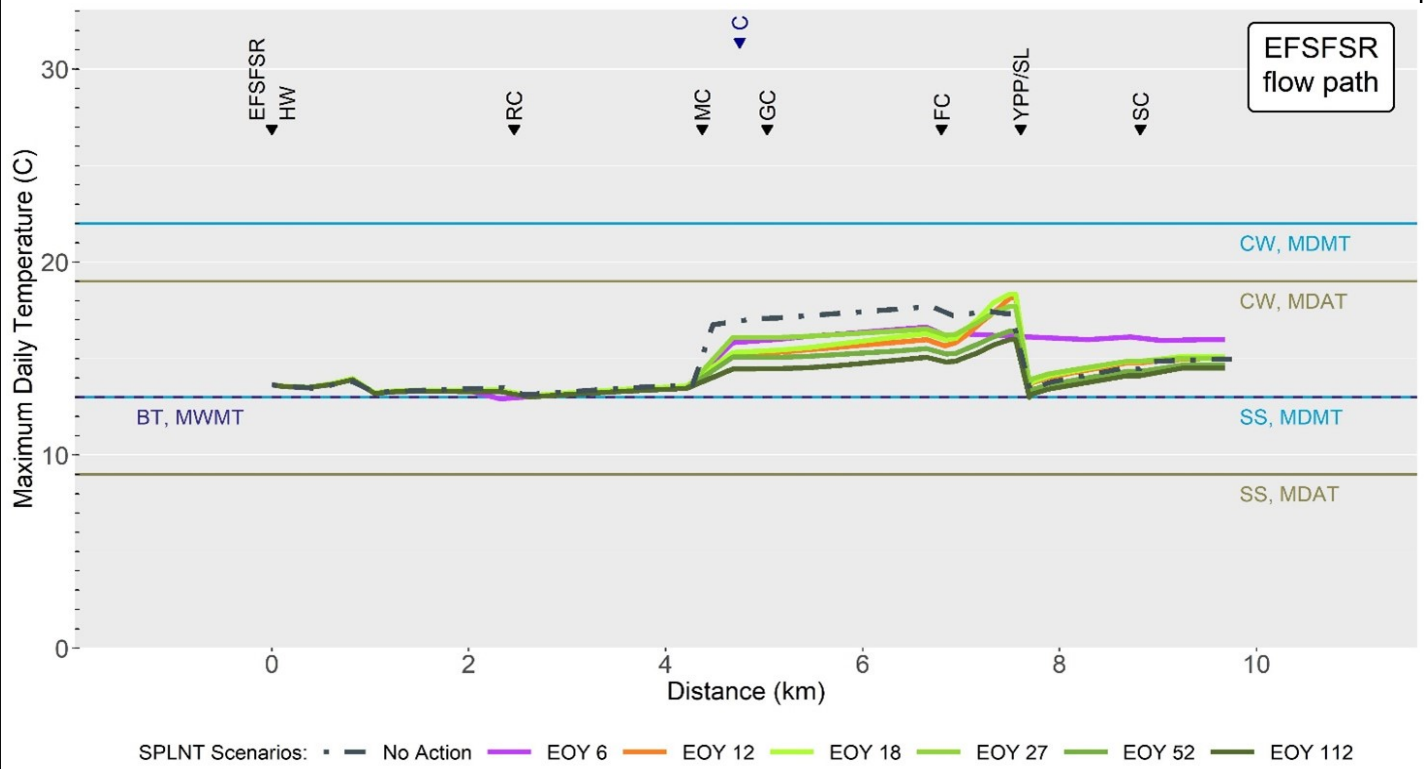
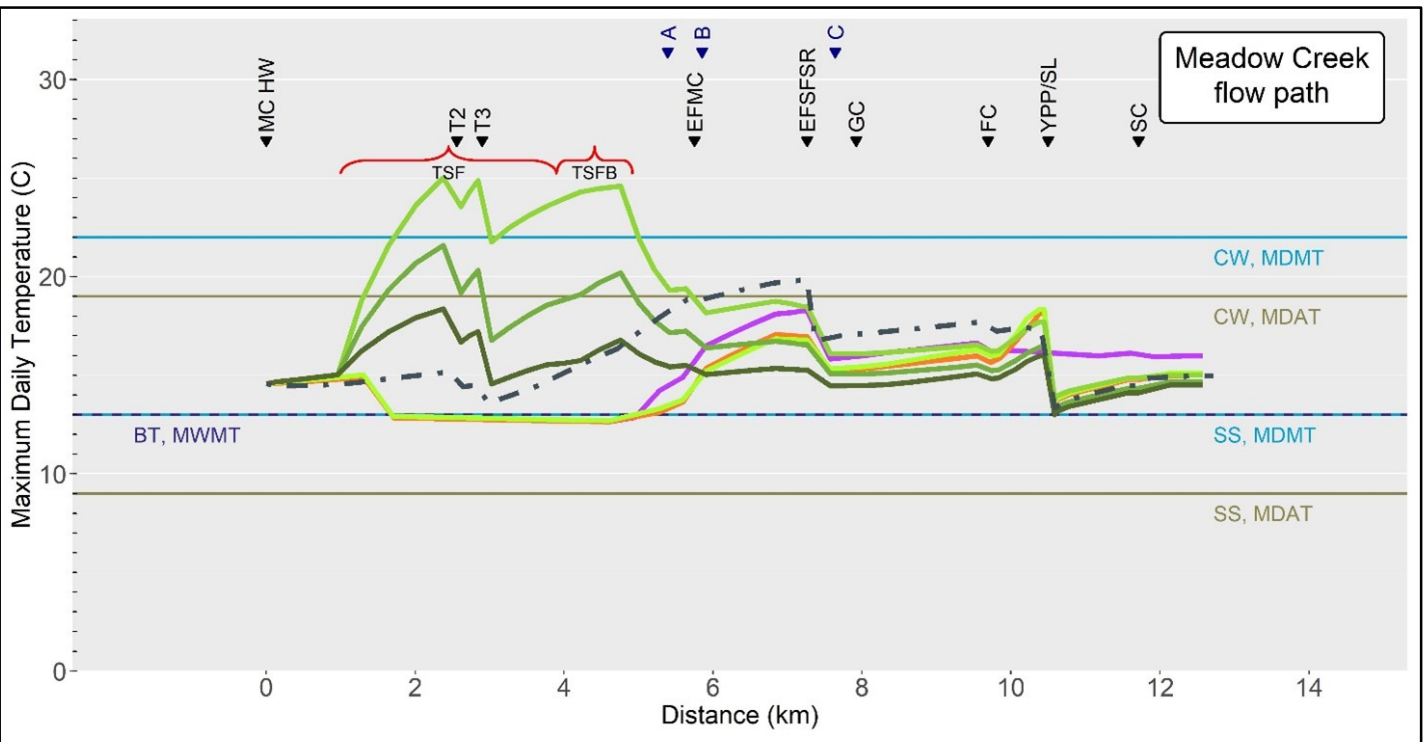


Figure 7-29
Predicted Maximum
Temperatures for the Maximum
Weekly Summer Temperature in
Meadow Creek and the EFSFSR

Stibnite Gold Project
Stibnite, ID
Data Sources: (Brown & Caldwell 2021b)

