WEST HIGH YIELD (W.H.Y.) RESOURCES LTD.

2023

JOINT MINES ACT AND ENVIRONMENTAL MANAGEMENT ACT PERMIT APPLICATION

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WEST HIGH YIELD (W.H.Y.) RESOURCES LTD.

RECORD RIDGE INDUSTRIAL MINERAL MINE PROJECT

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OCTOBER 2023

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EXECUTIVE SUMMARY

ES – Introduction and Project Overview

West High Yield (W.H.Y.) Resources Ltd. (W.H.Y. Resources or the Company) is a Canadian junior exploration company listed on the Toronto Venture Exchange (TSX-V: WHY) with its registered office in Calgary, Alberta (AB). W.H.Y. Resources is the proponent and is proposing to develop and operate the Record Ridge Industrial Mineral Mine Project (RRIMM Project), an intermediate-advanced stage magnesium exploration project covering 8,972 hectares located in southeastern British Columbia (BC), Canada. It is located 7.5 km west-southwest of the city of Rossland, BC, Canada, 5.5 km north of the Canada-US International Border, and approximately 400 km east of Vancouver, BC.

W.H.Y. Resources retains 100% of the mineral rights to the property of the RRIMM Project. The property consists of 29 contiguous mineral claims covering 8,972 ha. W.H.Y. Resources also has land holdings consisting of eight Crown Granted claims and one private tenure with surface and mineral rights (9 titles), totaling 86 ha. The known magnesium mineralization of the Project is located within two of the mineral claims. Infrastructure for the proposed RRIMM Project is located on mineral tenures controlled by W.H.Y. Resources.

The proposed RRIMM Project is designed to supply two years of run of mine (ROM) magnesium-bearing serpentinite rock at a rate no greater than 200,000 tonnes per year. The mine plan will be a conventional open pit operation with a sequence of drilling, mechanical ore extraction and/or blasting, loading ROM rock, crushing using a mobile crushing unit, and then hauling cobble-sized, crushed rock off site to a processing facility. Mining operations, crushing and highway transportation will be conducted by experienced contractors.

This document is W.H.Y. Resources' joint application for a *Mines Act* (MA) Permit and *Environmental Management Act* (EMA) permit for the RRIMM Project (referred to hereafter as 'the Permit Application'). This document's structure and content follows guidance provided in the *Joint Application Information Requirements for Mines Act and Environmental Management Act Permits* prepared by BC Ministry of Energy, Mine and Petroleum Resources and BC Ministry of Environment and Climate Change Strategy (2019). In addition, this Permit Application addresses the list of information requirements as per the approved Joint Information Requirements Table (IRT) that was developed and reviewed by the Mine Development Review Committee, specifically for the RRIMM Project.

Key on-site facilities of the proposed RRIMM Project include the open pit, waste rock storage facility, sediment pond and diversion ditches, soil stockpile, associated support facilities, mine access and mine haulage roads, and additional ancillary facilities. Off-site facilities include highways, and processing facility. There are no underground workings, on-site processing plant, tailings storage facility, or low-grade ore stockpile for this industrial mineral mine development.

ES – Baseline Information

The proposed RRIMM Project is located within the Regional District of Kootenay Boundary and within the western portion of the Kootenay Region and the Arrow Boundary Forest District. The area in, and around, the proposed RRIMM Project has been, and continues to be, used by several First Nation groups, including the Syilx/Okanagan, Sinixt, and Secwepemc/Shuswap people. These uses entail a range of past and current activities, such as fishing, hunting, trapping, and plant harvesting, important for consumption, construction, and cultural purposes.

The RRIMM Project is located west of, and high above, Highway 22 in the Rossland Range of the Monashee Mountains, a subrange of the Columbia Mountains. It is situated mainly within the Sophia Creek drainage, a tributary to Little Sheep Creek approximately 7.5 km southwest of Rossland, BC, and approximately 5.5 km north of the Washington border. Little Sheep Creek flows in a southern direction into the United States, where it joins the Columbia River. Just at the western boundary of the RRIMM Project area is the Big Sheep Creek drainage, which also flows in a southerly direction into the United States, where it joins the Columbia River.

The RRIMM Project is located on Crown land, with a variety of overlapping tenures. There are a dozen diverse types of land tenures and uses that are either overlapping, or proximal to, the RRIMM Project. Two large-scale utility infrastructures intersect the area, including a transmission and pipeline. Proximal to the RRIMM Project, and along the transportation route, are private properties with homes and buildings. The popular Red Mountain Ski Resort is approximately 21.5 km by road northeast of the Project. Several mineral tenures or leases exist around the RRIMM Project with recent, low value technical work, and no current development plans. Active forest management occurs nearby, including recent cut blocks in the area. No parks or protected areas overlap the area, the closest of which is King George VI Provincial Park, located approximately 5 km southeast near the US border.

The RRIMM Project falls within the area covered in the Kootenay-Boundary Land Use Plan (KBLUP; BC MFLNRO 1995). These lands are divided into three categories based on their ability to accommodate industrial activities, of which the RRIMM Project overlaps with one, the Integrated Resource Management Zone; designated as an area with low to moderate sensitivity to resource development (BC MFLNRO 1995). It is also situated in the area included in the Arrow Resource Management Zones (RMZ), in particular, Area N501 which has a low rating for biodiversity emphasis.

Most of the area in, and in the vicinity of, the RRIMM Project is comprised of lower elevation forested land of the Interior Cedar – Hemlock (ICH) biogeoclimatic ecosystem classification (BEC) zone. Upper elevations are primarily drier Engelmann Spruce Subalpine Fir (ESSF) forests with bedrock outcrops. ICH has an interior, continental climate dominated by easterly moving air masses that produce cool wet winters and warm dry summers (Ketcheson et.al 2018). This is one of the wettest zones in the BC interior. High snow melt in the ICH contributes to the hydrologic regime, minimizing summer soil moisture deficits. ICH is the most productive forest zone in the BC interior, and second in all of Canada. Upland coniferous forests dominate the landscape and the ICH has the highest diversity of tree species of any zone in BC. Western redcedar and western hemlock dominate mature forests, but several other species are included in the mix.

Majority of the area in the vicinity of the RRIMM Project is comprised of mature conifer forests, with some areas having been previously harvested and are now young regenerating forests. Tree species primarily include western redcedar, Douglas fir, western hemlock, lodgepole pine, grand fir, western white pine, western larch, ponderosa pine, paper birch, and trembling aspen. Subalpine fir and hybrid white spruce are found in the upper elevations, with outcrops of bedrock exposure. Grasslands presumed to be influenced by serpentine geology occurring throughout the Project area, majority of which is in the ESSF moist hot BEC zone.

As part of the development of the Permit Application detailed baselines were initiated in 2016. These programs cover the regional area as well as the specific project area and characterize the biophysical and biological environments of the proposed RRIMM Project. Baseline studies focused on all terrestrial aspects including Heritage Resources have been completed and sampling locations have been coordinated amongst surface and groundwater quality, sediment quality, and fisheries and aquatic resources. Detailed reports documenting baseline studies are appended to this Permit Application and summarized in Chapter 2.0 Baseline Summary.

ES – Mine Plan

The mine development sequence includes a three-month construction period, which includes construction of site access haul roads and pads, as well as stockpiling topsoil from the project disturbed areas and mobilization of the required equipment. The production phase includes two years of mining no greater than 200,000 tonnes per year of mineralized material, which will be delivered to the crusher pad before being hauled off-site. Thus, the mine includes a total of not more than 400,000 tonnes of plant feed material comprising a magnesium-rich product (~23.8% Mg). During the two years of production, operations will be conducted for six months (Apr/May to Oct/Nov).

Facilities that will be constructed include the open pit and adjacent waste rock storage facility, a soil stockpile, a level pad for primary and secondary crushing, a maintenance pad, dry, and an office building. In addition, an access road from the Old Rossland Cascade Highway to site and a variety of access roads on site in order to reach each facility will be required.

Mine excavation is designed to be mined in 6 m benches with a 60° to 70° bench face angle and 8.0 m wide catch berms are left every 12 m to achieve an inter-ramp wall angle of 34° to 44°. The excavation is designed to be free draining to the southwest and the highwall of the pit has a maximum height of 30 m.

All contact water will be collected and diverted to the site sedimentation pond to allow for the settlement of suspended sediments. The water quality model developed for the RRIMM Project concluded that TSS, ammonia, nitrate, and nitrite are parameters of potential concern in contact water primarily due to the accumulation of blasting residuals. The proposed discharge method from the sedimentation pond where blasting is required is to utilize a land application of treated effluent to the upper reaches of the Sophia Creek catchment; where mechanized ore extraction is used, treated effluent will be discharged to Sophia Creek via a diversion channel.

ES – Reclamation and Closure Plan

Under the BC *Mines Act* and Health, Safety, and Reclamation Code for Mines in BC, the primary objective of the closure and reclamation plan will be to return areas disturbed by mining operations to acceptable land use and capability.

The reclamation plan incorporates current practices to return the landscape to similar slopes and structure with revegetation practices and prescriptions that facilitate pioneering vegetation communities and establishment of natural successional trajectories. End land use and capability objectives are based on pre-development site conditions and include target eco-sites to support wildlife habitat, recreation, and forest harvesting end land uses and capabilities. The post-closure landscape will reflect current conditions with ecosystems and habitats reflecting a mix of forested land, grassland, and exposed rock.

Given the small scale of this proposed project, it will not produce any large waste dumps, large open pits or tailings management facilities that would typically require landform engineering to meet the closure objectives. The closure activities proposed herein integrate the principals of landform engineering and are all designed to eliminate or limit erosion through the construction of engineered slopes and accepted revegetation practices.

Most areas in the mine site will be returned to their original contours by replacing cut-fill overburden and soil, except for the open pit. The waste rock will be backhauled to the open pit and placed against the pit wall and floor. The floor of the open pit will be sloped so that water does not collect in the bottom. Stockpiled soil will be placed on disturbed areas which will be revegetated to prevent erosion and support the end land use objectives.

Annual reclamation monitoring will be conducted as required by conditions of the *Mines Act* permit, including submission of the Annual Reclamation Report to the BC Ministry of Energy, Mines and Low Carbon Innovation (EMLI) by March 31 of the following year. Reclamation monitoring completed by a qualified professional will include quantitative and qualitative assessments of successful seed germination, growth/health of all planted stock, a photo-point monitoring program, and an evaluation of trace element content within restored vegetation. The program will be conducted annually for four years following reclamation to confirm establishment of natural succession and pioneering vegetation communities.

ES – Modelling, Mitigation, and Discharges

Water within the RRIMM Project area will be managed according to established best management practices, including provisions for diverting clean water around the Project area and to capture and manage contact water in appropriately designed channels, sumps, and sedimentation pond. Water management for the Project includes storm water management, assessment of water quality and potential implications for the downstream aquatic environment, as well as proposed water quality mitigation methods, safe discharge practices, and proposed discharge quality limits.

The main water management infrastructure for the RRIMM Project consists of channels for collecting contact water and for diverting clean runoff around the Project site, a sedimentation pond, and a discharge system via land application.

Mine contact water is runoff and seepage flowing from:

- Waste rock and soil stockpile area
- Crusher and ore stockpile area
- Open pit
- Access roads and office area.

Seepage and runoff from the waste rock area, crusher/ore stockpile pad and runoff from the open pit are expected to be the primary sources of water quality parameter loadings to the mine contact water. Throughout operations, water in contact with the mine will be collected in a sump. This water will be transferred to the site sedimentation pond for analysis to ensure it is protective of the environment prior to release to the receiving environment. All contact water will be collected and diverted to the site sedimentation pond to allow for the settlement of suspended solids.

A water quality model developed for the RRIMM Project was used to estimate loading sources, evaluate the quality of contact water on the Project site and assess potential effects on the downstream receiving environment. The water quality assessment conducted for the RRIMM Project concluded that the quality of water collected in the sedimentation pond is generally good except for a few parameters of potential concern. These included aluminum, beryllium, chromium, copper, and nitrite, nitrate from blast residuals. Treatment of water reporting to the sedimentation pond was designed to mitigate the parameters of potential concern.

The sedimentation pond was designed in accordance with BC Provincial guidelines for sizing sedimentation ponds (BC MOE 2015). All structures will be designed to withstand a minimum of a 1 in 200-year storm event and will be sized to capture particles with a diameter equal to or less than 15 µm in a 1 in 10-year, 24-hour storm event. Suspended solids that consist of particles with diameters less than 10 µm will be removed by adding ferric chloride coagulant and flocculant to the settling pond influent water. This will improve settling of TSS and also mitigate discharge water quality.

Under a scenario where blasting is required, land application of discharge from the sedimentation pond is another mitigation measure intended to reduce loadings of ammonia, nitrite and nitrate that could report to the aquatic environment downstream of the Project. This involves an irrigation system that pumps water collected in the sedimentation pond to a series of sprinklers that will irrigate the uppermost vegetated catchments of the Project area.

ES – Environmental Assessment Predictions

Key conclusions of predicted effects on groundwater quantity and quality, surface water quantity and quality, and aquatic resources are as follows:

- Effects of the project on local and regional groundwater flows are expected to be minimal, and effects on groundwater quality are expected to be insignificant as discharge water from the sedimentation pond is predicted to meet relevant Contaminated Site Regulation (CSR) standards.
- Effects on surface water flows are expected to be minimal or negligible.

The potential for chronic effects of nitrite, nitrate and dissolved copper are expected to be negligible for all receptor groups, as follows:

- Fish populations – Effects on fish populations are expected to be negligible. Nitrite is expected to marginally exceed water quality guidelines in fish-bearing waters in limited months, and the maximum predicted concentrations are below those associated with chronic effects to individual fish. Effects to individual fish are therefore unlikely, and effects on fish populations are very unlikely. Predicted concentrations of nitrate exceed water quality guidelines in fish-bearing waters in only one case (one location in one month, under dry conditions), and the concentrations are below levels where effects to rainbow trout would be expected. Predicted concentrations of dissolved copper exceed guidelines in fish-bearing waters but are far below the toxicity data for trout, and therefore effects of copper on fish are not expected.
- Benthic invertebrate community – Effects on the benthic invertebrate community are expected to negligible. None of the three COPCs would be expected to affect individual invertebrates at the maximum predicted concentrations, although data are more limited for nitrite and nitrate than for copper, so there is more uncertainty for those cases.
- Periphyton – Effects on the periphyton community are expected to be negligible. Evidence suggests that periphyton are less sensitive than other taxonomic groups to nitrite. For nitrate, no toxicity information is reported by BC or CCME (2012) for plants or algae – according to the CEQG (CCME 2012), nitrate is the primary source of nitrogen for aquatic plants in oxygenated systems such as creeks. Predicted concentrations of dissolved copper exceed are far below the toxicity data for algae and macrophytes, and therefore effects of copper on periphyton are not expected.
- Amphibians – Effects on individual amphibians are expected to be negligible. Nitrate and copper would not be expected to affect amphibians at the maximum predicted concentrations. There is uncertainty about nitrite, as no toxicity data were found in the guideline documents or other literature reviewed.
- Predicted changes to Sophia Creek surface flow (water quantity) and stream temperature associated with the filling and discharge of effluent from the sedimentation pond are expected to be negligible, thus are not anticipated to result in any adverse effects to the Rainbow Trout (*Oncorhynchus mykiss*) population that occupy reaches approximately 2.7 kilometers downstream from the point of discharge.

Key conclusions of predicted effects on vegetation and wildlife resources are as follows:

- Up to 24.5 ha of vegetated ecological communities (i.e., 2% of vegetated ecological communities in the RSA) will be removed during construction, and will remain unvegetated until mine closure, until revegetation establishes during closure and post-closure of the Project. The incremental temporary loss of vegetated habitat is anticipated to result in negligible to low magnitude, short-term, and reversible effects to wildlife and wildlife habitat and are not considered substantiative residual effects on wildlife and wildlife habitat.
- One at-risk species, mountain holly fern (*Polystichum scopulinum*), a species that is provincially red-listed and federally listed as Threatened on Schedule 1 of the *Species a Risk Act* (SARA) and Threated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; BC CDC 2023a), was

identified at three locations in the vegetation resources LSA. Protective mitigations, as identified in Section 9.12 (Vegetation Management Plan), will avoid and minimize effects to this species.

- One red-listed graminoid grassland (Gg) community, Idaho fescue – bluebunch wheatgrass – silky lupine – junegrass, occurs in up to 5.5 ha of the Surface Footprint (i.e., 10% of its occurrence in the RSA).
- No wetland or old forest ecological communities occur in the LSA; therefore, these ecosystems of management concern are not predicted to be impacted (loss or edge effects) from the Project infrastructure or activities.
- Sensory disturbances and mortality effects for wildlife are anticipated to be negligible to low magnitude, short-term, and reversible effects, as are the potential cumulative effects.

ES – Environmental Monitoring

The RRIMM Project as proposed will discharge mine contact water to the receiving environment. Mine site and receiving environment monitoring is a key component of the overall environmental management for the Project. Monitoring will include the aquatic receiving environment as well as groundwater. For the former, a comprehensive Aquatic Effects Monitoring Program (AEMP) is proposed that includes surface water chemistry, sediment chemistry, bioassays, and biological monitoring of periphyton, benthic invertebrates and fish.

The discharge system for the RRIMM Project is an irrigation system that pumps water collected in the sedimentation pond to a series of sprinklers that will irrigate the uppermost vegetated catchments of the project area. Flow of mine contact water will be monitored on an ongoing basis by a mechanical flow meter installed on the discharge pipe in proximity to the discharge pump. Mine contact water quality samples for on-site analysis will be collected daily from the settling pond and analyzed for ammonia, nitrite and TSS/turbidity since these parameters are most likely to approach the proposed discharge standards. Water quality samples for off-site laboratory analysis will be collected weekly. In addition to mine contact water sampling and monitoring, groundwater and surface water samples will be collected for off-site laboratory analysis as part of the receiving environment monitoring program.

Receiving environment monitoring will be conducted at surface and groundwater monitoring stations downstream of the land application area. These stations will be monitored weekly. Increasing trends in water quality parameter concentrations at those stations that point to a potential concern for the receiving water quality would trigger implementation of additional water quality mitigations measures as described in the Safe Discharge Plan.

An Aquatic Effects Monitoring Program (AEMP) will be implemented to enable detection of potential ecologically-relevant effects on aquatic life and other relevant water uses prior to effects occurring. The results of the AEMP will be used as a feedback mechanism to determine the effectiveness of management practices in mitigating potential effects on water uses, and to determine if additional management actions are warranted to prevent or address potential impacts. An annual AEMP report will be produced for each calendar year of construction and operations.

ES – Health and Safety

Employee health and safety on mine sites in BC is regulated under the *Mines Act* through the Health, Safety and Reclamation Code for Mines in BC.

The *Mines Act* requires the manager of a mine to develop and implement a written Health and Safety Program applicable to each department, and to establish a joint management-worker occupational health and safety committee to conduct regular inspections, participate in the investigation of accidents [and dangerous occurrences], address employee health and safety concerns, and review the Health and Safety Program.

The Occupational Health and Safety Plan (OHSP) aims to protect employees and all other persons from undue risks to their health and safety arising out of, or in connection with, activities of the mine. The plan addresses the management objectives, applicable legislation and guidelines, controls, monitoring, and roles and responsibilities that will be implemented as practicable to avoid and minimize the risk of occupational health and safety hazards at the Project's workplace. This is a conceptual plan and will be updated as needed to reflect input from the construction contractor to include additional details relating to occupational health and safety measures, inspections, reporting, documentation, and details of continual improvement initiatives.

ES – Management Plans

Key mine management plans developed to support construction and operations of the RRIMM Project describe protection measures implemented on-site to avoid or reduce potential adverse effects and address environmental, operational and health and safety issues. The plans reflect site-specific operational management and monitoring requirements. Mine management plans are considered living documents and will be kept up to date, reviewed routinely, and be made available at the mine site at all times.

Mine management plans are developed in accordance with industry best management practices (BMP) and standards, applicable regulations, and include both general and site-specific environmental, operational and health and safety protection measures. Contractors completing work on the RRIMM Project may be required to develop site-specific management or environmental work plans in addition to the plans described here. These mine management plans described in this Permit Application will guide and supplement any required site-specific management plans and apply to all person involved with the development of the RRIMM Project.

Mine management plans developed in support of the Permit Application (as guided by the provincial joint application guidance document; EMLI and ENV 2019) are listed below:

- Mine Emergency Response Plan
- Occupation Health and Safety Plan
- Environmental Management Plan
- Construction Management Plan
- Surface Erosion Prevention and Sediment Control Plan

- Fuel Management and Spill Control Plan
- Waste (Refuse) Management Plan
- Safe Discharge Plan
- ML/ARD Characterization and Management Plan
- Traffic Management Plan
- Chemicals and Materials Storage and Handling Plan
- Vegetation Management Plan
- Wildlife Management Plan
- Archaeological Management and Impact Mitigation Plan
- Fugitive Dust Management Plan
- Noise Abatement Plan
- Asbestos and Fibrous Minerals Management Plan

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ABBREVIATIONS AND ACRONYMS

°C	degrees Celsius
µg	microgram
µm	micrometre
AAQO	Ambient air quality objectives
AB	Alberta
AEMP	Aquatic Effects Monitoring Program
AIA	archaeological impact assessment
ALS	ALS Environmental Ltd.
AMZ	Arrow Regional Management Zone
ANCOVA	analysis of covariance
ANFO	ammonium nitrate and fuel oil
AOA	archaeological overview assessment
AOP	areas of potential
AP	acid potential
ARD	acid rock drainage
B	Billion
BA	Before-After
BACI	Before-After-Control-Impact
BC	British Columbia
BCG	Biological Condition Gradient
BEC	Biogeoclimatic Ecosystem Classification
BMP	Best management practices
BNSF Railway	Burlington Northern Santa Fe Railway
Ca	calcium
CABIN	Canadian Aquatic Biomonitoring Network
CAC	Criteria air contaminants
CCME	Canadian Council of Ministers of the Environment
CDA	Canadian Dam Association
CDC	Conservation Data Centre
CEQG	Canadian Environmental Quality Guidelines
CES	critical effect size
CI	control-impact
CIM	Classified Measured and Indicated

cm	centimeter
CMSHP	Chemicals and Materials Storage and Handling Plan
COPC	contaminants of potential concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CP	Canadian Pacific
CSM	Conceptual Site Model
CSR	Contaminated Site Regulation
CSR WQS	Contaminated Site Regulation Generic Numerical Water Standards
DBM	dead burned magnesium
DO	dissolved oxygen
EA	environmental assessment
EEM	Environmental Effects Monitoring
EMA	*Environmental Management Act*
EMLI	BC Ministry of Energy, Mines and Low Carbon Innovation
ENV	BC Ministry of Environment and Climate Change Strategy
EPT	Ephemeroptera, Plecoptera and Trichoptera
ESSF	Engelmann Spruce Subalpine Fir
ESSFmh	Engelmann Spruce Subalpine Fir Moist Hot
FAA	First Aid Attendant
FHAP	Fish Habitat Assessment Procedures
ft	feet
GBPU	grizzly bear population unit
GPM	gallons per minute
Greenwood	Greenwood Environmental Inc.
ha	hectares
HDPE	high-density polyethylene
HEC-HMS	Hydrologic Engineering Center Hydraulic Modelling System
hp	Horsepower
hr	hour
ICH	Interior Cedar - Hemlock
ICHdw	Interior Cedar – Hemlock Kootenay Dry Warm variant
ICHmw5	Interior Cedar – Hemlock Granby Moist Warm variant
ICHxw	Interior Cedar – Hemlock Very Dry Warm subzone
IDF	Intensity Duration Frequency
in	inch

ISQG	interim sediment quality guideline
KBLUP	Kootenay-Boundary Land Use Plan
kg	kilogram
km	kilometre
km²	square kilometre
KPM	Kingston Process Metallurgy
K-S	Kolmogorov-Smirnov
kW	kilowatts
L	litres
lbs	pounds
LG	Lerch-Grossman
LOEC	lowest effect concentration
LOI	loss on ignition
LOO	licenses of occupation
LTA	long-term average
m	metre
m^2	square metre
m^3	cubic metre
Ma	mega-annum
MA	*Mines Act*
MATC	Maximum Acceptable Toxicant Concentration
MD	mildly divergent
MERP	Mine Emergency Response Plan
Mg	magnesium
mg	milligram
$Mg(OH)_2$	magnesium hydroxide
MgO	magnesium oxide or magnesia
ML	metal leaching
ML/ARD	metal leaching and acid rock drainage
mm	millimetre
MOF	BC Ministry of Forests
MRI	Mineral Resources International Ltd.
MSDS	material safety data sheets
Mt	million tonnes
n	number of samples

NP	neutralization potential
NTS	National Topographic System
OBSCR	Open Burning Smoke Control Regulation
OGMA	Old Growth Management Areas
OHSP	Occupational Health and Safety Plan
OIB	Osoyoos Indian Band
ONA	Okanagan Nation Alliance
PAG	potentially ARD-generating
PEA	preliminary economic assessment
PEL	probable effect level
PEM	predictive ecosystem mapping
PFR	Preliminary Field Reconnaissance
PGE	Platinum Group Elements
PPE	personal protective equipment
ppm	parts-per-million
psi	pound-per square inch
PSL	permissible sound level
QA/QC	quality assurance/quality control
RAAD	Remote Access to Archaeological Data
RCA	Reference Condition Approach
RCMP	Royal Canadian Mounted Police
REE	Rare Earth Elements
RMZ	Resource Management Zones
ROC	Receptors of Concern
ROM	run of mine
RRIMM Project	Record Ridge Industrial Mineral Mine Project
s	seconds
SARA	Species at Risk Act
SBEB	Science-Based Environmental Benchmarks
SD	standard deviation
SMU	soil map unit
SOP	standard operating procedures
SRK	SRK Consulting Canada
STM	short-term maximum
SUV	sport utility vehicle

TEM	Terrestrial Ecosystem Mapping
the Code	Health, Safety and Reclamation Code for Mines in British Columbia
TIC	total inorganic carbon
TOC	total organic carbon
TRG	tissue residue guidelines
TRIM	Terrain and Resource Inventory Management
TSA	timber supply area
TSP	total suspended particulate
TSS	total suspended solids
TSX-V	Toronto Venture Exchange
US	United States
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WHMIS	Workplace Hazardous Materials Information System
W.H.Y. Resources	West High Yield (W.H.Y.) Resources Ltd.
WMU	Wildlife Management Unit
WQG	water quality guidelines
WQG PAL	water quality guidelines for protection of aquatic life
WSQG	working sediment quality guidelines
XRD	X-ray diffraction

1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 APPLICATION BACKGROUND

West High Yield (W.H.Y.) Resources Ltd. (W.H.Y. Resources or the Company) initiated the permitting process for the proposed Record Ridge Industrial Mineral Mine Project (RRIMM Project) with submission of the RRIMM Project Description (May 2018) and draft Information Requirements Table (IRT). W.H.Y. Resources submitted a draft Joint BC Mines Act and BC Environmental Management Act (EMA) Permit Application (Joint Permit Application) in February 2019 for 'screening review' by the BC Mine Development Review Committee (MDRC) in 2019. The MDRC is led by the Regional Director and includes representatives from Indigenous groups and technical representatives from the Ministry of Energy Mines and Low Carbon Innovation (EMLI), Ministry of Environment and Climate Change Strategy (ENV), Ministry of Forests and Ministry of Transportation and Infrastructure (MOTI).

The screening review process was initiated by the MDRC in 2019 and subsequently paused by W.H.Y. Resources until 2022. W.H.Y. Recourses and their technical consultants engaged the MDRC through 2022 and 2023 to revise the application to meet requirements of MDRC's technical review process. This Joint Permit Application (October 2023) includes outcomes from the 'screening review' process.

During the 'screening review' process, W.H.Y. Resources conducted two open house sessions within the City of Rossland BC; May 17 and 18 2023. The open house sessions were attended by residents from the City of Rossland, the Regional District Kootenay Boundary, Rossland Council members and Indigenous groups. Participants of the open house sessions raised various concerns and questions. This Joint Permit Application (October 2023) includes revisions to the scope of the proposed RRIMM project and additional mitigation measures to address concerns raised during the May 2023 open house sessions; including the following:

Project Production Capacity Reduction – W.H.Y Resources has reduced the overall disturbance area of the project by limiting the production capacity to 200,000 tonnes per year from 249,000 tonnes per year. The reduced production capacity results in a smaller open pit and less development rock generated over the two-year duration of the proposed RRIMM Project.

Seven Summits Trail Mitigation – W.H.Y. Resources has provided the Kootenay Columbia Trail Society (KCTS) with funding to develop a proposal to relocate a portion (approximately 1.3 km) of the Seven Summits Trail in the vicinity of the proposed RRIMM Project. The KCTS has recently confirmed that terrain on the West side of the ridge is suitable for a re-route and would retain the character and quality experience of the existing trail. The preliminary estimate of approximately $30-40K is acceptable to WHY and the relocation has been included in the updated application as a new proposed mitigating measure, subject of course to necessary approvals and Indigenous consultation.

Off-site Transportation of Ore – W.H.Y. Resources has revised the proposed RRIMM Project to avoid transportation of ore through the City of Rossland BC. W.H.Y. Resources is proposing to the MOTI to truck ore along Highway 22 to North Port, Washington, rather than passing through the City of Rossland. W.H.Y. Resources' revised transportation route is currently under consideration by MOTI.

Ore Extraction – W.H.Y. Resources has updated the operational plan to make mechanical extraction of ore the primary permitted means of ore removal during operations, with the alternate ability to use blasting (explosives) if the Seven Summits Trail relocation is undertaken, the environmental considerations related to the original plan for blasting are satisfactory and W.H.Y. Resources encounters technical or economic reasons to make blasting during operations preferable.

Ore Crushing – W.H.Y. Resources has included an enclosed environment for crushing equipment to effectively manage dust and noise.

1.1.1 PURPOSE AND SCOPE OF APPLICATION

W.H.Y. Resources intends to develop the proposed RRIMM Project in an environmentally, socially, economically, and culturally safe manner to the benefit of the local community, First Nations, British Columbia, and W.H.Y. Resources shareholders. This document is W.H.Y. Resources' Joint Permit Application for a BC *Mines Act* permit and BC *Environmental Management Act* (EMA) permit for the RRIMM Project.

The proposed RRIMM Project includes extraction of only a fraction of the potential resource as defined in the 2013 Preliminary Economic Assessment (PEA) (Stryhas et al. 2013) and does not include various aspects of the 2013 PEA mine plan; i.e., an on-site processing facility and a tailings management facility. The mine plan for the proposed RRIMM Project includes extraction and crushing of ore to be trucked off-site and processed by a third party.

The operation and closure of the proposed RRIMM project herein would not result in the sterilization of any of the remaining resources reported in W.H.Y. Resources' 2013 PEA should a subsequent project be contemplated in the future. Any such future project would require a separate permitting process which may include an environmental assessment under the BC Environmental Management Act, BC *Mines Act* and BC *EMA* permitting and are not a part of this application.

The proposed RRIMM Project is designed to supply two years of run of mine (ROM) magnesium-bearing serpentinite rock (i.e., ore) at a rate no greater than 200,000 tonnes per year. The mine plan will be a conventional open pit operation with a sequence of ore extraction, loading ROM rock, crushing using a mobile crushing unit within an enclosure to mitigate noise and fugitive dust, and then hauling cobble-sized, crushed rock off-site to a third-party processing facility.

1.1.2 APPLICATION STRUCTURE

This document's structure and content follows guidance provided in the *Joint Application Information Requirements for Mines Act and Environmental Management Act Permits* prepared by BC Ministry of Energy, Mines and Low Carbon Innovation (EMLI) and BC Ministry of Environment and Climate Change Strategy (2019). Specifically, the following sections and information are presented:

1. **Section 1.0 Introduction and Project Overview:** provides contextual background information on the proposed RRIMM Project, including proponent identification, project location, project overview, and mine components and development proposal, and consultation and engagement.

2. **Section 2.0 Baseline Information**: provides information on the characterization and presentation of baseline environmental conditions, including baseline work undertaken to support assessment of the Project.

3. **Section 3.0 Mine Plan:** provides information on detailed mine plan including an overview, development sequence and schedule, and mine facility design and development.

4. **Section 4.0 Reclamation and Closure Plan:** provides information on end land use and capability objectives, reclamation approaches, and conceptual final reclamation plan with reclamation and closure prescriptions for each mine site feature or area.

5. **Section 5.0 Modelling, Mitigation, and Discharges:** provides an overview characterizing project components and expected contaminant sources, as well as the planned water management and pollution control works or best management practices requirements for each.

6. **Section 6.0 Environmental Assessment Predictions**: describes predicted residual effects on receiving environment components or assessment endpoints. This includes an assessment of potential residual environmental effects and an evaluation of the risks of the mine project on human health and water users including aquatic and terrestrial resources, through the life of the project to post-closure.

7. **Section 7.0 Environmental Monitoring**: summarizes proposed monitoring and reporting programs throughout the life of the project which enable ongoing evaluation of waste management performance and receiving environment condition and evaluation of impact predictions made during the permit application.

8. **Section 8.0 Health and Safety**: describes the health and safety program throughout the life of the project including health and safety management practices, hazard identification, training, and reporting.