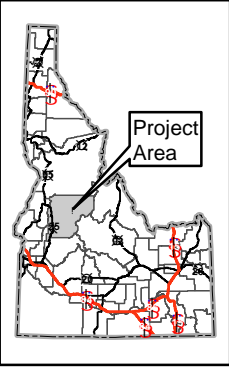
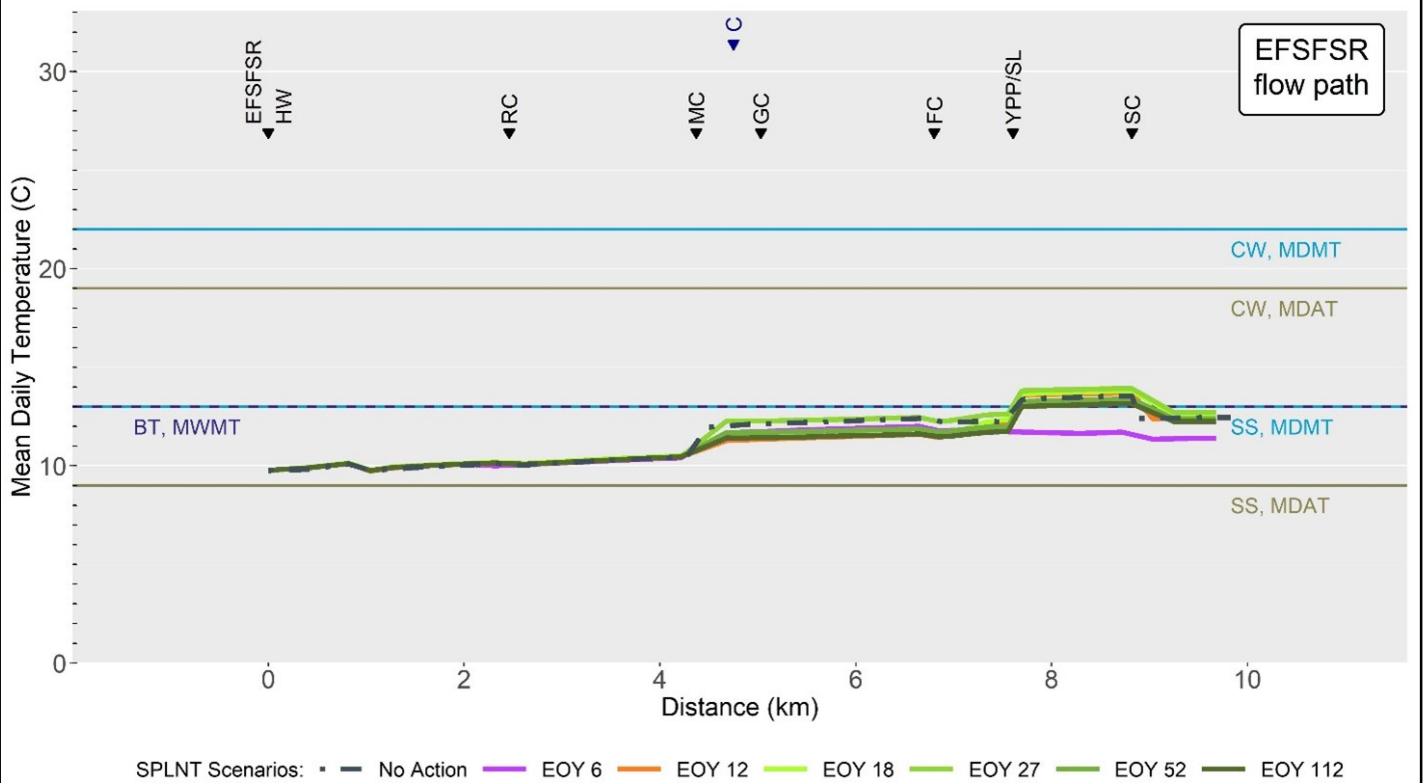
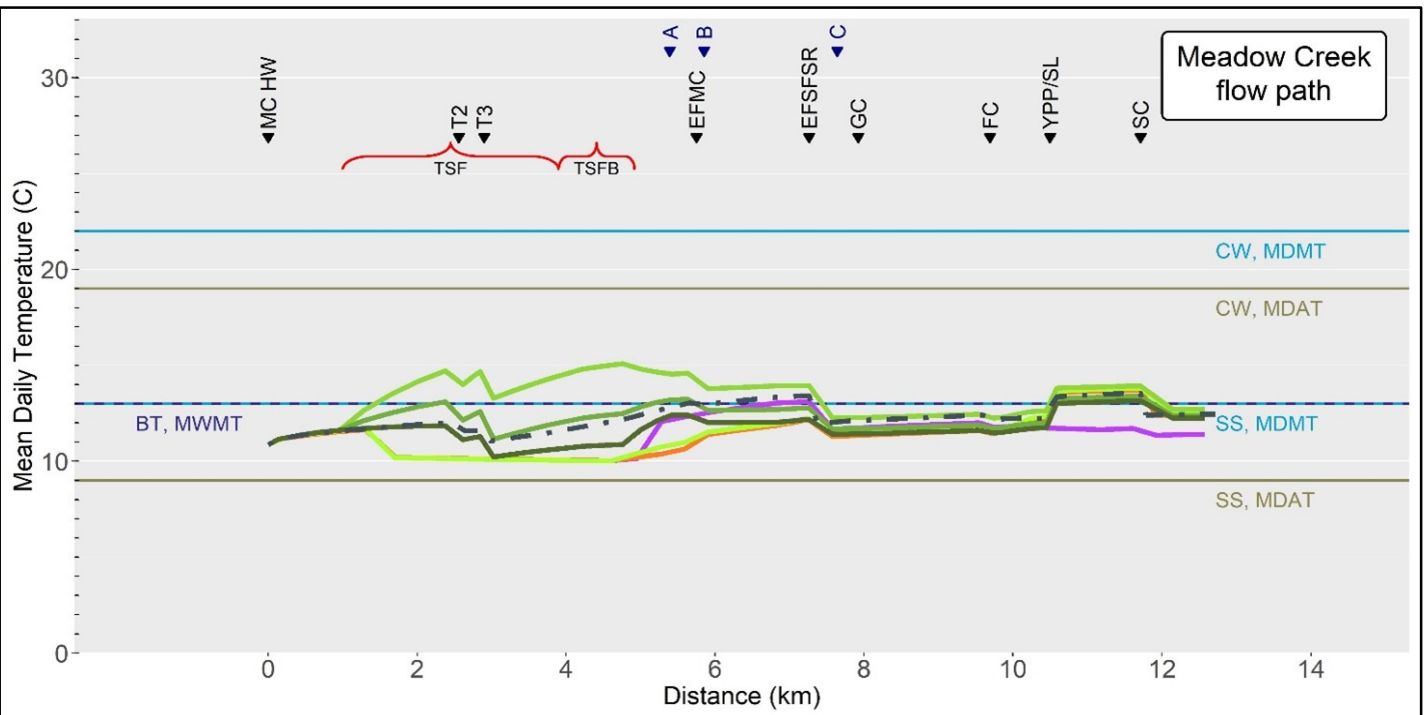
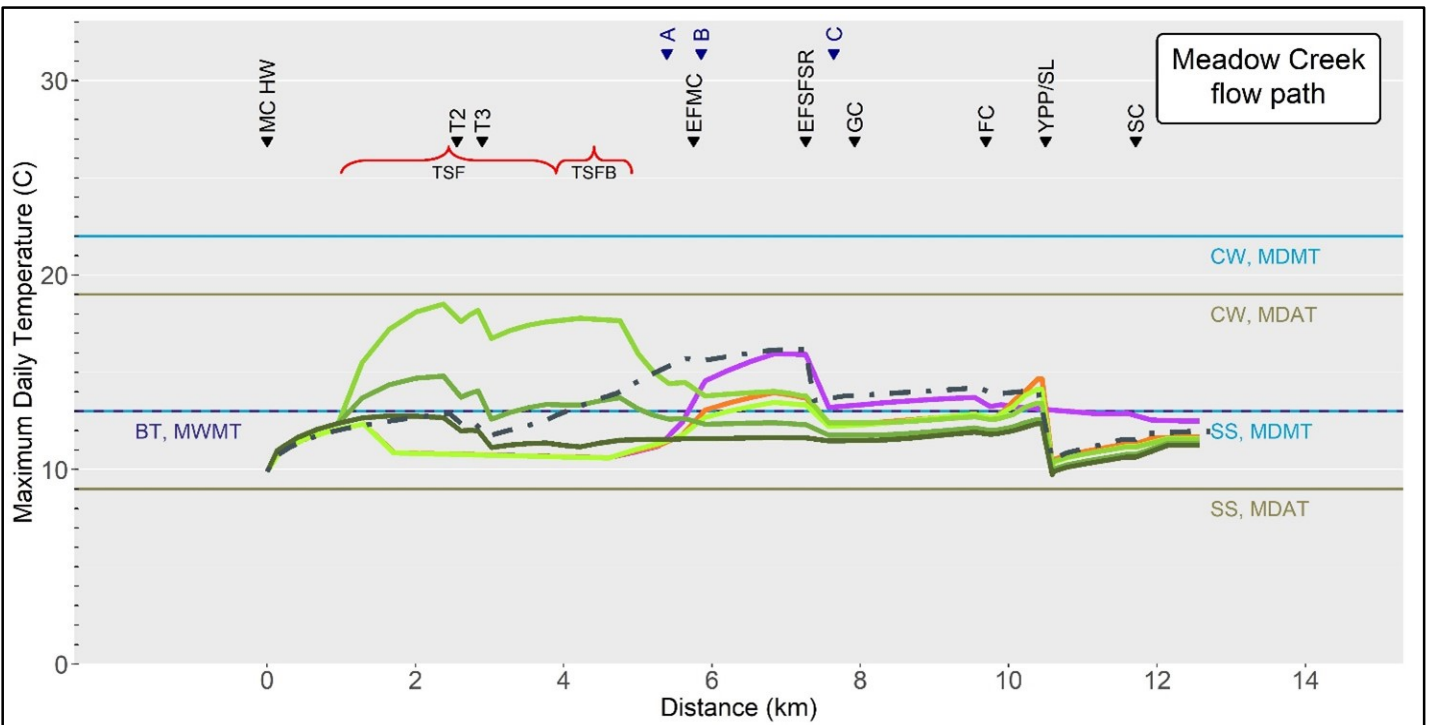
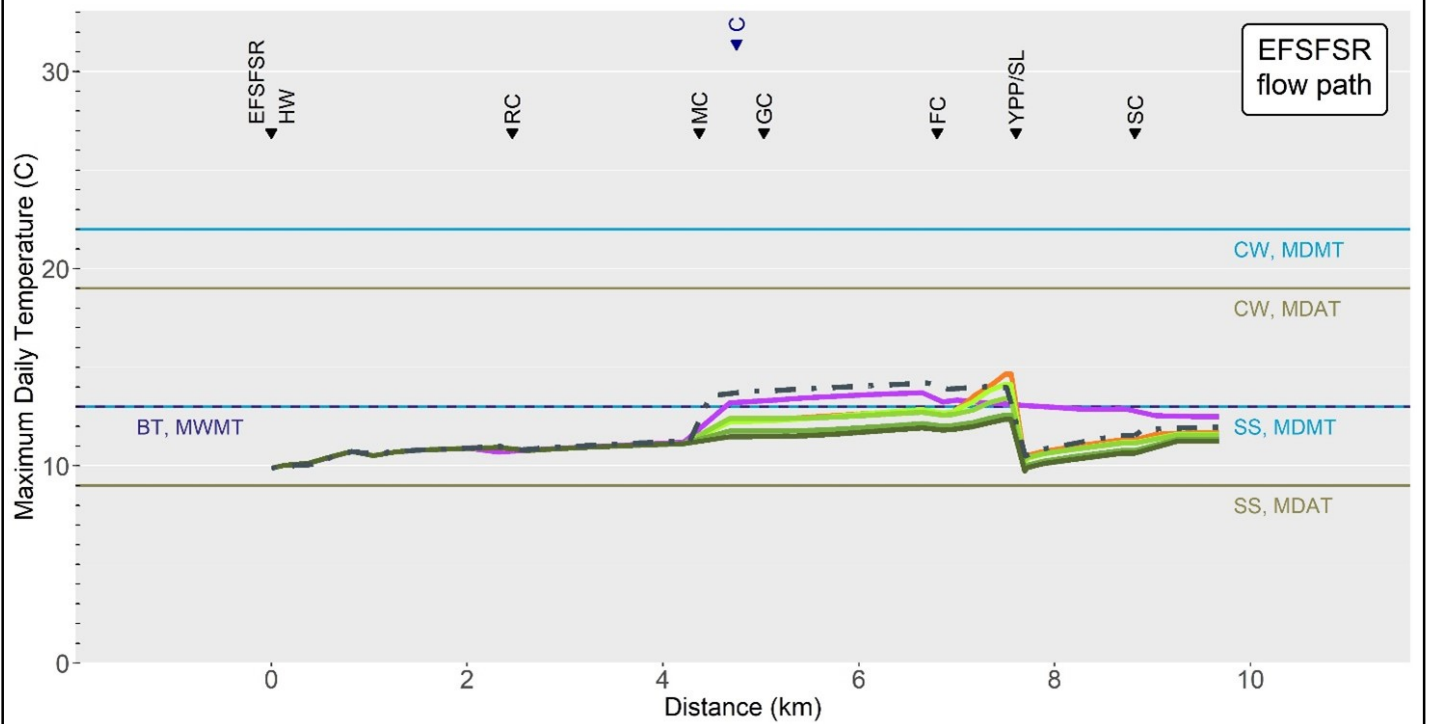


Figure 7-30
Predicted Average
Temperatures for the Maximum
Weekly Summer Temperature in
Meadow Creek and the EFSFSR

Stibnite Gold Project
Stibnite, ID
 Data Sources: (Brown & Caldwell 2021b)



SPLNT Scenarios: - - No Action - - EOY 6 - - EOY 12 - - EOY 18 - - EOY 27 - - EOY 52 - - EOY 112



SPLNT Scenarios: - - No Action - - EOY 6 - - EOY 12 - - EOY 18 - - EOY 27 - - EOY 52 - - EOY 112

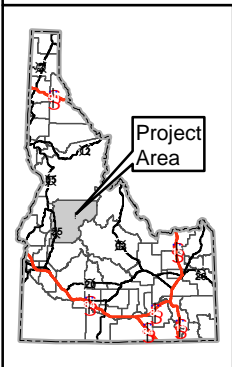
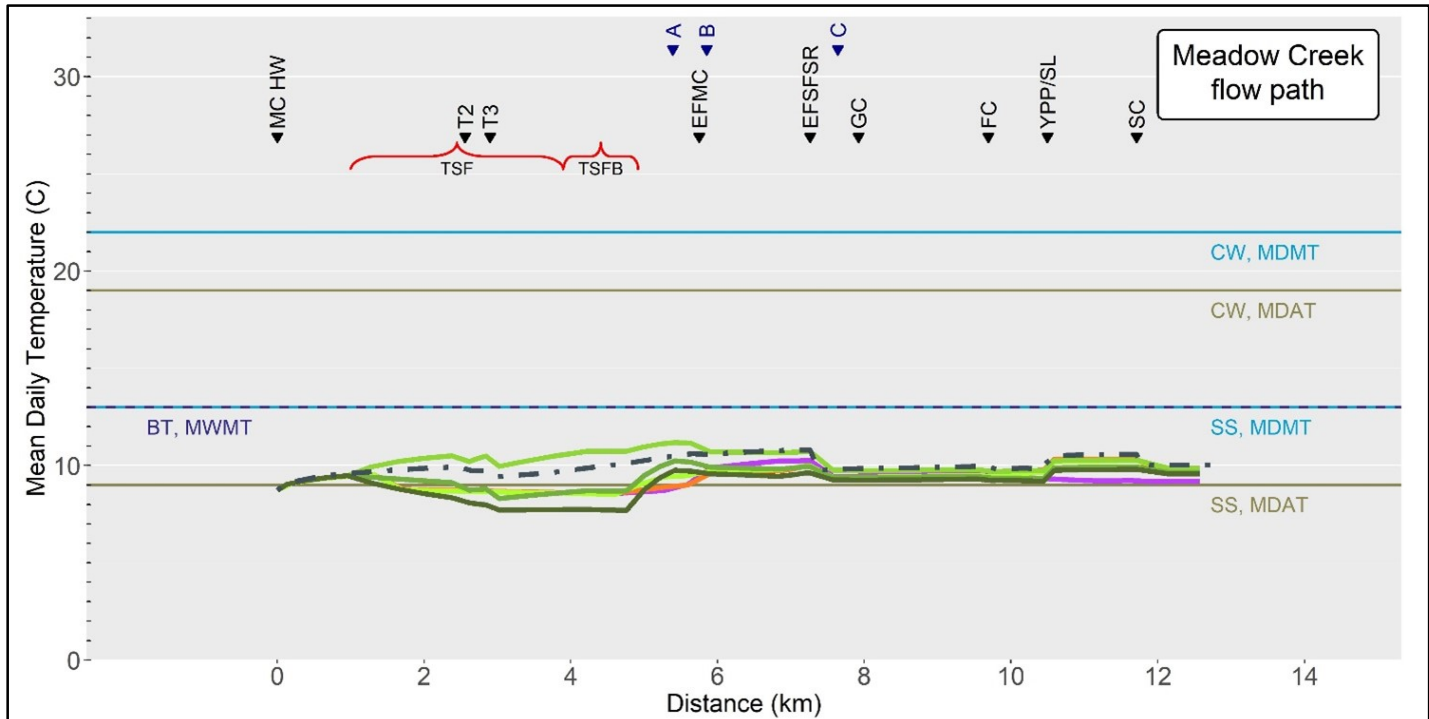


Figure 7-31
Predicted Maximum
Temperatures for the Maximum
Weekly Fall Temperature in
Meadow Creek and the EFSFSR

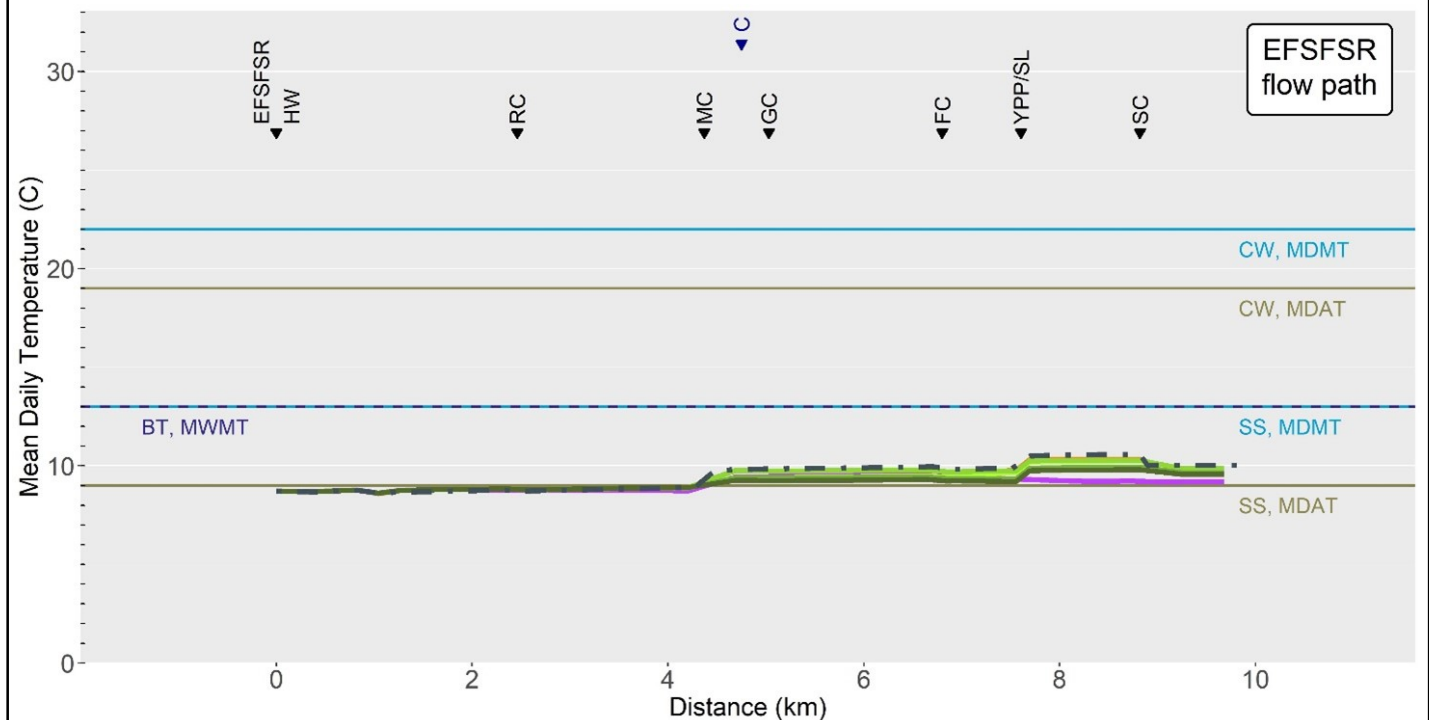
Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021b)





SPLNT Scenarios: - - No Action EOY 6 EOY 12 EOY 18 EOY 27 EOY 52 EOY 112



SPLNT Scenarios: - - No Action EOY 6 EOY 12 EOY 18 EOY 27 EOY 52 EOY 112

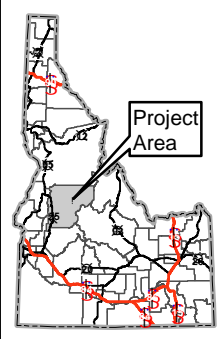


Figure 7-32
Predicted Average
Temperatures for the Maximum
Weekly Fall Temperature in
Meadow Creek and the EFSFSR

Stibnite Gold Project
Stibnite, ID
Data Sources: (Brown & Caldwell 2021b)

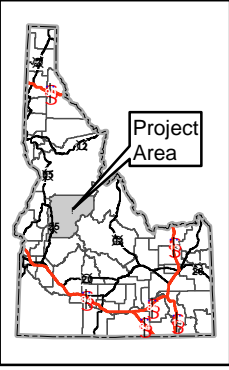
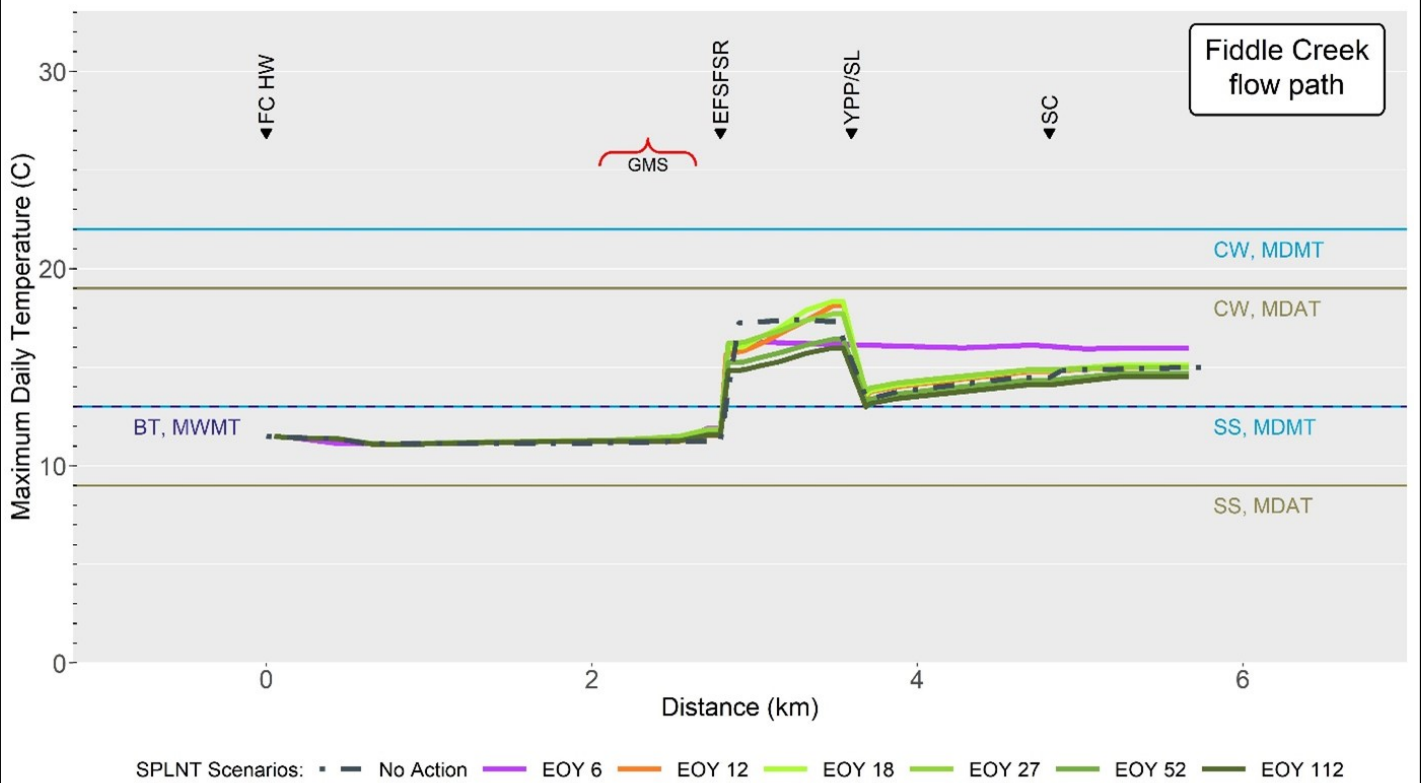
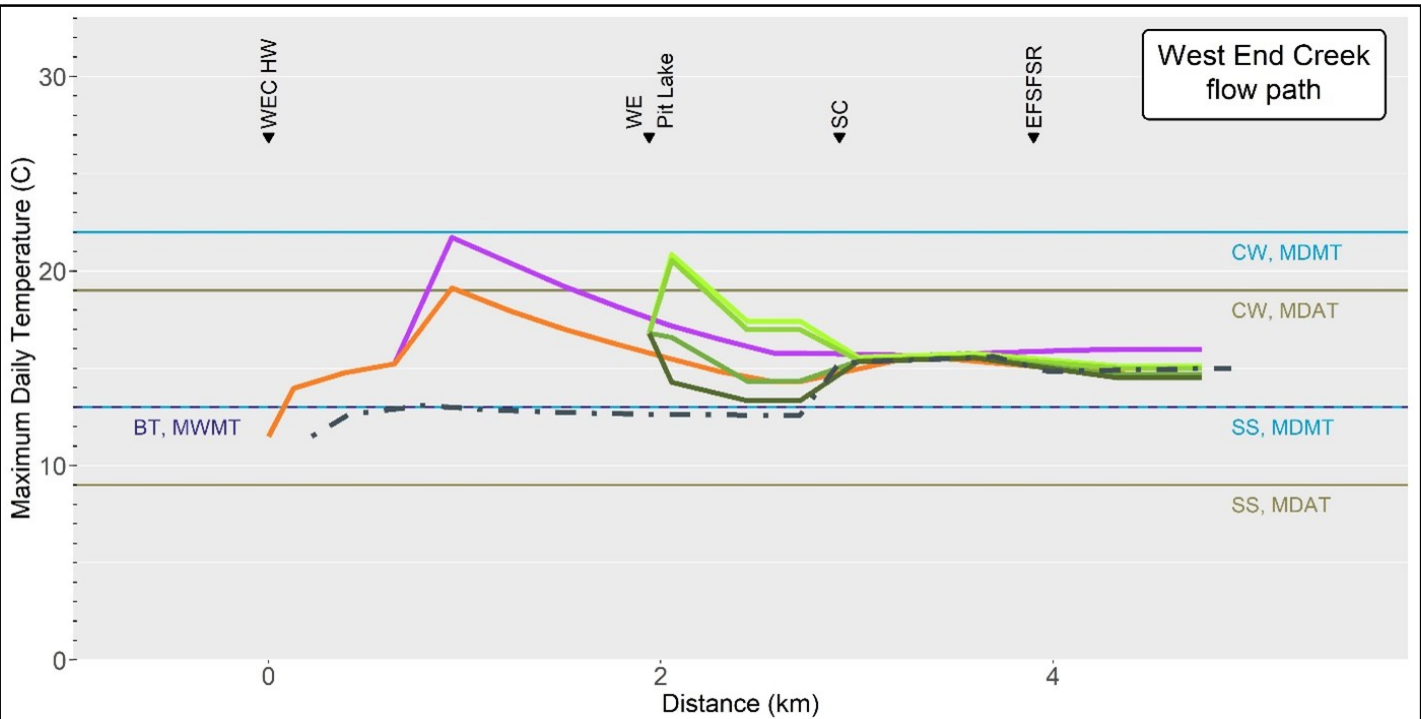

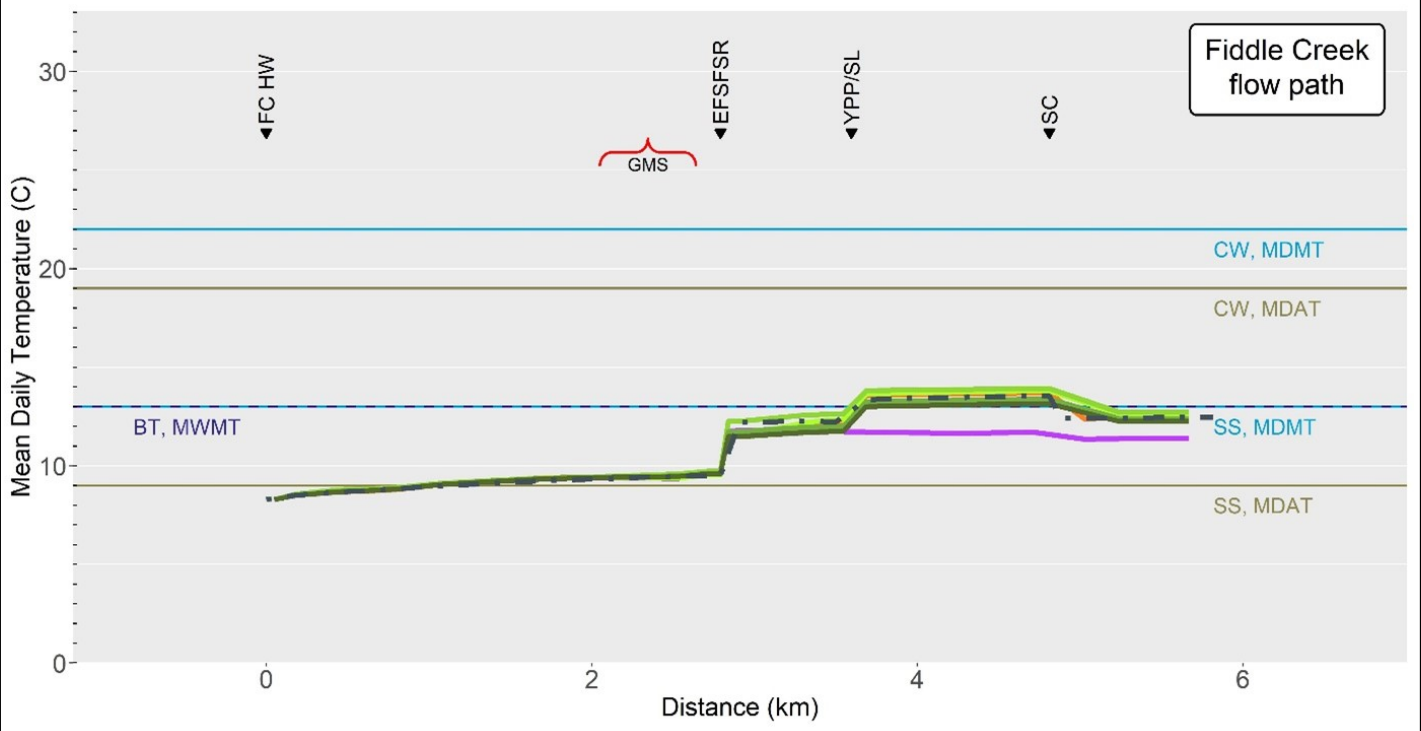
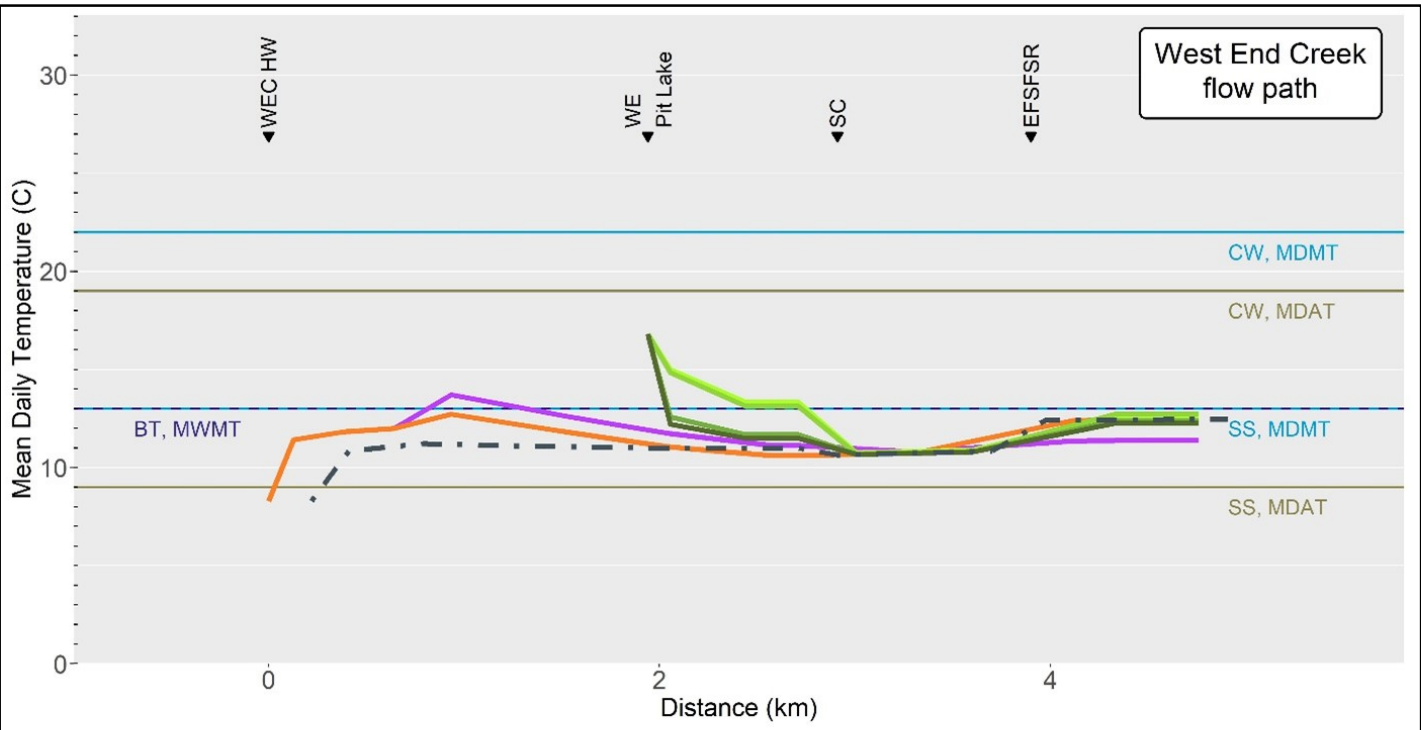