9. **Section 9.0 Management Plans**: provides mine management plans developed in support of construction and operations of the proposed RRIMM Project.

1.1.3 REGULATORY ENVIRONMENTAL ASSESSMENT

The RRIMM Project is an industrial mineral mine with production capacity no greater than 200,000 tonnes per year; therefore, it does not trigger the provincial and federal environmental assessment process.

1.1.4 SUMMARY OF KEY COMMITMENTS

Key commitments that would apply to project development, as outlined in this Joint Permit Application, are summarized below:

- Application of established best management practices throughout construction, operations, reclamation and closure, including diversion of clean water around the proposed RRIMM Project and collection and treatment of all contact water prior to its safe discharge in a manner that will not adversely affect the downstream receiving environment.

- Production capacity no greater than 200,000 tonnes per year.
- Substituting the use of explosives with mechanized equipment for ore extraction as the primary means of ore extraction. Explosives will be used for construction and would be an alternate option for operations should mechanical means prove insufficient.
- Implementing enclosed environments for crushing equipment to effectively manage dust and noise.
- No processing plant, no generation of tailings or a tailings management facility on site.
- Off-site disposal of all hazardous and non-hazardous wastes in approved licensed facilities.
- Closure and reclamation of the proposed RRIMM Project to acceptable land use and capability in accordance with the BC Mines Act and Health, Safety and Reclamation Code for Mines in BC.
- Proposing the option with MOTI of utilizing a trucking route along Highway 22 to North Port (WA), rather than passing through the City of Rossland.

1.2 PROPONENT INFORMATION

West High Yield (W.H.Y.) Resources Ltd. (W.H.Y. Resources or the Company) is a Canadian junior exploration company listed on the Toronto Venture Exchange (TSX-V: WHY) with its registered office in Calgary, Alberta (AB). W.H.Y. Resources is the proponent and is proposing to develop and operate the Record Ridge Industrial Mineral Mine Project (RRIMM Project), an intermediate-advanced stage magnesium exploration project located in south eastern British Columbia (BC), Canada.

Company Registered Legal Name and Address

West High Yield (W.H.Y) Resources Ltd.
PO Box 68121 Calgary, Alberta Canada T3G 3N8

Company Head Office

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Consultant Contact

W.H.Y. Resources engaged Greenwood Environmental Inc. (Greenwood) and SRK Consulting Canada (SRK) as the primary consultants to support the environmental and permitting aspects for the RRIMM Project.

Shane Uren, M.A.Sc., RPBio.
Greenwood Environmental Inc.
Suite 907 – 510 Burrard Street, Vancouver, British Columbia Canada V6C 3A8
Phone: (604) 970-1688
Email: shaneu@greenwoodenvironmental.ca

Mark Liskowich, PGeo
SRK Consulting (Canada) Inc.
22nd Floor, 1066 West Hasting Street, Vancouver, British Columbia Canada V6E 3X2
Phone : (604) 681-4196
Email : mliskowich@srk.com

A diverse team of consultants and professionals have contributed to the collection of baseline information and development of this *Mines Act* and *Environmental Management Act* Joint Permit Application and supporting technical documents under the management of Greenwood:

- ALS Environmental – Analytical laboratory
- Azimuth Consulting – Aquatic Resources
- Cascara Environmental Ltd. – Vegetation & Reclamation
- David Yole, M.Sc. P.Ag. – Soils Mapping
- Dialectic Research Services – Land Use and First Nation Interests
- Dynamic Exploration Ltd – Geology
- E. Wind Consulting – Amphibians and Reptiles
- Keefer Ecological Services Ltd. – Vegetation and Wildlife
- L. Ford Consulting Ltd. – Reclamation Planning
- Lotic Environmental – Fisheries Resources
- Ophiuchus Consulting – Bats
- Serac Environmental Ltd. – Surface Water Quality Sampling
- SNT Geotechnical Ltd. – Geohazard Mapping
- Spicker GIS Services – GIS Mapping
- Ursus Heritage Consulting – Archaeology

Environmental Policy

W.H.Y. Resources is committed to protecting the health and safety of its employees, contractors, and the public, and to safeguarding the environment affected by its activities. We care about our employees, the environment, and communities in which we operate.

Key principles of W.H.Y. Resources' environmental policy are:

- Conduct all activities in compliance with applicable legislation, policy and programs thus providing for protection of the environment, employees, and the public.
- Be a responsible environmental steward through taking the necessary precautions to minimize environmental effects of operations and developing controls to mitigate environmental risks.
- Ensure awareness among employees and contractors of this environmental policy, promote shared responsibility and accountability for environmental obligations, and provide support and training necessary to achieve these objectives.
- Communicate openly with government, employees, location communities, First Nations, and the public to sustain mutual understanding of environmental, social, cultural, and economic issues.

1.3 PROJECT OVERVIEW

1.3.1 Project History

The RRIMM Project is focused on mining the mineral serpentine, a complex magnesium-iron phyllosilicate. The serpentine-bearing host rock is known as the "Record Ridge Ultramafic Body". In the early 1900's, the nearby Rossland-Trail Mining Camp was the second largest lode-gold camp in BC. Since lode-gold in quartz veins are often found spatially associated with ultramafic formations, the Record Ridge ultramafic has been the subject of more than 100 years of intensive mineral exploration and geological bulletins.

The RRIMM Project area is part of a larger claim block historically explored for gold, nickel, magnetite and/or chromite by at least three previous owners. In 1973, Mineral Resources International Ltd. (MRI) of Calgary, AB, owned the "Job" claims, located on Ivanhoe Ridge, 2 kilometres (km) east of Record Ridge. In 1973, George G. Addie, P.Eng. P.Geo., was retained by MRI to conduct a magnetometer survey over the claims in search for gold in serpentinite. The survey found anomalous magnetic zones within the claims linked to the occurrence of magnetite within the Record Ridge ultramafic body that lies in the area called Ivanhoe Ridge.

The next work documented on the property occurred in 1978, when the claims MAR 1-4, LAND 1-6, SKIN 1-4, ROSS and CAL, became the "Morrison-White" property. This property was evaluated for gold in ultramafics on behalf of United Canso Oil and Gas, Calgary, AB. A 460 hectares (ha) area was first mapped at a scale of 1:10,000 on an enlarged aerial photo base and then a location grid was established, and certain parts were geologically mapped at a scale of 1:2,500. The same area was also surveyed by soil sampling on a 50 meter (m) x 100 m grid. Magnetic profiling at 10 m station intervals was also completed. This work delineated eleven soil geochemical anomalies. Follow-up field work concluded that eight of these were of sufficient interest to warrant further geophysical and/or geochemical evaluation.

The next documented exploratory work was in 1984 on the CAL and ROSS 2-3 claims, by Noranda Exploration Company for chromite. They performed trenching, soil sampling, a magnetometer survey over 16 km, as well as induced polarization and electromagnetic surveys over 1 km. A total of 177 samples were taken.

In 2005, W.H.Y. Resource acquired mineral tenures covering a major portion of the 6.2 km² Record Ridge ultramafic body plus an additional three mineral claims (Hidden Valley, Hidden Valley 2, and Hidden Valley 3). Like its predecessors on the property, the Company's initial exploration focus was for gold. However, early exploration results indicated the Record Ridge ultramafic serpentines were principally nickeliferrous, cobalt-chromite-bearing and magnesium-rich.

During the 2007 and 2008 field seasons, surface sampling delineated a high magnesium anomaly located on the east flank of Record Ridge, interpreted to be representative of the underlying serpentinite unit. The anomalous zone was then drill tested by 51 diamond core drill holes totaling 6,340 m, with 3,874 assays. This information was compiled and verified by SRK and was utilized to provide a Technical Report on Resources by SRK of Lakewood, CO, compliant to Canadian National Instrument NI 43-101 (Stryhas and Collins 2009). That Resource Estimation provided a Classified Measured and Indicated (CIM) Mineral Resource (Table 1.3-1).

Table 1.3-1: Record Ridge Mineral Resource Statement (2009)

Resource Category	% Mg Cut-off	Total Mt (%)	Mg Grade	Contained Mg (Mt)
Measured	12	15.7	23.1	3.62
Indicated		24.0		5.54
Measure and Indicated		39.8		9.16

Stryhas and Collins (2009)

In 2011, the Company drilled an additional 26 diamond drill holes in the Record Ridge South area, comprising line-grid drilling north of the 2007 and 2008 holes. It also acquired an additional claim (847539) located west of, and contiguous with, the Frank Sr. 3 claim. As a result, W.H.Y. Resources controlled mineral tenures covering the entirety of the Record Ridge ultramafic. During three diamond drilling seasons the Company had drilled some 14,954 meters in 77 holes in Record Ridge South and another 15 holes to test prospects in the Ivanhoe Ridge, West Sophia, and Hidden Valley claims. Based on this drilling, the limits of the Record Ridge Resource (as summarized in Table 1.3-1) have not been delineated. The Record Ridge Resource is open to the south, to the west, to the north (particularly the northeast), and to depth.

During 2013, metallurgical test work was conducted to evaluate the potential of using a hydrometallurgical process to extract magnesium and convert it to a marketable product. The program was designed to evaluate the parameters which affect the amount of magnesium extracted via acid leaching, slurry neutralization and impurity removal. Metallurgical test work focused on optimization of the extraction process and improving the grade and purity of a magnesium oxide end product. In 2013, SRK completed a *Revised NI 43-101 Technical Report Preliminary Economic Assessment, Record Ridge Project, British Columbia, Canada* (Stryhas et al. 2013) (hereafter referred to as a "PEA"). The PEA report provides a comprehensive review of exploration activities, metallurgical test work and economic analysis conducted for the Record Ridge Resource. Table 1.3-2 presents the revised Measured and Indicated Mineral Resource for Record Ridge.

Following the revised PEA, SRK and Greenwood were retained to undertake baseline studies in support of permitting and project development. Starting in 2016, baseline environmental studies in the RRIMM Project area undertaken to characterize the local and regional environment include: rock geochemistry, soil type and geochemistry, surface water hydrology, groundwater hydrogeology, water quality, sediment quality, fisheries and aquatic resources, and vegetation and wildlife.

Table 1.3-2: Record Ridge Mineral Resource Statement (2013)

Resource Category	% Mg Cut-off	Total (Mt)	% Mg Grade	Contained Mg (Mt)
Measured	21.9	28.4	24.82	7.05
Indicated		14.6	24.21	3.54
M&I		43	24.61	10.59
Inferred		1.07	24.37	0.26

Stryhas et al. 2013

Archaeology, land use, and cultural use were also completed to characterize the human environment. Results of the baseline program are summarized in Section 2.0 Baseline Information and baseline reports are referenced and provided as appendices to this Joint Permit Application.

In late 2017, the Company engaged Kingston Process Metallurgy Inc. (KPM) of Kingston, Ontario to evaluate magnesium processing and recovery alternatives and to conduct metallurgical testing on the Company's magnesium-bearing serpentine, with the objective of producing high value commercial grade magnesia (MgO) and magnesium hydroxide $Mg(OH)_2$ products. KPM recommended that the Company return to its initial metallurgical processing initiative using hydrochloric acid. Subsequent metallurgical testing directed by KPM utilized a commercial hydrochloric acid processing circuit that has a higher magnesium (Mg) recovery rate and high leachate acid recovery. KPM is working closely with a major European process engineering, design and equipment manufacturer that has had this process and equipment installed in an operating serpentine magnesium processing facility since 1992.

It is important to note that the PEA and the metallurgical and processing test work are not relevant to the proposed RRIMM Project presented within this Joint Permit Application. The PEA contemplated a project that included on-site processing of ore and production/storage of tailings. Metallurgical and processing studies after the PEA were completed to assess processing options to generate a final magnesium oxide product. The proposed RRIMM Project only includes extraction and crushing of ore on-site followed by transportation of the crushed ore to a third party of off-site processing.

1.3.2 OVERVIEW OF PRODUCTS AND MARKETS, AND PROJECTED PROJECT BENEFITS

1.3.2.1 Products and Markets

The Canadian portion of the RRIMM Project does not include processing of the host serpentinite rock other than crushing, which reduces the rock from a run of mine (ROM) size to that suitable for highway truck transport.

Metallurgical processing of RRIMM Project industrial mineral rock will be done in the United States (US). Two direct products are being anticipated, first being magnesium oxide (MgO), magnesium hydroxide ($Mg(OH)_2$) and eventually, using the ALCOA Magnatherm process, Magnesium Metal. Although magnesium is found in more than 60 minerals, the industry-standard source rock for magnesium is magnesite $MgCO_3$ and dolomite $CaMg(CO_3)_2$. The Record Ridge host rock is different as it is a polymorphous phyllosilicate of a mineral group called serpentine, basically $(Mg, Fe)_3\ Si_2O_5(OH)_4$.

In 2017, China controlled 67% of world magnesium mine production (USGS 2018) from magnesite which is used for the production of magnesium oxide and magnesium compounds. The Chinese supply chain dominance pattern is similar to that they have used to gain and retain dominance in the Rare Earth Elements (REE's) and Tungsten metals. Until recently, lax environmental standards and abundant coal as the primary fuel (energy) for magnesium production, using the Pidgeon thermal process, have ensured that China was the lowest cost producer and ensuring its magnesium market share dominance. While there are currently numerous changes in the Chinese magnesium industry, the direction is towards centralized control and increased production efficiency. This will yield a greater share of profits at the federal level and ensure and entrench their monopolistic position in the world 'MgO trade'.

In the last few years, 2015 to 2017, the United States Geological Survey (USGS; USGS 2018) has indicated that seawater and natural brines accounted for between 63% and 70% of the annual US magnesium compound production. The remainder was recovered from the minerals dolomite, magnesite, and olivine. There is no US primary mining production of magnesium. Imports made up for the shortfall relative to consumption of domestic production of magnesium compounds with China as the main supplier, accounting for 55% of imports of caustic-calcined magnesia and 50% of imports of dead-burned magnesia (DBM) and fused magnesia.

The Net Import Reliance of the United States as a percentage of Apparent Consumption for the years 2006 to 2017 was between 66% and 47% (USGS 2018). China was the principal external source for US magnesium imports at 65.4% average over the prior 12 years and it has supplied an annual average of 212,000 tons of magnesium compounds to the US. China has exceeded this average annual tonnage for 7 of those 12 years.

So, while the overall, 'apparent' magnesium compound supply may not be an issue, the security of supply is likely a better lens with which to view the magnesium market in the United States.

Until recently, successive administrations in the west and, particularly, the US have studiously ignored the issue of potential control of the world supply of certain strategic metals and minerals, including magnesium. The potential impact on the political, economic and National Security of a country as the result of the threat or factual limiting of the supply of strategic minerals and metals would be very significant. China currently controls world production and sale of rare earth metals which are vital for a variety of electronic technologies; tungsten, key for making metal tooling and cutting in the mining and construction industries; and, magnesium for the addition to aluminum and steel for the auto industry or hot metal desulphurization during steelmaking.

Recently, the US began examining its industrial needs and are displaying signs of becoming increasingly concerned about their magnesium supply. In February 2018, magnesium was declared a strategic metal and included in a list of 35 critical mineral commodities considered vital to US interests.

Table 1.3-3: US Magnesium Compound Market (2006-2017)

Year	USA	Comsumption	Shortfall	Net Import	China	China
	Prdn/yr-Kt	Apparent-Kt	Kt	Reliance %	Source %	Kt
2006	282	624	342	55	73	250
2007	342	673	331	49	76	242
2008	274	591	317	54	78	231
2009	239	399	160	40	79	117
2010	261	524	263	50	78	192
2011	306	602	296	49	72	216
2012	341	485	144	54	64	105
2013	324	648	324	52	56	237
2014	342	721	379	60	54	277
2015	380	818	438	66	54	320
2016	390	594	204	51	52	149
2017	330	620	290	47	49	212
	317.6	**608.3**	**290.7**	**52.3**	**65.4**	**212**

Source USGS – compiled by I.Kennedy

MAGNESIUM COMPOUNDS – VITAL TO KEY US INDUSTRIES

Magnesium oxide is a widely used product in construction and industrial applications. It is used as a soil additive in the agricultural industry, a neutralizing agent in the chemical industry and, in very pure forms, is in high demand within the pharmaceutical industry. Magnesium is used in steel as it is stronger and 33% lighter than aluminum. Magnesium wallboard can be used instead of conventional plywood with the added benefits of being fire, smoke and waterproof. MgO is also a key ingredient in Portland cement as magnesia based cements cure quickly, are corrosion resistant and are also fire proof. MgO has some key properties that make it ideal for a wide range of refractory and electrical applications, including being corrosion resistant, having a high thermal conductivity and low electrical conductivity.

Magnesium has important applications as a desulphurizing agent in the production of iron and steel; as a refractory brick for pyro-processing of aluminium alloys; in the production of die-cast products (alloyed with zinc) and the production of titanium. The 100 billion (B) pop cans made annually in the US contain about 1% magnesium in each of the can tops and bottoms.

The US is the world's third largest steel maker. In 2014, steel output was valued at $113 B. Magnesium is a key additive for the desulfurization of iron. This process produces steel having a higher tensile strength that makes thinner, lighter automotive steel, far stronger construction steel, and a much more wear-resistant steel for drilling deep oil and gas wells. Hot metal desulfurization with magnesium has proven to be the optimum solution for sulfur control during steelmaking. Magnesia Bricks (>90% Mg0) are heat resistant and therefore used in many industrial processes including basic open-hearth furnaces for steelmaking, electric furnaces, rotary cement kilns, heating furnaces, glass furnaces and hyperthermia tunnel kilns.

The automobile industry continues to make use of magnesium alloys as a strategic lightweight material to reduce the weight in vehicles to help reach the environmental guidelines. Because of the relatively higher cost of magnesium, the main sectors of the auto market segments using magnesium have been luxury vehicles, sports cars and high-end sport utility vehicles (SUVs). However, China, with its massive auto market, is experiencing increases in specific consumption of magnesium per vehicle as manufacturers seek to comply with government-imposed emission reduction targets. Some typical applications of magnesium alloys in cars include steering hanger beam, wheels, cylinder head cover, intake manifold, steering wheel, tailgate inner door panel, transmission case, seat frame and inner door frame.

Commercial Magnesium Compounds in the US

There are two leading magnesium compounds in the United States 'Apparent Consumption' magnesium market. In descending order of importance, they are magnesia (MgO) and magnesium hydroxide ($Mg(OH)_2$). There are three forms of magnesia: caustic-calcined magnesia, dead-burned magnesia, and fused magnesia.

The leading commercial magnesium compound was caustic-calcined magnesia, which is used, in descending order by volume, in the chemical industry, as agricultural supplements and environmental applications. Domestic apparent consumption of caustic-calcined magnesia increased by 11%; shipments in 2015 increased slightly from those in 2014, and imports for consumption increased by 21%.

The second-leading commercial magnesium compound was dead-burned magnesia, which is used for refractory products, in descending order of volume, by the steel, cement, and glass industries. US apparent consumption of dead-burned magnesia in 2015 decreased by 10%; production decreased by 19% from that in 2014, shipments decreased by 11%, imports for consumption increased by 8%, and exports increased by 19%. The decreased production of dead-burned magnesia was attributed to increased imports of magnesia from China and to decreased demand for refractory products.

The third-leading commercial magnesium compound was magnesium hydroxide, which is used for, in descending order of volume, environmental applications, chemicals, and flame retardants. Apparent consumption of magnesium hydroxide in 2015 was essentially unchanged from that in 2014; domestic shipments decreased slightly from those in 2014, exports decreased by 9%, and imports decreased by 4%.

1.3.2.2 Projected Project Benefits

The RRIMM Project will provide direct local employment (though short-term), as well as indirect contracts to various service providers. The Project will also serve to inform opportunities for future mining beyond the two-year mine plan currently proposed. It is anticipated that the proposed RRIMM Project will require approximately 10 permanent W.H.Y. Resources employees covering the professional responsibilities such as project management, accounting/payroll, legal support, human resources, logistical support, environmental monitoring, health and safety, engineering, and geology.

Given the seasonal operating period and short-term duration all additional positions outside of the management and administration roles will be contracted. Mining operations will be contracted to BC based mining contractor specializing in the construction, operation, and closure of projects of this nature. It is anticipated that the selected contractor will require a staff of approximately 20-30 individuals comprised of supervisors, trades people, miners/drillers, equipment operators and a pool of labourers.

W.H.Y. Resources will also contract with a BC based company specializing in transportation. The selected contractor will be responsible for transporting the crushed ore off-site to a third-party processing facility. It is estimated they will require a fleet of approximately nine 30 tonne trucks licensed for use on public highways. The servicing of the fleet will be the responsibility of the contractor with those operating costs covered within that contract.

In addition, contracted services will be required to support mine operations in order to keep the RRIMM Project supplied with fuel, explosives, garbage removal and other miscellaneous services which will be sourced from nearby communities such as Trail and/or Rossland. It is difficult to project tax revenue for the proposed RRIMM Project as the processing will be completed in a different jurisdiction. There will however be revenues collected by the British Columbia government in the form of royalties for tonnages mined. These royalties will be calculated and collected in accordance with the BC Mines Act.

1.3.3 Location, Access and Land Use

1.3.3.1 Location and Access

The proposed RRIMM Project is an intermediate-advanced stage magnesium exploration project covering 8,972 hectares. It is located 7.5 km west-southwest of the City of Rossland, BC, Canada, 5.5 km north of the Canada-US International Border, and approximately 400 km east of Vancouver, BC. (Figure 1.3-1). The RRIMM Project area is centered at approximately 49°02’29” N Latitude and 117°53’44” W Longitude (UTM coordinates 434,550 E and 5,432,430 N; NAD 83, Zone 11). The property is located on Canadian National Topographic System (NTS) Mapsheet 082F/04, or British Columbia Geographic System Terrain and Resource Inventory Management (TRIM) Mapsheet 82F001.

The area is readily accessible by 2WD vehicles during summer months with SUV or truck recommended during spring, fall, and winter months. Access from Rossland, BC, follows Provincial Highway 3B 1.5 km west, then proceeds along Highway 22 west for 0.4 km, and then turns right onto the Old Rossland-Cascade Highway. Follow this provincially maintained gravel road for 10.5 km to W.H.Y. Resource’s drill road access on the north side of the highway. The drill road climbs a 10% grade for about 200 m to the area of the southernmost drill sites. A network of four-wheel drive drill roads in good condition access the remainder of the exploration area. Drive time from Rossland is approximately 20 minutes to complete the 10.5 km route.

The City of Rossland lies approximately 22.5 km north of the US-Canada border via Highway 22. Trail, on the Columbia River, is approximately 9 km downhill from Rossland and is serviced by the Canadian Pacific (CP) Railway. This rail system routes directly to Calgary, Alberta or Vancouver, BC, and ties southward into the Burlington Northern Santa Fe (BNSF) Railway system near Cranbrook, BC, approximately 150 km to the east. The BNSF railway services the north and northwestern United States.

1.3.3.2 Mining Tenure

W.H.Y. Resources retains 100% of the mineral rights to the property of the RRIMM Project. The property consists of 29 contiguous mineral claims covering 8,972 ha as of August 31, 2018 (Table 1.3-4, and Figure 1.3-2). W.H.Y. Resources also has land holdings consisting of eight Crown Granted claims and one private tenure with surface and mineral rights (9 titles), totaling 86 ha (Table 1.3-5).

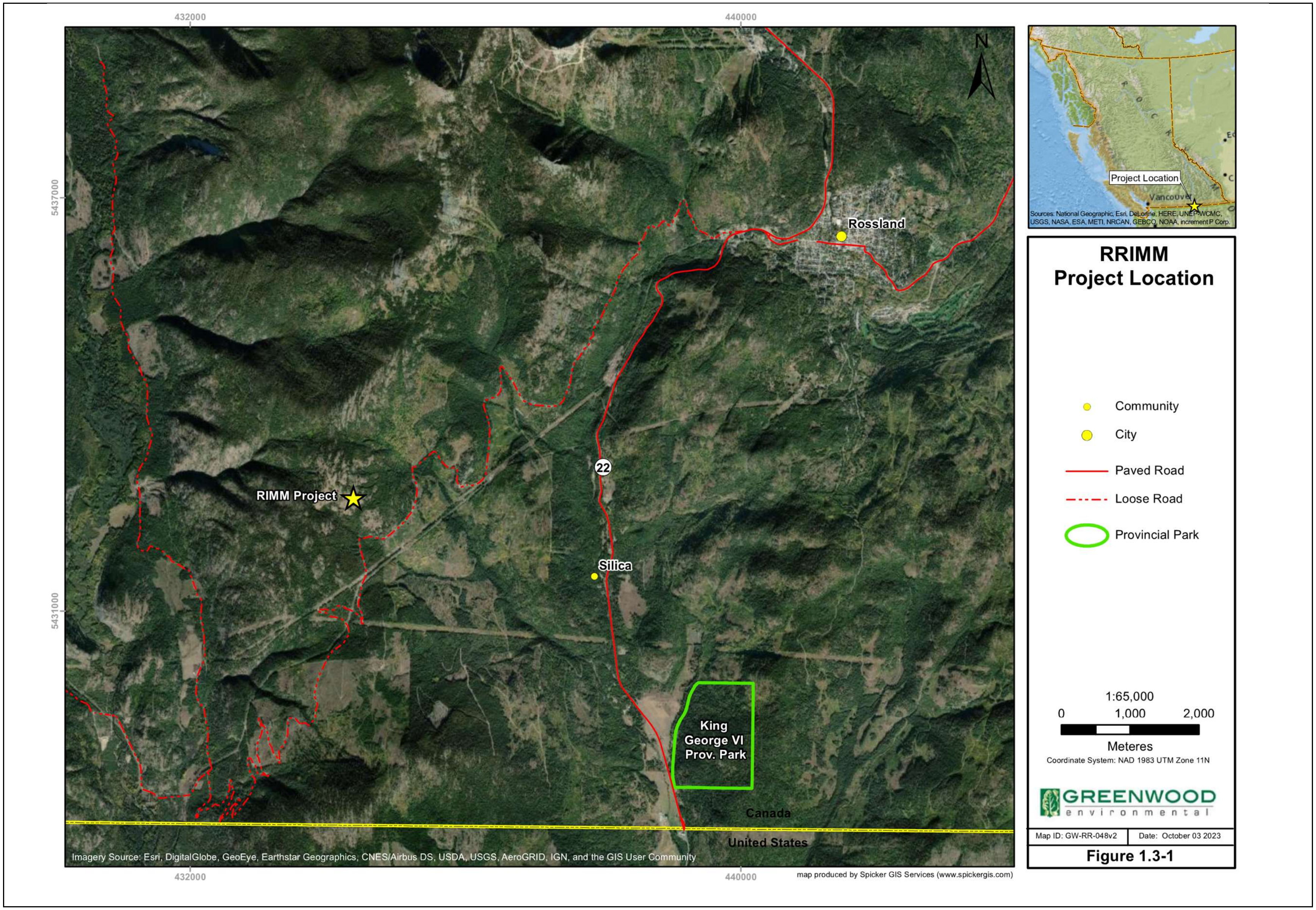


Figure 1.3-1: RRIMM Project Location

Table 1.3-4: W.H.Y. Resources Mineral Claims

Title Number	Claim Name	Issue Date	Good To Date	Status	Area (ha)
513010	RAM3	2005/MAY/19	2029/JAN/29	GOOD	528.87
513018	FRANK SR 2	2005/MAY/19	2029/JAN/29	GOOD	529.11
513757	HIDDEN VALLEY	2005/JUN/01	2029/JAN/29	GOOD	190.63
513788	HIDDEN VALLEY 2	2005/JUN/02	2029/JAN/29	GOOD	211.79
513794	HIDDEN VALLEY 3	2005/JUN/02	2029/JAN/29	GOOD	127.06
514607	FRANK SR3	2005/JUN/16	2029/JAN/29	GOOD	317.59
517620		2005/JUL/13	2029/JAN/29	GOOD	211.70
517622	FRANK SR3	2005/JUL/13	2029/JAN/29	GOOD	232.76
518969		2005/AUG/12	2029/JAN/29	GOOD	359.62
518970	RAM	2005/AUG/12	2029/JAN/29	GOOD	63.49
518971	RAMFRAC	2005/AUG/12	2029/JAN/29	GOOD	105.78
529246		2006/MAR/02	2029/JAN/29	GOOD	21.15
529441	WHITE BUFFALO	2006/MAR/05	2029/JAN/29	GOOD	254.14
574472	ROSSLAND 1	2008/JAN/25	2029/JAN/29	GOOD	528.65
574473	ROSSLAND 2	2008/JAN/25	2029/JAN/29	GOOD	528.58
580083	WEST HIGH YIELD RESOURCES	2008/APR/01	2029/JAN/29	GOOD	507.03
580084	WEST HIGH YIELD RESOURCES	2008/APR/01	2029/JAN/29	GOOD	528.44
580085	WEST HIGH YIELD RESOURCES	2008/APR/01	2029/JAN/29	GOOD	528.27
580087	WEST HIGH YIELD RESOURCES	2008/APR/01	2029/JAN/29	GOOD	359.31
847539	THE RIDGE	2011/FEB/26	2029/JAN/29	GOOD	381.18
1000746		2012/JUN/25	2029/JAN/29	GOOD	508.38
1020435	SUPER RIDGE	2013/JUN/21	2029/JAN/29	GOOD	402.32
1023877	SUPER RIDGE II	2013/NOV/18	2029/JAN/29	GOOD	465.68
1033138	WHY 1	2015/JAN/05	2029/JAN/29	GOOD	21.18
1044723	MALDIE	2016/JUN/13	2027/DEC/27	GOOD	127.13
1045540	MALDIE EAST	2016/JUL/24	2029/JAN/29	GOOD	169.51
1048034		2016/NOV/24	2029/JAN/29	GOOD	84.73
1050093	SILICA	2017/FEB/17	2029/JAN/29	GOOD	402.28
1052499	MALDE EAST	2017/JUN/12	2029/JAN/29	GOOD	275.38
29 Tenures					8971.69

Source: British Columbia Government, 2018

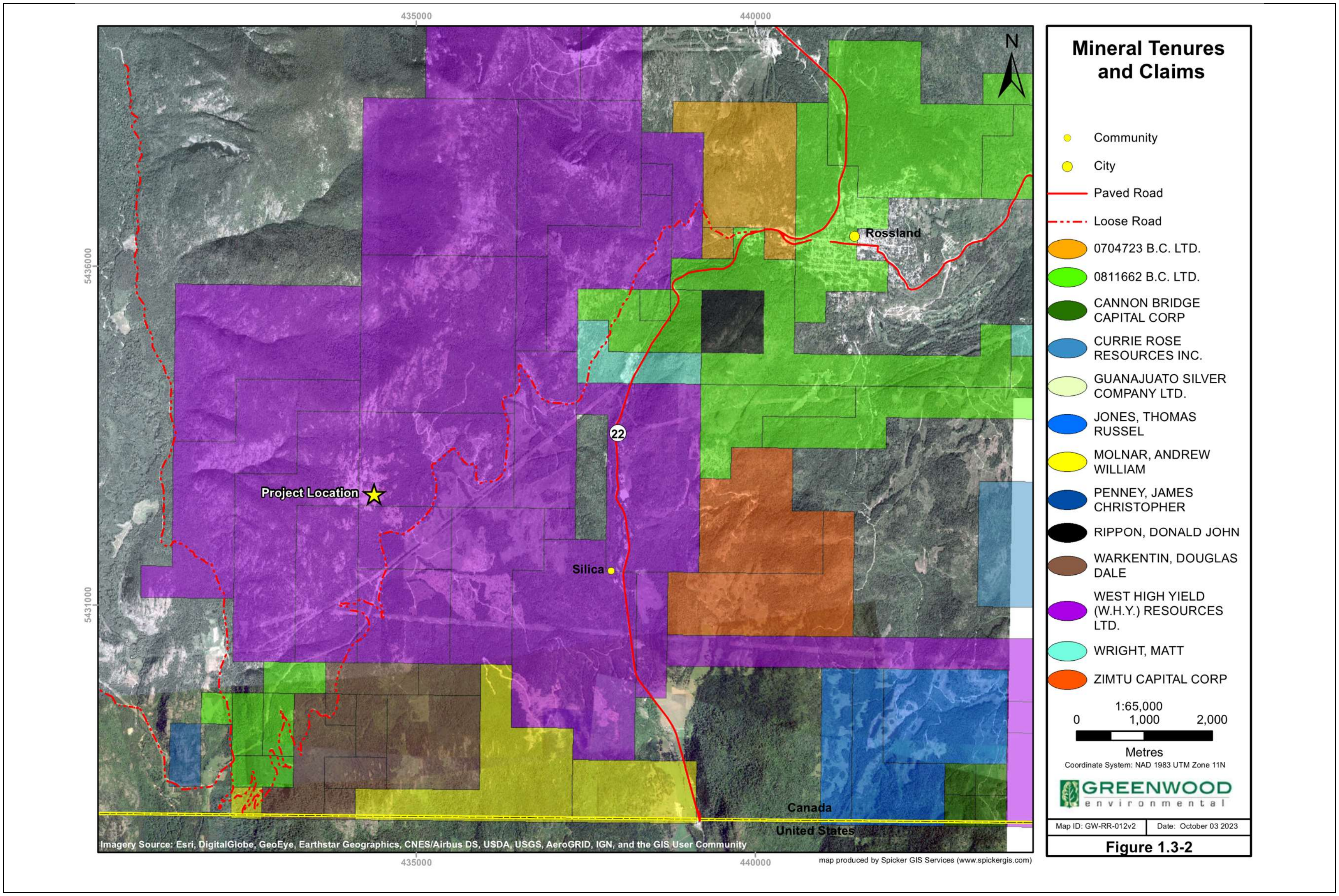


Figure 1.3-2: Mineral Tenures and Claims

Table 1.3-5: W.H.Y. Resources Crown Granted Lands and Private Titles

Name	Lot	Crown Grant #	Title ID	Area (ha)	WHY Equity (%)
Midnight	1186	87–70	1134921	17.66	100
June	1216	156–86	N.A.	17.40	100
Golden Butterfly	1217	200–90	N.A.	17.40	100
Golden Butterfly Fr.	1943	237–90	N.A.	4.57	100
Little Dalles	1215	278–87	KV110354	2.73	100
OK Fraction	2675	274–90	N.A.	0.49	100
OK	678	60–68	KV112056	12.85	51
IXL	679	68–68	KV112053	7.85	100
Sub Lot 82 (Midnight)	Plan S82	87–80	KV112055	4.98	51
9 Titles				85.93	

Source: West High Yield (W.H.Y.) Resources Ltd

The known magnesium mineralization of the RRIMM Project is located within two of the mineral claims. The northern portion of the identified mineralization is located within tenure #514607 (Frank SR), which covers approximately 318 ha. The southern portion of the mineralization is located on claim #513794 (Hidden Valley 3) which covers 127 ha. These tenures are also shown in Figure 1.3-2. Infrastructure for the proposed RRIMM Project is located on mineral tenures controlled by W.H.Y. Resources.