Figure 7-33
Predicted Maximum
Temperatures for the Maximum
Weekly Summer Temperature in
West End Creek and Fiddle
Creek
Stibnite Gold Project
Stibnite, ID
Data Sources: (Brown & Caldwell 2021b)





SPLNT Scenarios: - - No Action EOY 6 EOY 12 EOY 18 EOY 27 EOY 52 EOY 112

SPLNT Scenarios: - - No Action EOY 6 EOY 12 EOY 18 EOY 27 EOY 52 EOY 112

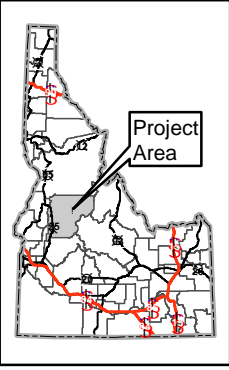


Figure 7-34
Predicted Average
Temperatures for the Maximum
Weekly Summer Temperature in
West End Creek and Fiddle
Creek
Stibnite Gold Project
Stibnite, ID
Data Sources: (Brown & Caldwell 2021b)

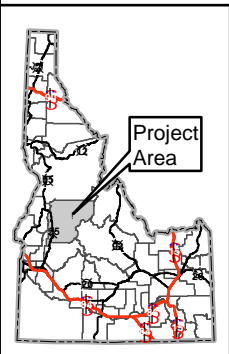
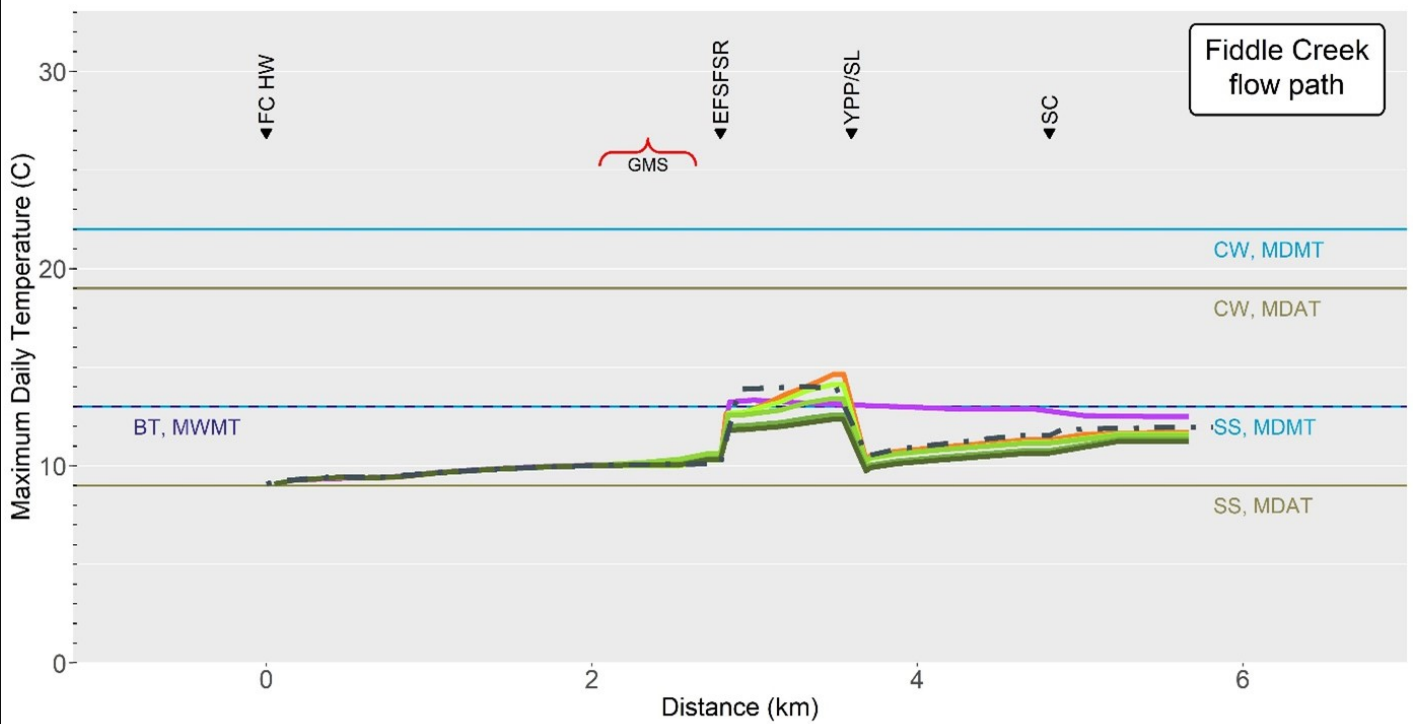
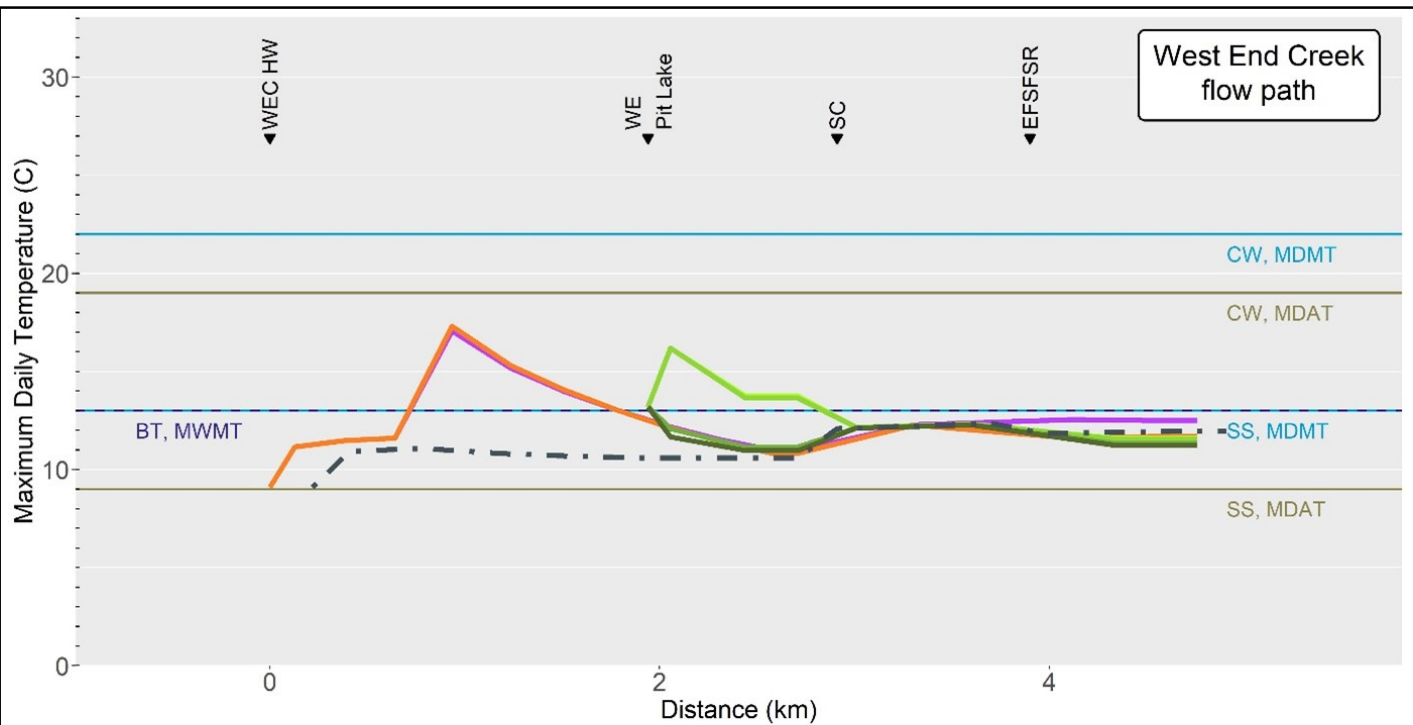


Figure 7-35
Predicted Maximum
Temperatures for the Maximum
Weekly Fall Temperature in
West End Creek and Fiddle
Creek
Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021b)