1.3.3.3 Physiography

Physiography of the property is gentle to moderately steep and controlled by the underlying geology. The RRIMM Project is located along the southeast facing slopes of the northeast trending Record Ridge. Record Ridge separates Big Sheep valley and creek on the west from the Little Sheep valley and creek to the east.

Topography of the regional area is characterized by steep hills and broad valleys, with elevations ranging from 1,023 m in Rossland to 1,720 m at the mountain summits within the RRIMM Project. Hills and ridges are drained by gentle to deeply incised creeks and valleys. The ground surface of elevated areas is covered by residual soil and bedrock outcrops are relatively plentiful. In the valley areas, glacial and alluvial gravel fill is relatively deep and bedrock outcrop is limited to stream banks.

Vegetation is typical of the northern Rocky Mountains; locally varying between dense forest and open grass covered areas. Coniferous trees include fir, spruce and tamarack on north and east facing slopes; whereas ponderosa and lodgepole pine grow more in the open south and west facing slopes. Various brush species and poplar (deciduous trees) are common along streams and riverbanks.

1.3.3.4 Land Use

The historic mining city of Rossland is located in the Monashee Mountain at an elevation of 1,023 m in the West Kootenay region of BC. In 1890, two prospectors started a gold rush when they staked the Le Roi claim. Soon other important discoveries were made, including the Center Star, War Eagle, and Joise mines. Production records indicate that the Rossland Camp produced approximately 9.9 million grams of Gold;

15.3 million grams of Silver and 6.2 million kilograms of Copper between 1896 and 1982, making the Rossland Camp the second largest source of lode gold in BC. By the turn of the nineteenth century, Rossland was one of the largest cities in western Canada and a smelter was built in the valley below at Trail to service the mines. In 1906, the mines and smelter were amalgamated to form Cominco, which was subsequently bought out by Teck. By the 1940's, the heyday of gold mining at Rossland was over but the Cominco smelter remained active.

Today, Rossland and Record Ridge are in an area with active forestry and outdoor recreation, including multi-season skiing, hiking and mountain biking sports. The Dewdney, Record Ridge and Seven Summits hiking and mountain bike trails are located near the proposed RRIMM Project. Red Mountain Ski resort is located to the north of Rossland and the RRIMM Project area. King George VI Provincial Park, hosting no facilities, is the closest provincial park located approximately 5 km southeast of the Project near the US border.

In terms of forestry interests, there are two nearby cut blocks held by Kalesnikoff Lumber Co. Ltd and Wood Products Ltd. and 10 parcels of managed forest lands, including overlapping parcels owned by Selkirk Forest Mountain Ltd. and proximal parcels owned by Copper Creek Cedar Ltd.

Trapping and resident hunting occur in the area. One trapline (TR409T001) overlaps with the RRIMM Project area, having a primary focus on harvest of beaver, marten, and weasel, with a low rate of recorded harvest (Dialectic Research Services 2018). One guide, Barry Brandow of Granby Guide and Outfitters, has operated in an area 10 km west of the Project for nearly 40 years.

Land uses and tenures of the area in, and around, Rossland reveal the area's balance between reliance on resource development (such as mining and forestry) while making lands available for public enjoyment, such as outdoor recreation, among locals and visitors alike. Local residents take advantage of the local recreational opportunities and welcome tourists from across BC, Alberta and Washington State year-round, as well as for several key annual events, some of whose activities overlap with the RRIMM Project area (Dialectic Research Services 2018).

1.3.4 Mine Components and Off-Site Infrastructure

1.3.4.1 Overview

This section provides a description of the key on-site facilities of the proposed RRIMM Project, including the open pit, waste rock storage facility, sediment ponds and diversion ditches, soil stockpile, associated support facilities, mine access and mine haulage roads, and additional ancillary facilities. Off-site facilities include power supply and distribution, highways, and processing facility. The mine plan is discussed in detail in Section 3.0 Mine Plan (Appendix 3-B).

Figure 1.3-3 illustrates the key mine components. Mine components include surface infrastructure to support the use of explosives to extract ore; i.e., powder magazine and access road. Note that the use of explosives to extract ore is secondary to mechanical methods and would only be deployed if mechanical methods prove to be insufficient for the operation.

There are no underground workings, on-site processing plant, tailings storage facility, or low-grade ore stockpile for this industrial mineral mine development.

1.3.4.2 Open Pit

The two-year open pit is designed targeting near-surface magnesium bearing material known as serpentinite. The open pit area consists of undeveloped, bare land with no previous development, mining or milling history. Pit walls are designed to have low heights for long term geotechnical stability, with 6 m benches which will be double benched.

A mobile rock crushing unit will be mobilized to and used on-site. Run of mine feed will be crushed (within an enclosure) and screened to an appropriate size for haulage to an off-site processing plant. Crushed rock will be hauled to a process facility in the USA (or overseas) for magnesium extraction and recovery testing.

1.3.4.3 Waste Rock Storage Facility

It is expected that the mine will generate approximately 320,380 tonnes of waste rock over the life of the project; of which, 281,780 tonnes is to be used as construction material, and 38,600 tonnes is to be stored in the waste rock storage facility. The waste rock storage facility will be located north of the crusher pad. It will be a level dump head, developing the dump as a side-hill fill, down topography which has an existing slope of approximately 15°. The dump is designed to a maximum height of 35 m and has a face angle of 35° to 44° which is the anticipated angle of repose. When production is completed, waste rock will be back-filled into the open pit.

1.3.4.4 Site Water Management Facilities

Water management infrastructure is designed to maximize diversion of clean water around the components of the RRIMM Project, while ensuring capture of contact water throughout the site. This will be accomplished with diversion ditches and one site sedimentation pond.

A local sump will be constructed into the hillside near the toe of the waste rock storage facility. Toe seepage and runoff will be directed to the site sedimentation pond via diversion channels constructed along the toe. Seepage from the ore stockpile will be collected in a local sump and pumped or flow by gravity in a pipe to the site sedimentation pond.

Runoff from the open pit, haul roads, and other developed areas will be collected in channels and directed to the site sedimentation pond where suspended sediment will be removed.

1.3.4.5 Ore and Low-Grade Ore Stockpiles

It will be necessary to create an ore stockpile pad large enough to allow for a run of mine stockpile, an enclosed crusher, and a crushed product ore stockpile. Ore from the crushed stockpile will be loaded on to highway trucks for transport off site. All topsoil stripped during the construction of this pad will be stockpiled for future site reclamation.

There will be no low-grade ore stockpile.

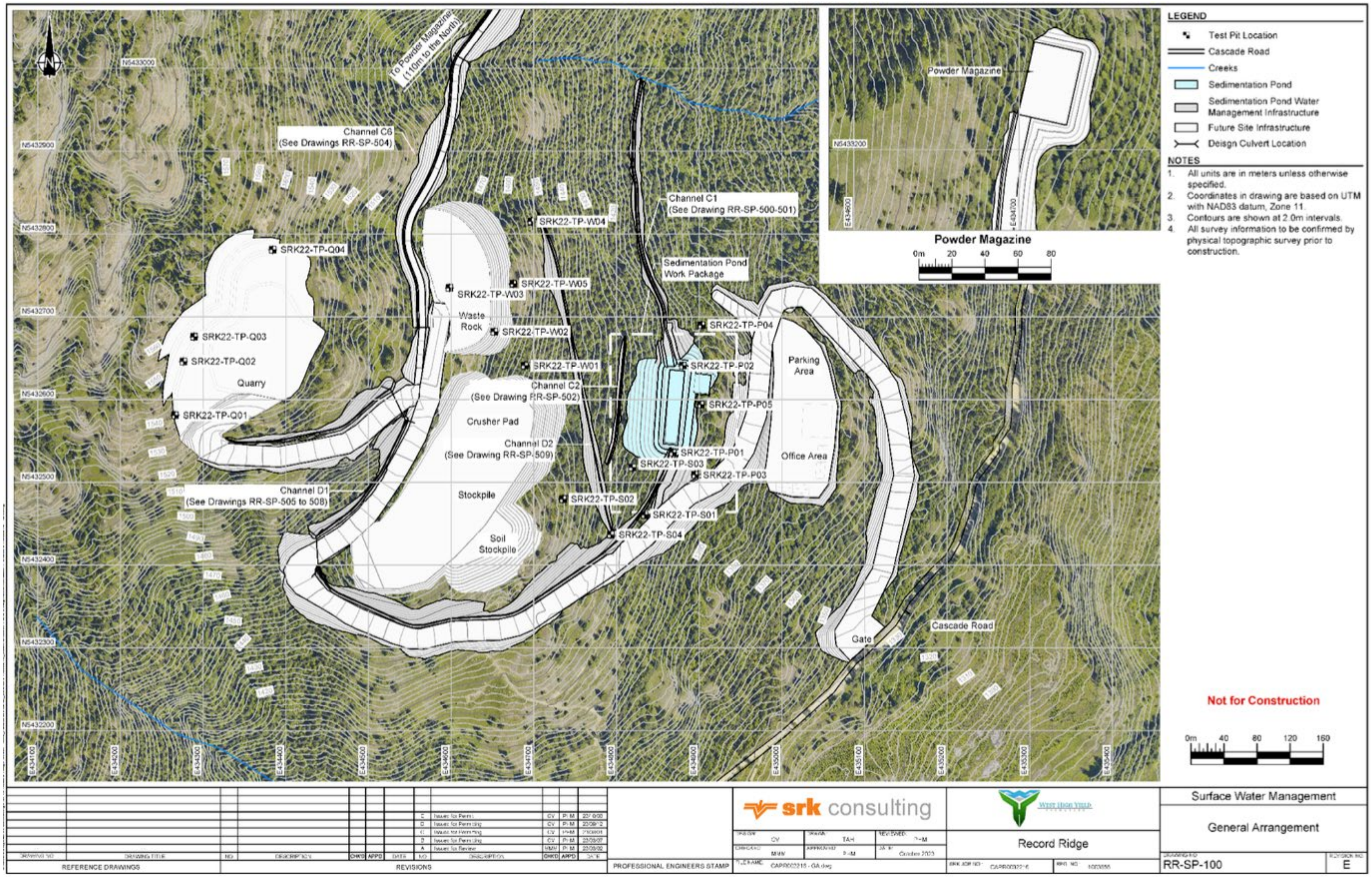


Figure 1.3-3: Key Mine Components

1.3.4.6 Overburden and Soil Stockpiles

The open pit, waste rock storage facility, and the footprint of the haul road and pads will be cleared of vegetation and topsoil stripped and stockpiled for future site reclamation activities. The soil stockpile will be located between the crusher pad and the sedimentation pond.

1.3.4.7 Access and Mine Site Roads

An access haul road will be constructed to connect the Old Rossland-Cascade Highway with the main haul road leaving the Project site. The same road will connect to the open pit, crusher pad, waste rock storage facility, and the site office pad. The main haul road is designed with a maximum grade of 10% and a width of 25 m, which includes vehicle running width, a safety berm and drainage ditch that complies with the *Health, Safety and Reclamation Code for Mines in British Columbia* (referred to hereafter as 'the Code') haul road design guidelines (Ministry of Energy and Mines 2022).

1.3.4.8 Power Supply and Distribution

The RRIMM Project area is traversed by electrical transmission lines leading from Rossland westward. These lines would not, however, need to be moved to accommodate the proposed RRIMM Project. Power requirements for this proposed RRIMM Project will be sourced from nearby electrical lines, with portable generator(s) used to supply back up power, if needed.

1.3.4.9 Ancillary Buildings and Other Infrastructure

Additional on-site infrastructure will include a crusher pad and a number of temporary buildings. A pad will be cleared adjacent to the site entrance, near the office building facilities, which will include mobile office and dry buildings as well as the equipment maintenance pad and equipment parking area. The site entrance will have an access gate and security building.

1.3.5 Mine Development and Operations

The mine design provides two years of Mg-rich product material at a rate no greater than 200,000 tonnes per year. The mine development sequence includes a three-month construction period, which includes construction of site access haul roads and pads, as well as stockpiling topsoil from the project disturbed areas and mobilization of the required project equipment. The production phase of the project includes two years of mining no greater than 200,000 tonnes per year of mineralized material, which will be delivered to the crusher pad and crushed before being hauled off-site. During the two years of production, operations will be conducted for approximately six months, extending to eight months depending on weather (Apr/May to Oct/Nov); i.e., non-winter months. Throughout operations, water in contact with the mine will be collected in a sump. This water will be transferred to the site sedimentation pond for analysis to ensure it is protective of the environment prior to release to the receiving environment.

All contact water will be collected and diverted to the site sedimentation pond to allow for the settlement of suspended sediments. All discharges of contact water will be done in accordance with the Safe Discharge Plan (section 9.8; Appendix 9-C).

1.3.6 MINE DESIGN AND ASSESSMENT TEAM

W.H.Y. Resources engaged Greenwood Environmental Inc. (Greenwood) and SRK Consulting Canada (SRK) to support the environmental and permitting aspects for the RRIMM Project, including preparation of the documentation for the Joint Permit Application. This application was prepared by a core team of contributors as summarized below.

INTRODUCTION AND PROJECT OVERVIEW	VEGETATION AND WILDLIFE
SRK Consulting Canada	**Keefer Ecological Services Ltd.**
Mark Liskowich, BSc, pGeo	Michael Keefer, MSc, pAg
Greenwood Environmental Inc.	Myra Juckers, BSc, pAg
Brandie Roberts, M.Sc.	Andrew Simon, BASc
Shane Uren, M.A.Sc.	Jakob Dulisse, BSc, RPBio
METEOROLOGY AND CLIMATE	Clayton Apps, PhD, RPBio
SRK Consulting Canada	Scott Holmgren, MASc
Soren Jensen, MSc., PEng	**E. Wind Consulting**
GEOLOGY	Elke Wind
Dynamic Exploration Ltd.	**Ophiuchus Consulting**
Rick Walker, MSc, pGeo	Mike Sarrell
Soils Baseline Report	**Cascara Environmental Ltd**.
David Yole, MSc., pAg	Nicole Tennant, B.Sc, RPBio
TOPOGRAPHY, SURFACE DRAINAGE FEATURES AND NATURAL HAZARDS	LAND STATUS AND USE
SNT Geotechnical Ltd.	**Dialectic Research Services**
Doug Nicol, P.Eng.	Kai Scott, M.A.
WATER QUANTITY	ARCHAEOLOGY
SRK Consulting Canada	**Ursus Heritage Consulting**
David Moran, MEng, B,Eng	Fraser Bonner, B.A
Soren Jensen, MSc., PEng	CULTURAL USE
GROUNDWATER AND SURFACE WATER QUALITY	**Dialectic Research Services**
SRK Consulting Canada	Kai Scott, M.A.
Michael Royle, pGeo,	MINE PLAN
Soren Jensen, MSc., PEng	**SRK Consulting Canada**
Azimuth Consulting	Grant Carlson, pEng
Ryan Hill, MRM, RPBio	
Gary Mann, MSc, RPBio	

Sediment Quality	**Reclamation Planning and Effective Mine Closure**
Azimuth Consulting	**SRK Consulting Canada**
Ryan Hill, MRM, RPBio	Mark Liskowich, BSc, pGeo
Gary Mann, MSc, RPBio	**L. Ford Consulting Ltd.**
Fisheries and Aquatic Resources	Loretta Ford, MSc, pAg
Azimuth Consulting	**Cascara Environmental Ltd**
Ryan Hill, MRM, RPBio	Nicole Tennant, B.Sc, RPBio
Gary Mann, MSc, RPBio	**Greenwood Environmental Inc**.
Lotic Environmental	Brandie Roberts, MSc.
Jamie Smithson, BSc	**Discharges and Treatment**
Mike Robinson, MSc, RPBio	**SRK Consulting Canada**
Mine Management Plans	Soren Jensen, MSc., PEng
W.H.Y. Resources	**Environmental Effects Predictions**
Ian Kennedy, B.Sc, P. Eng	**SRK Consulting Canada**
Greenwood Environmental Inc.	Soren Jensen, MSc., PEng
Shane Uren, M.A.Sc, RPBio	**Azimuth Consulting**
Brandie Roberts, MSc.	Ryan Hill, MRM, RPBio
SRK Consulting Canada	**Discharges and Environmental Monitoring Requirements**
Mark Liskowich, BSc, pGeo	**SRK Consulting Canada**
Soren Jensen, MSc., PEng	Soren Jensen, MSc.
	Azimuth Consulting
	Ryan Hill, MRM, RPBio

1.3.7 Regulatory Framework

1.3.7.1 Required Permits/Authorizations

The RRIMM Project is an industrial mineral mine with production capacity no greater than 200,000 tonnes per year; therefore, it does not trigger the provincial and federal environmental assessment process and will not require an Environmental Assessment Certificate. A *Mines Act* (MA) and *Environmental Management Act* (EMA) effluent discharge permit are required for construction and operations of the project. W.H.Y. Resources submits this Joint Permit Application, with supporting documents, for review.

1.3.7.2 Potentially Applicable Statutory Requirements

Regulatory consultation will take place to determine all licenses, permits, and/or authorizations required for the RRIMM Project. Table 1.3-6 outlines provincial statutory requirements that may be applicable to the RRIMM Project development and/or operation and will be updated throughout the consultation process.

Federal legislation and regulations that may be applicable to the RRIMM Project are:

- *Explosives Act* (1985)
- *Fisheries Act* (1985)
- *Migratory Birds Convention Act* (1994)
- *Species at Risk Act* (2002)

Table 1.3-6: Anticipated Provincial Licenses, Permits, and Authorizations

Regulator Agency	Provincial Legislation	Licenses, Permits, and Authorizations
BC Ministry of Energy, Mines, and Petroleum Services	*Mines Act* (1996)	*Mines Act* Permits to construct, operate, close and decommission, and reclaim a mine.
		Explosives Storage and Use Permit
	Mineral Tenure Act (1996)	Mining Lease
	Mining Right of Way Act (1996)	Mining Right of Way Permit
BC Ministry of Environment and Climate Change Strategy	*Environmental Management Act* (2003)	Liquid Effluent Discharge Permit
		Air Emissions Discharge Permit
		Hazardous Waste Registration
		Fuel Storage Registration
BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development	*Land Act* (1996)	License of Occupation and Statutory Right-of-Way
		Temporary Use/Work Permits
		Investigative Use Permit
	Forest Act (1996) *Forest and Range Practices Act* (2002)	Occupant License to Cut
		Special Use/Road Use Permit
		License of Occupation and Statutory Right-of-Way
	Water Sustainability Act (2014)	Section 11 Notification
		Section 11 Approval or Authorization for Changes in and about a stream
		Section 9 and 10 Approval, Water Use License
	Wildlife Act (1996)	Animal Salvage
	Integrated Pest Management Act (2003)	Noxious Weed Control Permit
	Wildfire Act (2004)	Burning authorization
	Heritage Conservation Act (1996)	Heritage Inspection Permit
	Industrial Roads Act (1996)	Industrial Access Permit
	Transportation Act (2004)	Controlled Access Permit

Regulator Agency	Provincial Legislation	Licenses, Permits, and Authorizations
BC Ministry of Transportation and Infrastructure	*Transportation Act* (2004)	Utility Permit
	Motor Vehicle Act (1996)	Approval for oversized loads or bulk haul
BC Safety Authority	*Safety Standards Act* (2003) –- Electrical Safety Regulation	Permit to connect a Powerline
BC Ministry of Health	*Drinking Water Protection Act* (2001)	Potable water

1.4 ENGAGEMENT AND CONSULTATION

As part of the Joint Permit Application process, the provincial government must meaningfully consult on any decision that may affect an Indigenous group's treaty rights or asserted or established Aboriginal rights and title and may delegate certain aspects of the consultation procedure to the proponent. W.H.Y. Resources acknowledges the importance of early and continuous engagement and is committed to carrying out the Project in a manner that is socially and environmentally responsible. We aim to develop and maintain good relationships based on trust with neighbouring communities and Indigenous groups whose interest might be affected by the Project.

1.4.1 APPROACH

W.H.Y Resources adheres to the definition of Indigenous Peoples as outlined in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). W.H.Y Resources understands engagement is about sharing information, listening to, and respecting concerns raised, and looking for ways to address them. It is our desire to develop long term mutually beneficial relationships with the communities where we operate through early, open, honest, and regular meaningful engagement with representatives of Indigenous groups whose interests might be affected by our project.

The main purpose of W.H.Y. Resources approach to Indigenous consultation is to provide Indigenous communities with project information and seek input for consideration in the development of the Project.

The approach to consultation aims to deliver the following objectives:

a) Inform Indigenous communities about the project and opportunities to provide input: build Indigenous awareness of the Project by providing timely and relevant information pertaining to the Project, the environmental/regulatory review process, and opportunities for Indigenous communities to provide input.

b) Gather Indigenous input, both within and in addition to the Application: assemble information regarding the interests and concerns of each Indigenous community related to the Project.

c) Report Indigenous Input: report out on the issues raised and how they were considered through consultation.

d) Consider and respond to Indigenous Input: refine elements of the Project or develop proposed mitigation measures to address input where possible, subject to technical and financial constraints.

e) Meet regulator's Indigenous consultation requirements for the Application.

W.H.Y. Resources will use a range of mechanisms to communicate, consult and engage with members of Indigenous groups and neighbouring communities, including:

- formal and informal in person or phone meetings, emails and letters
- event presentations or community meetings
- W.H.Y. Resources website, social media, market and media releases.

Full transparency in all interactions and activities with and between W.H.Y Resources and Indigenous groups is of key importance. This includes the provision of clear, factual, and accurate information in an open manner on an ongoing basis. Interactions must always be based on mutual respect, with sufficient opportunities for communities to raise issues, to make suggestions and to voice their concerns and expectations about the Project activities.

1.4.2 Activities

Specific engagement and consultation activities include:

- Ensuring Indigenous communities understand the opportunities for consultation.
- Providing timely and meaningful information to all participating Nations.
- Sharing detailed information with respect to proposed Project activities.
- Provide Indigenous communities with sufficient information to allow for meaningful evaluation of the Project.
- Identifying Treaty Rights and overarching interests that could be affected by the Project.
- Collecting information about how Treaty Rights and interests may be affected by the Project.
- Identifying and developing measures to prevent, mitigate, or otherwise address potential effects on Treaty Rights and overarching interests.
- Meet with Indigenous communities to discuss project-specific concerns and proposed mitigation and management plans.
- Responding to feedback received from Indigenous communities in a timely manner.
- Documenting and reporting to regulators the results of consultation with Indigenous communities.

W.H.Y Resources will maintain a record to respond to Indigenous comments and feedback.

2.0 BASELINE INFORMATION

2.1 SUMMARY

The proposed RRIMM Project is located within the Regional District of Kootenay Boundary and within the western portion of the Kootenay Region and the Arrow Boundary Forest District. The area in, and around, the proposed RRIMM Project has been, and continues to be, used by several First Nation groups, including the Syilx/Okanagan, Sinixt, and Secwepemc/Shuswap people. These uses entail a range of past and current activities, such as fishing, hunting, trapping, and plant harvesting, important for consumption, construction, and cultural purposes.

The RRIMM Project is located west of, and high above, Highway 22 in the Rossland Range of the Monashee Mountains, a subrange of the Columbia Mountains. It is situated mainly within the Sophia Creek drainage, a tributary to Little Sheep Creek approximately 7.5 km southwest of Rossland, BC, and approximately 5.5 km north of the Washington border (Figure 1.3-1). Little Sheep Creek flows in a southern direction into the United States, where it joins the Columbia River. Just at the western boundary of the RRIMM Project area is the Big Sheep Creek drainage, which also flows in a southerly direction into the United States, where it joins the Columbia River.

The RRIMM Project is located on Crown land, with a variety of overlapping tenures. There are a dozen diverse types of land tenures and uses that are either overlapping, or proximal to, the RRIMM Project. Two large-scale utility infrastructures intersect the area, including a transmission and pipeline. Proximal to the RRIMM Project, and along the transportation route, are private properties with homes and buildings. The popular Red Mountain Ski Resort is approximately 21.5 km by road northeast of the Project. Several mineral tenures or leases exist around the RRIMM Project with recent, low value technical work, and no current development plans. Active forest management occurs nearby, including recent cut blocks in the area. No parks or protected areas overlap the area, the closest of which is King George VI Provincial Park, located approximately 5 km southeast near the US border.

The RRIMM Project falls within the area covered in the Kootenay-Boundary Land Use Plan (KBLUP; BC MFLNRO 1995). These lands are divided into three categories based on their ability to accommodate industrial activities, of which the RRIMM Project overlaps with one, the Integrated Resource Management Zone; designated as an area with low to moderate sensitivity to resource development (BC MFLNRO 1995). It is also situated in the area included in the Arrow Resource Management Zones (RMZ), in particular, Area N501 which has a low rating for biodiversity emphasis.

Most of the area in, and in the vicinity of, the RRIMM Project is comprised of lower elevation forested land of the Interior Cedar – Hemlock (ICH) biogeoclimatic ecosystem classification (BEC) zone. Upper elevations are primarily drier Engelmann Spruce Subalpine Fir (ESSF) forests with bedrock outcrops. ICH has an interior, continental climate dominated by easterly moving air masses that produce cool wet winters and warm dry summers (Ketcheson et.al 2018). This is one of the wettest zones in the BC interior. High snow melt in the ICH contributes to the hydrologic regime, minimizing summer soil moisture deficits. ICH is the most productive forest zone in the BC interior, and second in all of Canada. Upland coniferous forests dominate the landscape, and the ICH has the highest diversity of tree species of any zone in BC. Western redcedar and western hemlock dominate mature forests, but several other species are included in the mix.

Majority of the area in the vicinity of the RRIMM Project is comprised of mature conifer forests, with some areas having been previously harvested and are now young regenerating forests. Tree species primarily include western redcedar, Douglas fir, western hemlock, lodgepole pine, grand fir, western white pine, western larch, ponderosa pine, paper birch, and trembling aspen. Subalpine fir and hybrid white spruce are found in the upper elevations, with outcrops of bedrock exposure.

As part of the development of the Permit Application detailed baselines were initiated in 2016. These programs cover the regional area as well as the specific project area and characterize the biophysical and biological environments of the proposed RRIMM Project. Baseline sampling locations have been coordinated amongst surface water quality, sediment quality, and fisheries and aquatic resources. Detailed reports documenting baseline studies are appended to this Permit Application and summarized below by component.

2.2 METEOROLOGY AND CLIMATE

2.2.1 METEOROLOGY AND CLIMATE

Government of Canada climate data from two weather stations were used to summarize climate data for the RRIMM Project. The former Rossland McLean station (ID 1146874; Latitude 49°05'00.000" N, Longitude 117°48'00.000" W, Elevation 1085.1 m), was located approximately 6.3 km west of Rossland and provides data for 1971 to 2000 (Government of Canada 2018; Table 2.2-1). This station was located in, or near, mineral tenure 513010 and in the ICH Granby Moist Warm (ICHmw5) biogeoclimatic subzone/variant (Figure 2.2-1).

The currently maintained Warfield weather station is approximately 4 km east of Rossland, in the village of Warfield (ID 1148700; Latitude 49°06'00.000" N, Longitude 117°45'00.000" W, Elevation 605.6 m), and has data for 1981 to 2010 (Government of Canada 2018; Table 2.2-2). This station is in the Interior Cedar – Hemlock Kootenay Dry Warm (ICHdw1) biogeoclimatic subzone/variant. At an elevation approximately 480 m lower than the Rossland McLean weather station, Warfield records warmer temperatures and less precipitation, particularly as snowfall, than Rossland McLean.

As recorded at the former Rossland McLean weather station, average temperature in January is -5.8 degrees Celsius (°C), ranging between -3.0°C and -8.6°C, and the record low occurred on December 29, 1968, at -33.3°C. Average precipitation is 78.7 millimetres (mm), with 10.6 mm falling as rain and 88.5 cm as snow. Average temperature is relatively constant from July through August at 17°C, ranging between a high of 23.4°C and a low of 10.5°C. The record high of 35°C occurred on August 17, 1967. Average precipitation is 48.7 mm of rain. Average annual precipitation for the same period is 599.9 mm of rain and 179.1 cm of snow, for a total of 917.2 mm. Snow can be expected on the ground between October (average of 10.6 cm) and April (20.7 cm). Table 2.2-1 and Table 2.2-2 provide climate normals at both stations.

To measure local rainfall, two rainfall gauges were installed 40 m apart in the Sophia Creek catchment. The gauges recorded continuous rainfall between September 19, 2016 and December 12, 2016. Rainfall measured at the two stations are in good agreement, as shown in Figure 2.2-2. The figure also shows rainfall recorded at the Warfield Meteorological Station (Station ID 1148705), which is the nearest regional meteorological station located approximately 12 km northeast of the RRIMM Project area. The Warfield station is operated by Weather Canada and has been recording since 2001.

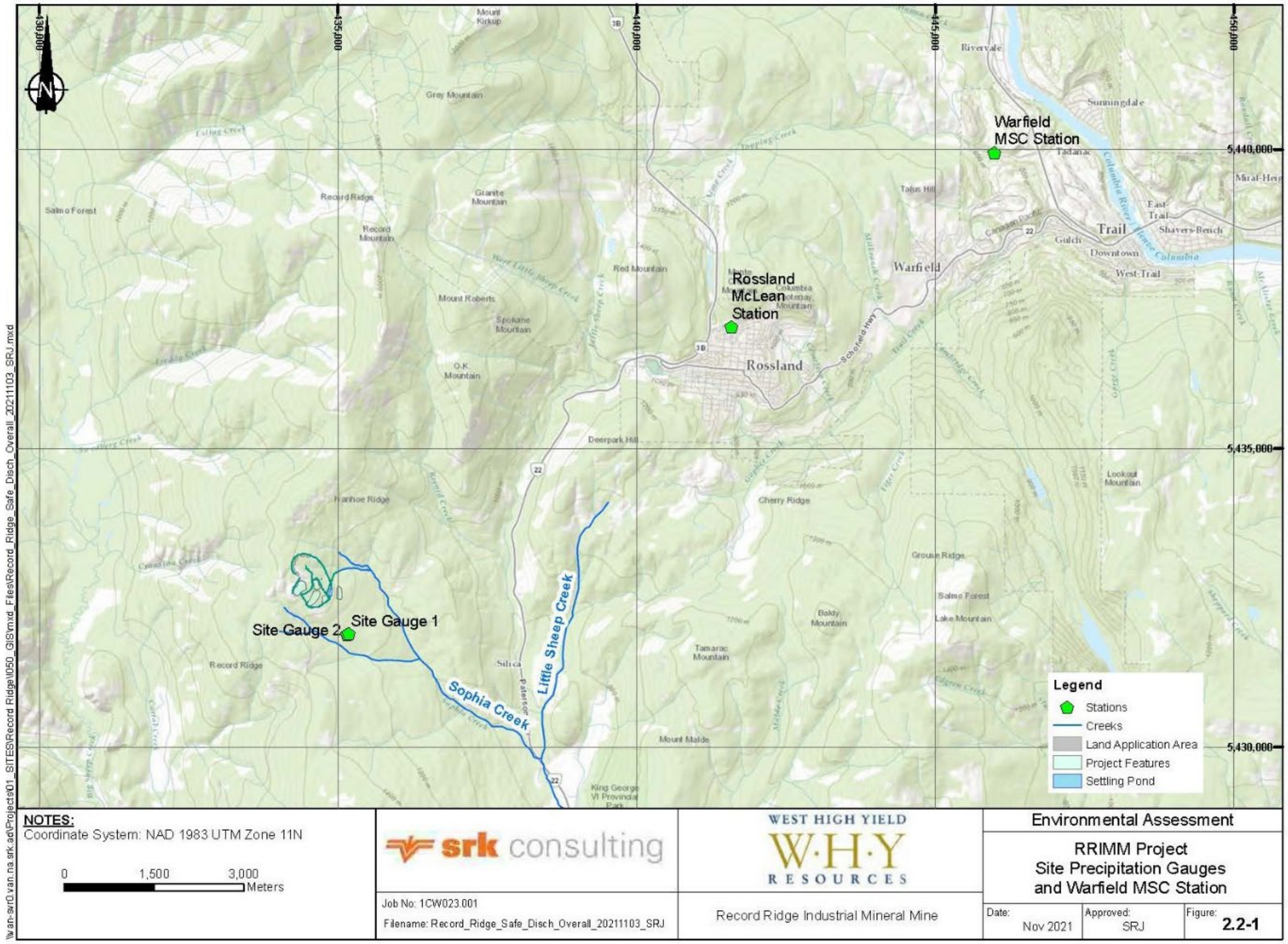


Figure 2.2-1: Site Precipitation Gauges and Warfield MSC Station

Table 2.2-1: Climate Normals 1971–2000 Rossland Maclean Station Data

Climate Normals 1971-2000 Station Data

STATION NAME
ROSSLAND MACLEAN

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Temperature														
Daily Average (°C)	-5.8	-3.4	0.7	5.2	9.8	13.8	17	17	11.5	5.7	-1.6	-5.3	5.4	D
Standard Deviation	2.5	1.7	1.7	1.4	1.4	1.7	1.8	1.9	2	1.5	2.4	2.4	1.7	D
Daily Maximum (°C)	-3	0	4.9	10.3	15.4	19.6	23.4	23.4	17.3	10.6	1	-2.8	10	D
Daily Minimum (°C)	-8.6	-6.7	-3.5	0	4.1	8	10.5	10.6	5.6	0.9	-4.2	-7.7	0.7	D
Extreme Maximum (°C)	7.5	13.3	16	27.2	30.5	31	35	35	32.8	25	15	9		
Date (yyyy/dd)	Jun-84	1968/29	1987/31	1977/25	1986/31	1987/30	Oct-75	1967/17	Jan-67	Jun-80	Apr-75	1980/25		
Extreme Minimum (°C)	-25.5	-25	-17.8	-9.4	-4.5	0	2	2.2	-3.9	-18	-25	-33.3		
Date (yyyy/dd)	Jan-79	Feb-89	Apr-76	Jan-75	Dec-85	Jan-76	Aug-81	1969/29	1972/27	1984/31	1985/28	1968/29		
Precipitation														
Rainfall (mm)	10.6	16.5	35.6	39.5	73.4	68	46.6	48.7	50.1	44.4	42.3	25	500.6	D
Snowfall (cm)	88.5	78.6	41.5	20.7	1.5	0	0	0	0.6	10.6	77.4	97.9	417.1	D
Precipitation (mm)	98.5	95	77	60.2	74.9	68	46.6	48.7	50.7	55	119.7	122.9	917.2	D
Extreme Daily Rainfall (mm)	20.8	22.3	34.3	35.1	41.7	29.5	26.4	55.9	30.2	30	30.2	38.9		
Date (yyyy/dd)	1971/29	1980/26	1967/22	1969/23	1969/29	Dec-64	1968/19	1968/15	1986/23	1971/19	May-88	1966/13		
Extreme Daily Snowfall (cm)	35.6	34	24.1	18	6	0	0	0	5.1	22	40	37		
Date (yyyy/dd)	Sep-69	Jun-85	Oct-67	Sep-83	Oct-85	Jan-64	Jan-64	Jan-64	1971/29	1985/31	Jan-84	Mar-80		
Extreme Daily Precipitation (mm)	35.6	34	34.3	35.1	41.7	29.5	26.4	55.9	30.2	32.5	40	38.9		
Date (yyyy/dd)	Sep-69	Jun-85	1967/22	1969/23	1969/29	Dec-64	1968/19	1968/15	1986/23	1971/19	Jan-84	1966/13		
Extreme Snow Depth (cm)	125	131	110	72	0	0	0	0	0	6	75	115		
Date (yyyy/dd)	Jun-83	Nov-83	Jan-89	Feb-89	Jan-81	Jan-81	Jan-81	Jan-80	Jan-81	1984/29	1984/30	1984/30		

Legend
A = WMO "3 and 5 rule" (i.e. no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation)
B = At least 25 years
C = At least 20 years
D = At least 15 years

Table 2.2-2: Climate Normals 1981–2010 Warfield Station Data

Climate Normals 1981-2010 Station Data

STATION NAME
WARFIELD

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Temperature														
Daily Average (°C)	-1.8	0.1	4.6	9.1	13.5	16.9	20.4	20.4	15.2	8.1	2	-2.4	8.9	C
Standard Deviation	1.8	2	1.4	1.2	1.8	1.6	2.1	1.4	2.2	1.2	2.3	2.4	1.1	C
Daily Maximum (°C)	0.5	3.3	9.2	15	19.8	23.3	27.8	28.1	22.1	12.8	4.5	-0.2	13.8	C
Daily Minimum (°C)	-4	-3.1	0	3.2	7.1	10.5	12.9	12.7	8.4	3.4	-0.5	-4.5	3.8	C
Extreme Maximum (°C)	11.1	14	22	30.6	35.6	37.2	41.1	38.9	36	26.1	18.3	14.4		
Date (yyyy/dd)	Nov-53	1986/25	1994/31	1939/28	1936/30	1933/14	1934/28	Mar-61	Mar-98	Feb-32	Mar-75	Feb-41		
Extreme Minimum (°C)	-27.8	-27.2	-21.1	-11.1	-4.5	2.8	0.6	4	-3	-13.3	-20.5	-31.1		
Date (yyyy/dd)	1950/25	Sep-33	Apr-55	Jan-36	Oct-83	1952/13	Jan-76	1984/29	1983/20	1935/31	1985/23	1968/30		
Precipitation														
Rainfall (mm)	27.8	35.2	55.8	60.7	73.9	74.4	48.2	35.5	39.7	49.7	64.4	34.7	599.9	C
Snowfall (cm)	50.6	25.4	10.3	1.4	0.1	0	0	0	0	1.7	32	57.7	179.1	C
Precipitation (mm)	78.4	60.6	66.1	62	74	74.4	48.2	35.5	39.7	51.4	96.5	92.4	779	C
Snow Depth at Month-end (cm)	31	19	0	0	0	0	0	0	0	0	11	27	7	D
Extreme Daily Rainfall (mm)	27.2	37.1	35.4	28.7	35.9	50.8	44.2	48.3	72.4	42.9	35	49		
Date (yyyy/dd)	1983/26	1958/24	1993/22	1932/19	1998/26	Sep-58	1989/15	1954/23	1997/17	Mar-38	Oct-83	2002/14		
Extreme Daily Snowfall (cm)	34.3	44.5	23.3	12.7	1	0	0	0	0	14.7	27.9	40.4		
Date (yyyy/dd)	1968/29	1938/14	Aug-95	1960/14	Oct-85	Jan-28	Jan-28	Jan-28	Jan-28	1945/21	1961/21	1951/18		
Extreme Daily Precipitation (mm)	34.3	44.5	35.4	28.7	35.9	50.8	44.2	48.3	72.4	42.9	35	49		
Date (yyyy/dd)	1968/29	1938/14	1993/22	1932/19	1998/26	Sep-58	1989/15	1954/23	1997/17	Mar-38	Oct-83	2002/14		
Extreme Snow Depth (cm)	75	70	71	3	0	0	0	0	0	6	39	79		
Date (yyyy/dd)	Jul-97	Jan-97	1997/16	Feb-89	Jan-81	Jan-81	Jan-81	Jan-80	Jan-81	1996/18	1996/28	1996/25		

Legend
A = WMO "3 and 5 rule" (i.e. no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation)
B = At least 25 years
C = At least 20 years
D = At least 15 years

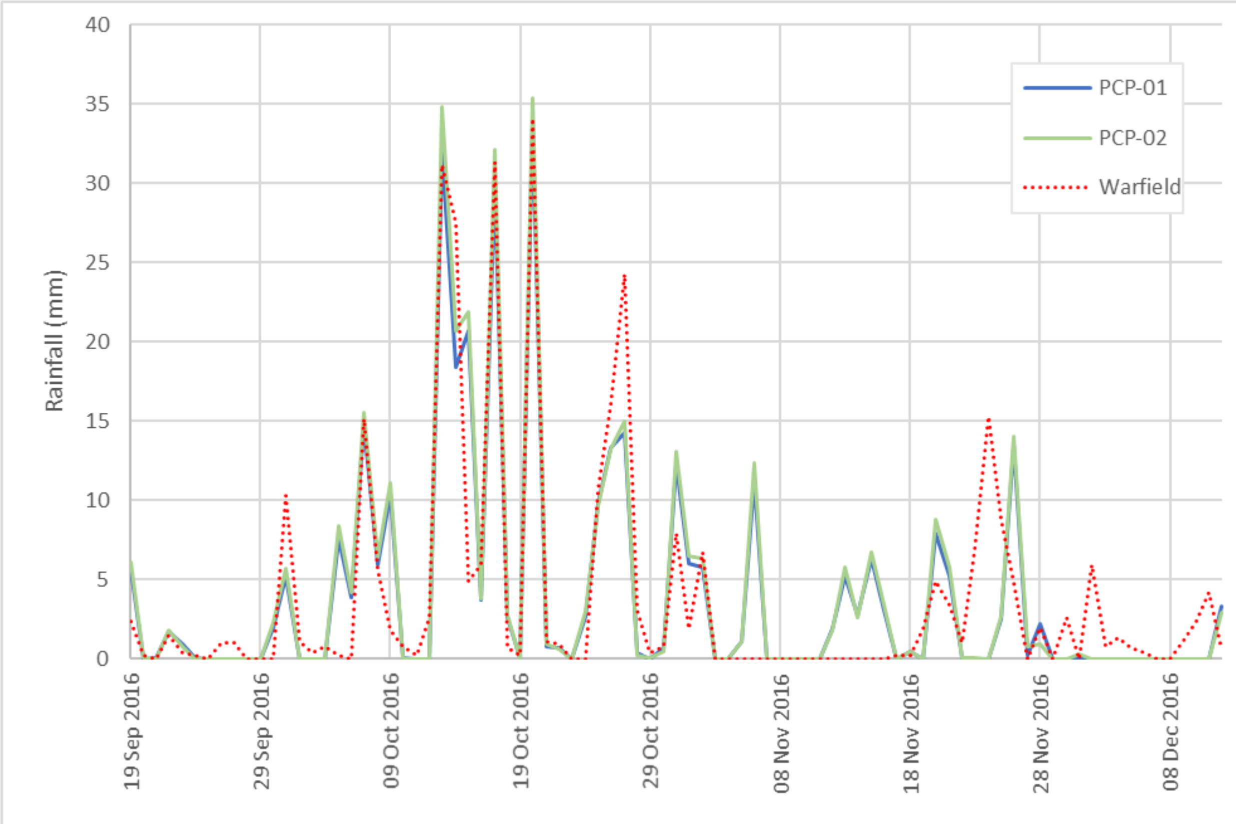


Figure 2.2-2: Recorded Rainfall Data and Warfield Rainfall Record

Local rainfall data trends are reasonably similar to the rainfall trends recorded at Warfield, which indicates that the station provides a reasonable representation of precipitation for the RRIMM Project site. Currently there is no power, facilities or personal present at the RRIMM Project site, therefore the meteorological and climatic data gathered and used to support the design of hydrological controls such as diversion channels and sedimentation pond has been taken from the two weather stations referenced above. Following the establishment of permanent staff at site, W.H.Y. Resources will install a meteorological station at the Project site that will be used to support the monitoring requirements of the Project throughout construction and operations when personnel are on site.

The local weather of the site is not expected to overly influence the operations of the Project. As discussed in more detail in Appendix 3-A (SRK 2023a), Appendix 5-A (SRK 2023e) and Appendix 9-C (SRK 2023g), the water management features designed to support the Project, such as diversion channels, the sedimentation pond, and the overall approach to the discharge of effluent from the Project have considered average monthly precipitation, 1 in 4 year dry monthly conditions and 1 in 10 year wet monthly conditions. Each of these different hydrological conditions were considered during the evaluation of the quality and quantity of water interacting with the Project as well as the downstream implications to the receiving environment.

Following each of the operating seasons the sedimentation pond will be drawn down to near empty conditions to accommodate snow melt and runoff during freshet prior to resuming operations. A more detailed discussion of the relationship between average, dry and wet conditions at the site and how these various conditions influence the management of site runoff, treatment and discharge of contact water are found in Appendix 9-C, and the Water Quality Model (SRK 2023e) developed for the site.

The Water Quality Model in turn was a critical component utilized to evaluate the expected interaction between all site water (contact and non-contact) with that of the natural drainage systems of the area. This evaluation ultimately led to the decision to propose a land application of treated effluent which is discussed in detail in section 9.8 Safe Discharge Plan (Appendix 9-C; SRK 2023g) as well as Chapter 5.

Potential effects on the Project due to climate change was not specifically considered because of the short duration proposed for the project (two years of operation from April/May through October/November). The short duration is also the reason why short return-period events were selected for the assessment (1 in 4 year dry and 1 in 10 year wet conditions).

2.2.2 AIR QUALITY

With respect to air and dust emissions an emissions inventory (Appendix 2-A; SRK 2018a) was completed for the proposed Project as well as a Fugitive Dust Management Plan (Section 9.15; Appendix 9-E; SRK 2023f). The emissions inventory is based on the proposed activities at the Project site and associated types of emissions and considered TSP, PM10, PM2.5, SO2, NOx and CO. Due largely to the smaller footprint of the Project the emissions inventory concluded that dust emissions will be relatively low, and that the majority of the dust will be associated with road traffic. Therefore, as stated in the Fugitive Dust Management Plan (Section 9.15; Appendix 9-E) the primary mitigation of dust will be realized through a road watering program.

2.2.3 AIR QUALITY DISPERSION MODELLING

An emissions inventory was completed for the RRIMM Project (Appendix 2-A) but an air quality dispersion model was not developed for the Project. As described in the Emissions Inventory, mobile equipment and crushing are expected to be the primary emissions sources at site and the feet of highway dump-trucks are expected to be main emission sources off site. The onsite fleet of mobile equipment is small, comprising six heavier construction vehicles and two pick-up trucks. Nine highway trucks are expected to actively haul ore from site at all times.

Because of the limited fleet size on and off the site, and the anticipated use of new equipment that meet current emissions standards, exhaust emissions of NO_x, SO_2 and PM2.5 are not expected to exceed general air quality guidelines. The greatest air quality concern for all mobile and stationary emissions sources is of fugitive dust. Fugitive dust is notoriously difficult to model with any accuracy. AP-42 emissions factors for mobile equipment on unpaved roads are highly sensitive to moisture content of the surface aggregate. In the absence of measured moisture content or silt content, the quality rating of the emissions factors is “D”, which is defined as follows: “Tests are based on a generally unacceptable method, but the method may provide an order-of-magnitude value for the source.[1]”

Fugitive dust is best managed by implementing an adaptive fugitive dust management plan. The plan developed for the Project is included in Appendix 9-E. Air dispersion modelling was excluded because

[1] https://www3.epa.gov/ttnchie1/ap42/c00s00.pdf

modelling results would merely establish that a fugitive dust management plan for the Project would be required.

2.3 GEOLOGY

2.3.1 Regional Geology

2.3.1.1 Stratigraphy

Elise Formation

The Elise Formation belongs to the Early Jurassic Rossland Group, composed of metamorphosed volcanic rocks, with intercalated fine-grained sedimentary rocks, at least 5,000 m thick and of predominantly andesitic composition. Hypabyssal, subvolcanic intrusions that occur as dykes and sills are hosted by, and correlated to, the Rossland Group. The largest is the Rossland Sill, a composite pluton which varies from monzonite to monzodiorite, depending upon the proportion of augite, biotite, hornblende, plagioclase, and alkali feldspar. The Rossland sill is a medium-grained intrusion between 0.7 and 1.0 km wide, containing hornblende and augite phenocrysts, and locally displays fragmental or flow-banded textures.

Marron Formation

The Marron Formation consists of Tertiary age, porphyritic and amygdaloidal trachyte and andesite flows and tuffs up to 2 km thick, interpreted to be the volcanic equivalent of the Coryell Intrusive. Phenocrysts are typically plagioclase, augite, or biotite. The unit weathers to blocky grey, dark grey to dark green outcrops.

Coryell Intrusive

The Coryell Intrusive is a predominantly medium- to coarse-grained quartz monzonite, having a Middle Eocene (Tertiary) age; however, it includes syenites, granites and monzonites. The unit is commonly fractured and deeply weathered. The intrusive occurs as a large batholith; however, correlatives also occur as dikes and small stocks that intrude all older lithologies and form a north-trending linear, dike-like body along the Jumbo fault. Margins of the batholith have narrow halos of thermal metamorphism, indicating a shallow level of emplacement.

Record Ridge Ultramafic

The RRIMM Project area hosts a variably serpentinized ultramafic body, the Record Ridge Ultramafic, which underlies an area of approximately 6.2 square kilometers (km^2), extending from the southern tip of Record Ridge, south to the foot of Mount Sophia and east to Ivanhoe Ridge in the upper Sophia Creek drainage (Figure 2.3-1; Ash 2001). The Record Ridge Ultramafic comprises variably serpentinized, and locally carbonatized, ultramafic cumulates, including Dunite, Pyroxene-bearing Dunite, Olivine-bearing Wehrlite, Wehrlite and Lherzolite, dependent upon the relative proportion of olivine to pyroxene. Disseminated chrome spinel (chromite) is present in all ultramafic rocks. On fresh surfaces, the ultramafic is very fine grained with a black color. It also contains abundant veinlets of light green to bluish serpentinite. Weathered outcrops have a light brown colour with a distinctive lack of vegetation in the nearby soils.

As a result of variably developed, pervasive serpentinization, primary mineralogy and original textures are difficult to identify in the eastern portion of the ultramafic body. The western portion of the ultramafic body, exposed along the southern extent of Record Ridge, has been mapped as weakly serpentinized (Ash 2001).

Three additional, although small, ultramafic bodies are mapped southwest of the Record Ridge Ultramafic; one in the vicinity of the Velvet mine and two farther south, on the western slope of Mount Sophia. The Record Ridge Ultramafic and three small ultramafic occurrences are located between a small stock of Late Jurassic and/or Cretaceous quartz-feldspar porphyry (Unit Kqp) and intrusive lithologies correlated to the Eocene Coryell Batholith and may represent pendants of the Record Ridge Ultramafic within the younger intrusive bodies.

The western portion of the property, including the western slopes of Record Ridge and Record Mountain, is underlain by predominantly syenite and quartz monzonite lithologies correlated to the Coryell Intrusions.

Where observed, contacts of the ultramafic body with host rocks are sharp and display varied amounts of fault movement. The western and southern contacts juxtapose the Record Ridge Ultramafic against the younger Coryell Intrusive. In addition, small apophyses and dykes of felsic material have been described in drill core recovered from Record Ridge (Kim and Peck 2008, 2011). Taken together with the lobate nature in map view and the presence of small isolated ultramafic bodies (possible xenoliths or rafts within the Coryell batholith several kilometers to the south), the western and southern contacts are interpreted to suggest an intrusive contact with the batholith.

At the extreme southwest margin of the Record Ridge Ultramafic, in the western portion of the Sophia Creek drainage, the ultramafic is in intrusive contact with a small stock of Cretaceous age quartz-feldspar porphyry.

Along its eastern margin, the contact is not exposed, however, the ultramafic is juxtaposed against massive fine-grained, aphanitic mafic volcanic rocks correlated to the Early Jurassic Elise Formation of the Rossland Group. In addition, the presence of fish-scaled serpentine with localized carbonate altered shear zones near the margin of this body is interpreted to suggest a faulted contact (Price 2006). The contact of the ultramafic is interpreted to be fault controlled, with an interpreted east-directed thrust fault juxtaposing the Record Ridge Ultramafic against mafic volcanics correlated to the Late Jurassic Elise Formation.

The inferred northern contact of the body is marked by a linear topographic depression which Fyles (1984) interpreted as a faulted contact. The interpreted fault juxtaposes the Record Ridge Ultramafic, tentatively interpreted to be Pennsylvanian in age, against variable intermediate to mafic volcanic lithologies correlated to the Middle Eocene Marron Formation. It has been interpreted as a north-side down normal fault. A minor increase in alteration intensity in the ultramafic rocks towards the contact is interpreted to suggest the fault has been affected by only limited movement or is restricted to late, high level brittle faulting.

2.3.1.2 Alteration

The dominant style of alteration associated with the Record Ridge Ultramafic is serpentinization, a metasomatic process involving hydration of magnesium and/or iron-rich olivine. Serpentinization of the Record Ridge Ultramafic Body is interpreted to be related to emplacement of the Coryell Batholith and associated hydrothermal activity. Hydrothermal fluids may have been meteoric, and silica would have been readily available, leached from adjacent volcanics and/or derived from the intrusive itself.

2.3.1.3 Structure

The most significant feature in the RRIMM Project area, the “Rossland Break”, is an east-trending zone of crustal weakness marked by faults and intrusions that include the ultramafic bodies, the Rainy Day Pluton and the Rossland monzonite. It is defined, in part, by a thrust fault along the eastern boundary of the Record Ridge Ultramafic and extends northeast through the historic Rossland Mining Camp (Fyles 1984; Hoy and Dunne 1998).

This long-lived, major structural break is interpreted to have had three major episodes:

- Extensional tectonism during deposition of the Elise Formation of the Rossland Group in Early Jurassic time.
- Compressive tectonism produced east-directed thrust faulting between 187 and 167 Ma, prior to intrusion of Middle and Late Jurassic plutons.
- Normal faulting in the Eocene occurred before and after emplacement of the Coryell intrusions. These faults are numerous, steeply-dipping, north-trending, gouge-filled structures. Although movement on most was very minor, some have larger displacements of listric geometry (Hoy and Dunne 2001). A few examples, such as the Jumbo and OK faults which truncate the western end of the Rossland monzonite, have large normal displacements. These faults appear to have controlled emplacement of Coryell syenite and lamprophyre dykes, but movement continued at least sporadically after emplacement of young intrusions, which are commonly brecciated.

The Rossland Break separates two regional domains, characterized by differing structural fabrics. On the south side of the break, structural fabrics strike to the northeast. In contrast, on the north side, structural fabrics strike due north. Deformation within country rocks reportedly intensify in the vicinity of the break.

In the study area, only the Elise Formation of the Rossland Group is located on the southern side of the break. This unit is relatively massive, with abundant primary structures and lacks a pervasive foliation. Bedding strikes northeast and dips steeply to the northwest, interpreted to parallel the orientation of the thrust fault. Small scale folding has been observed, supporting an interpreted top to the east thrust sense.

Units on the north side of the break include the Record Ridge Ultramafic, the Marron Formation and the Coryell Batholith. The ultramafic has a widely anastomosing fabric defined by zones of serpentinization. Contacts of this unit with surrounding hosts rocks are described as variably developed faults, interpreted to result from differential movement along the Rossland Break or, alternatively, during volume increase associated with serpentinization of the ultramafics. Volcanics of the Marron Formation are relatively massive, with abundant primary structures and lack a pervasive foliation. The Coryell batholith is massive with no distinctive ductile fabric, but it does have a highly fractured brittle fabric (Fyles 1984).

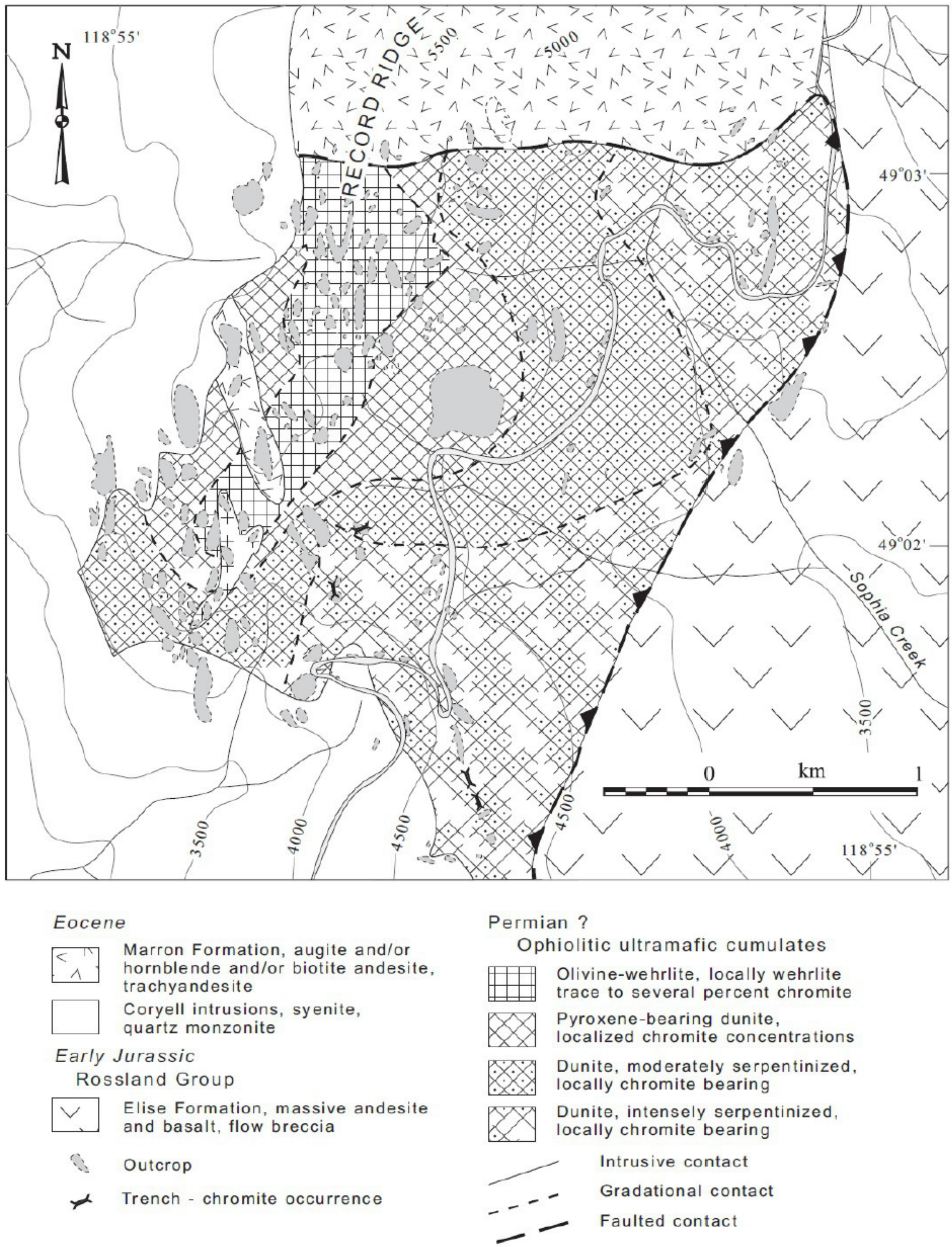


Figure 2.3-1: Geological Map of the Record Ridge Ultramafic Exposed on Record Ridge

2.3.1.4 Groundwater Flow in Bedrock

RRIMM Project geology consists of metamorphosed volcanic rocks and intrusive bodies that have been altered via serpentinization and silica enrichment along hydrothermal pathways (i.e., structural features). This combination of rock types and metamorphic alteration will reduce the primary hydraulic conductivity (matrix flow) of the rockmass at project scale and results in a low flow system. Later structural deformation can produce secondary permeability features (faults/fractures), which then become preferential groundwater flow targets for site assessment and monitoring.

The groundwater system at the RRIMM Project site is expected to be a fracture dominated (secondary permeability) system where the bulk of the rock mass is low hydraulic conductivity. Structural elements (faults and fractures) will control groundwater flow in this type of rockmass.

2.3.1.5 Lithological Controls on Groundwater Flow System

Lithological layering within the serpentinites is poorly defined as a result of the intensity with which structural discontinuities are developed within the Record Ridge Ultramafic. Based on structural interpretation and modelling sub-surface drill hole data, the orientation of the felsic monzonite documented within the Record Ridge Ultramafic is interpreted to have a regional strike of 010° and a dip to the east and ESE. The lithology fabric is not expected to exert a significant control on groundwater flow at the RRIMM Project.

2.3.1.6 Structural Controls on Hydrogeology

Geological structures in the Project area will affect groundwater flow in that they can act as either preferential pathways or barriers to flow. Currently, the influence on structure is not well defined, but several observations have been made that indicate how structure will interact with groundwater flow.

Drill hole RRS11-02 was drilled next to a cross cutting fault immediately south of the proposed open pit. This drill hole was drilled on the up-slope (up-gradient) side of the fault and has been left open and has been flowing since completion in 2011 (Figure 2.3-2). The observed upwards gradient indicates that the fault is impeding flow and acting as a barrier.

A review of the geological data from the 2008 and 2011 drill programs, regional mapping, and field observations were carried out by SRK in 2016 and used to assess potential impacts on the flow system. As specific data from drilling are not available for assessing the mapped/modelled faults away from the previous drilling, these have been assumed to be enhanced groundwater flow pathways to be conservative. These structural elements are consequently the target for groundwater and surface water (discharge) monitoring networks and will be assessed as work progresses on the site.

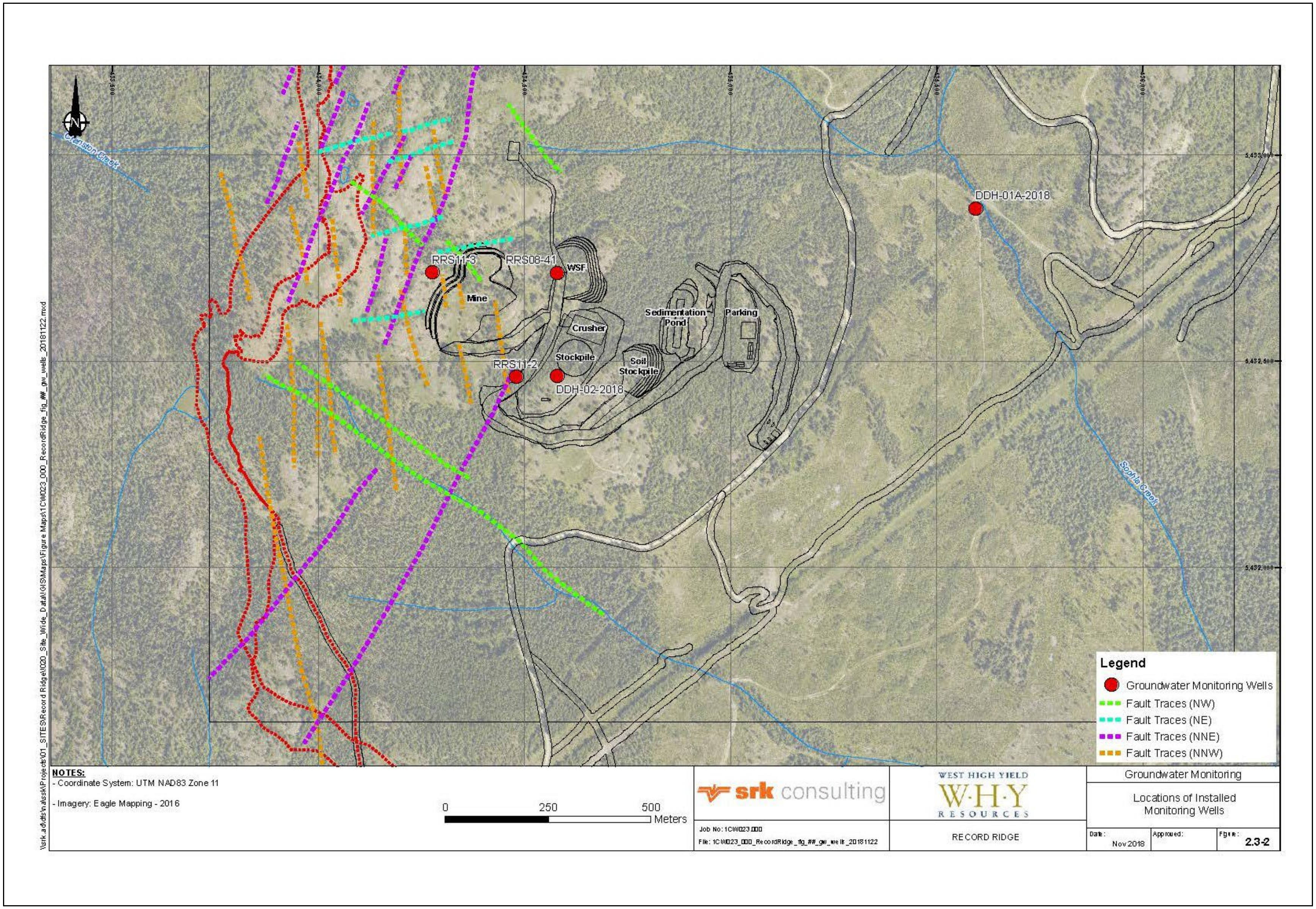


Figure 2.3-2: Location of Groundwater Monitoring Wells and Mapped Structure

2.3.2 DEPOSIT (ORE) GEOLOGY

2.3.2.1 Mineral Deposit

Alpine-type ultramafic complexes are interpreted to represent sections of oceanic crustal thrust faulted (obducted) onto continental crust. Oceanic crust has distinctive set of lithologies, termed the Ophiolite suite. The basal portion consists of cumulate peridotites (olivine-rich ultramafics), overlain by cumulate gabbros, overlain by plagiogranites, overlain by mafic dike swarms, and capped with pillow basalts. Serpentinization of the ultramafic portion of the sequence frequently occurs during deformation and subsequent metamorphism. These bodies commonly have a lens, or augen shape, bounded by ductile fault planes. Due to the inherent and characteristic compositional layering of the ophiolite site, they also possess distinctive, large scale chemical zonation.