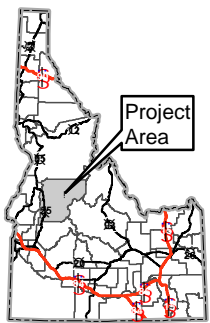
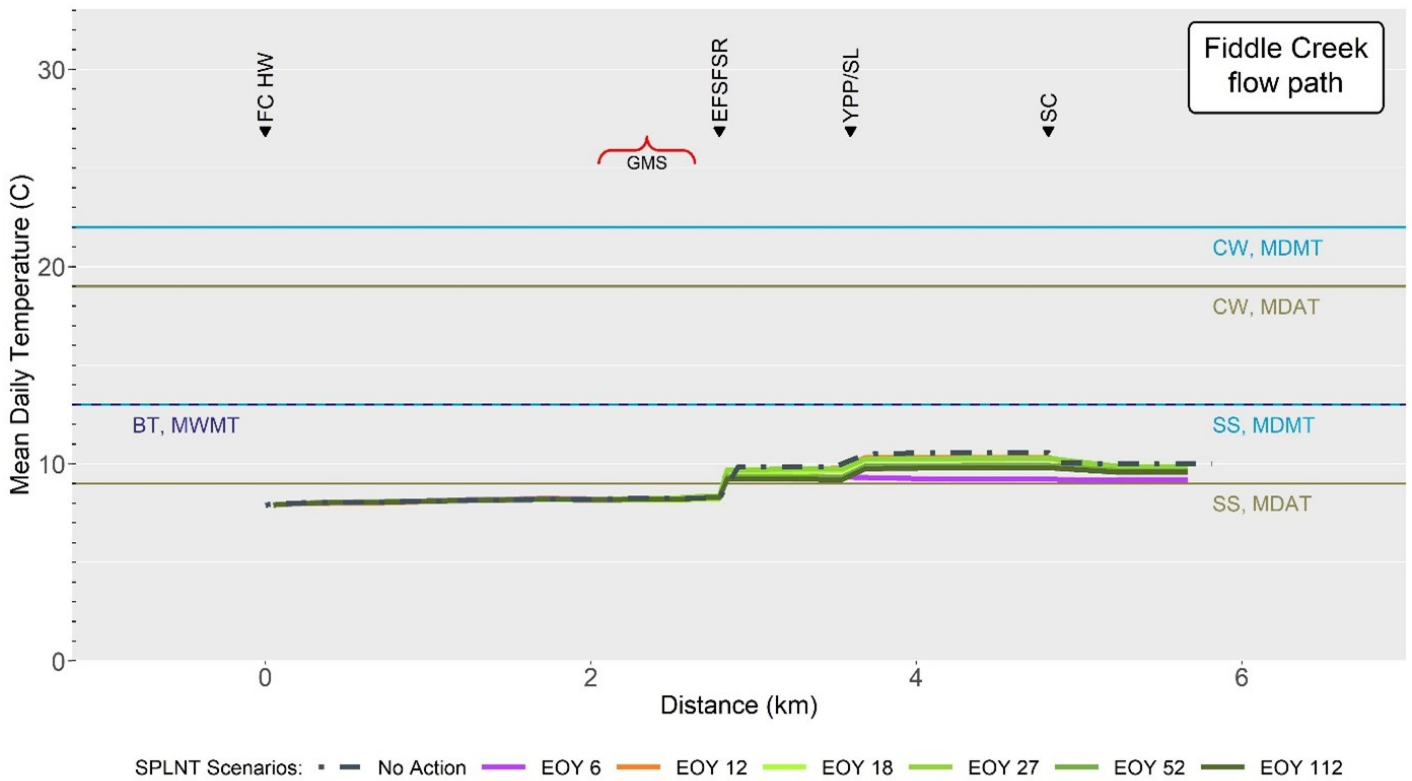
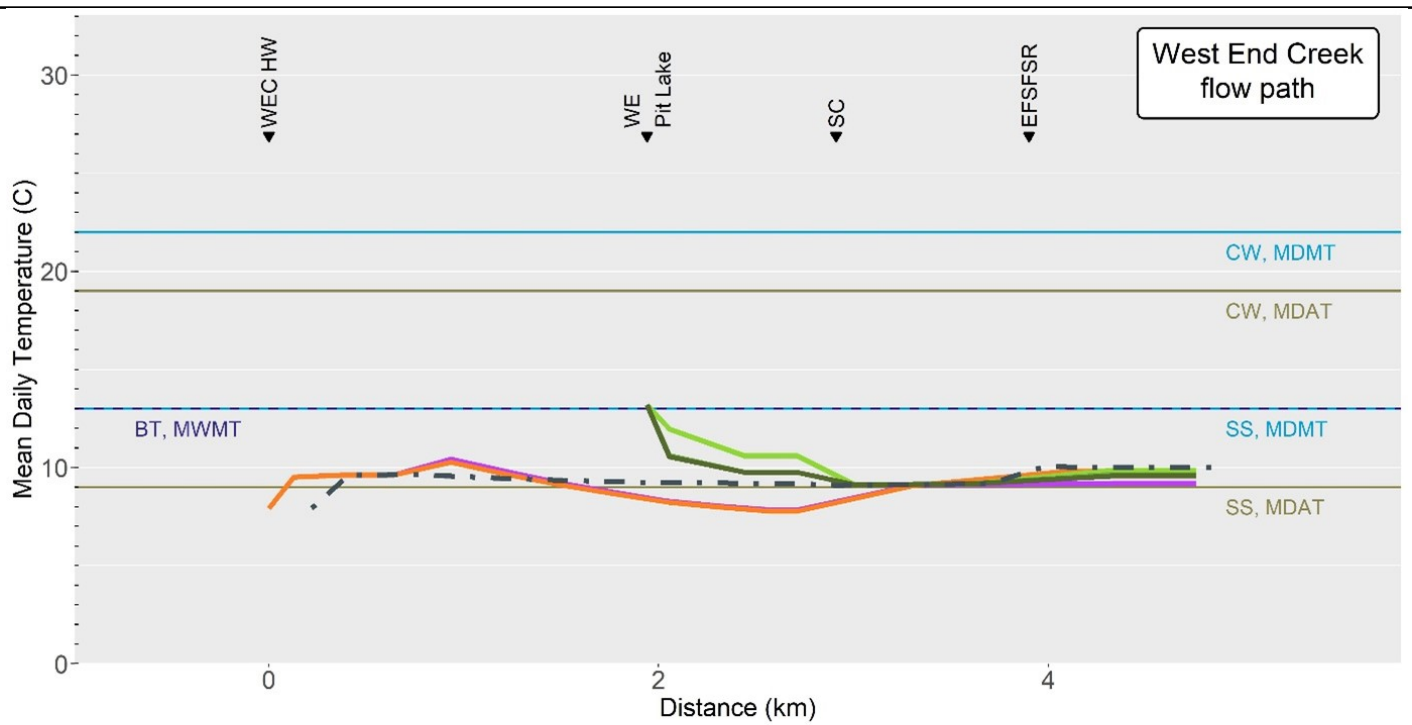


Figure 7-36
Predicted Average
Temperatures for the Maximum
Weekly Fall Temperature in
West End Creek and Fiddle
Creek
Stibnite Gold Project
Stibnite, ID

Data Sources: (Brown & Caldwell 2021b)



Compared to existing conditions, project operations are predicted to increase temperatures in West End Creek by up to 9°C and the East Fork SFSR below the Yellow Pine pit area by up to 3°C. Upon closure activities, Meadow Creek temperatures are predicted to increase by up to 10°C as the stream channel is restored atop the TSF while formation of the West End pit lake raises temperatures in West End Creek by approximately 4°C. With the exception of the West End Creek segment below the pit area, predicted temperatures return to existing conditions over a period of approximately 100 years as stream restoration and riparian plantings along with the moderating effect of the Stibnite Lake feature take effect (see also **Section 7.4**).

The consequences of increased stream temperatures are related to fish habitat and are evaluated in the Fish and Aquatic Resources Specialist Report (Forest Service 2022c). This analysis is able to conclude that changes in stream water temperatures would be localized and long-term except for a segment in West End Creek where the effect would be permanent. During the operating period as the Yellow Pine pit is mined (i.e., Mine Year 6), summer and fall maximum temperatures in the East Fork SFSR below the Sugar Creek confluence are predicted to be warmer than existing conditions by up to one degree Celsius, while average summer and fall temperatures are predicted to be cooler than existing conditions. The higher maximum temperatures would raise maximum temperatures by less than one degree Celsius in the downstream reach of the East Fork SFSR until mixing with influent tributaries (Salt and Pepper Creek and Tamarack Creek) and groundwater discharge returned temperatures to existing conditions approximately two miles downstream from Sugar Creek. Aside from the operating period, predicted maximum and average summer and fall water temperatures in the East Fork SFSR below Sugar Creek are comparable to existing conditions and would also be comparable in the downstream reach. The implications of forecasting uncertainty of these affects are described in **Section 7.3** with mitigation measures developed to address uncertainty described in **Section 7.4**. Impacts to fisheries are discussed in the SGP Fish and Aquatic Resources Specialist Report (Forest Service 2022c).

7.2.2.8 Impaired Waterbodies

Of the 71 stream crossings for access roads, 14 are listed by IDEQ as impaired. **Table 7-26** lists the Category 4 or 5 streams, the cause of impairment, and the beneficial use.

Table 7-26 Access Road Stream Crossings of Impaired Waters

Road	Stream Name	IDEQ Category	Cause of Impairment (Designated Beneficial Use¹)
Burntlog Road & Stibnite Road	East Fork SFSR	5	Arsenic (DWS) Arsenic (SCR)
Burntlog Road & Johnson Creek Road	Johnson Creek	4A	Water temperature (SS)
Burntlog Road	Landmark Creek	4A	Water temperature (SS)
Cabin Creek Groomed OSV	Cabin Creek	4A	Water temperature (SS)
Johnson Creek Road & Cabin Creek Groomed OSV	Lunch Creek	4A	Water temperature (SS)
Johnson Creek Road & Cabin Creek Groomed OSV	Park Creek	4A	Water temperature (SS)
Johnson Creek Road & Cabin Creek Groomed OSV	Pid Creek	4A	Water temperature (SS)
Johnson Creek Road & Cabin Creek Groomed OSV	Sheep Creek	4A	Water temperature (SS)

Road	Stream Name	IDEQ Category	Cause of Impairment (Designated Beneficial Use ¹)
Johnson Creek Road & Cabin Creek Groomed OSV	Trout Creek	4A	Water temperature (SS)
McCall-Stibnite Road	Profile Creek	4A	Water temperature (SS)
McCall-Stibnite Road	Sugar Creek	5	Mercury (COLD) Arsenic (SCR)
Warm Lake Road	Beaver Creek	5	Combined biota/habitat bioassessments (COLD)
Warm Lake Road	South Fork Salmon River	4A	Water temperature (SS) Sedimentation (COLD)
Warm Lake Road	Warm Lake Creek	4A	Water temperature (SS)

Source: IDEQ 2020a

COLD = cold water aquatic life

¹ DWS = domestic water supply

SCR = secondary contact recreation

SS = salmonid spawning

Most of the impaired waterbodies are listed for temperature, which is affected when riparian vegetation canopy shading is reduced from natural and anthropogenic impacts such as landslides or wildfires, road construction, and timber harvest. Access roads associated with the project would likely have a very small effect on temperature at stream crossings, where vegetation removal of shade-providing canopy would be localized, if required at all.

Access road crossings of the East Fork SFSR and Sugar Creek are unlikely to contribute arsenic or mercury loading because those road crossings are outside the mineralized areas targeted by the mine operations. Additionally, the Warm Lake Road crossings of the South Fork Salmon River and Beaver Creek are existing paved crossings, where additional SGP-related traffic would not be expected to contribute to sedimentation at the South Fork Salmon River Bridge or have effects to biota or habitat in Cascade. As such, access roads associated with the project would not be expected to affect overall progress toward beneficial use attainment of listed streams.

7.2.3 Johnson Creek Route Alternative

The water quality effects of the Johnson Creek Route Alternative and 2021 MMP are comparable with regard to contact water, water treatment, groundwater chemistry, surface water chemistry, stream temperature, and impaired water bodies. The change in site access does result in some differences in effects of sedimentation and fuels and hazardous chemicals.

Construction and operation of the Landmark Maintenance Facility and the SGLF would have the potential for increased runoff, erosion, sedimentation (as a result of vegetation removal and excavation of soil, rock, and sediment) and fuel and/or material discharge to nearby waterbodies during operations (if not properly stored or contained). However, design features proposed by Perpetua (**Table 2-2**), environmental protection measures required by the Forest Service (**Table 2-1**), and permit stipulations from state and federal agencies (including BMPs, sanitary wastewater treatment, and SPCC Plan) would control runoff, erosion, sedimentation, and the potential for discharges. Therefore, effects of the Landmark Maintenance Facility and the SGLF were considered to be negligible to surface water quality analysis.

7.2.3.1 Sediment

The number of streams crossed along the Johnson Creek Route (43) would be fewer compared to the 2021 MMP as a result of the Burntlog Route not being constructed and used during operations. However, the Johnson Creek Route, adjacent to Johnson Creek and the East Fork SFSR, would be widened and upgraded under this alternative. Therefore, surface water quality impacts from erosion and sedimentation during access road construction could increase during the construction activities and would require implementation of sediment and erosion BMPs.

Use of the Johnson Creek Route for site access would avoid construction-related impacts from sedimentation at 21 different streams compared to the 2021 MMP. These streams include Burntlog Creek, East Fork Burntlog Creek, the East Fork SFSR, Johnson Creek, Landmark Creek, Peanut Creek, Rabbit Creek, Riordan Creek, Trapper Creek, and 12 unnamed waterbodies.

During mine construction, the number of daily vehicle trips to the SGP would be comparable between the alternatives. The number of daily vehicle trips also would be the same during mine operations and reclamation; however, all vehicle trips would traverse the Johnson Creek Route under this alternative, resulting in greater use of the Johnson Creek Route access roads, and more fugitive dust generation and greater wear and tear on the road surface. In addition, use of the Johnson Creek Route would require two additional years of construction. The resulting surface water quality impacts from erosion and sedimentation would therefore differ in location and extent compared to 2021 MMP but would be similar in magnitude because the number of vehicle trips to the SGP would remain the same.

Prevention of these types of impacts would be achieved through proper road design, construction, grade control, fugitive dust control and, in the winter months, snow removal and “sanding” using gravel and coarse sand with minimal fines to avert slippery conditions and reduce off-site sedimentation during the spring runoff season (**Tables 2-2 and 2-3**).

Overall, based on identified maintenance activities, design features proposed by Perpetua, mitigation measures required by the Forest Service, and permit stipulations from state and federal agencies, traffic-related dust and erosion/sedimentation would be within the normal range of properly maintained National Forest System roads. The duration for traffic-related dust and erosion/sedimentation would last throughout the entire period of use of the Johnson Creek Route (approximately 40 years); however, the potential for these effects would be incrementally reduced during closure and reclamation (when AADT would be reduced). Due to the nature of airborne dust and sediment transport by streams, the geographic extent of the impact could be hundreds of feet to miles, depending on many site- and event-specific factors, but it is expected that effects would be limited to within the subwatersheds of the analysis area.

The effects of the Johnson Creek Route Alternative of sedimentation would be moderate, long-term, and localized.

7.2.3.2 Fuels and Hazardous Chemicals

The potential for surface water quality impacts from accidental fuel or chemical spills along the mine access roads would be comparable between the alternatives. However, all vehicle trips would traverse the Johnson Creek Route under this alternative, resulting in greater use of the Johnson Creek Route access roads. The potential location and extent of accidental spills would therefore differ compared to the 2021 MMP. The Johnson Creek Route is located in close proximity to streams (i.e., within 100 feet) for 6.5 miles or 18 percent of its approximately 36-mile length, so the potential for fuel and hazardous chemical spills impacting surface water quality is higher than for travel on the Burntlog Route which is within 100 feet of a stream for 1.69 miles or four percent of its length. Overall design features proposed by Perpetua,

mitigation measures required by the Forest Service, and permit stipulations and regulatory requirements from state and federal agencies (including use of USDOT-certified containers and USDOT-registered transporters) would reduce the risk of spills and promote effective response should a spill occur.

The effects of spills associated with the Johnson Creek Route alternative on surface water would be major, temporary, and localized.

7.3 Model Sensitivity and Uncertainty

The model results discussed for groundwater and surface water are based on calibrated groundwater flow, stream and pit lake temperature, and geochemical equilibrium balance models (Brown and Caldwell 2018, 2021a, 2021b, 2021g; SRK 2018b, SRK 2021a).