2.3.2.2 Geological Model Applied

The Record Ridge Ultramafic, comprising predominantly dunite, with subordinate wehrlite and/or lherzolite, is plutonic, with well-preserved primary cumulate textures typical of both Alaskan- and Alpine-type ultramafics. The rhombic geometry evident in plan view reflects faulting along its northern and eastern margins and an intrusive contact on its western to southwestern margins. Internal variation between dunite and wehrlite/lherzolite is interpreted to reflect structural deformation (i.e., thrust slivers) and is, therefore, inconsistent with a zoned ultramafic complex.

Ash (2001) reported results of analysis of the complete suite of Platinum Group Elements (PGE) from samples of massive chromitite taken from the Record Ridge Ultramafic. Normalized Platinum Group Element abundances document an enrichment in osmium, iridium, and rhodium relative to platinum and palladium, consistent with PGE abundances of ophiolitic chromitites. In contrast, Alaskan-type chromitites are characterized by the reverse relationship in which platinum and palladium are enriched relative to the other PGE.

Furthermore, Ash (2001) reported "Petrographic study of the ultramafic rocks provides additional evidence in support of an ophiolitic affinity. Intercumulate orthopyroxene has been identified in a number of thin sections. Orthopyroxene is a common minor intercumulate phase in ophiolitic ultramafic cumulates but is characteristically absent in Alaskan-type complexes due to their strongly alkaline composition. The geochemical and petrological character of these ultramafic rocks suggests that they are most likely ophiolitic in origin and implies formation within the lower plutonic crust at an oceanic spreading centre."

The ore and waste for this project will be separated through a combination geochemical analysis of diamond drill core and visual inspection/observations during the mining process. The ore and waste lithologies are easily distinguished on the basis of colour. The ore is black in colour and the waste materials, andesite and monzonite are distinctly lighter in colour and easily distinguishable to the naked eye.

2.3.2.3 Record Ridge Deposit and Mineralogy

The principal element of commercial interest is magnesium hosted within serpentinized ultramafic rocks. In general, the deposit geology of Record Ridge is relatively simple, comprised of variably serpentinized ultramafic, with subordinate andesite, correlated to the Elise Formation, and minor cross-cutting felsic intrusions, as dykes and/or sills, correlated to the Coryell Intrusive.

These lithologies have been cross-cut, and variably offset, by four sets of faults, oriented east-northeast, north (to northeast), north and northwest. Timing of these faults with respect to one another has not been determined. It is possible these faults are, essentially, small scale blocks faults, having minor offsets, to accommodate the volume increase associated with serpentinization of the ultramafic and, therefore, restricted to the ultramafic.

Two major faults have been identified, the Divide Fault and the Boundary Fault. The Boundary Fault has an orientation similar to the “Northwest” fault set and may belong to that set, having slightly more local offset. The Divide Fault is oriented to the northeast and does not correspond to any of the other fault sets. Furthermore, it has locally significant offset as it juxtaposes serpentinite having very little andesite (to the north) from serpentinite having an estimated 40-50% andesite to the south. While the offset is significant, it’s sense (i.e., whether normal or reverse) is unknown.

Magnesium content throughout the ultramafic varies from approximately 11-18% in andesites and between 19 and 31% in the serpentinite. Variation within the “andesite” unit is interpreted to reflect lithological variation from predominantly intermediate andesite and basaltic andesite to more mafic dioritic phases.

Magnesium content within the serpentinite is interpreted to reflect internal lithological variation between dunite, through lherzolite to wehrlite, dependent upon the olivine: clinopyroxene: orthopyroxene content of the original protolith.

Late, felsic dykes, correlated to the Middle Eocene (Tertiary) Coryell Intrusive, generally trend to the northeast and dip steeply to the east.

Additional mineralogy often associated with serpentinites can be asbestiform minerals, (elongated, fibrous to acicular minerals). Common minerals falling into this category are Gunerite, Chrysotile and amphibole minerals such as Tremolite-Actinolite, and Anthophyllite. An extensive investigation of existing drill core from all previous drilling on Record Ridge was completed to determine what asbestiform minerals are present within the deposit and, if present, identify the minerals present and their frequency of occurrence throughout the deposit. Approximately 1,400 m of core, of 15,221 m drilled to date, was examined. The core targeted for examination initially focused on all intervals previously identified during initial logging as containing asbestiform minerals (1,274.41 m over 6 holes, with a potential total identified, cumulative meterage of 20.74 m). In addition, core chosen for examination represented predominantly serpentinite altered intervals, as well as holes proximal to the major structures identified within the deposit, given that this type of mineralization is secondary in nature and most often formed in fault zones. On-site examination included initial visual identification of potentially asbestiform minerals, followed by confirmation of the mineral species by refractive index using a Polarized Light Microscope. The study confirmed that fact that initial logging incorrectly identified white to grey minerals as asbestiform minerals.

The investigation identified 15 occurrences of Chrysotile and 7 occurrences of an asbestiform amphibole mineral, suspected to be Tremolite or Anthophyllite. All occurrences were in the millimetre (to, rarely, centimeter) size range and exclusively associated with veinlet structures. Collectively, the cumulative thickness of asbestos-bearing intervals amounted to approximately 6 cm. In summary, total veinlet-hosted, asbestos mineralization amounted to approximately 0.004% of the total core examined, with greater than 50% occurring as Chrysotile.

2.3.3 Surface Geology and Terrain Mapping

2.3.3.1 Surficial Materials

Surficial geology and terrain mapping at 1:10,000 scale was completed for the purpose of terrain stability and natural hazards mapping. The RRIMM Project site is comprised of several surficial materials including colluvium, weathered bedrock, fluvial soils, glacial fluvial soils, till, and organic rich soils. A summary is provided, however, more detail on the local surficial materials and geomorphic processes are included in *Record Ridge Magnesium Project Natural Hazards Assessment* (SNT Geotechnical Ltd 2018; Appendix 2-B).

Colluvium: Within the study area, colluvium is most commonly derived from local bedrock which has moved downslope by means of rock falls, debris slides or snow avalanches. For the most part, colluvial deposits within the study area tend to be loosely packed and coarse textured (typically 50% coarse fragments or greater) with a matrix of sandy silt or silty sand. In general, colluvial deposits closer to the source, such as a rockfall deposit just below a rock outcrop, has a higher coarse fragment content (up to 100% coarse fragments) and a coarser to non-existent matrix. As transportation distance from the source increases, colluvium often has a finer textured matrix and lower coarse fragment content (40 to 60%). Coarse fragments in colluvial deposits are typically angular to sub-angular and vary in size from pebbles to large blocks depending upon the nature of the deposit.

Weathered Bedrock: Within the study area, weathered bedrock has been mapped in 8 out of 126 polygons. These polygons are found along the gentle ridge top positions usually associated with undulating or hummocky bedrock.

Fluvial: Within the study area, fluvial materials have been mapped in three polygons. Fluvial materials may be present in small amounts along other gentle gradient portions of creeks but generally not comprising more than 10% of the polygon.

Glaciofluvial: Glaciofluvial materials may have been deposited in close contact with glacial ice (kame deposits), along valley sides, in some upland areas, or in front of a receding ice margin where no direct ice contact occurs (outwash deposits). Glaciofluvial deposits within the study area have been mapped in 13 polygons, mainly along the southern boundary.

Till: Till is common throughout the study area, appearing as a component in many of the terrain symbols (109 out of 126 polygons).

2.3.3.2 Impact on Groundwater Flow

Shallow groundwater flow will be influenced by the surficial materials and weathered bedrock, with flow taking place at the contact of unconsolidated and consolidated materials. Combined with the steep terrain, the unconsolidated materials tend to direct shallow flow to topographic features that are controlled by the larger scale geological structures. These incised gulleys will form flow paths and be where the main groundwater and surface water interaction occurs, with groundwater discharging to the creeks as it flows down the slope. Surface water monitoring, especially at low flow periods, will be the most effective means of assessing this interaction.

2.3.4 Terrain Stability and Natural Hazards

A natural hazard assessment and a snow avalanche hazard assessment of the study area (1,305 ha) were completed for the RRIMM Project. A summary is provided, however, more detail on terrain stability and natural hazards are included in *Record Ridge Magnesium Project Natural Hazards Assessment* (SNT Geotechnical Ltd 2018; Appendix 2-B).

The natural hazard assessment was conducted to identify natural hazards that have potential to impact the mine, waste dumps, or mine infrastructure. Preliminary polygon delineation and terrain interpretation was completed in a digital environment using ESRI ArcMap. Terrain interpretation was completed using LiDAR based Bare Earth model, slope themed mapping, and 5 m topographic contours, in addition to high resolution orthomosaic imagery, Google Earth, and hard copy air photo interpretation. A total of 126 polygons were mapped and field sites were located across a variety of terrain. A total of 66 field sites were located among 48 polygons.

There are few areas of natural hazards that are likely to affect development in the RRIMM Project site (Figure 2.3-3). Areas subject to rockfall are generally associated with relatively small rock bluffs as opposed to large rock faces. This hazard is typically localized and not widespread. The main gully systems are also subject to periodic gully sidewall failures, as well as some areas of dormant retrogressive slumping in thick till along gully sides of Sophia Creek and its primary tributary. Debris flow activity has been identified in the upper reaches of East Corral Creek. Sophia Creek is likely subject to periodic debris flood processes but does not appear to be prone to debris flow initiation or transport. Both Sophia Creek and East Corral have well defined fans containing both public and private transportation infrastructure as well as private land and infrastructure where they reach the valley bottom.

Although areas adjacent to, and within, the proposed RRIMM Project area are predominately stable, there are areas with moderate to high terrain hazard classes, moderate terrain stability classes, and snow avalanche hazards (Figure 2.3-4; SNT Geotechnical Ltd. 2018; Appendix 2-B). The site has limited areas of avalanche hazard due to dense forest cover and low angle slopes below approximately 30 degrees (Figure 2.3-5). Avalanche hazard areas include short (20 to 80 m elevation) grassy slopes with sparse trees that exceed 30-degree slope steepness.

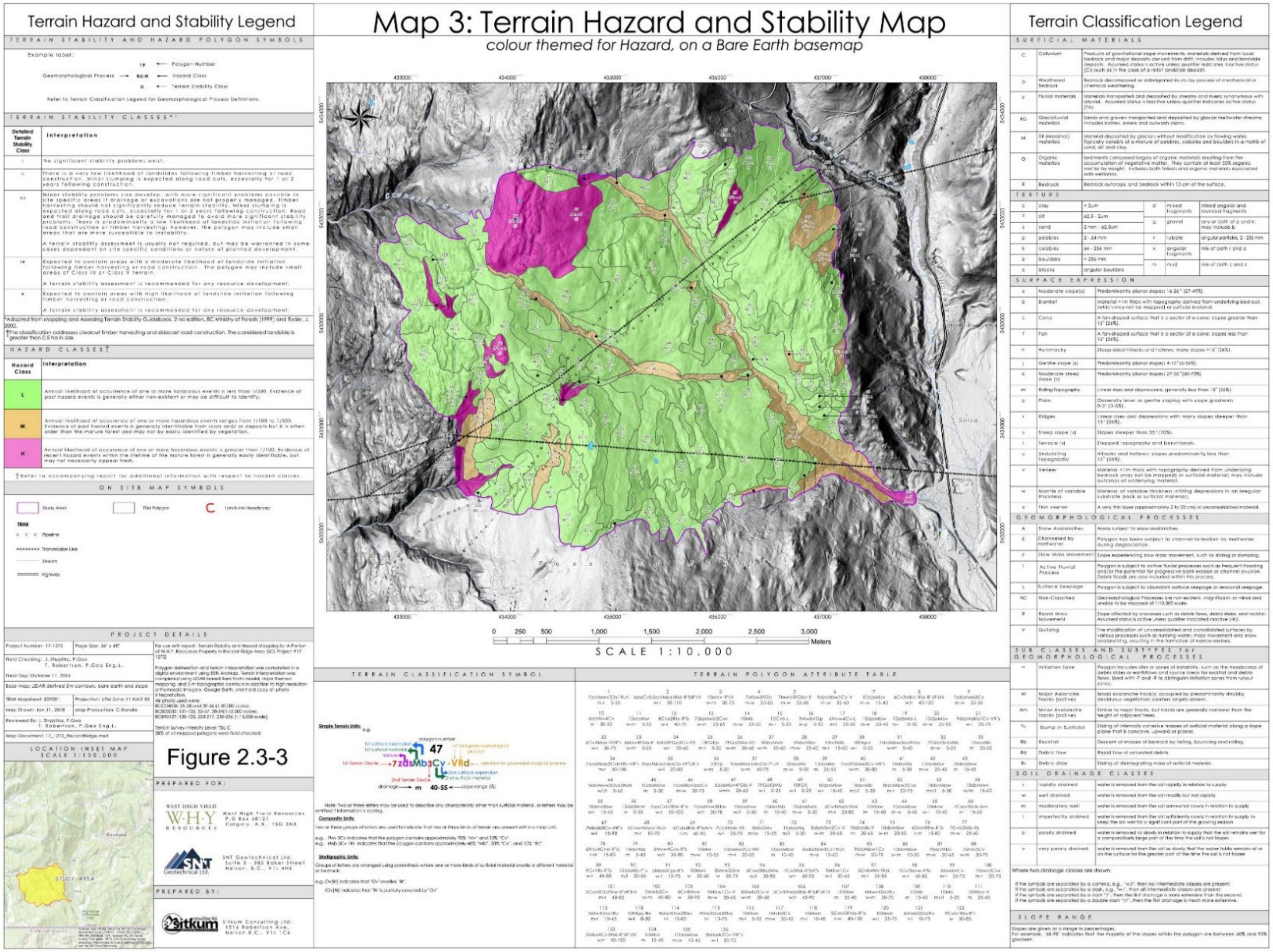


Figure 2.3-3: Terrain Hazard and Stability Map – Hazard

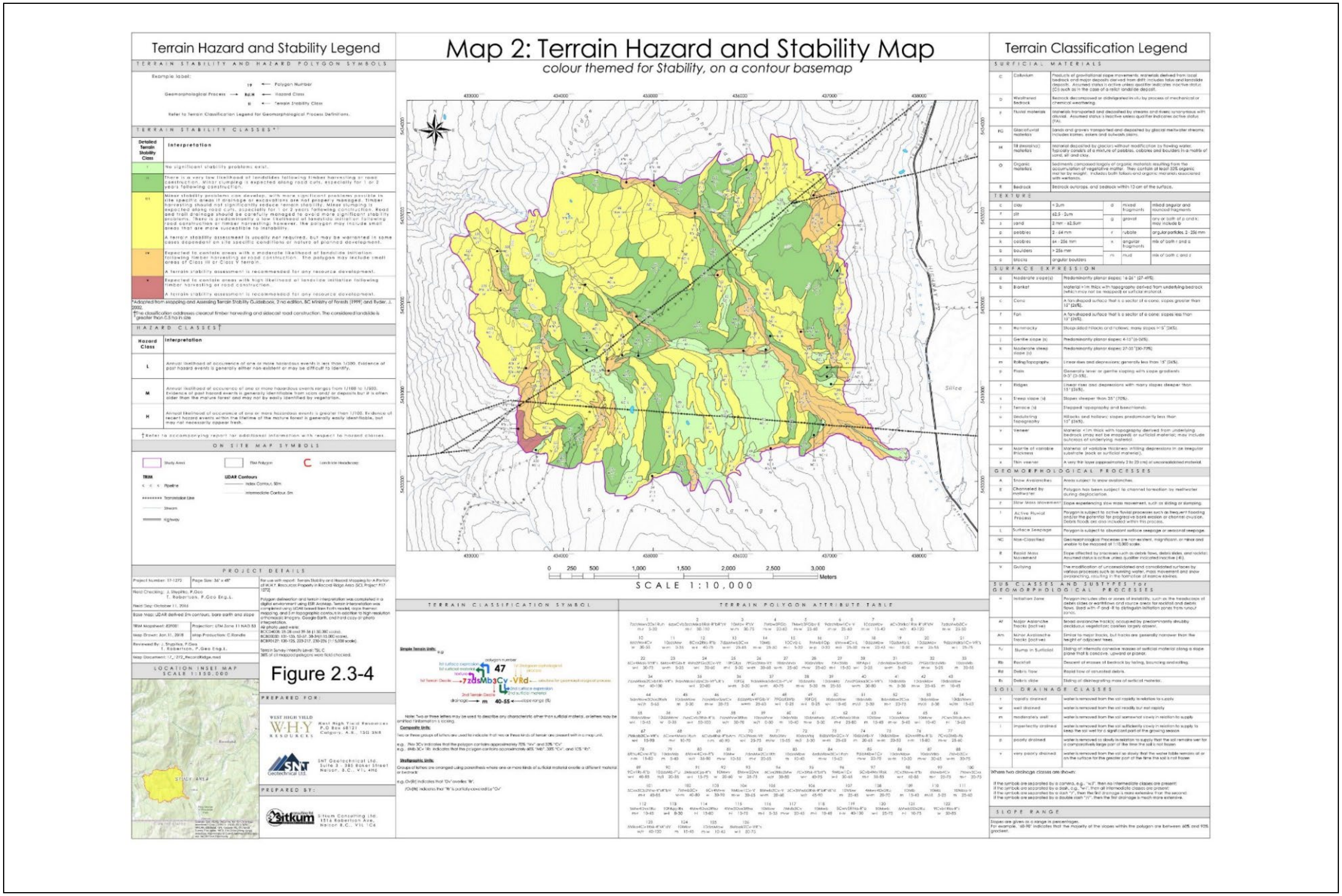


Figure 2.3-4: Terrain Hazard and Stability Map – Stability

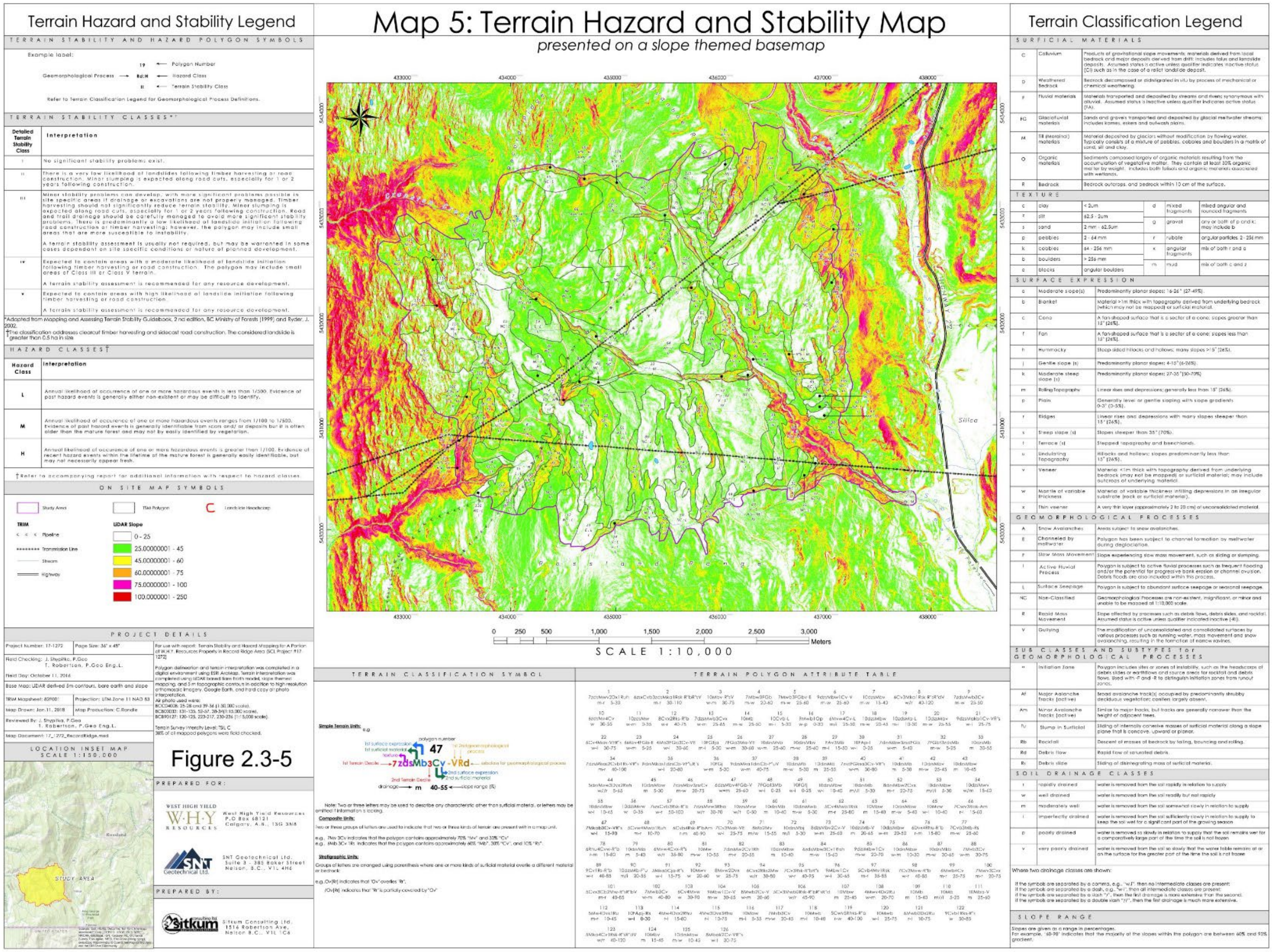


Figure 2.3-5: Terrain Hazard and Stability Map – Slope

2.3.5 Soil Survey and Soil Characterization for Reclamation

2.3.5.1 Baseline Conditions

Soil resources were surveyed in 2016 following Soil Inventory Methods for BC (Resource Inventory Committee 1995) and defined by the Canadian System of Soil Classification (Soil Classification Working Group 1998). A summary is provided, however, more detail on soil baseline conditions are included in *Record Ridge Project Baseline Soils Resources Report* (Yole 2018, Appendix 2-C). Most common soils are Brunisols and Podzols. Soils with similar profile descriptions and characteristics were grouped into categories called Soil Map Unit (SMU).

Of the twelve different SMUs identified and mapped (Figure 2.3-6; and Figure 2.3-7) in the wider Record Ridge region, SMUs 1, 2 and 4 were the most common. These SMUs are characterized as the following:

- SMU 1: Relatively deep, silty sandy gravelly/cobbly glacial till of moderate depth (0.6 to 1.5 m) with medium moisture and nutrient content (32% of the study area).
- SMU 2: Shallow soils to bedrock (approximately 0.2 to 0.6 m depth) (22% of the study area).
- SMU 4: Deep, sandy, silty rubbly colluvial materials on steep slopes (21% of the study area).

Nine other soil types were mapped and described but their occurrence was minimal. SMUs that occur in the mine footprint area are SMUs 1, 4A, and 5. SMU 1 is described above. SMU 4A are generally loose soils with a high volume of rock fragments. They have low moisture holding capacity and often have lower fertility status. SMU 5 consists of bedrock outcrops complexed with very thin till and colluvium to bedrock.

Certain parts of the study area contain naturally high concentrations of trace elements such as nickel, chromium and, to a lesser extent, arsenic, lead, cadmium, and zinc. These elevated levels of trace elements are natural to the mine area and are likely related to the underlying bedrock hosting the deposit. Silty and fine sandy soils near creeks and organic soils are susceptible to soil erosion. These soil types do not occur in the mine area.

2.3.5.2 Soil Suitability for Salvage

It is beneficial to understand the existing characteristics of soil in locations that could potentially be disturbed so that they can be salvaged and stockpiled for later use in reclamation as growth medium. This practice greatly increases the chances of reclaiming areas to stable, self-sustaining plant communities.

Soil characteristics used to group soils into SMU categories and evaluate suitability for salvage and use for reclamation are presented in Table 2.3-1 and Table 2.3-2. Table 2.3-1 summarizes important physical soil characteristics observed that influence soil fertility. Soils with deeper LFH and Ah horizons have higher nutrient content and generally deeper rooting depth. The depth of main root growth is a good indication of the most productive or biologically active soil layer.

Table 2.3-1: Mean Values of Important Soil Characteristics for Different SMUs

SMU	Number of Samples (n)	LFH Depth (cm)	Ah Depth (cm)	Rooting Depth (cm)	Depth of Restrict Layer (cm)	Slope Gradient (%)
1	32	3.8	0.8	35.5	20	28
1B	4	5.5	35.0	29.3	32	21
2	15	1.7	3.2	18.1	20	29
2A	4	1.3	27.5	41.7	30	26
3	4	2.8	-	32.5	38	10
4	4	4.3	-	30.0	75	52
4A	2	1.5	18.0	-	-	40
4B	1	5.0	-	20.0	20	50
5	12	0.6	4.5	16.2	14	30
6	9	4.3	3.0	33.5	-	22
7	4	45.8	18.0	26.7	35	0
8	14	8.1	12.8	36.5	51	12

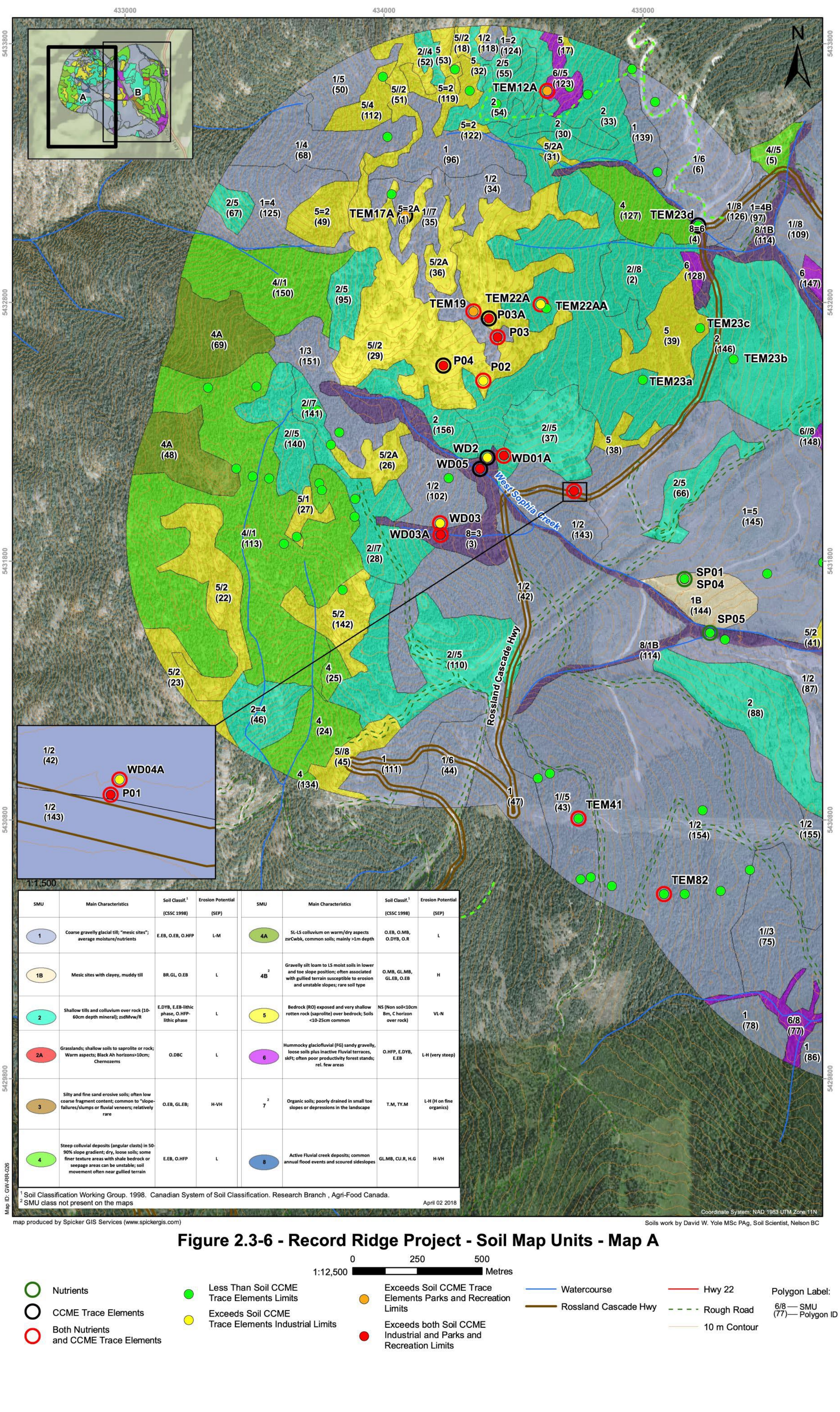


Figure 2.3-6: Soil Map Units Map A

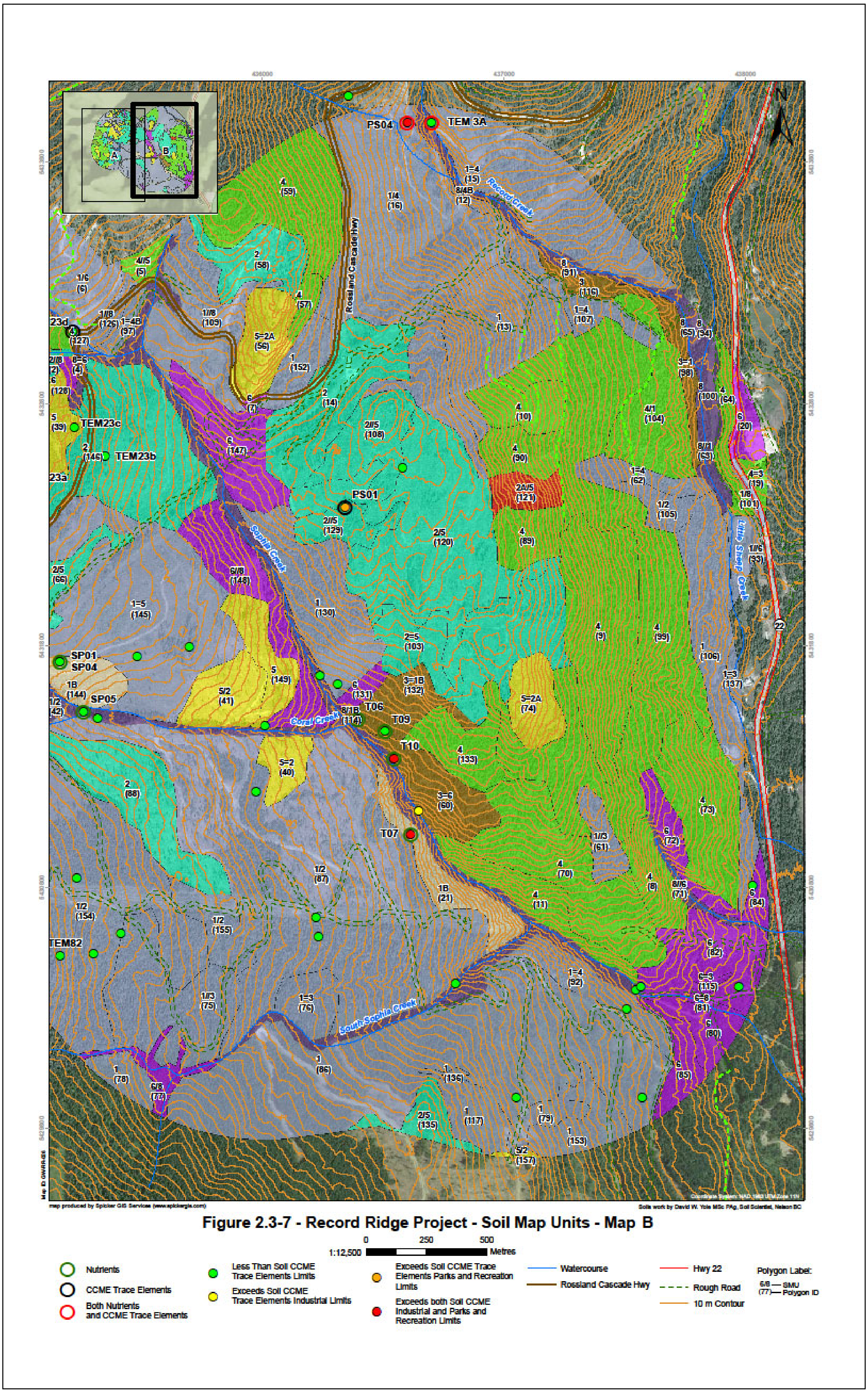


Figure 2.3-7: Soil Map Units Map B

Table 2.3-2: Mean Soil Fertility Values by SMU and Soil Horizon[1]

SMU	1		1B		2		3		5		6		7		8	
Parameter	LFH	0-15 cm	Subsurf	LFH	0-15 cm	LFH	0-15 cm	0-15 cm	LFH	0-15 cm	0-15 cm	Oh	H	Subsurf	0-15 cm	Subsurf
n	7	7	1	1	1	1	1	1	1	1	1	1	1	1	5	2
Average of pH (1:2 H2O)	5.2	5.5	6.0	5.0	6.2	5.2	5.6	5.5	5.1	5.2	5.4	5.0	6.1	4.9	6.0	6.5
Average of Buffered pH	6.3	6.3		6.4		6.6	6.4	6.0	6.7	6.2	6.5	6.2		6.0	6.4	
Average of Est E.C. (mmhos cm-1)	0.41	0.29	0.23	0.46	0.30	1.06	0.34	0.22	0.50	0.30	0.24	0.42	0.66	0.30	0.34	0.50
Average of Leco Carbon (%)	28.0	3.41	0.89	43.4	1.77	31.6	2.72	2.18	36.7	2.77	1.79	19.4	28.0	16.23	4.66	9.65
Mean Total N (%)	1.06	0.19	0.06	1.01	0.11	1.23	0.11	0.11	1.09	0.09	0.09	1.13	1.52	0.65	0.28	0.44
Mean of Avail P (ppm)	73	87	80	31	20	250	10	115	220	31	48	32	21	26	42	14
Mean of Avail K (ppm)	516	111	110	620	155	1500	95	100	467	85	48	78	210	31	106	130
Mean of Avail Ca (ppm)	4,329	888	1,000	7,200	3,000	4,667	600	750	4,833	575	500	1,000	3,700	410	1,255	2,000
Mean of Avail Mg (ppm)	1,950	783	1,330	580	265	867	65	90	1,233	205	50	610	7,600	490	1,425	3,000
Mean of C/N Ratio	26.1	19.2	14.8	43.0	16.1	25.7	24.7	19.8	33.6	30.8	19.9	17.1	18.4	25.0	16.5	21.93

SMUs 2A, 4, 4A and 4B were not sampled

Soil samples were collected from SMUs and submitted for laboratory analysis for fertility parameters (Table 2.3-2). This data was used to confirm the nutrient status of SMUs and inform the potential need for nutrient augmentation by fertilizers during reclamation. This information, combined with additional data collected during field survey, was used to create categories for rating soil characteristics suitable for salvage. Ratings range from high to very low/nil (Table 2.3-3). Each of the SMUs studied were then rated based on this system (Table 2.3-4). SMUs rated good or fair to good for salvage were SMUs 1, 1B, 2A and 8.