In the site-wide water chemistry model, constituents and nodes where the relative percent difference between simulated and observed analyte concentrations was greater than a 20 percent threshold range for analytical variation (which included antimony and arsenic at several nodes), the discrepancy between simulated and observed concentrations was attributed to diffuse unquantified sources of constituent loading in the East Fork SFSR between Fiddle Creek and Sugar Creek, likely originating from several sources including mineralized bedrock outcrops and subsurface groundwater load inputs. To improve the model calibration, additional loading was added or subtracted from the simulation of the existing condition to represent the non-specific input to the river and achieve calibration for each constituent at each node. This is standard model calibration practice, and the additional loads that were added or subtracted to achieve calibration for the existing condition were carried forward to the simulation of the 2021 MMP used to generate future water quality predictions.

Despite the calibration of the water chemistry model, there is uncertainty inherent in the model predictions, as there would be for any model of this type. The technical adequacy review identified the following sources of model uncertainty and potentially non-conservative model assumptions:

- During the geochemical characterization program, three development rock samples were reported with paste pH less than 6. Although materials submitted for kinetic testing did not generate acidity during the duration of those tests (up to 197 weeks), actual long-term conditions for the proposed mine facilities could vary the rate of sulfide oxidation along with the leachate pH and/or leached analyte concentrations.
- First-flush chemistry for contact water coming from development rock was not considered relevant to surface water quality predictions (SRK 2018b). This is deemed a non-conservative assumption. First-flush releases from the development rock material could cause short-term increases in downstream concentrations above and beyond what is currently predicted by the model.
- Air temperature correction factors used to scale laboratory reaction rates to field conditions by the model could underestimate actual reaction rates and chemical releases from mined materials, and hence, surface water quality impacts.
- The surface water quality model predictions do not include mass loading inputs from permitted IPDES outfalls that would be required for the SGP. Additionally, mercury inputs from atmospheric deposition caused by the SGP have not been considered in the model. These additional loads were discussed qualitatively or semi-quantitatively in the analysis above but could modify future analyte concentrations compared to predicted values.

- Model-predicted concentrations generated by the SWWC Model are for the dissolved fraction only and may underpredict concentration levels for constituents such as mercury that have been shown to occur in particulate form.

The degree of potential predictive error from the above model assumptions and SGP design features was evaluated through sensitivity analysis simulations (SRK 2019a, 2021b). Of the model uncertainties identified above, the sensitivity analysis mainly addressed the potential for acid-generation (via the NPR cutoff value used to classify PAG material) and the air temperature correction used to scale laboratory reaction rates to field conditions. Additional model runs also were conducted to evaluate the sensitivity of scaling assumptions related to the proportion of preferential flow paths and finer particle gradation in the TSF Buttress and pit backfills, as well as the pit wall fracture thickness and density.

Findings from the SWWC model sensitivity analysis evaluation include the following:

- Varying model input parameters for the sensitivity analysis had little effect on the mine operations model results.
- In one of the model sensitivity runs, the NPR cutoff for defining PAG material was increased to 2 (resulting in a greater percentage of pit wall rock and development rock lithology types being classified as PAG). The post-closure model results were not sensitive to increasing the NPR cutoff. The lack of model sensitivity to this parameter occurs because the mass loading rates for some constituents are lower in the PAG model source term input compared to some non-PAG units (SRK 2019a). Thus, increasing the percentage of PAG rock in the TSF Buttress and pit lake models does not lead to higher predicted post-closure concentrations.
- The model is not sensitive to varying the pit wall blast-damaged zone thickness.
- The model is most sensitive to inputs that vary the bulk scaling factor of reactive rock, including the percentage of development rock fines, the percentage of rock contacted due to preferential flow paths through the TSF Embankment and Buttress, and increasing the reaction temperature.
- When the bulk scaling factor of reactive rock is increased, concentrations of arsenic, antimony, sulfate, mercury, and aluminum are predicted to increase in contact water derived from the mined materials (SRK 2019a). The constituents exceeding surface water standards in contact water were the same as those predicted for the 2021 MMP (SRK 2018b, 2021a), but the duration of contact water exceedances was affected in the model sensitivity runs.

Although not considered in the sensitivity analysis, mass loading from IPDES outfalls was examined in a water treatment scenario evaluated in the Water Quality Management Plan (Brown and Caldwell 2020). Results of the water treatment simulation show that concentration reductions achieved by treating mine contact water greatly outweigh any loading contribution from the water treatment plant outfall (**Figure 7-24**).

Overall, the sensitivity analyses (SRK 2019a, 2021b) and the water treatment evaluations (Brown and Caldwell 2020, 2021c) address model uncertainty and non-conservative assumptions associated with acid-generation potential, IPDES outfalls, and air temperature correction factors. The sensitivity analysis and model treatment simulations show that changing the NPR cutoff for defining PAG material and adding the load from the water treatment plant outfall do not substantially alter predicted mine operational or post closure concentrations. However, increasing the reaction temperature in mined materials and pit walls was shown to produce higher post-closure arsenic concentrations in the pit lakes and downstream assessment nodes. Incorporation of first-flush chemistry in the model predictions would slightly increase predicted

analyte concentrations. Effects of model uncertainty from simulating dissolved rather than total concentrations have not been evaluated, but total concentrations of analytes that appear in particulate form would be greater than the simulated dissolved concentrations.

For stream water temperature modeling, inherent sources of model uncertainty include:

1. the actual effectiveness, timing, and sustainability of the shading effects of riparian plantings beside restored stream channels on reclaimed versus native soils and in an environment affected by weather events and wildfire which would be based on shading effects rather than typical reclamation revegetation goals (e.g., 70 percent of pre-existing cover),
2. the actual effectiveness of the constructed and lined Stibnite Lake feature in achieving simulated surface water temperature reductions attributed to the unlined Yellow Pine pit lake. Introduction of the lined lacustrine feature atop the lined and covered backfill in the Yellow Pine pit would modify the volume of diffuse subsurface groundwater inflow. The lined Stibnite Lake feature would receive inflow from the cover material in contrast to the existing groundwater inflow from native bedrock into the Yellow Pine pit lake. Depending on the hydraulic properties of the cover material compared to the native bedrock, the volume of groundwater inflow to the lake could differ from existing inflow rates with associated implications for resulting lake water temperature. The current temperature model does not incorporate any potential cooling effects from subsurface inflow into the Stibnite Lake feature,
3. spatial variability associated with the reduction and recovery of groundwater levels and groundwater discharge to surface water, and
4. potential broader effects of climate change on air temperature, meteoric precipitation, weather events, wildfire, and plant growth.

These sources of uncertainty relate largely to spatially and temporally variable implementation success and sustainability of closure activities which are difficult to simulate directly with a temperature model. Qualitatively however, insufficiently effective closure activities and/or adverse changes in broader climate conditions could result in higher than predicted stream temperatures.

7.4 Mitigation and Monitoring

Mitigation measures required by the Forest Service would represent reasonable and effective means to reduce the impacts identified in the previous section or to reduce uncertainty regarding the forecasting of impacts into the future. These mitigation measures would be in addition to the Forest Service requirements and EDFs (**Section 2.4**) accounted for in the preceding impact analysis.

Mitigation measures may be added, revised, or refined based on public comment, agency comment, or continued discussions with Perpetua regarding this specialist report or subsequent analysis under NEPA. The adopted mitigation measures will be finalized in the Final EIS.

Issue: Long-term performance of stream temperature reduction measures may have the potential to not fully achieve the forecasted stream temperature results. For example, the restored stream channel across the closed TSF may experience different consolidation, hydrologic, and/or re-vegetation performance compared to model forecasts that would affect its viability for reducing stream temperature as well as maintaining a physically and chemically stable closure for the TSF.

Mitigation Measure - Contingent Stream Temperature Reduction Measures: Due to inherent limitations in modeling and forecasting stream flow temperatures over a multi-decade period, effectiveness of the actual performance of TSF consolidation, stream channel restoration, riparian plantings, and other temperature reduction measures implemented may differ from forecast. At less than full design efficiency, predicted stream temperatures remain elevated in the TSF area and near existing conditions in downstream areas without realizing the benefit of the restored stream channel over the TSF on reducing stream temperatures below the existing condition (**Figure 7-37**).

Without this temperature reduction, stream temperatures downstream of the Yellow Pine pit area could also be greater than existing conditions.

Ditches and pipelines utilized to divert water around the TSF during operations are expected to result in cooler water temperatures downstream than existing conditions. In addition, these diversions would not be affected by TSF consolidation or implementation of stream channel restoration. Therefore, these surface flow diversions would continue to be utilized and not be removed/reclaimed until:

- 1) TSF consolidation appropriate for stream channel restoration could be verified via consolidation monitoring and remodeling for the as-built tailings facility,
- 2) Stream restoration design and implementation could be re-assessed prior to construction by resurveying the as-built and partially consolidated TSF surface to determine whether design stream gradients could be achieved or whether the stream channel design would need adjustment to accommodate the gradients of post-consolidation TSF surface, and
- 3) Achievement of design shading effects of riparian plants on stream temperatures could be re-assessed prior to construction by measuring the success of establishing riparian plantings at locations outside the TSF footprint (e.g., Hangar Flats pit diversion corridor, TSF Buttress, across the Yellow Pine pit backfill or other pit backfill) or a TSF-analogous test plot location utilizing the design cover materials and thicknesses.

Operational period maintenance practices for the diversions would remain into effect into the closure and post-closure period to prevent sedimentation and other factors from impairing the effective use of the diversions. Upon verification of the items above with any associated design adjustments, stream water temperature monitoring data in the constructed restored stream channel would be collected to confirm the performance of the temperature reduction measures. In an event where monitoring data indicated that acceptable stream temperatures would not be attained, the ditch and pipeline diversions would be re-commissioned and utilized to convey surface flows until an effective planting design would be developed and implemented.

Effectiveness: This monitoring and mitigation measure would be effective in reducing stream temperatures to predicted levels. However, it could delay the reclamation of surface water diversion ditches and pipelines for a period of several years, until stream temperature reductions could be achieved by shading, channel reconfiguration, or other means. This could delay the placement of up to 33,000 BCY of growth media. Any extended usage of the operational period diversion would also delay the implementation of approximately 121 acres of riparian planting and wetlands restoration plus the establishment of potential fish habitat on the reclaimed TSF area. However, the stream temperatures could be more conducive to fish occupancy in reaches of the East Fork SFSR in the mine site area (see the SGP Fisheries and Aquatic Resources Specialist Report (Forest Service 2022c) for additional details).

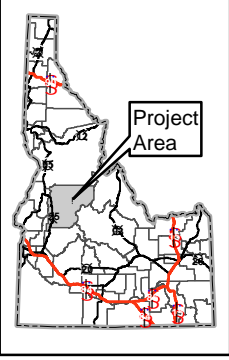
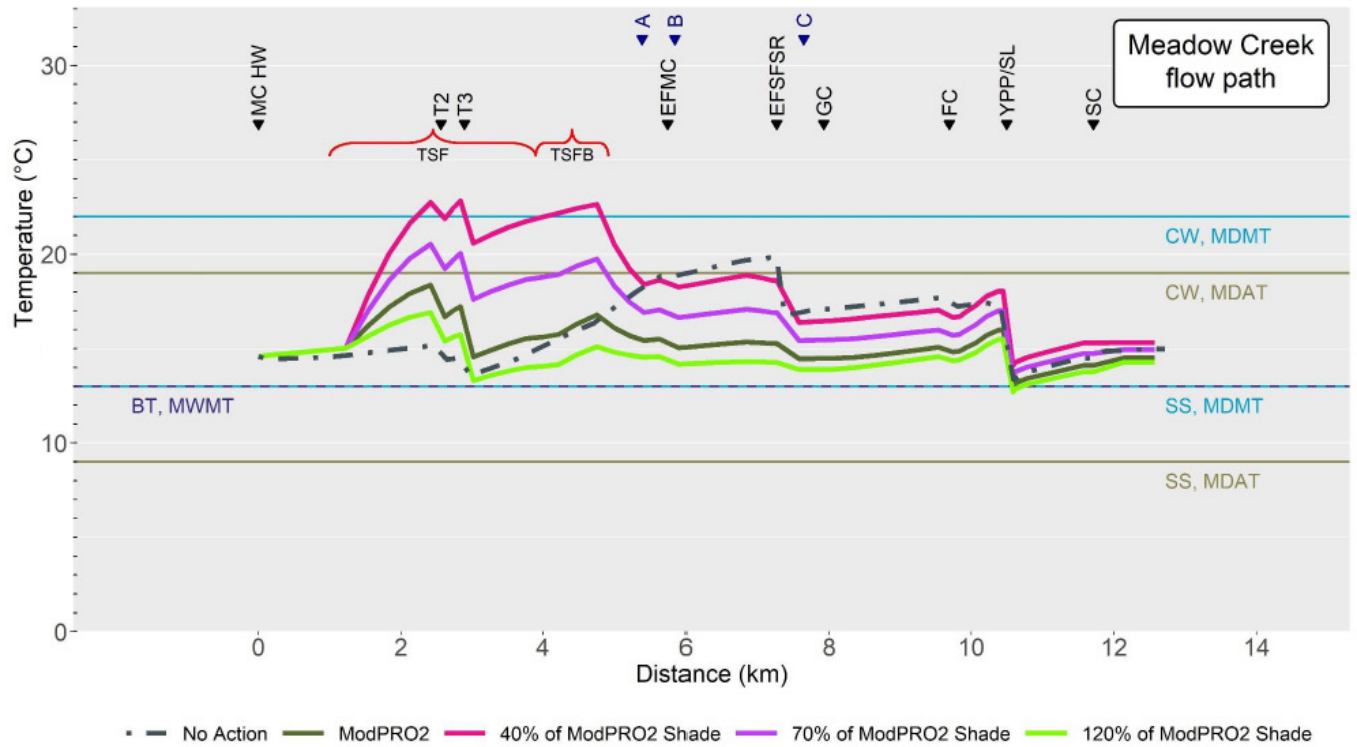


Figure 7-37
Sensitivity Analysis of
Predicted MWMT Summer
Temperature in Meadow Creek
and the EFSFSR

Stibnite Gold Project
Stibnite, ID
Data Sources: (Brown & Caldwell 2022)

Issue: As with any predictive model, limitations to long-term water chemistry modeling may result in underestimation of the nature and/or extent of surface water and groundwater quality impacts.