Table 2.3-3: Soil Salvage Potential Ratings

Criteria	High	Fair	Low	Very Low or Nil
Ah depth (cm); high % organic matter	3-10+cm	1-3cm	0-0.5 cm	0 cm
Mineral Texture	SiL, L, SL	fine LS, SiCL, fine LS	S, C	HC, SiC, no soil or rock
Root Zone Depth (cm)	40-75+	25-40	<10-25	<10
Coarse Fragment Content (%)	<20	20-45	45-70	>70
Reaction (pH)	6.5-7.5	5.5-6.4	4.5-5.4	<4.5 >9
Calcareous Subsurface	Nil to minor fizz	Moderate fizz	Strong fizz; Visible salt crystals	Very strong fizz
Improve Moisture Retention/Containment	HC, C	SiCL, L, SC	n/a	n/a

Table 2.3-4: Suitability of Soil for Salvage by Soil Map Unit (SMU)

SMU	Suitability Rating	Mean Soil Depth (m) for Salvage	Limitations
1	Good to Fair	0.36	Coarse fragment content variable, 0-40 CF%
1B	Good to Fair	0.29	Moist locations; compaction expected; gravelly > 30 cm
2	Fair to Low	0.18	Very gravelly (>60% volume) shallow soils; subject to drought; low nutrient status
2A	Good	0.42	Significant black Ah horizon; shallow
3	Fair	0.33	Often moderately steep sloping areas and highly erodible soils; near steep-sided stream channels; moderate nutrient content
4	Low to Unsuitable or Nil	0.30	Steep to very steep landscapes; very high % CF; low cohesion and excessively droughty as salvage material
4A	Unsuitable	0.18	Coarse rubbly/blocky; steep
4B	Fair	0.20	Lower/toe slope; wet
5	Unsuitable to Very Low	0.16	Bedrock-dominated; saprolite often breakable and usable; often high coarse fragment content in saprolite

SMU	Suitability Rating	Mean Soil Depth (m) for Salvage	Limitations
6	Fair to Low	0.34	Coarse sandy gravelly sgFG materials; soil layers with “brown” colour worth salvaging
7	Fair to Good as amendment	0.27	Wet organic veneers associated with wetlands
8	Good	0.37	Adjacent to creeks; prone to seasonal flooding; high to very high erosion potential

During construction, soil suitable for use as growth medium will be salvaged, to the extent practicable, from footprints of mine facilities and stockpiled for use in reclamation. SMUs in the proposed mine facilities footprint that would be disturbed were assessed for their suitability for salvage as growth medium (Table 2.3-5). SMUs 1, 1B, and 2A are the most suitable for salvage in the mine area. In many areas of the mine footprint, particularly in the proposed open pit location, bedrock is at, or near, surface which has resulted in poor soil development. Overall average depth of soil that could be salvaged from disturbed areas in the mine footprint is 22 cm. The estimated volume of soil suitable to salvage as growth medium is 35,619 m^3 (Table 2.3.5).

Table 2.3-5: Soil Salvage Depth and Volume Available in the Mine Footprint

Infrastructure	SMU	Area (m^2)	Depth of Salvage (m)	Volume Salvaged (m^3)
Open Pit	1	9,391	0.36	3,380.8
Open Pit	2	4,585	0.18	825.3
Open Pit	5	17,758	0.16	2,841.3
Open Pit	7	2,348	0.27	634.0
Crusher Pad	2	34,573	0.18	6,223.3
Crusher Pad	5	1,863	0.16	298.1
Waste Storage Facility	2	10,450	0.18	1,881.0
Waste Storage Facility	5	951	0.16	152.2
Powder Magazine	2	1,159	0.18	208.5
Office Pad	2	6,657	0.18	1,198.2
Office Pad	5	9,650	0.16	1,543.9
Haul Roads	1	1,066	0.36	383.6
Haul Roads	2	53,351	0.18	9,603.2
Haul Roads	5	29,388	0.16	4,702.1
Haul Roads	7	152	0.27	41.1
Haul Roads	8	253	0.37	93.4
Runaway Lane	2	1,081	0.18	194.5
Sediment Pond	5	1,321	0.16	211.3

Infrastructure	SMU	Area (m^2)	Depth of Salvage (m)	Volume Salvaged (m^3)
Sediment Pond	2	6,688	0.18	1,203.8
Total		192,685		35,619

2.3.5.3 Potential for Erosion

The potential for soil to erode was evaluated in the field and confirmed with laboratory test work for particle size analysis. Each SMU was evaluated for its potential to erode and mapped (Figure 2.3-8). Further details are provided in the *Record Ridge Project Baseline Soils Resources Report* (Yole 2018, Appendix 2-C).

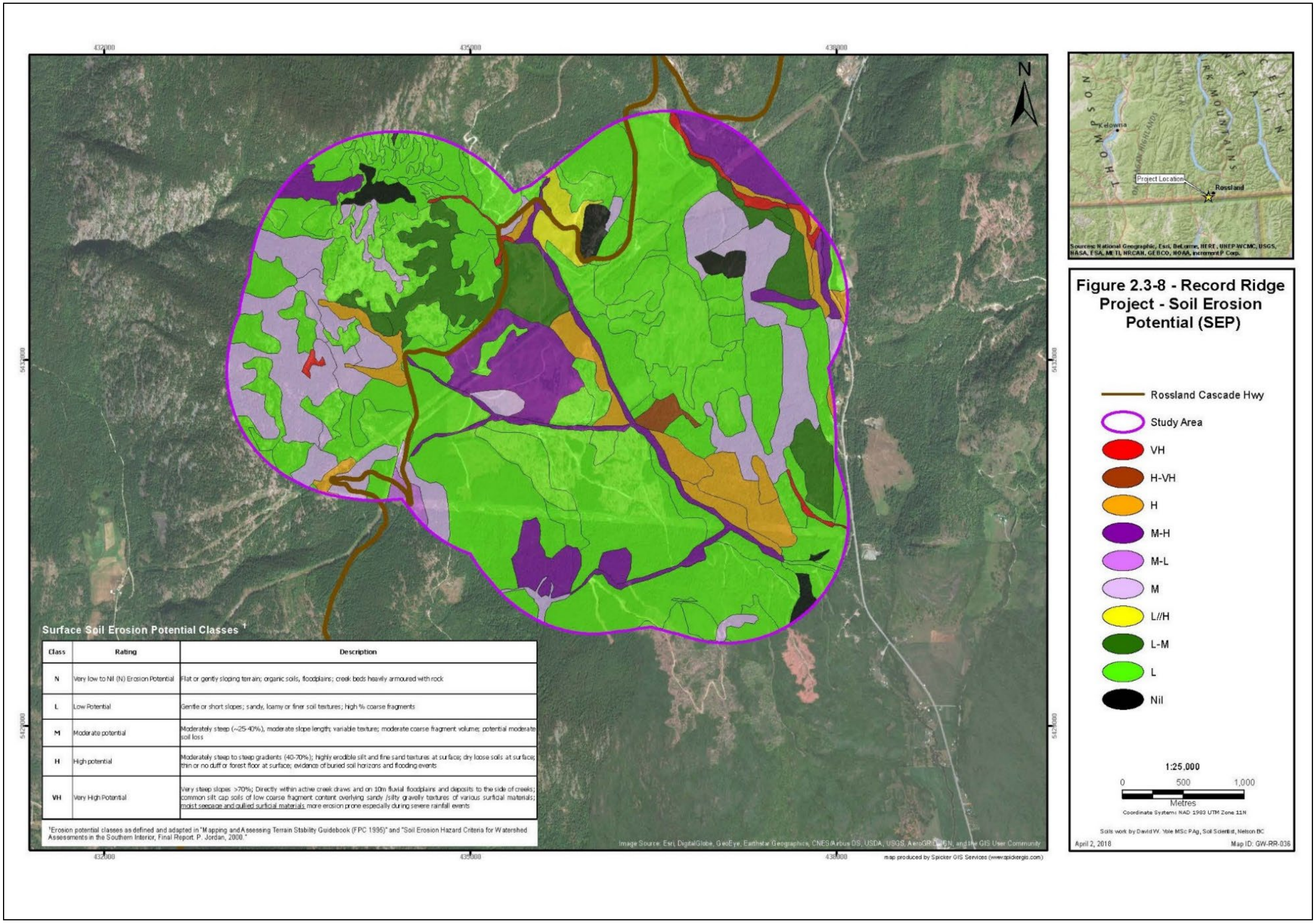


Figure 2.3-8: Soil Erosion Potential

2.4 GEOCHEMICAL CHARACTERIZATION AND SOURCE TERMS

2.4.1 GEOCHEMICAL CHARACTERIZATION PROGRAM OVERVIEW

Assessment of metal leaching (ML) and acid rock drainage (ARD) potential to date has focused on waste rock and geochemical characterization of core from exploration drilling programs conducted in 2007, 2008 and 2011. In August 2016, the Project's exploration geochemistry database was reviewed and 75 drill core composite samples for static geochemical characterization were selected. The main objectives of the static characterization program for waste rock were to:

- Obtain data on ARD potential using conventional methods for neutralization potential (NP) and acid potential (AP).
- Determine if results from these methods correlate with routine determinations of calcium (a potential surrogate for NP) and sulphur (a potential surrogate for AP) performed during exploration for which a larger dataset is available.

Intervals were selected to represent the three dominant rock types (andesite, monzosyenite, and serpentinite) and range of sulphur content for each rock type. The selected intervals were analyzed at Maxxam Analytics laboratory in Burnaby, BC, for ARD potential parameters (including paste pH, Modified NP, total carbon, total inorganic carbon, total sulphur, and sulphate), whole rock analysis by sodium peroxide fusion, and trace elements by aqua regia and four acid digestions. Testing was completed in November 2016. On the basis of this work, the exploration geochemistry database was queried to identify six composites for kinetic testing.

Kinetic testing consisted of both laboratory-scale humidity cell tests (containing 1 kg of -1/4 inch rock) and onsite barrel tests (containing 150 to 250 kg of -1 inch rock). Each program has six parallel samples, one sample duplicate, and one method blank. The objectives of kinetic testing are to measure mineral reaction and element release rates to:

- Assist in establishing site-specific criteria for ARD potential classification.
- Measure element leaching rates as input to contact water chemistry predictions.

Humidity cell tests were started on March 31, 2017, at Maxxam Analytics laboratory in Burnaby. The serpentinite and monzosyenite humidity cell tests met test objectives and were closed on February 2, 2018, after 44 weeks of testing. The monzosyenite humidity cell test and its duplicate were continued and reached 47 weeks of testing as of February 23, 2018. Leachate from the humidity cell tests is collected and analyzed weekly for pH and electrical conductivity. Sulphate, acidity/alkalinity, chloride, fluoride, phosphate, and dissolved elements by ICP-MS were analyzed on weeks 0, 1, 2, 4, 6, 8…44, 46.

Barrel tests were started between April 3 and April 7, 2017, at Record Ridge. Leachate from the barrels is collected when a sufficient volume has accumulated following precipitation events. Leachate from the barrels was collected in April, May, and June 2017, and analyzed for a similar suite of parameters as the humidity cell tests. Barrel leachate monitoring continued throughout 2018.

A summary is provided in this section of the Permit Application, however, more detail on geochemical characterization and assessment are included in *Metal Leaching and Acid Rock Drainage Potential Assessment and Management Plan* (SRK 2023h; Appendix 9-D).

2.4.2 SUMMARY OF FINDINGS

Static testing of the 75 selected drill core samples and comparison of these data with the exploration geochemistry database has shown that the exploration geochemistry database can be used to determine the ARD potential of andesite, monzosyenite and, potentially, serpentinite. ARD potential in serpentinite and monzosyenite is typically low due to low sulphide content (less than 0.1% S) or off-setting carbonate content. Andesite has localized ARD potential, with potentially acid generating (PAG) intervals ranging in length from 1.3 to 8.0 m (average 3.0 m) identified in drill holes within the south western section of the investigation area, and typically intermixed with non-PAG serpentinite.

On the basis of trace element enrichment relative to average crustal abundances for comparable rock types, metal leaching potential was identified for antimony, arsenic, boron, cadmium, chromium, cobalt, nickel, lead, silver, uranium, and zinc.

Humidity cell testing of the six selected drill core composites has shown all rock types have remained alkaline (pH 8.6 to 10) after 44 weeks of testing, consistent with the non-PAG static ARD classification. The highest sulphate, antimony, barium, cobalt, and nickel release rates were associated with leachate from the serpentinite humidity cell tests. The highest cadmium and copper release rates were associated with leachate from the andesite humidity cell tests. The highest uranium release rate was associated with leachate from the monzosyenite humidity cell test.

Similarly, onsite kinetic (barrel) testing of the six selected drill core composites has shown all rock types have remained alkaline (pH 8.1 to 10.2) after one year of testing. Comparison of element concentrations between the humidity cell and barrel leachates indicates several trace elements including aluminium, barium, boron, iron, lead, manganese, thallium, and uranium are likely constrained by mineral solubility limits under field conditions. Barrel tests remained operational throughout 2018 with samples collected and analyzed monthly if a sample was available.

Detailed results for all static and Kinetic testing completed are provided in *Metal Leaching and Acid Rock Drainage Potential Assessment and Management Plan* (SRK 2023h; Appendix 9-D). Predictions of contact water chemistry (geochemical source terms) for waste rock were used in a water and load balance model for the mine (Water Quality Model; Appendix 5-A).

2.5 TOPOGRAPHY, SURFACE DRAINAGE FEATURES, AND NATURAL HAZARDS

The RRIMM Project area consists mainly of gentle to moderately steep valley sides which are forested or contain regenerating forests of various ages. Rounded ridge tops are typical with elevations ranging from 740 m along lower Sophia Creek to 1,635 m at the height of land. On the west side of the height of land, the study area drops to approximately 1,260 m near Cranston Creek and 1,040 m near East Corral Creek. Local and regional drainage basins that will be affected by the Project, areas of groundwater discharge, wetlands and notable topographic features is provided in Figure 2.5-1.

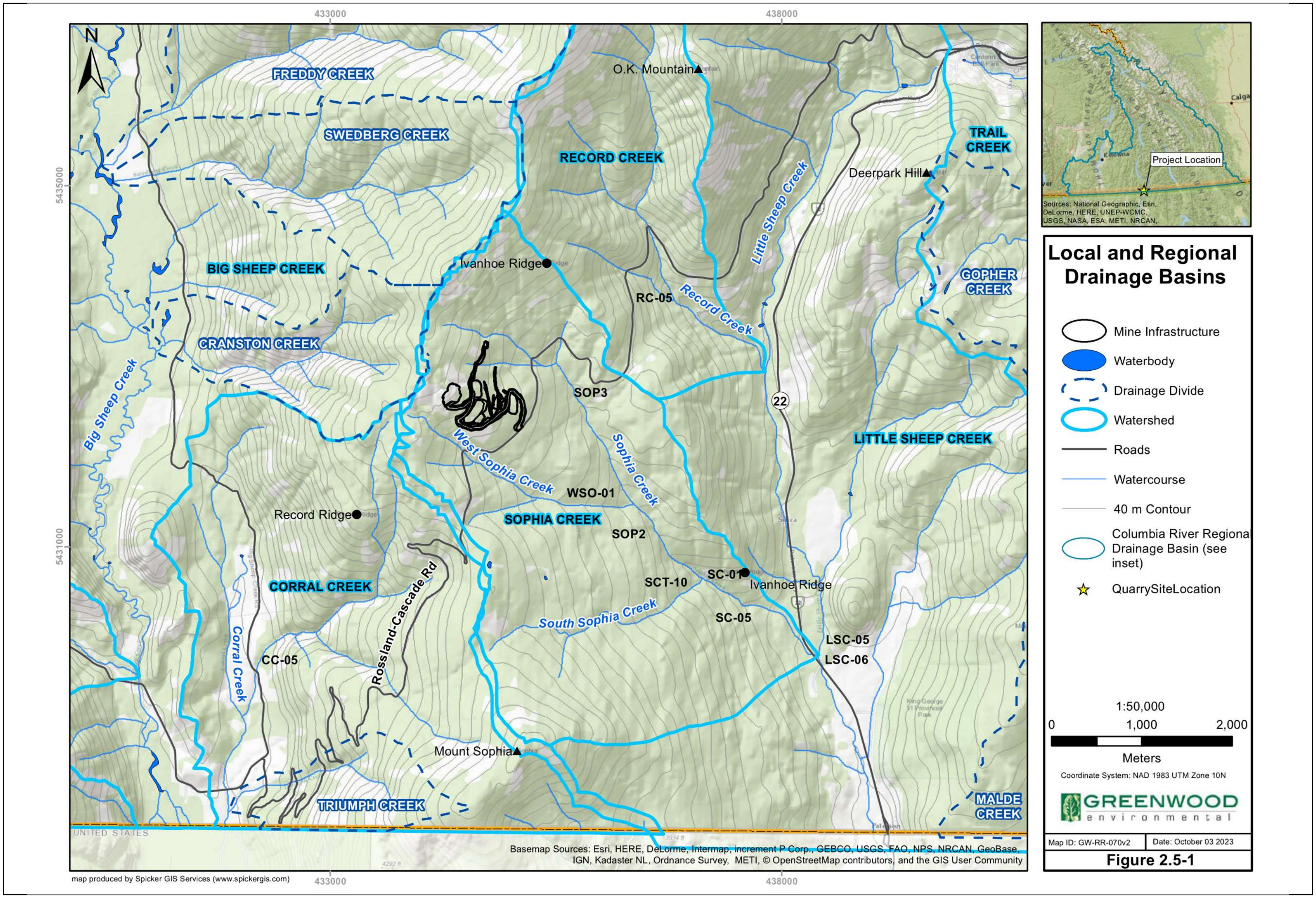


Figure 2.5-1: Local and Regional Drainage Basins

The slopes are typically less than 25° with steeper slopes in the gullies and sidewalls of Sophia Creek, Cranston Creek, and East Corral Creek and along local bedrock bluffs.

The majority of the area is located within the gentle to moderately sloping broad basin of Sophia Creek and the rounded, sparsely treed Record Ridge. The westernmost portion of the study area is part of Corral Creek and Cranston Creek watersheds and the terrain near the eastern study area boundary falls into Record Creek and Little Sheep Creek watershed. Little Sheep Creek flows in a southern direction into the United States, where it joins the Columbia River. The most westerly portion of the study area is part of the Big Sheep Creek drainage. Big Sheep Creek also flows in a southerly direction into the United States, where it joins the Columbia River.

2.6 WATER QUANTITY

2.6.1 SURFACE WATER – HYDROLOGY

Site-specific hydrometric monitoring for the Project began in August 2016. Four stations were installed within the Little Sheep Catchment and one at Coral Creek Catchment. Both catchments drain into Big Sheep Creek which drains south into the Columbia River. Gauges in the Little Sheep catchment are located on the Record Creek tributary (one gauge) and around the confluence of Sophia Creek and Little Sheep Creek (three gauges) (Figure 2.6-1). A summary is provided in this section of the Permit Application, however, more detail on baseline hydrology is included in *Record Ridge Baseline Hydrology* report (SRK 2022a; Appendix 2-D).

2.6.1.1 Key Surface Drainages

To better understand the water courses near the site, five local hydrometric stations have been installed as part of the baseline program. These are located on Sophia Creek (HSC-05), Record Creek (HRC-05), Little Sheep Creek (HLSC-05 and HLSC 06) and Coral Creek (HCC-05). These stations record water levels and water temperature and have been recording continuously since August 2016. The hydrometric stations, ID, and grid reference are listed in Table 2.6-1. To supplement the data, flow gauges have been completed eight times over an 8-month period at each of the stations. These data have been used to construct rating curves for each hydrometric gauge.

Table 2.6-1: List of Hydrometric Stations

Hydrology Station	ID	Easting (m)	Northing (m)
Corral Creek	HCC-05	432185	5429621
Sophia Creek	HSC-5	438208	5430154
Little Sheep Creek d/s Sophia	HLSC-06	438417	5429723
Little Sheep Creek u/s Sophia	HLSC-05	438433	5429938
Record Creek	HRC-05	436702	5433905

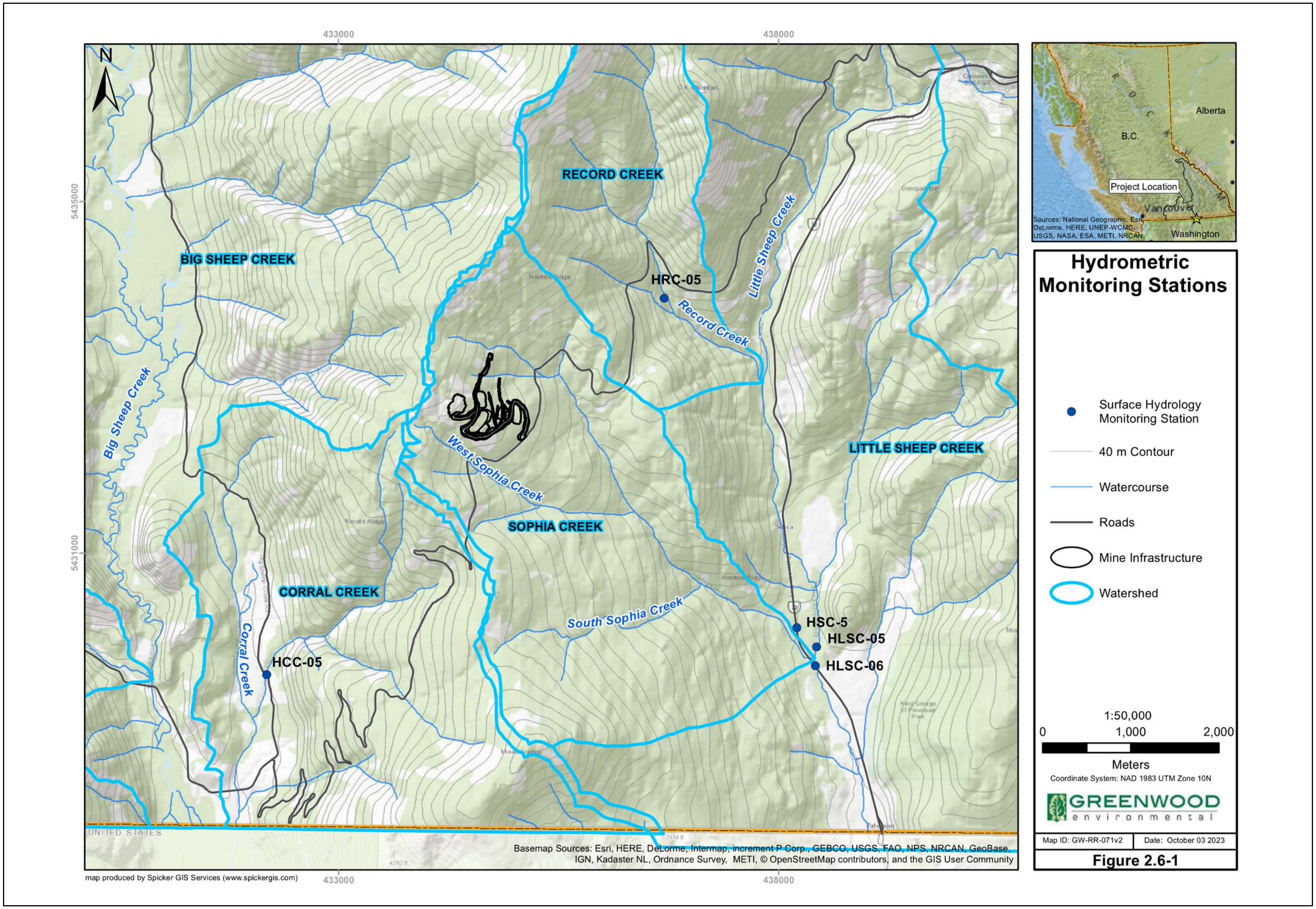


Figure 2.6-1: Hydrometric Monitoring Stations

2.6.1.2 Hydrologic Analysis of Key Surface Drainages

Using the local hydrometric data, the characteristics of the study area catchments have been determined. The 2017 freshet began in March in the study area, reaching an annual peak in May. Monthly average peak flows ranged from 2,009 l/s at HLSC06 to 797 l/s at HRC05. Following the freshet, stream flow in the project area declined to an annual low flow level in September. During this period recorded low flows ranged from 336 l/s at HLSC06 to no flow at HRC05.

2.6.1.3 Regional Analysis

As part of the regional hydrological analysis, data is provided by the hydrometric stations at Big Sheep Creek near Rossland. This station is nearest to the proposed Project site, approximately 5 km southwest of the site. Its catchment is approximately 347 km^2. This station has significant record lengths in the region, providing data back to the 1930’s.

2.6.1.4 Baseline Conditions versus Former Disturbance

All data recorded over the monitoring period is considered as baseline data. No historical mining is understood to have impacted the hydrometric data. One previously drilled exploration drill hole displays artesian conditions. This well is capped and discussed further as part of Section 2.6.2.

2.6.1.5 Continuous Hydrometric Data Collection

Five local hydrometric stations are continuously recording water level data and are anticipated to do so over the lifetime of the Project. Maps of hydrometric station locations relative to the Project site are provided in Figure 2.6-1. Hydrometric stations were established in the Sophia Creek catchment for the collection of baseline data. These stations will continue to be monitored throughout operations and closure and reclamation of the Project. There is no hydrometric station at the proposed discharge location. The proposed discharge of water from the site sedimentation pond is a land application as described in the Safe Discharge Plan (Section 9.8; Appendix 9-C).

Manual flow gauges methodology and water level collection methods consisted of a combination of integrated non-vented pressure transducers, barometric pressure loggers installed in galvanized steel screens, manual level measurements and flows were measured using the salt dilution method. These are discussed further in the *Baseline Hydrology Report* (Appendix 2-D; SRK 2022a).

2.6.1.6 Streamflow Measurements

A record of all flow measurements taken at the local hydrometric stations are provided in *Baseline Hydrology Report* (Appendix 2-D; SRK 2022a). Low flow metric for extreme conditions was not produced for this Project given its limited size and duration.

2.6.1.7 Water Balance Model

The water balance model (the model) for the RRIMM Project is a mass-conservative mass balance model that accounts for flows and water quality parameter loadings from sources within the RRIMM Project area.

The objective of the model is to estimate water quality in the sedimentation pond which is the collection point for all contact water on site and the final discharge point. In addition, predictions are made for nodes at different locations in the receiving environment downstream of the RRIMM Project area.

2.6.1.8 Water Balance Components

The model was developed in Excel and considered monthly flows and concentrations assuming full build-out of the mine. Figure 2.6-2 shows a schematic of the model components. In the model, flow and loadings from the waste rock area, soil stockpile, the crusher pad, the open pit, and catchment runoff are routed to the sedimentation pond and concentrations are calculated by assuming complete mixing of all sources. Under the scenario where explosives are used, water collected in the sedimentation pond is land applied in the upper catchments of Sophia Creek and eventually reports to the creek as seepage; where mechanized equipment is used for ore extraction, water is discharged from the sedimentation pond to Sophia Creek via a discharge channel. Runoff from the office pad area joins runoff from the Cascade Highway and flows towards Sophia Creek upstream of the monitoring station SOP-2. Further details are discussed in Appendix 5-A: Water Quality Model (SRK 2023e).

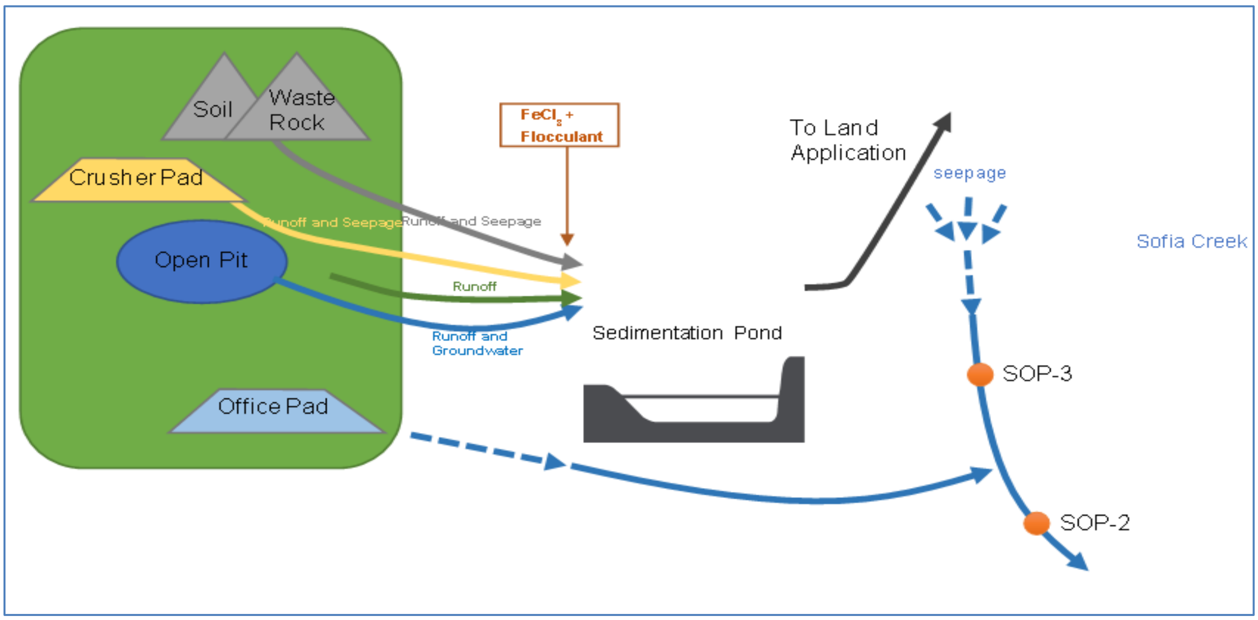


Figure 2.6-2: Water Balance Components

2.6.1.9 Estimates of Upper and Lower Bound, and Expected Groundwater Recharge

HYDROLOGY

Surface runoff estimates were based on data from Water Survey of Canada's hydrometric station at Big Sheep Creek (Station ID 08NE039). Although the RRIMM catchment is considerably smaller, the regional hydrology was considered adequate as an order-of-magnitude estimate of local monthly hydrology.

Unit runoff estimates, and monthly hydrographs were calculated for data collected between 1950 and 2016. Average annual runoff was estimated at 505 mm/year. The average hydrograph is presented in Appendix 5-A, Water Quality Model (SRK 2023e).

GROUNDWATER

The presence of artesian groundwater conditions in the RRIMM Project area means that groundwater is expected to flow to the open pit through all stages of development. Groundwater flow estimates are based on a preliminary hydrogeological assessment for the site completed in October 2016. The program consisted of a site reconnaissance for siting new drill holes for long term monitoring well installations and installation of monitoring wells in select historic exploration holes. Samples were collected from the installed wells and a single flowing artesian hole.

Analytical calculations to estimate potential inflow for the pit were used based on the Dupuit Forchiemer method. Considering the rock type and expected hydraulic conditions, and the small up-gradient recharge area, inflows between 25 m^3/day and 450 m^3/day (0.3 L/s to 5.2 L/s) are anticipated. The average of the estimated lower and upper flow range was used as an input to the model (238 m3/day or 2.7 L/s).

2.6.1.10 Results and Worst Case Scenarios

The primary water balance finding is that the open pit is the greatest source of contact water because of the groundwater discharge to the pit. Nitrite, and to a lesser extent nitrate and ammonia, are constituents of potential concern for effluent from the RRIMM site and are blasting residuals. In all cases, the predicted concentrations of these constituents are less than the BC Contaminated Site Regulation (CSR) water quality standards and less than an order of magnitude above the general BC water quality guidelines for protection of aquatic life. Each of the parameters of potential concern will be monitored through the life of the Project, including during closure. Potential mitigation measures to address each of the parameters are described in section 9.8 and detailed in Appendix 9-C Safe Discharge Plan (SRK 2023g). The mitigation measures can be implemented in short order if monitoring results indicate that mitigation may become necessary. The water quality predictions are discussed and interpreted in more detail in Appendix 9-C Safe Discharge Plan. Additional potential effects on stream flow due to the proposed Project are discussed in Chapter 6.

2.6.2 Groundwater – Hydrogeology

2.6.2.1 Work to Date

A preliminary hydrogeological assessment was carried out on the site in 2016 AND 2018 (SRK 2022b; Appendix 2-E). The 2016 program consisted of a site reconnaissance for installation of monitoring wells in historic resource drill holes and siting new drill holes for long term monitoring well installations. The new holes were installed in the fall of 2018. Details of the 2018 drilling and hydraulic testing program are presented in Appendix 2-E.

Samples were collected from the installed wells in 2016, and again in 2018. The data from these wells represent pre-development baseline conditions for the footprint location and provide groundwater chemistry and water levels for later evaluation for operational and closure conditions.

2.6.2.2 Aquifer/Aquitard Characterization

The hydrogeological system at RRIMM Project is not defined by classical definition of aquifers and aquitards, as normally thought of in groundwater systems. These types of groundwater flow systems are more commonly encountered when dealing with sedimentary units and deal with the primary porosity (matrix flow), whereas the intrusives and meta-volcanics at the Project site are dominated by secondary porosity/flow (fractures and geological structure). As such, the concept of aquifers and aquitards does not apply to the Record Ridge area. Instead, hydrogeological flow characterization is controlled by the understanding of structural and lithological contacts (i.e.: along contacts with intrusive units). Structural interpretation is discussed in more detail above (section 2.3) and was used in the conceptualization of groundwater flow, potential discharge points on the slope, and design of the groundwater monitoring system.

2.6.2.3 Groundwater Monitoring System and Conceptual Flow System

The current hydrogeological understanding is based on geologic interpretation, drill hole logging review and monitoring based on the scale of the Project. The intent is to manage groundwater during operations. Surficial and bedrock conditions at site are discussed in detail in Section 2.3 (Geology). The mine area and recharge catchment have a thin veneer of colluvium and glacial till, overlying metamorphosed volcanic and sedimentary lithology, dominated by intrusive bodies (ore zone). These rock types will have low primary hydraulic conductivity and storage ranges, with flow systems controlled by secondary features related to structural deformation. This allows for conceptualization of the assumed flow paths based on understanding of the structural controls, which are well mapped in the Rossland mining district.

Groundwater monitoring wells have been installed on the Project site in 2016 and 2018 (Figure 2.6-3; Appendix 2-E). The locations were chosen based on available open exploration holes in 2016 and purpose drilled holes targeting significant geological structures in 2018. The conceptual groundwater flow on the Project site is indicated in Figure 2.6-4. The general flow pattern is expected to follow topography with discharge to creeks down slope of the mine site. This is supported by the observed upwards gradient in DDH-01A-2018, indicating that deeper groundwater is flowing upwards towards the creek bed.

Groundwater chemistry, QA results, and well installation methodology are provided in Appendix 2-E (SRK 2022b) and Appendix 2-F (SRK 2018b). Currently there are not enough data points to provide a water level map beyond the immediate open pit area, but site reconnaissance and observations of open boreholes indicate water levels near ground surface will occur across the site, with possibly perched water levels in the overlying overburden and deeper levels within bedrock in steeper terrain.

2.6.2.4 Groundwater Monitoring Plan

Currently only two rounds of samples have been collected to date. However, WHY Resources intends to continue sampling the existing groundwater monitoring wells currently established for the project (2016 and 2018). Groundwater will be monitored from the five monitoring wells on a quarterly basis, assuming access is possible during winter months. Sampling and water level data will be collected and compared to previous data to determine if any changes are detected.

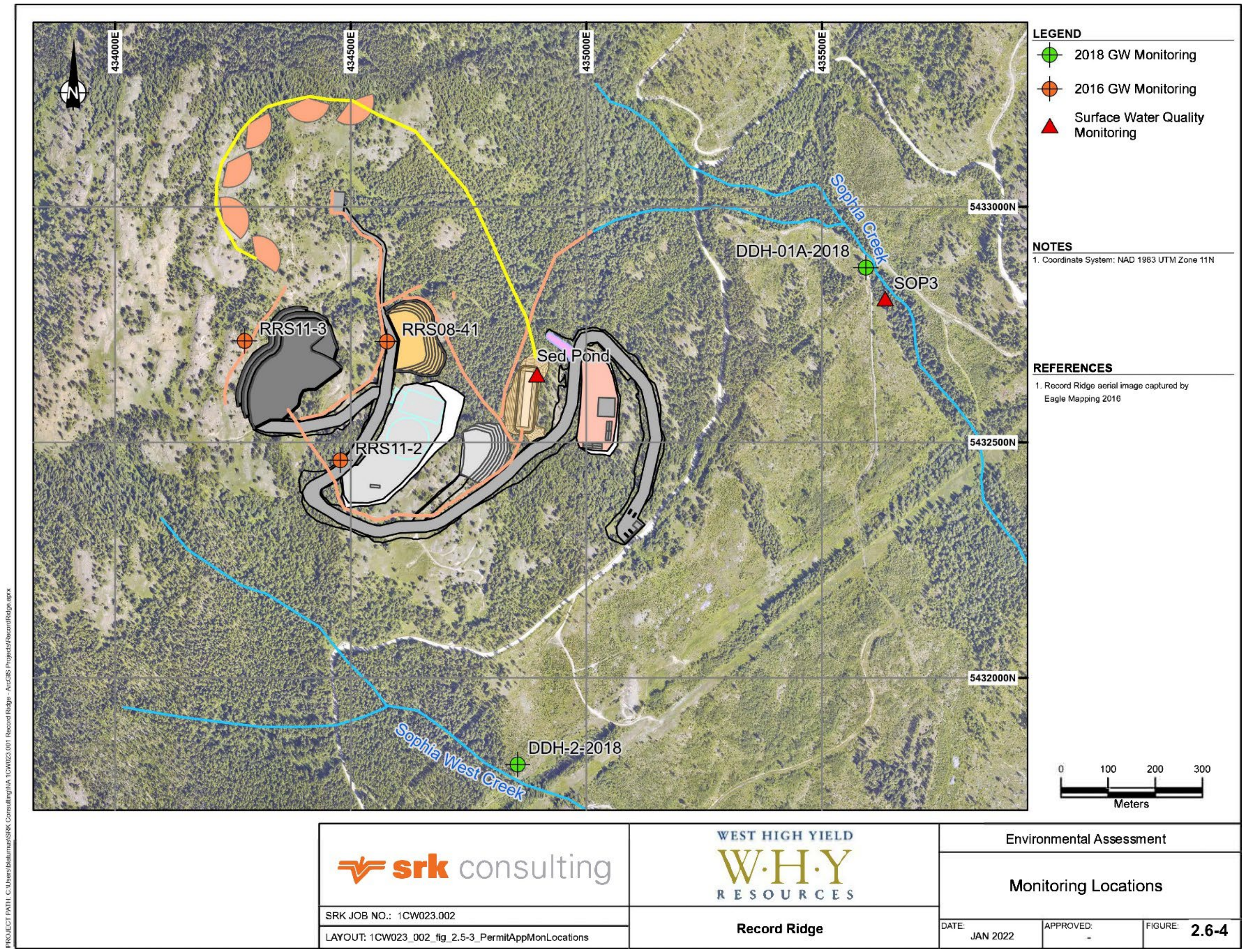


Figure 2.6-3: Groundwater Monitoring Wells

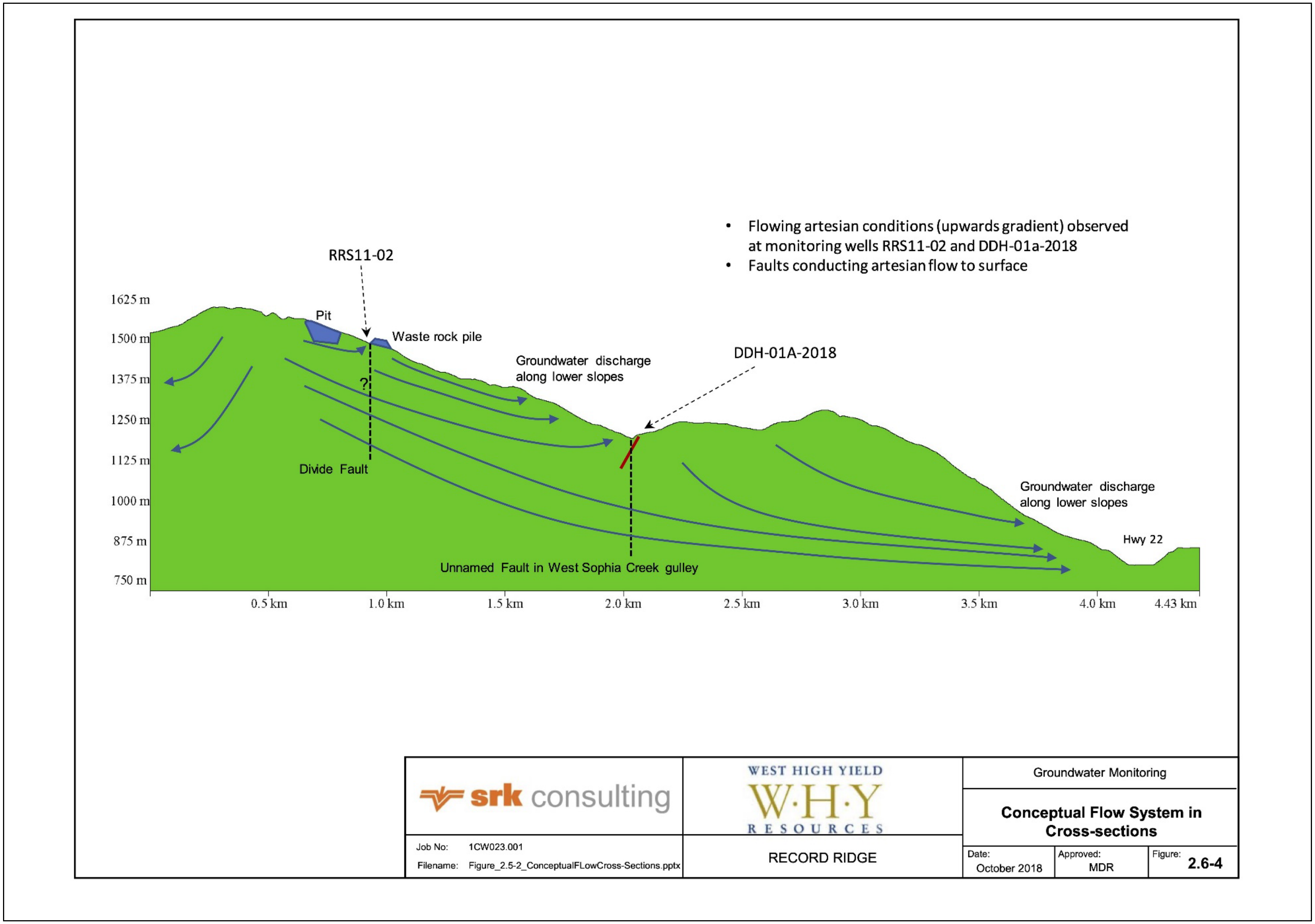


Figure 2.6-4: Conceptual Flow System in Cross-section

2.6.2.5 Estimated Groundwater Inflow to Pit

The groundwater system at Record Ridge is expected to be a fracture dominated (secondary permeability) system where the bulk of the rock mass is low hydraulic conductivity. Structural elements (faults and fractures) will control groundwater flow in this type of rockmass, so will be targeted in any additional drilling and installation of monitoring wells for the program. Hydraulic testing was not carried out in the two monitoring wells installed in 2016 in the pit area but was in the newly drilled holes in the 2018 drilling program further down the slope. Because of this, inflow estimates to the pit were based on expected hydrogeological conditions at the mine location.

Analytical calculations to estimate potential inflow for the pit were based on pit design geometry, mapped rock types for assumed hydraulic characteristics, and using the Dupuit Forchiemer method (calculation of steady state flow into a pot or trench). Considering the rock type and expected hydraulic conditions, and the small up gradient recharge area, inflows between 25 to 450 m^3/day would be anticipated, with the lower end more likely. Structural geology intersecting the pit, inferred from the flowing artesian conditions observed, indicate that structure causes compartmentalisation of groundwater flow.

The Dupuit calculation schematic is provided in Figure 2.6-5 below, with values used in the calculation:

- $K_{overburden} = 5 \times 10^{-6}$ m/s
- $K_{bedrock} = 1 \times 10^{-7}$ to 1×10^{-9} m/s
- h_1 = 5m (overburden) and 200m (bedrock)
- h_2 = 0m (overburden) and 10m (bedrock)
- L = 250m (perimeter of pit
- R = 917mm/yr

Depuit (1863):

$$Q = K \frac{(h_1^2 - h_2^2)}{2L} + R \frac{L}{2}$$

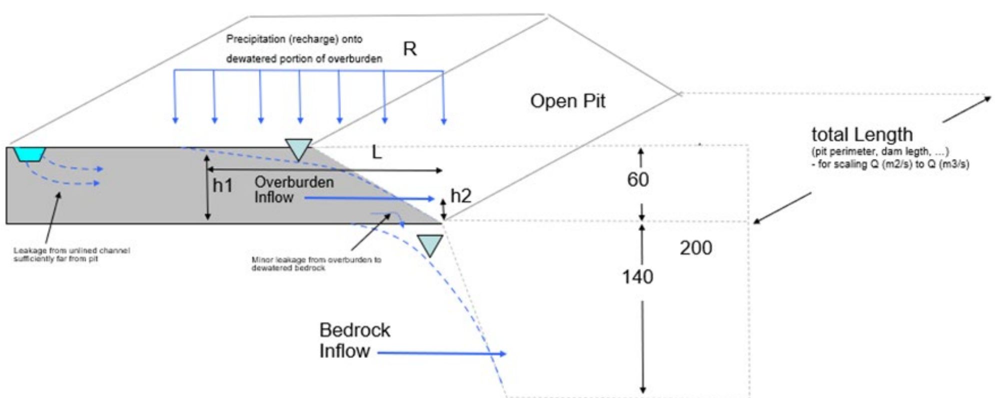


Figure 2.6-5: Depuit Diagram

2.7 GROUNDWATER AND SURFACE WATER QUALITY

2.7.1 GROUNDWATER QUALITY

2.7.1.1 Groundwater Usage

Groundwater is used by several of the private properties proximate to the RRIMM Project by means of water wells or licensed seeps along Highway 22 east of the site, as illustrated in the *Desk-based Land Use Baseline Report* (Dialectic Research Services Inc., 2018; Figure 9.4.1 in Appendix 2-S) and section 2.11.6. Groundwater from the RRIMM Project will not affect water rights to the west as this is across the water divide for Record Ridge. Additionally, properties are mainly upstream of the intersection of Sophia Creek with Little Sheep Creek and thus have limited interaction with groundwater from the RRIMM Project.

2.7.1.2 Baseline Study Design

A baseline study design was developed to provide an inventory of pre-development hydrogeological conditions and assess potential for groundwater to be impacted and impact on other receiving environments (i.e.: down slope creeks). To do so, the groundwater monitoring, in particular the hydrogeochemistry monitoring, was matched to the surface water monitoring program such that specific parameters assessed, and detection limits used, were designed to allow for comparison to both Canadian Environmental Quality Guidelines (CEQG) and BC Water Quality Guidelines (WQG) for protection of aquatic life using the same parameter suite as the surface water sampling. This allows a direct comparison to be made regarding surface water/groundwater interaction (discharge/recharge), which is discussed in the Section 2.7.3. Figure 2.6-3 shows locations of groundwater monitoring wells.

Groundwater samples were collected from the installed monitoring wells and from the flowing artesian drillhole to assess background water quality, with samples submitted to ALS Laboratory in Burnaby, BC for analysis. Detailed sampling and lab analysis documents are provided Appendix 2-F. The following parameters were analysed (details in Table 2.7-6):

- Total and dissolved metals
- Total and dissolved mercury
- Nitrate Nutrients: nitrate, nitrite, ammonia
- General parameters and anions: conductivity, hardness, DOC, TOC, pH, TSS, TDS, alkalinity, chloride, fluoride, bromide, sulphate, ortho-phosphate.

Details of the monitoring well installations are provided in installation and monitoring update memos (SRK 2022b and SRK 2018b; Appendix 2-E and Appendix 2-F respectively). Details of the groundwater monitoring wells are provided in Table 2.7-1, below. All of the monitoring well locations are located in undisturbed ground, with the wells in the upper part of the site located in previously drilled exploration holes. No other significant disturbance has occurred on site.

The standpipes have been sampled to date using downhole submersible pumps, following accepted sampling procedures.

Table 2.7-1: Groundwater Monitoring Wells

Monitoring Well ID	Screened Interval (m)	Rationale for Monitoring Well Location
RRS11-02	Open hole	Cross cutting fault down gradient of proposed pit
RRS11-03	6.8 to 12.2	Upgradient of proposed pit
RRS08-41	6.2 to 12.5	Downgradient of proposed pit
DDH-1A-2018	56 to 80	Major structure down gradient of mine layout on expected groundwater/surface water flow path
DDH-02-2018	10 to 36	Cross cutting fault down gradient of proposed pit

2.7.1.3 Groundwater Hydrogeochemistry Results

Results of the hydrogeochemistry sampling and analysis are presented in Appendix 2-F. Raw lab data and QA/QC assessments are compiled for each of the sampling rounds, along with assessment of results and comparison between sample locations.

A review of the major anions and dissolved metals indicates that one sample RRS11-03 had an anomalously high level of chloride (3.99 mg/L) in the initial sampling round (October 2016). While the chloride is still above BC WQG (0.1 mg/L) in the June 2018 sample for RRS11-03 and for RRS11-02, the concentration was significantly reduced (0.7 and 0.5 mg/L, respectively).

No other exceedances in anions and nutrients, or in dissolved metals were noted in the 2018 samples. As groundwater does not carry suspended solids, dissolved metals (from field filtered samples) are considered to be more appropriate when reviewing groundwater chemistry. Therefore, apparent exceedances in Total Metals (unfiltered samples) are noted but not considered to represent actual exceedances of the guidelines.

The samples were also plotted on a tri-linear Piper plot to compare the relative concentrations of specific parameters (Appendix 2-F). This comparison is useful when comparing groundwater to surface water to see what parameters may be elevated in one or the other system. The comparison shows the three samples are all very similar in composition. This also appears to show, as the flowing artesian well (RRS11-02) is very similar geochemically to the other two well samples, that the samples from the monitoring wells are representative of local groundwater and not impacted by surface water that may have entered the open holes prior to well completion.

2.7.1.4 Spatial or Temporal Gaps in Data

The groundwater database requires additional sampling to build up the available hydrogeochemical data for a more complete seasonal and temporal data set. With the installation of the two new drilled monitoring wells in fall of 2018, and additional sampling being carried out as per the monitoring plan, this will be achieved within the next nine months.

2.7.2 Surface Water Quality

2.7.2.1 Baseline Study Design

Details of the surface water quality monitoring program for the RRIMM Project are provided in *Baseline Aquatic Monitoring Studies, 2016-2017 Record Ridge Magnesium Property* (Azimuth 2018; Appendix 2-G).

The purpose of the water quality monitoring program is to assess baseline ambient physical and chemical conditions prior to development of the RRIMM Project. Surface water sampling has been completed approximately monthly, beginning in June 2016, from water monitoring stations on Little Sheep Creek (LSC-05 and LSC-06), Record Creek (RC-05), Sophia Creek (SC-01, SC-05, SCT-10), and Corral Creek (CC-05) (Figure 2.7-1). The water quality stations were originally classified as either baseline stations or Aquatic Effects Monitoring Program (AEMP) stations depending on their location relative to the proposed development and their use in long-term monitoring of water quality for the Project. Updates to the mine plan since completion of the *Baseline Aquatic Monitoring Studies, 2016-2017 Record Ridge Magnesium Property* report led to reclassification of SOP3 and WSO1 from EA stations to AEMP stations for long-term monitoring of water quality and aquatic resources (Table 2.7-2). The frequency of water sample collection is shown in Table 2.7-3.

Table 2.7-2: Coordinates for the Surface Water Quality and Aquatic Resource Monitoring Stations

Station	Station Type	C / I [1]	C / I Grouping [2]	Description	Easting [3]	Northing
LSC-05	EA/AEMP	C	Little Sheep Creek	Little Sheep Creek u/s from confluence with Sophia Creek	438426	5429921
LSC-06	EA/AEMP	I	Little Sheep Creek	Little Sheep Creek d/s from confluence with Sophia Creek	438402	5429829
SCT-10	EA/AEMP	C	Sophia Creek	South Sophia Creek - Tributary	437059	5430597
RC-05	EA/AEMP	C	Sophia Creek	Record Creek reference station	436716	5433916
CC-05	EA/AEMP	C	N/A	Corral Creek reference station	432185	5429622
SC-01	EA/AEMP	I	Sophia Creek	Sophia Creek mid-field exposure station, above confluence with South Sophia Creek	437117	5430645
SC-05	EA/AEMP	I	Sophia Creek	Sophia Creek mid-field exposure station, below confluence with South Sophia Creek	437739	5430328
SOP2	EA	NA	NA	Sophia Creek	436588	5431134
SOP3	EA/AEMP	I	Sophia Creek	Sophia Creek near-field exposure station; immediately downstream of the discharge	435634	5432807
WSO-01	EA/AEMP	I	Sophia Creek	West Sophia Creek	435570	5431469

Notes:
1. Control / impact designation. Applicable only for long-term monitoring stations.
2. Control / impact grouping for comparing stations in the biological community assessment. Applicable only for long-term monitoring stations.
3. UTM zone 11U

In-situ field measurements of temperature, conductivity, pH, and total dissolved solids were synoptically collected with surface water grab samples for analysis of conventional parameters, major ions, nutrients, and metals. Water chemistry analyses were conducted by ALS Environmental (Burnaby, BC). Samples collected up to, and including, December 2017 are included in the *Baseline Aquatic Monitoring Studies* report (Appendix 2-G; Azimuth 2018).

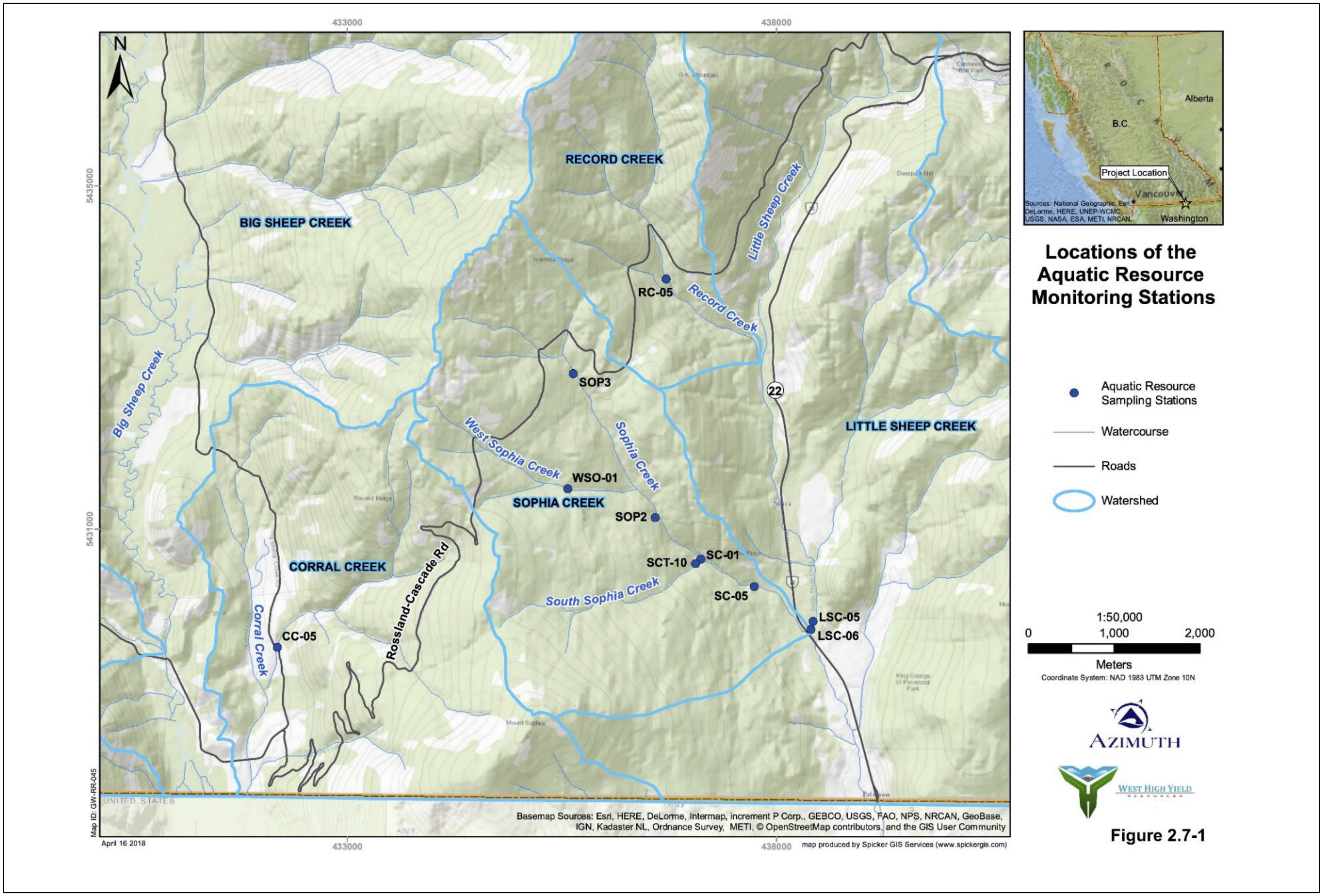


Figure 2.7-1: Aquatic Resource Monitoring Stations

Table 2.7-3: Water Quality Sampling Events Completed in 2016 and 2017

Year	Month	Control Stations				Impact Stations		
		CC-05	LSC-05	RC-05	SCT-10	LSC-06	SC-01	SC-05
2016	June	●	●	●	●	●	●	●
	July	○	●	●	●	●	●	●
	August	○	●	●	●	●	●	●
	September	○	●	●	●	●	●	●
	October	●	●	●	●	●	●	●
	November	●	●	●	●	●	●	●
	December	●	●	●	●	●	●	●
2017	January	●	●	●	●	●	●	●
	February	●	●	●	●	●	●	●
	March	●	●	●	●	●	●	●
	April	●	●	●	●	●	●	●
	May	●	●	●	●	●	●	●
	June	●	●	●	●	●	●	●
	July	○	●	●	●	●	●	●
	August	○	●	●	●	●	●	●
	September	○	●	●	●	●	●	●
	October	○	●	●	●	●	●	●
	November	○	●	●	●	●	●	●
	December	○	●	●	●	●	●	●

Notes:

● = Samples collected

○ = Sampling planned, but not completed because the creek was dry

Water quality data were screened against provincial water quality guidelines (WQG) for the protection of aquatic life, wildlife, irrigation water, and livestock (BC MOE, 2017) and BC Contaminated Sites Regulation (375/1996) standards under the *Environmental Management Act* (2003) for protection of drinking water for human consumption. The applicable ecological WQGs are presented in Table 2.7-4 and the human health drinking water quality guidelines are shown in Table 2.7-5. The screening process identified parameters that are naturally elevated and would likely require special consideration (e.g., development of site-specific targets based on background conditions).

2.7.2.2 Surface Water Quality Results

Ambient water quality data collected between June 2016 and December 2017 from creek stations is characteristic of small streams in watersheds with little, to no, glacial cover. Creeks within the Record Ridge Project area receive flow either by surface runoff from precipitation and the winter snow pack or groundwater flow. On an annual basis, spring freshet is the dominant event responsible for watershed-wide changes in water quality in the creeks. Total suspended solids (TSS) concentrations tended to increase in all the creeks in the Project area during spring freshet. Increased TSS during spring freshet was accompanied by lower conductivity and total dissolved solids. The magnitude of the increase in TSS was highest for stations in Sophia Creek and Little Sheep Creek. Upstream control station RC-05 on Record Creek had lower concentrations of TSS during freshet.