Monitoring Measure - Water Resource Monitoring Plan Implementation: Because construction, operation, and closure of the proposed Project has potential to impact surface or groundwater resources, a focused Water Resources Monitoring Plan for the approved project would be developed by Perpetua. As the mine owner/operator, Perpetua would be responsible for the implementation of the Water Resources Monitoring Plan for any approved action incorporating the confirmation of predicted surface water and groundwater chemistry plus surface water temperature. The plan would include mined development rock and ore, surface water, groundwater, and meteorological monitoring requirements. Monitoring results would be provided to the Forest Service on a quarterly basis and summarized in an annual report. Perpetua would be responsible for continued monitoring and reporting of surface and groundwater chemistry and temperature prior to, during, and after operations for a period of time in the post-reclamation period. The plan would be reviewed and approved by the Forest Service and implemented prior to the commencement of mining. State authorizations may also have monitoring requirements and these requirements along with monitoring already conducted or proposed could be applied to satisfy the needs of this mitigation measure.

Effectiveness: This monitoring measure would provide for identification of potential impacts to groundwater and surface water resources as a result of mine-related water management activities. Implementation of this monitoring measure in conjunction with associated mitigation measures is anticipated to mitigate any impacts that deviate outside model uncertainty to surface water and groundwater resources resulting from mine-related water management during the construction, mining, and closure periods. If such deviation is observed, actions may consist of additional investigation and evaluation, including additional monitoring as necessary, to determine effective management practices and prevent adverse impacts.

Issue: Despite the best efforts at calibration and validation, predictive modeling of groundwater and surface water chemistry and temperature entails uncertainty and future field conditions may vary from model predictions.

Monitoring Measure - Updated Geochemical and Temperature Modeling: Geochemical modeling and/or temperature modeling would be updated as necessary (at the request of the Forest Service) if monitoring results obtained from the Water Resources Monitoring Plan or other data collection indicate a change in water quality conditions that would significantly influence prediction and recognition of potential mine impacts. The Forest Service's review of quarterly and annual monitoring results compared to predicted conditions would provide early warning of potentially unanticipated, undesirable impacts to water resources to allow for implementation of appropriate mitigation measures. Implementation of these mitigation measures would reduce or eliminate potential impacts to water quality.

Effectiveness: Implementation of this monitoring measure is expected to be effective in sustaining predictive models as usable evaluation tools that reflect site conditions and monitoring data for the purpose of predicting impacts and developing effective management practices.

7.5 Cumulative Effects

7.5.1 Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The cumulative effects analysis area for surface water quality that could be directly or indirectly affected by the SGP consists of the 22 subwatersheds containing the proposed SGP, access roads, transmission lines, and off-site facilities (**Figure 5-1**). This is the same area used to analyze impacts from the SGP and was selected to encompass the extent where potential cumulative surface water quality effects could occur, such as constituent loading and sediment transport.

The cumulative effects analysis area for geochemistry and groundwater quality includes the Sugar Creek and Headwaters East Fork SFSR subwatersheds (**Figure 5-2**). This also is the same extent that was used to analyze impacts from the SGP.

Cumulative effects associated with the SGP consider the range of existing and foreseeable activities and their potential effects with respect to surface water and groundwater quality. Past and present actions that have, or are currently, affecting surface water quality include development projects, transportation projects, mineral exploration and mining activities, and closure and reclamation projects. Past and present actions that have or are currently affecting the mine site geochemistry and groundwater quality mainly include historical mining activity and recent mineral exploration undertaken by Perpetua.

Reasonably foreseeable future actions that could cumulatively contribute to water quality impacts in the analysis area include:

- South Fork Restoration and Access Management Plan,
- East Fork Salmon River Restoration and Access Management Plan,
- Gold Stallion Horse Heaven Project, and
- the ASAOC signed January 15, 2021.

7.5.2 No Action Alternative

The existing baseline surface water quality associated with the mine site is expected to improve to an extent due to the removal of legacy mining materials in contact with surface waters in Meadow Creek and the East Fork SFSR under the ASAOC Phase I. Phase I of the ASAOC is a separate action and not tied to the permitting of the proposed mine. Although impacts would likely be reduced due to a reduction of mine waste available for contact with surface water, elevated arsenic and antimony concentrations would persist as a cumulative impact with inputs from other historical sources (e.g., SODA) and inputs from natural sources that would continue to cause contaminant loading to the environment and influence Meadow Creek and East Fork SFSR stream flow concentrations. These actions are consistent with standard EPA presumptive remedies for this type of site.

Cumulative surface water quality impacts also could occur at the SGP area due to continuing surface exploration for the Golden Meadows Exploration Project. These previously approved activities include construction of several temporary roads (approximately 0.32 mile of temporary roads) to access drill sites (total of 28 drill sites), drill pad construction (total of 182 drill pads) and drilling on both Forest Service and private lands at and in the vicinity of the SGP. The continuation of approved exploration activities at the SGP by Perpetua could cumulatively increase stream sediment levels resulting from surface

disturbance and erosion. Exploration activities also could cause cumulative surface water quality impacts through accidental spills of diesel, gasoline, and jet fuel stored at the SGP in aboveground tanks.

7.5.3 2021 Modified Mine Plan

Compared to the No Action Alternative, the 2021 MMP would remove additional legacy mining materials and further reduce their impacts on water quality but would also contribute new sources of mine waste material to the East Fork SFSR drainage. However, the new mine waste materials would be equipped with current technologies and design features (e.g., liner and cover systems) to reduce their impacts.

Across the rest of the cumulative effects analysis area, future actions that could impact surface water quality would mainly affect stream temperatures and stream sediment concentrations. Other reasonably foreseeable future actions in the analysis area would mainly contribute sediment loading to adjacent streams. Although most of these future actions would likely have sediment control measures in place, the cumulative effect across the watershed may still include higher sediment loads in the East Fork SFSR and its tributaries.

Valley County Quarry, an active aggregate mine approximately 0.25 mile east-southeast of the village of Yellow Pine, is separated from the East Fork SFSR and Johnson Creek by the village itself, as well as several forest roads and native vegetation buffers. The quarry also includes surface water management features that retain runoff within the quarry perimeter (Forest Service 2017). Thus, the Valley County Quarry would not contribute to cumulative surface water quality effects in the analysis area.

7.5.4 Johnson Creek Route Alternative

Compared to the No Action Alternative and the 2021 MMP, cumulative effects to stream sediment concentrations from reasonably foreseeable future actions would be affected by mine access because the Johnson Creek Route Alternative would require all mine-related traffic during construction, operations, and reclamation to use the Johnson Creek Route. This would increase traffic on Johnson Creek Route during the mine operational and reclamation period, leading to greater rutting and degradation, greater road maintenance needs, and potentially higher erosion rates from the road surface along the Johnson Creek Route instead of the Burntlog Route. The cumulative effect from this change could combine with other planned activities in the Johnson Creek watershed to increase the sediment load in Johnson Creek compared to other alternatives. This consideration is especially important given that Johnson Creek Road, the longest segment of the alternative route, primarily follows the course of Johnson Creek. Thus, any additional sediment or dust generated from increased traffic on the Johnson Creek Route would have a direct pathway be deposited into Johnson Creek.

7.6 Short-term Uses and Long-term Productivity

7.6.1 No Action Alternative

Under the No Action Alternative, there would be no open pit mining or removal of legacy waste material at the SGP. Consequently, no short-term use would occur that would affect geochemical, surface water, or groundwater resources, and no change in long-term productivity would occur.

7.6.2 2021 Modified Mine Plan

Mining by its nature is a short-term land use that typically results in long-term impacts by permanently altering the natural environment. For the 2021 MMP, mining-related changes include open pit mining and disposition of mine waste material in the TSF, the TSF Buttress, and pit backfills. The long-term impacts

associated with these features have been quantified through modeling as discussed above, and would be offset to a degree by removal, reprocessing, and disposal of the SODA and Bradley tailings material currently present in Meadow Creek valley. However, there are still several constituents that are predicted to be elevated above existing conditions and/or applicable water quality standards in surface water or groundwater throughout the entire 100-year model-simulated post closure period, attributable to a combination of existing conditions and mine-impacted waters. Due to these predicted water quality changes, water treatment of several mine-related discharges would be required to maintain the long-term productivity of water resources both within and downstream of the mine area until facility seepage collection plus cover and liner systems effectively abate discharge of mine-impacted water to the environment (over approximately 40 years).

7.6.3 Johnson Creek Route Alternative

Under the Johnson Creek Route Alternative, long-term losses of groundwater and surface water productivity would be the same as the 2021 MMP except that transportation-related impacts to surface waters in the Johnson Creek drainage could be greater in nature and/or extent.

7.7 Irreversible and Irretrievable Commitments of Resources

7.7.1 No Action Alternative

Under the No Action Alternative, there would be no open pit mining or removal of legacy waste material at the mine site. Consequently, no changes would occur to current geochemical, surface water, or groundwater conditions in the analysis area, and no change to the current commitment of these resources would occur. Therefore, there would be no irreversible or irretrievable commitment of geochemical, surface water, or groundwater resources.

7.7.2 2021 Modified Mine Plan

With respect to geochemistry, gold, silver, and antimony are non-renewable resources that would be mined from ore deposits and then milled to remove the metals, constituting an irreversible commitment of mineral/geochemical resources. Other metals and elements present in the Yellow Pine, Hangar Flats, and West End Deposits that are not currently economically viable also would be removed from their native geologic setting and may not be retrievable in the future.

Additionally, under the 2021 MMP, the geochemistry of the mine site would be altered by removing and disposing of legacy mine waste, and by introducing new sources of waste material to the natural environment, including tailings, development rock, and exposed leachable material in the pit walls. The geochemical changes brought about by mining would therefore be irretrievable, because in many cases the geochemical impacts to groundwater chemistry and the West End pit lake are predicted to persist into the post-closure period.

No irreversible surface water quality impacts would occur because surface water is a renewable resource. However, surface water quality changes caused by the 2021 MMP would effectively be irretrievable because uses could be impaired until impacts were abated by EDFs and/or mitigation measures.

Groundwater at the mine site also can be considered a renewable resource because it is adequately replenished by natural recharge, preventing the occurrence of irreversible groundwater impacts except beneath mine facilities such as the TSF, the TSF Buttress, Hangar Flats pit backfill and Yellow Pine pit

backfill where reductions in recharge caused by cover systems would permanently lower groundwater levels. Formation of the West End pit lake would also permanently lower groundwater levels in its vicinity. Irretrievable impacts would occur when concentration changes in the mine site groundwater are predicted to persist throughout the entire 100-year post closure period. This type of long-term concentration change would be considered an irretrievable impact because it may limit the productivity of groundwater for designated uses.

7.7.3 Johnson Creek Route Alternative

Under the Johnson Creek Route Alternative, irreversible geochemical impacts would be the same as for the 2021 MMP. Irretrievable geochemical and water quality impacts also would be the same.

7.8 Summary

All action alternatives would include handling and storage of mineralized materials which could potentially leach major ions, total dissolved solids, and/or metals and could result in adverse impacts to surface water and/or groundwater chemistry. Mineralized materials that would be managed include ore, development rock, and newly generated tailings. The management of these materials would include blasting, excavation, crushing, ore processing to remove the saleable mineral fraction, and onsite disposal of the materials in mine pits, the TSF Buttress, and the TSF. The actions of blasting and crushing would result in potential exposure of these materials to oxygen and water, leading to leaching of major ions, total dissolved solids, and /or metals into nearby surface water and groundwater resources. Similarly, mineralized materials would be exposed in pit walls, also resulting in exposure to oxygen and water, and the potential for leaching. Several proposed activities, including storage of mineralized materials above engineered liners and below engineered covers, diversion of stormwater and surface water around the disposal locations, and movement of legacy mineralized materials (tailings) from their current locations to engineered disposal facilities, would reduce, but not eliminate, the potential for the release of leached chemicals to surface water and groundwater.

The analysis shows that remaining rock in pit walls and the development rock, both that deposited in the TSF Buttress and pit backfills, would be largely non-acid generating, but would be capable of leaching aluminum, antimony, arsenic, cadmium, copper, manganese, mercury, zinc, sulfate and TDS into surface water and groundwater in concentrations that exceed water quality criteria. Therefore, active contact water collection and water treatment would be required for a period of time during the operations and post-closure period until geochemical stability of mined materials could be achieved. In the case of the TSF where stabilization would depend on consolidation of tailings plus liner and cover installations, this collection period would be approximately 40 years. The water treatment would prevent mine-impacted waters with elevated analyte concentrations from contacting surface water in the environment. Upon closure, inundation of development rock placed in pit backfills would result in analyte leaching from the backfilled material to alluvial and bedrock groundwater. However, this leaching would not materially affect the utilization of groundwater compared to its existing condition where it frequently does not meet water quality criteria except for an area (around MWH-A17 and SRK-GM-04S) where antimony and arsenic concentrations are below groundwater standards.

Surface waters also would be impacted by modification of temperature due to removal of shading vegetation, development of pit lakes, and modification of stream depth during construction, operations, or the post closure/reclamation period. Design features to reduce stream temperatures in the East Fork SFSR would take approximately 10 years to implement post-closure, while temperature changes in segments of the restored Meadow Creek and West End Creek would be permanently raised by approximately 4°C compared to existing conditions.

Surface water quality also could be impacted by increased sedimentation associated with mining activities, access road construction and use, and the construction and maintenance of required utilities. Erosion and sedimentation could occur during active surface material disturbance associated with mine construction, operations, closure, and reclamation, with the greatest potential for in-stream impacts occurring during times of higher overland flow. The effect to surface water quality as a result of sedimentation and erosion would be limited by applicable environmental protection measures and control techniques, by the limited duration of active surface disturbing activities, and by the adaptability of the receiving environment. The magnitude and location of erosion and sedimentation associated with mining activities is expected to be approximately the same for all action alternatives.

Sedimentation impacts also could be caused by the deposition of fugitive dust from vehicles and heavy equipment into adjacent water bodies. These potential impacts would be addressed through fugitive dust control on mine haul roads as necessary to mitigate dust emissions. The extent of sedimentation effects from erosion and fugitive dust would be concentrated at the SGP and along the Burntlog and Johnson Creek access routes; however, due to the nature of sediment transport by streams, the geographic extent of the impact could extend farther downstream in the East Fork SFSR.

Both surface water and groundwater quality could potentially be impacted by accidental spills and releases of fuels and hazardous chemicals used in mine construction or operations under all action alternatives. In both cases, implementation of required standard design, permit stipulations, and regulatory requirements governing storage and handling of these materials would reduce the risk of spills and promote effective response should a spill occur, which would limit impacts to both surface water and ground water quality.

Table 7-27 provides a summary comparison of surface water and groundwater quality impacts by issues and indicators for each alternative.

Water quality implications on human and ecological receptors are described in detail in other specialist reports (Forest Service 2022c, 2022e), and are summarized below.

The inventoried waterbodies at the mine site have designated beneficial uses of “cold water communities,” “salmonid spawning,” and “primary contact recreation.” All waterbodies except Sugar Creek have additional designated beneficial uses of “drinking water supply” and presumed beneficial uses of “secondary contact recreation.” Sugar Creek has additional beneficial uses of “agricultural water supply” and “wildlife habitat.” However, under existing conditions, each of these inventoried waterbodies (except for West End Creek) are listed as impaired for specific uses in accordance with Clean Water Act Section 303(d). The causes for listing of these waters are associated with arsenic (plus antimony and mercury at some locations) for exceedances of Idaho's human health criterion for consumption of water and organisms. Operational and post-closure concentrations of these elements in the East Fork SFSR are predicted to be comparable to or less than the existing conditions. The IDEQ may also identify goals towards developing a water quality improvement plan/total maximum daily loads for the East Fork SFSR. Public health impacts related to surface water would be localized, long term, and negligible.

Groundwater analyte concentrations beneath the mine site, particularly in the vicinity of the TSF, TSF Buttress, Hangar Flats pit backfill, and Yellow Pine pit backfill, are expected to increase in response to constituent leaching from development rock. However, existing groundwater in those areas typically does not meet regulatory criteria for use as drinking water due primarily to arsenic and antimony concentrations.

There are three permitted wells on the mine site which are controlled by Perpetua: the Gestrin Airstrip mining well, the original temporary camp water supply well, and the new camp water supply well. Use of these wells for drinking water supply would require water treatment for arsenic and antimony removal. There are no active domestic groundwater wells used for residential drinking water within 15 miles of the SGP. Yellow Pine's public water system uses surface water from Boulder Creek, which is located approximately 15 miles downstream of Yellow Pine. Because groundwater is not currently used as a public drinking water source at the SGP and is assumed to be unlikely to be used as a drinking water source in the future, the ATSDR Public Health Assessment conducted for the existing mine site eliminated the groundwater as drinking water pathway from consideration as a public health concern (ATSDR 2003). The IDEQ would further regulate groundwater quality standards under its Idaho Pollutant Discharge Elimination System permit. Public health impacts related to groundwater would be localized, long term, and negligible.

Activities in the Operations Area Boundary area related to nutrition include fishing, hunting, or gathering of berries (or other edible vegetation). Contaminants in surface water could potentially bioaccumulate in the edible tissues of fish in impacted surface water or in wildlife that drink impacted surface water. As discussed above, implementation of controls and surface water management during mine operations and the closure and reclamation activities would likely decrease concentrations of contaminants in surface water relative to existing conditions. Public health and safety impacts related to consumption of fish, wildlife, or plants would be localized, long term, and negligible.

With regard to wetland and riparian areas, changes to water quality parameters would occur under the 2021 MMP during the construction and operation phases. The 2021 MMP would improve some of the existing water quality conditions observed in Meadow Creek and the East Fork SFSR by removing and repurposing legacy mine wastes. However, the 2021 MMP would have direct permanent impacts on water quality, as it would contribute new sources of mine waste material to the East Fork SFSR drainage. Indirect effects to wetlands and riparian areas could occur under the 2021 MMP if the quantity and or quality of surface and groundwater flows, including the chemical characteristics of the waters, change downstream of disturbance areas, and if those changes impact water quality or habitat conditions during active mining and after SGP closure.

With respect to wildlife, fish have historically been used as used as surrogates for other wildlife such as amphibians in evaluating chemical impacts in aquatic environments (Glaberman et al. 2019). Despite analysis area improvements to water quality as a result of the removal and reclamation of legacy mine wastes, exceedances of the most stringent water quality standards (including both human health and aquatic life) for water column antimony, arsenic, copper, and mercury are anticipated. In considering only the aquatic life criteria, which are more relevant for the protection of fish species, impacts due to antimony and arsenic are not anticipated. For copper and mercury, impacts may be minimal but uncertainties in predicting future conditions exist. For copper, the Biotic Ligand Model-based criteria are preliminary and do not encompass the range of monitoring nodes and the range of variability required for Biotic Ligand Model implementation (Brown and Caldwell 2020). For mercury, while the predicted concentrations do not exceed the aquatic life criterion based on water column, it is uncertain whether incremental change in water column concentrations beyond baseline would cause fish tissue concentrations to exceed the tissue-based criterion.

Table 7-27 Comparison of Surface Water and Groundwater Quality Impacts by Alternative

Issue	Indicator	Existing Conditions	No Action	2021 Modified Mine Plan	Johnson Creek Route Alternative
The SGP may affect soil and water resources through acid rock drainage and/or metals leaching from mineralized rock in the mine pits, development rock, and TSF.	Volume and disposition of mineralized waste generated.	No new mining waste generated.	No new mining waste generated.	Development Rock: <ul style="list-style-type: none"> • TSF buttress and embankment (142 MT) • Yellow Pine pit backfill (113 MT) • Midnight pit backfill (7 MT) • Hangar Flats pit partial backfill (18 MT) • On-site lime generation (1 MT) Tailings: <ul style="list-style-type: none"> • TSF (115 MT) 	Same as 2021 MMP
	Lithologic composition of final pit walls and exposure of potentially acid-generating material.	No known mapped extent of exposed lithologies in existing Yellow Pine and West End pits.	No known mapped extent of exposed lithologies in existing Yellow Pine and West End pits.	Area of PAG rock exposed in pit walls: <ul style="list-style-type: none"> • Hangar Flats pit (7.9% of total surface area; 6% of surface area above backfill elevation). • West End pit (0.4%) • Midnight Area (0.1%) • Yellow Pine pit (20.1% of total surface area; 3% of surface area above backfill elevation) 	Same as 2021 MMP
	Removal of legacy mine tailings and waste rock.	Legacy waste in Meadow Creek valley from historical mining operations, including SODA and Bradley tailings.	No removal of legacy mine tailings and waste rock.	SODA and Bradley tailings removed and repurposed.	Same as 2021 MMP
	Predicted leachate chemistry of development rock and tailings.	Not Applicable.	Same as Baseline Condition	Development Rock and Tailings are generally non-acid generating but capable of leaching arsenic, antimony, aluminum, manganese, sulfate, TDS, copper, cadmium, and zinc above water quality criteria.	Same as 2021 MMP

Issue	Indicator	Existing Conditions	No Action	2021 Modified Mine Plan	Johnson Creek Route Alternative
The SGP may cause changes in surface water and groundwater quality.	Surface water quality parameters (e.g., pH, temperature, major ions, total dissolved solids, metals, sediment content, and organic carbon).	East Fork SFSR ¹ : <ul style="list-style-type: none"> • Antimony (0.005 to 0.037 mg/L) • Arsenic (0.014 to 0.076 mg/L) • Mercury (5 to 10 ng/L) • Summer Max Temperature (13.4 to 17.4°C) Meadow Creek: <ul style="list-style-type: none"> • Antimony (0.001 to 0.025 mg/L) • Arsenic (0.004 to 0.075 mg/L) • Mercury (1 to 2 ng/L) • Summer Max Temperature (17.9 to 19.8 °C) West End Creek: <ul style="list-style-type: none"> • Antimony (0.008 to 0.012 mg/L) • Arsenic (0.064 to 0.088 mg/L) • Mercury (4 to 6 ng/L) • Summer Max Temperature (12.9°C) 	Same as Baseline Condition	East Fork SFSR ¹ : <ul style="list-style-type: none"> • Antimony (0.004 to 0.041 mg/L) • Arsenic (0.010 to 0.066 mg/L) • Mercury (4 to 10 mg/L) • Summer Max Temperature (13.4 to 18.0°C) Meadow Creek: <ul style="list-style-type: none"> • Antimony (0.001 to 0.014 mg/L) • Arsenic (0.001 to 0.018 mg/L) • Mercury (1 to 5 ng/L) • Summer Max Temperature (14.6 to 24.5 °C) West End Creek: <ul style="list-style-type: none"> • Antimony (0.002 to 0.014 mg/L) • Arsenic (0.008 to 0.095 mg/L) • Mercury (4 to 63 ng/L) • Summer Max Temperature (16.8 to 21.7°C) 	Same as 2021 MMP
	Potential for spills in proximity to streams and sedimentation from access road traffic	No mine- related traffic on existing Forest Service roads	Same as Baseline Condition	<ul style="list-style-type: none"> • Mine access roads would cross 71 different streams. • 1.56 miles (4% of routes) would be within 100 feet of streams. • Sedimentation and fugitive dust predicted to be within normal range of properly maintained Forest Service roads. 	<ul style="list-style-type: none"> • Mine access roads would cross 50 different streams. • 6.5 miles (18% of routes) would be within 100 feet of streams. • Sedimentation and fugitive dust predicted to be within normal range of properly maintained Forest Service roads.
	Sedimentation from utility stream crossings	No transmission line upgrades or new lines constructed	Same as Baseline Condition	<ul style="list-style-type: none"> • Mine utility work would cross 36 different streams. • Potential for transmission line-related erosion and sedimentation would be minimized by BMPs. 	Same as 2021 MMP

Issue	Indicator	Existing Conditions	No Action	2021 Modified Mine Plan	Johnson Creek Route Alternative
	Groundwater quality parameters (e.g., pH, major ions, total dissolved solids, metals).	TSF area groundwater ¹ : <ul style="list-style-type: none"> • pH (7.57) • Arsenic (0.006 mg/L) • Antimony (0.0020 mg/L) • Mercury (0.6 ng/L) Hangar Flats: <ul style="list-style-type: none"> • pH (6.4 to 7.2) • Arsenic (0.0005 to 1.8 mg/L) • Antimony (0.002 to 0.61 mg/L) • Mercury (10 to 43 ng/L) Yellow Pine: <ul style="list-style-type: none"> • pH (6.8 to 8.2) • Arsenic (0.13 to 0.32 mg/L) • Antimony (0.010 to 0.014 mg/L) • Mercury (0.8 to 3 ng/L) West End: <ul style="list-style-type: none"> • pH (7.4 to 7.9) • Arsenic (0.009 mg/L) • Antimony (0.002 mg/L) • Mercury (47 to 55 ng/L) 	Same as Baseline Condition	TSF area groundwater ¹ : <ul style="list-style-type: none"> • pH (7.6) • Arsenic (0.009 to 0.48 mg/L) • Antimony (0.003 to 0.22 mg/L) • Mercury (1 to 50 ng/L) Hangar Flats: <ul style="list-style-type: none"> • pH (8.3) • Arsenic (0.041 to 0.095 mg/L) • Antimony (0.010 to 0.030 mg/L) • Mercury (1 to 7 ng/L) Yellow Pine: <ul style="list-style-type: none"> • pH (8.1) • Arsenic (0.34 to 0.58 mg/L) • Antimony (0.021 to 0.050 mg/L) • Mercury (10 to 30 ng/L) West End: <ul style="list-style-type: none"> • pH (8.3) • Arsenic (0.09 to 0.13 mg/L) • Antimony (0.016 to 0.021 mg/L) • Mercury (13 to 33 ng/L) 	Same as 2021 MMP
The SGP may cause increased mercury methylation in adjacent waterbodies through SGP-related emissions and activities.	Predicted impact on methylmercury production.	MeHg <i>not detected</i> in 90 percent of baseline stream samples (<0.1 ng/L)	Same as Baseline Condition	Water treatment for mercury concentrations to target levels would result in methylmercury concentrations up to 0.24 ng/L in discharge to surface waters (at a 2% methylation rate). However, predicted MeHg concentrations in streams would remain below 0.1 ng/L.	Same as 2021 MMP

¹ **Bolded** concentration values exceed the respective water quality standard.

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