Table 2.7-4: Water quality guidelines for aquatic life, wildlife drinking water, and agricultural water uses in British Columbia

Parameter	BC WQGs for Protection of Aquatic Life		WQGs for Wildlife Drinking Water	Agriculture WQGs (Irrigation; Livestock)	Notes
	30-d Average	Maximum			
pH	Range from 6.5 to 9.0. For cases where natural pH<6.5 or >9.0, no statistically significant decrease/increase (respectively in pH from background.				Applicable to field pH.
Total suspended solids (mg/L)	6 mg/L, based on allowable change from background of 5 mg/L at any one time for a duration of 30 d in all waters during clear flows or in clear waters; assuming background of 1 mg/L	26 mg/L, based on allowable change from background of 25 mg/L at any one time for a duration of 24 h in all waters during clear flows or in clear waters; assuming background of 1 mg/L	Change from background of 20 mg/L when background is < 100 mg/L, or 20% when background is >100 mg/L		
Alkalinity (mg/L total $CaCO_3$)	For lakes only: <10 if dissolved Ca < 4mg/L; 10-20 if dissolved Ca 4-8 mg/L; >20 if dissolved Ca > 8 mg/L				BC guideline derived for lakes, not relevant for streams (WWQG)
Aluminum (dissolved) (mg/L)	if pH ≥ 6.5, d.Al = 0.05; if pH < 6.5, d.Al =$_e$(1.6 - 3.327 (med pH) + 0.402(med pH)^2)	if pH ≥ 6.5, d.Al = 0.1; if pH < 6.5, d.Al = $_e$(1.209 - 2.426 (pH) + 0.286 (pH)^2)			
Aluminum (total) (mg/L)			5 (max; total Al)	5 (max; total Al)	The CCME guideline for total aluminum is not used. Rather, the BC MOE guidelines for dissolved aluminum are applied.
Ammonia as N (mg/L)	pH and temperature dependent	pH and temperature dependent			Assumed pH 8.23 (maximum measured) and temperature 15 (maximum observed)
Antimony (µg/L)	9 for Sb(III)				WWQG
Arsenic (µg/L)		5	25	100 (irrigation 25 (Livestock Watering)	BC's aquatic life guideline for arsenic is based on the CCME guideline and is applied in BC as a maximum.
Barium (mg/L)	1				WWQG
Beryllium (µg/L)	0.13				WWQG
Boron (mg/L)	1.2		5	0.5-6.0 (irrigation, depends on crop) 5.0 (Livestock watering)	
Bromide					
Cadmium (dissolved) (µg/L)	$e^{(0.736 \ln (hardness) - 4.943)}$; applies to hardness range 3.4 to 285 mg/L; lower bound is 0.0176 (at hardness 3.4 or lower) and upper bound is 0.457 ug/L dissolved cadmium (at hardness 285 or higher).	$e^{(1.03 \ln (hardness) - 5.274)}$; applies to hardness range 7 to 455 mg/L; lower bound is 0.038 (at hardness 7 or lower) and upper bound is 2.8 ug/L dissolved cadmium (at hardness 455 or higher).			
Cadmium (total) (µg/L)				80 (Livestock) 5.1 (Irrigation)	The CCME guidelines for total cadmium are not used. Rather, the BC MOE guidelines for dissolved cadmium are applied. Livestock and Irrigation values are working WQG for Total Cadmium, adopted from CCME 2014.
Chloride (µg/L)	150	600	600	100 (Irrigation) 600 (Livestock)	
Chromium (µg/L)	1 (CrVI); 8.9 (CrIII)			4.9 (CrIII; mean; Irrigation) 50 (CrIII; mean; Livestock) 8 (CrVI; mean; Irrigation) 50 (CrVI; mean; Livestock)	The Cr(VI) number was used for screening. According the CCME factsheet for chromium, Cr(VI) is the principal species found in surface waters while Cr(III) is more prevalent in mildly reducing environments such as sediments and wetlands. BC's guidelines for

Parameter	BC WQGs for Protection of Aquatic Life		WQGs for Wildlife Drinking Water	Agriculture WQGs (Irrigation; Livestock)	Notes
	30-d Average	Maximum			
					chromium are based on the CCME guideline and are applied as a maximum.
Cobalt (µg/L)	4	110			There is a 2017 federal guideline for protection of aquatic life that is hardness-dependent. This has not been used
Copper (µg/L)	if hardness ≤ 50mg/L, then Cu ≤ 2 ug/L, if hardness 50-250 mg/L, then Cu≤ 0.04xhardness; if hardness > 250, then Cu ≤ 10 ug/L	0.094(hardness)+2	300 (max)	200 (max; Irrigation) 300 (max; Livestock)	
Fluoride (mg/L)		F≤ 0.4mg/L at water hardness of 10 mg/L CaCO3 or less; at hardness 10 to 385 mg/L, F ≤ (-51.73+92.57 $\log_{10}$ (hardness)) x 0.01;	1.0 (mean); 1.5 (max)	1.0 (mean), 2.0 (max) [Irrigation] 1.0-2.0 (mean), 1.5-4.0 (max) [Livestock, depends on type]	Both BC and CCME guidelines are outdated, and more robust values have been proposed recently. 1 mg/L is the low end of recently proposed values (Sinclair and Macdonald 2015; McPherson et al. 2014; Pearcy et al. 2015). That value is used for screening.
Iron (total) (mg/L)		1			The CCME guideline for total iron is not used. Rather, the BC MOE guidelines for dissolved and total iron are applied.
Iron (dissolved) (mg/L)		0.35			
Lead (µg/L)	(if hardness ≤ 8mg/L), no guideline;(if hardness > 8 up to 360 mg/L), ≤ (3.31 + $e^{(1.273 \ln (\text{mean hardness}) - 4.704)}$)	(if hardness ≤ 8mg/L), ≤ 3ug/L; (if hardness > 8 up to 360 mg/L), =$e^{(1.273 \ln (\text{hardness}) -1.460)}$	100 (max)	100 (max; Livestock)400 (max; Irrigation of neutral and alkaline fine-textured soils) or 200 (max; all other soils)	
Manganese (mg/L)	≤ 0.0044 (hardness) + 0.605; applies to hardness range 37 - 450 mg/L	≤ 0.01102 (hardness) + 0.54; applies to hardness range 25 - 259 mg/L			
Mercury (µg/L)	0.02			2.0 (max, Irrigation) 3.0 (max, Livestock)	where MeHg is mass (or concentration) of methyl mercury and THg is total mass (or concentration) of mercury in a given water volume
Molybdenum (mg/L)	1	2	0.05 (max)	0.05-0.08 (max; livestock, depending on type of feed) 0.05 (max), 0.01-0.03 (mean; Irrigation, depending on soil and crop type)	
Nickel (µg/L)	25 (max at hardness (as CaCO3) of 0 to 60mg/L); for hardness > 60 and < 180 mg/L, Ni ≤ ($e^{(0.76*\ln(\text{hardness})+1.06)}$); 150 (max at hardness greater than 180mg/L)			200 (mean, Irrigation) 1000 (mean, Livestock)	WWQG, was previously recorded as a maximum, but BC WWQG reports it as a long-term mean
Nitrite (as N) (mg/L)	0.02 when Cl < 2 mg/L; 0.04 for Cl 2-4; 0.06 for Cl 4-6; 0.08 for Cl 6-8; 0.10 for Cl 8-10; 0.2 for Cl > 10	0.06 when Cl < 2 mg/L; 0.12 for Cl 2-4; 0.18 for Cl 4-6; 0.24 for Cl 6-8; 0.30 for Cl 8-10; 0.6 for Cl > 10	10 (max)	10 (max; Livestock)	
Nitrate (as N) (mg/L)	3	32.8	100 (max)	100 (max; Livestock)	
Phosphorous (mg/L)	No guideline for creeks; for lakes only: 0.005 to 0.015 mg/L, where salmonids are the dominant fish				Not applied because all habitat is creeks, not lakes

Parameter	BC WQGs for Protection of Aquatic Life		WQGs for Wildlife Drinking Water	Agriculture WQGs (Irrigation; Livestock)	Notes
	30-d Average	Maximum			
Selenium (µg/L)	2	No maximum guidelines	2	10 (irrigation) 30 (livestock watering)	Places a 30-day average alert concentration at 1 ug/L, which is consistent with CCME guidelines The wildlife guideline for Se is not for drinking water per se but is set equal to the aquatic life guideline to protect against bioaccumulation. Irrigation and livestock numbers not updated since 2001
Silver (µg/L)	if hardness≤100mg/L, then Ag≤ 0.05; if hardness>100mg/L, then Ag≤ 1.5	if hardness≤100mg/L, then Ag≤ 0.1; if hardness>100mg/L, then A g≤ 3			
Sulphate (total SO_4)	128 mg/L at hardness 0-30 mg/L $CaCO_3$; 218 at hardness 31-75; 309 at hardness 76-180; 429 at hardness 181-250); **guideline requires site-specific work at hardness > 250			1,000 mg/L (Livestock)	BC does not have a guideline for the protection of livestock, but they recommend that the current CCME water quality guideline of 1,000 mg/L be used until the CCME update is complete. The updated CCME livestock guideline will be adopted upon review and acceptance by the BC Ministry of Environment
Thallium (µg/L)	0.8				WWQG
Uranium (µg/L)	8.5				WWQG, Guideline was developed by CCME using the species sensitivity distribution (SSD) method. This method has not been adopted by BC and therefore the lower fudicial limit of the SSD 5th percentile is adopted as the BC WWQG
Zinc (µg/L)	If hardness < 90 mg/L, then Zn≤ 7.5 Else (7.5 + 0.75 x (hardness -90))	If hardness < 90 mg/L, then Zn≤ 33 Else (33 + 0.75 x (hardness -90))		2,000 (Livestock) If pH less than 6, then Zn≤ 1,000, if pH between 6 and 7, then Zn≤ 2,000, if pH greater than 7, then Zn≤ 3,000 (Irrigation)	

Table 2.7-5: Human Health Drinking Water Screening Criteria (BC CSR 2017)

Parameter	Units	CSR Schedule 3.2 DW Standards[1]	Source of the DW Standard
Anions and Nutrients			
Nitrate	mg/L	10	Health Canada (2014); see footnote 6
Nitrite	µg/L	1,000	Health Canada (2014)
Sodium	mg/L	200	See footnote 3
Sulphate	mg/L	500	Health Canada (2014)
Chloride	mg/L	250	Health Canada (2014); see footnote 5
Metals			
Aluminum	µg/L	9,500	See footnotes 3 and 4
Antimony	µg/L	6	Health Canada (2014)
Arsenic	µg/L	10	Health Canada (2014)
Barium	µg/L	1,000	Health Canada (2014)
Beryllium	µg/L	8	US EPA (2015)
Boron	µg/L	5,000	Health Canada (2014)
Cadmium	µg/L	5	Health Canada (2014)
Chromium (as Cr[VI])	µg/L	50	Health Canada (2014)
Cobalt[2]	µg/L	20	US EPA (2015)
Copper	µg/L	1,500	See footnotes 3 and 4
Iron	µg/L	6,500	See footnotes 3 and 4
Lead	µg/L	10	Health Canada (2014)
Lithium	µg/L	8	US EPA (2015)
Manganese	µg/L	1,500	See footnotes 3 and 4
Mercury	µg/L	1	Health Canada (2014)
Molybdenum	µg/L	250	BC MOE (1986)
Nickel	µg/L	80	US EPA (2015)
Selenium	µg/L	10	BC MOE (2015)
Silver	µg/L	20	US EPA (2015)
Sodium	mg/L	200 mg/L	See footnote 3
Strontium	µg/L	2,500	US EPA (2015)
Thallium	µg/L	0.04	US EPA (2015)
Tin	µg/L	2,500	US EPA (2015)
Uranium	µg/L	20	Health Canada (2014)

Parameter	Units	CSR Schedule 3.2 DW Standards[1]	Source of the DW Standard
Vanadium	µg/L	20	US EPA (2015)
Zinc	µg/L	3,000	See footnote 3
Zirconium	µg/L	0.3	US EPA (2015)

Notes:

1. Drinking water standards are for unfiltered samples obtained at the point of consumption.
2. BC MOE has extended the cobalt interim background groundwater concentration estimate of 20 µg/L (vs. a drinking water standard of 1 µg/L)
3. Standard is specific to protection of human health. Standard is derived with a TRV protective of adults. Standard may not adequately protect other age groups.
4. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.
5. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.
6. Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.

Surface water pH values measured at the Little Sheep Creek and Sophia Creek stations were between approximately 7.5 and 8.25 for most samples. Corral Creek was slightly more basic, with most values measuring at, or above, 8. These headwater creeks closest to the mineralized zone are broadly characterized by high hardness, high alkalinity, and excess pH buffering capacity as measured by total alkalinity. Record Creek, located beyond the footprint of the proposed mining development, was at the lower end of the pH spectrum (approximately 7 to 7.5). Alkalinity and hardness (as well as other parameters) show seasonal patterns linked to freshet (i.e., they drop as surface flow inputs from snowmelt rise, then increase as groundwater inputs become more dominant). Magnesium concentrations showed substantial spatial variability within the Project area, with higher concentrations reported from Sophia Creek and Corral Creek near the mineralized zone compared to Record Creek (upstream) and Little Sheep Creek (downstream).

Water quality data were screened against all available WQG to determine which parameters naturally exceeded the provincial WQG (Appendix 2-H). There were no exceedances of provincial guidelines for wildlife, human health, irrigation, or livestock water uses in the baseline data set. There were, however, a small number of exceedances of guidelines for protection of aquatic life. Dissolved aluminum and total iron exceeded the BC short-term maximum guidelines only once each between June 2016 and December 2017. The dissolved aluminum exceedance was measured at the control station on Corral Creek during freshet in 2017. The exceedance of the short-term maximum guideline for total iron at SCT-10 occurred in the fall and corresponded with higher concentrations of TSS in that sample.

Long-term chronic guidelines were exceeded at least once for dissolved aluminum, total chromium, total copper, total mercury, total silver, and field pH. Most of the exceedances were sporadic (i.e., not measured in consecutive months) with the exception of chromium at the Sophia Creek stations SC-01 and SC-05 and reference station CC-05.

There is some evidence of natural differences among locations for metals, particularly for chromium, which follows a similar pattern to magnesium. Furthermore, there is clear evidence of within-station seasonal variability for most parameters. Higher metals concentrations were typically reported in the spring and fall sampling events, often coinciding with increased concentrations of TSS.

2.7.3 Surface Water and Groundwater Quality Comparison

A comparison of groundwater and surface water hydrochemistry data to date is provided in Table 2.7-6. Due to the large number of samples to date, the values for surface water chemistry have been condensed to the minimum and maximum values to allow for comparison in a single table. Where surface water chemistry exceeds the Canadian Environmental Quality Guidelines (CEQG) or the BC Water Quality Guidelines (WQG) for protection of aquatic life, the median value has also been calculated.

Besides the exceedances already noted for groundwater and surface water independently above, the parameters and stations where both groundwater and surface water were compared are presented in Table 2.7-6.

- Exceedances in both groundwater and surface water (maximum and median) are observed with respect to chloride, for all sample sites except the “spring”.
- Total iron is exceeded in groundwater from RRS11-03 and RRS08-41, as well as in surface water from SCT-10 (both median and maximum).
- Dissolved aluminum observed in the maximum sample measured at surface station CC-05, but the median value is less than the guidelines.

Groundwater reporting to the open pit is expected to range between 0.3 L/s 5.2 L/s. A groundwater flow rate of 2.7 L/s – the average of the estimated range – corresponds to roughly 2% of the flow in upper Sofia Creek at SOP-3 in May and about 22% of the flow in the creek in September and October in an average hydrological year. The groundwater quality is similar to the surface water quality in the RRIMM area. Therefore, any groundwater reporting to Sophia Creek is not expected to affect the water quality in the creek.

Table 2.7-6: Groundwater and Surface Water Hydrochemistry Comparison

Parameter	Lowest Detection Limit	Units	CCME	BC WQ	GROUNDWATER						
Sample Station					RRS11-02	RRS11-02	RRS 11-02	RRS11-03	RRS11-03	RRS08-41	RRS08-41
Date Sampled					27-Oct-2016	24-Apr-2018	28-May-2018	28-Oct-2016	21-Jun-2018	28-Oct-2016	31-May-2018
Physical Tests (Water)											
Colour, True	5.0	CU			<5.0	<5.0	5	39.5	17.2	14.0	<5.0
Conductivity	2.0	uS/cm			232	243	244	171	279	273	304
Hardness (as CaCO3)	0.50	mg/L			127	147	133	65.5	140	143	171
pH	0.10	pH	6.5-9	6.5-9	8.50	8.46	8.45	8.21	8.62	8.30	8.24
Total Suspended Solids	1.0	mg/L			<1.0	<1.0	1	334	330	776	115
Total Dissolved Solids	13	mg/L			108	121	128	183	151	166	165
Turbidity	0.10	NTU		*variable*[1]	0.12	<0.10	0.78	138	129	409	17.1
Anions and Nutrients (Water)											
Alkalinity, Bicarbonate (as CaCO3)	1.0	mg/L			125	124	129	84.8	146	156	165
Alkalinity, Carbonate (as CaCO3)	1.0	mg/L			7.8	7.2	5.8	<1.0	12	<1.0	<1.0
Alkalinity, Hydroxide (as CaCO3)	1.0	mg/L			<1.0	<1.0	1	<1.0	<1.0	<1.0	<1.0
Alkalinity, Total (as CaCO3)	1.0	mg/L			132	131	135	84.8	158	156	165
Ammonia, Total (as N)	0.0050	mg/L		1.9	<0.0050	0.0085		<0.0050	0.0324	0.0122	<0.0050
Bromide (Br)	0.050	mg/L			<0.050	<0.050	0.05	0.073	<0.050	<0.050	<0.050
Chloride (Cl)	0.50	mg/L	640	0.1	<0.50	<0.50	0.5	3.99	0.7	<0.50	<0.50
Fluoride (F)	0.020	mg/L	0.12	*variable*[2]	0.028	0.029	0.029	0.035	0.023	0.026	0.022
Nitrate (as N)	0.0050	mg/L	550	32.8	0.255	0.241	0.237	0.0053	0.336	0.104	0.129
Nitrite (as N)	0.0010	mg/L		*variable*[3]	<0.0010	<0.0010	0.001	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	0.050	mg/L			<0.050	0.066	0.05	0.465	1.45	0.590	<0.050
Total Nitrogen	0.030	mg/L			0.268	0.216	0.219	0.422	1.79	0.71	0.149
Orthophosphate-Dissolved (as P)	0.0010	mg/L			0.0056	0.0064	0.0063	0.0019	0.0029	0.0303	0.0091
Phosphorus (P)-Total Dissolved	0.0020	mg/L			0.0066	0.0070	0.0074	0.0100	0.0074	0.0349	0.0094
Phosphorus (P)-Total	0.0020	mg/L		*0.005-0.015*[4]	0.0120	0.0071	0.0060	0.112	0.261	0.538	0.0355
Sulfate (SO4)	0.30	mg/L		309	6.39	6.30	6.02	6.93	4.22	7.01	4.97
Organic / Inorganic Carbon (Water)											
Dissolved Organic Carbon	0.50	mg/L			<0.50			15.6		11.0	
Total Organic Carbon	0.50	mg/L			0.68	0.70	0.5	18.5	16.9	16.9	1.18
Total Metals (Water)											
Aluminum (Al)-Total	0.0030	mg/L	0.1		0.0203	0.0053	0.0049	6.13	5.77	9.45	0.489
Antimony (Sb)-Total	0.00010	mg/L			0.00012	0.00013	0.00013	0.00024	0.0129	0.00044	0.00027
Arsenic (As)-Total	0.00010	mg/L	0.005	0.005	0.00044	0.00048	0.00045	0.00191	0.00343	0.00998	0.00098
Barium (Ba)-Total	0.000050	mg/L			0.00972	0.00943	0.00893	0.0324	0.0786	0.166	0.0125
Beryllium (Be)-Total	0.000020	mg/L			<0.000020	<0.000020	0.00002	0.000870	0.000657	0.000879	0.00110
Bismuth (Bi)-Total	0.000050	mg/L			<0.000050	<0.000050	0.00005	0.000225	0.000198	0.000267	<0.000050
Boron (B)-Total	0.010	mg/L	29	1.2	0.014	0.013	0.013	<0.010	0.010	0.021	<0.010
Cadmium (Cd)-Total	0.0000050	mg/L	0.001		<0.0000050	<0.0000050	0.000005	0.0000427	0.000213	0.000670	0.000122
Calcium (Ca)-Total	0.050	mg/L			9.97	10.5	10.4	7.44	6.09	21.8	18.9
Chromium (Cr)-Total	0.00010	mg/L			0.00041	0.00049	0.0004	0.00430	0.0147	0.0517	0.00301
Cobalt (Co)-Total	0.00010	mg/L		0.11	<0.00010	<0.00010	0.0001	0.00275	0.0130	0.0505	0.00282
Copper (Cu)-Total	0.00050	mg/L	*variable*[2]	*variable*[2]	<0.00050	<0.00050	0.0005	0.00501	0.0548	0.0136	0.0767
Iron (Fe)-Total	0.010	mg/L	0.3	1	0.027	<0.010	0.01	2.80	6.97	13.7	0.705
Lead (Pb)-Total	0.000050	mg/L	*variable*[2]	*variable*[2]	<0.000050	<0.000050	0.00005	0.00953	0.0116	0.180	0.0122
Lithium (Li)-Total	0.0010	mg/L			0.0011	0.0010	0.0011	0.0034	0.0037	0.0104	0.0022
Magnesium (Mg)-Total	0.10	mg/L			24.7	26.4	25.9	19.4	47.6	80.0	33.0
Manganese (Mn)-Total	0.00010	mg/L		1.93954	0.00049	0.00032	0.00022	0.0602	0.291	0.810	0.0455
Mercury (Hg)-Total	0.0000050	mg/L	0.000026	*unquantifiable*[5]	<0.0000050	<0.0000050	0.000005	<0.000025	<0.000050	<0.000025	<0.0000050
Molybdenum (Mo)-Total	0.000050	mg/L	0.073	2	0.00185	0.00181	0.00182	0.000793	0.000762	0.00166	0.00136
Nickel (Ni)-Total	0.00050	mg/L	*variable*[2]		<0.00050	<0.00050	0.0005	0.0578	0.139	0.505	0.0283
Phosphorus (P)-Total	0.050	mg/L			<0.050	<0.050	0.05	0.092	0.311	0.621	0.060
Potassium (K)-Total	0.10	mg/L			1.13	1.15	1.16	0.94	1.44	3.44	1.89
Selenium (Se)-Total	0.000050	mg/L	0.001		0.000073	0.000074	0.000089	0.000093	0.000078	0.000244	0.000148
Silicon (Si)-Total	0.050	mg/L			3.82	3.79	3.62	20.0	15.5	45.4	10.1
Silver (Ag)-Total	0.000010	mg/L	0.00025	0.003	<0.000010	<0.000010	0.00001	0.000048	0.00254	0.000625	0.000062
Sodium (Na)-Total	0.050	mg/L			3.11	3.24	3.14	12.4	1.24	6.44	0.886
Strontium (Sr)-Total	0.00020	mg/L			0.253	0.266	0.271	0.0678	0.0573	0.208	0.138
Sulfur (S)-Total	0.50	mg/L			2.40	2.00	2.07	2.62	1.25	2.76	1.54
Thallium (Tl)-Total	0.000010	mg/L	0.0008		<0.000010	<0.000010	0.00001	0.000072	0.000079	0.000142	<0.000040
Tin (Sn)-Total	0.00010	mg/L			<0.00010	<0.00010	0.0001	0.00088	0.0121	0.00140	0.00022
Titanium (Ti)-Total	0.00030	mg/L			0.00221	<0.00030	0.0003	0.0254	0.154	0.301	0.0231
Uranium (U)-Total	0.000010	mg/L	0.033		0.00146	0.00150	0.00147	0.00199	0.000817	0.00378	0.00145
Vanadium (V)-Total	0.00050	mg/L			0.00099	0.00110	0.00098	0.00384	0.00762	0.0189	0.00254
Zinc (Zn)-Total	0.0030	mg/L	0.03	*variable*[2]	<0.0030	<0.0030	0.003	0.0174	0.0872	0.0995	0.0131
Zirconium (Zr)-Total	0.00030	mg/L			<0.00030	<0.00030	0.0003	0.00086	<0.00030	0.00036	<0.00030

Parameter	SURFACE WATER																							
Sample Station	SC-05	SC-05	SC-05	SC-01	SC-01	SC-01	SCT-10	SCT-10	SCT-10	RC-05	RC-05	RC-05	CC-05	CC-05	CC-05	LSC-05	LSC-05	LSC-05	LSC-06	LSC-06	LSC-06	SPRING	SPRING	SPRING
	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Physical Tests (Water)																								
Colour, True	<5	50.1		<5	65.8		<5	31.8		<5	24.8		8.3	45.1		<5	17.9		<5	23		<5	<5.0	
Conductivity	73.7	238		77.9	205		56.9	169		19.7	47.7		88.5	197		51.3	190		55.3	186		134	144	
Hardness (as CaCO3)	38.2	119		41.5	111		26.6	85.1		7.64	20.8		47	105		21.8	86.9		24.1	91.6		58.8	74	
pH	7.81	8.23		7.76	8.2		7.67	8.05		7.15	7.56		7.86	8.22		7.51	8.03		7.55	8.04		7.8	8.06	
Total Suspended Solids	<1	9.4		<1	9.6		<1	21.4		<1	7.2		<1	4.8		<1	15		<1	12.8		<1	<1.0	
Total Dissolved Solids	59	161		56	169		52	123		30	55		74	133		59	137		58	135		80	112	
Turbidity	0.13	7.51		0.16	6.44		0.17	14.4		0.11	2.59		0.27	3.38		0.13	6.33		0.11	7.05		<0.1	0.42	
Anions and Nutrients (Water)																								
Alkalinity, Bicarbonate (as CaCO3)	39.3	124		41.8	111		28.5	88.1		9.1	23.4		45	105		22.6	77.8		24.6	79.7		65.9	75.4	
Alkalinity, Carbonate (as CaCO3)	<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0	
Alkalinity, Hydroxide (as CaCO3)	<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0		<1	<1.0	
Alkalinity, Total (as CaCO3)	39.3	124		41.8	111		28.5	88.1		9.1	23.4		45	105		22.6	77.8		24.6	79.7		65.9	75.4	
Ammonia, Total (as N)	<0.005	<0.0050		<0.005	<0.0050		<0.005	0.0079		<0.005	0.0064		<0.005	<0.0050		<0.005	<0.0050		<0.005	<0.0050		<0.005	<0.0050	
Bromide (Br)	<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050	
Chloride (Cl)	<0.5	1.95	1.23	<0.5	0.84	0.67	<0.5	0.57	0.54	<0.5	0.56	0.53	<0.5	1.48	0.99	0.72	6.55	3.64	0.69	6.50	3.60	<0.5	<0.50	
Fluoride (F)	0.026	0.053		0.024	0.043		0.027	0.047		0.027	0.044		0.041	0.058		0.033	0.05		0.033	0.048		0.061	0.093	
Nitrate (as N)	<0.005	0.021		<0.005	0.0251		<0.005	0.0054		<0.005	0.0626		<0.005	0.0262		0.0059	0.0538		0.0052	0.0443		0.0624	0.0745	
Nitrite (as N)	<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010	
Total Kjeldahl Nitrogen	<0.05	0.244		<0.05	0.276		<0.05	0.212		<0.05	0.131		0.103	0.214		<0.05	0.184		<0.05	0.149		<0.05	<0.050	
Total Nitrogen	0.035	0.231		0.051	0.255		<0.03	0.202		<0.03	0.182		0.08	0.205		0.057	0.218		0.06	0.17		0.064	0.085	
Orthophosphate-Dissolved (as P)	0.0073	0.016		0.0075	0.016		0.0058	0.013		0.0016	0.0044		0.0131	0.0233		0.0016	0.0049		0.0016	0.0055		0.0072	0.0091	
Phosphorus (P)-Total Dissolved	0.0093	0.021		0.0088	0.024		0.0068	0.0165		<0.002	0.0066		0.0144	0.0339		<0.002	0.0062		<0.002	0.009		0.0065	0.0096	
Phosphorus (P)-Total	0.0069	0.020	0.014	0.009	0.032	0.020	0.0064	0.049	0.028	<0.002	0.0112		0.0127	0.0355	0.0241	<0.002	0.0358		<0.002	0.0317		0.0064	0.0167	0.012
Sulfate (SO4)	1.32	8.31		1.08	7.22		1.66	8.33		0.74	2.56		1.57	4.76		3.45	17.2		3.36	16.3		2.83	3.22	
Organic / Inorganic Carbon (Water)																								
Dissolved Organic Carbon	1.3	9.86		1.57	10.8		1.56	7.97		1.15	5.21		3.22	8.88		0.75	4.47		0.8	5.31		<0.5	0.81	
Total Organic Carbon	1.32	10.5		1.62	12		1.56	9.02		1.34	5.4		2.79	9.46		0.9	5.17		0.87	5.62		<0.5	0.94	
Total Metals (Water)																								
Aluminum (Al)-Total	0.013	0.55		0.0111	0.576		0.0167	1.01		0.0139	0.194		0.0233	0.279		0.0051	0.45		0.0061	0.349		0.0055	0.03	
Antimony (Sb)-Total	0.0001	0.00025		0.00013	0.00027		<0.0001	0.00024		<0.0001	<0.00010		0.00017	0.00023		0.00011	0.00024		0.00012	0.00024		<0.0001	<0.00010	
Arsenic (As)-Total	0.00054	0.0012		0.00051	0.00126		0.00044	0.00126		<0.0001	0.00017		0.00061	0.00083		0.00067	0.00153		0.00065	0.00131		0.00048	0.00065	
Barium (Ba)-Total	0.0095	0.032		0.00919	0.0246		0.0081	0.026		0.00346	0.00719		0.012	0.0204		0.00558	0.0183		0.00591	0.0182		0.00472	0.00605	
Beryllium (Be)-Total	<0.00002	0.000022		<0.00002	0.000023		<0.00002	0.000034		<0.00002	0.000023		<0.00002	0.000032		<0.00002	0.000025		<0.00002	<0.000020		<0.00002	<0.000020	
Bismuth (Bi)-Total	<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	0.000051		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050	
Boron (B)-Total	<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010	
Cadmium (Cd)-Total	<0.000005	0.000019		0.0000053	0.0000285		<0.000005	0.0000304		<0.000005	0.000012		<0.000005	0.0000104		0.0000183	0.0000454		0.000015	0.0000349		<0.000005	<0.0000050	
Calcium (Ca)-Total	5.77	28.3		4.6	18.2		6.51	20.8		2.38	5.88		6.18	16.5		7.33	27.5		7.3	27.5		19.2	23.4	
Chromium (Cr)-Total	<0.00056	0.0024		<0.00032	0.0026		<0.00026	0.00373		<0.00025	0.00062		0.00064	0.00203		<0.00022	0.0014		<0.00026	0.00122		<0.00073	0.00092	
Cobalt (Co)-Total	<0.0001	0.00031		<0.0001	0.0003		<0.0001	0.00059		<0.0001	<0.00010		<0.0001	0.0002		<0.0001	0.00027		<0.0001	0.00021		<0.0001	<0.00010	
Copper (Cu)-Total	<0.0005	0.00204		<0.0005	0.00217		<0.0005	0.00261		<0.0005	0.00094		0.00079	0.00214		<0.0005	0.00264		<0.0005	0.00206		<0.0005	<0.00050	
Iron (Fe)-Total	<0.01	0.549		<0.01	0.527		<0.01	1.05	0.53	<0.01	0.137		0.021	0.266		<0.01	0.478		<0.01	0.367		<0.01	0.029	
Lead (Pb)-Total	<0.00005	0.000364		<0.00005	0.000411		<0.00005	0.000617		<0.00005	0.000127		<0.00005	0.000281		<0.00005	0.000681		<0.00005	0.00041		<0.00005	0.000058	
Lithium (Li)-Total	<0.001	<0.0010		<0.001	<0.0010		<0.001	0.001		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	0.0014	
Magnesium (Mg)-Total	5.88	13.9		5.65	16.8		2.54	7.37		0.51	1.46		7.25	16.6		1.28	5.59		1.75	6.54		2.67	3.09	
Manganese (Mn)-Total	0.00015	0.00981		<0.00017	0.00919		<0.00039	0.0203		<0.00015	0.00267		0.0005	0.00634		<0.0006	0.00919		<0.0006	0.00705		<0.0001	0.00052	
Mercury (Hg)-Total	<0.000005	0.0000058		<0.000005	0.0000058		<0.000005	0.0000062		<0.000005	<0.0000050		<0.000005	0.0000069		<0.000005	0.0000538		<0.000005	0.0000187		<0.000005	<0.0000050	
Molybdenum (Mo)-Total	0.000212	0.001		0.000193	0.000708		0.00021	0.000811		0.000302	0.00456		0.000335	0.00104		0.00382	0.0105		0.00352	0.00913		0.000994	0.00175	
Nickel (Ni)-Total	0.00196	0.0086		0.00084	0.0127		0.00066	0.00526		<0.0005	<0.00050		0.00634	0.0151		0.00052	0.00186		0.00068	0.00299		<0.0005	<0.00050	
Phosphorus (P)-Total	0.0069	0.0203		0.009	0.0317		0.0064	0.049		<0.002	0.0112		0.0127	0.0355		<0.002	0.0358		<0.002	0.0317		0.0064	0.0167	
Potassium (K)-Total	0.68	2.16		0.59	1.74		0.72	1.83		0.42	0.8		0.64	0.98		0.6	1.73		0.64	1.73		1.01	1.2	
Selenium (Se)-Total	<0.00005	0.000086		<0.00005	0.0001		<0.00005	0.000087		<0.00005	<0.000050		<0.00005	0.000071		0.000075	0.000294		0.000086	0.000251		<0.00005	0.000071	
Silicon (Si)-Total	7.15	10.1		7.86	10.2		7.03	10.5		3.89	6.75		8.55	10.1		4.14	8.43		4.39	8.54		5.65	6.04	
Silver (Ag)-Total	<0.00001	0.000017		<0.00001	0.000053		<0.00001	0.000018		<0.00001	<0.000010		<0.00001	0.000018		<0.00001	0.000057		<0.00001	0.000017		<0.00001	<0.000010	
Sodium (Na)-Total	0.986	2.37		0.872	2.36		1.2	2.86		0.892	1.76		1.09	1.77		1.33	4.79		1.37	4.82		2.02	2.34	
Strontium (Sr)-Total	0.0442	0.18		0.039	0.137		0.0516	0.172		0.0382	0.0871		0.0569	0.141		0.0523	0.17		0.0523	0.175		0.2	0.263	
Sulfur (S)-Total	<0.5	3.04		<0.5	2.56		<0.5	3.03		<0.5	3.21		<0.5	1.54		1.13	6.03		1.01	5.62		0.91	1.3	
Thallium (Tl)-Total	<0.00001	0.000011		<0.00001	0.000019		<0.00001	0.000015		<0.00001	0.000012		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010	
Tin (Sn)-Total	<0.0001	0.00024		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010	
Titanium (Ti)-Total	<0.00034	0.0246		<0.0003	0.0483		<0.0005	0.0508		<0.0003	0.00702		0.00074	0.00899		<0.0003	0.024		<0.0003	0.0169		<0.0003	0.00285	
Uranium (U)-Total	0.000056	0.000341		0.000055	0.00019		0.000035	0.000191		0.000047	0.000153		0.000203	0.000813		0.000109	0.00034		0.000104	0.000319		0.000237	0.000409	
Vanadium (V)-Total	0.00074	0.00231		0.00077	0.00368		0.00063	0.00359		<0.0005	0.00096		0.00064	0.00111		0.00068	0.00197		0.00063	0.00173		0.00212	0.00238	
Zinc (Zn)-Total	<0.003	0.0032		<0.003	0.0044		<0.003	0.0038		<0.003	0.0038		<0.003	<0.0030		<0.003	0.0058		<0.003	0.0034		<0.003	0.0032	
Zirconium (Zr)-Total	<0.0003	0.00052		<0.0003	0.00051		<0.0003	0.00041		<0.0003	<0.00030		<0.0003	0.00101		<0.0003	<0.00030		<0.0003	<0.00030		<0.0003	<0.00030	

Table 2.7-6: Groundwater and Surface Water Hydrochemistry Comparison (cont.)

				Sample Station	GROUNDWATER RRS11-02	RRS11-02	RRS 11-02	RRS11-03	RRS11-03	RRS08-41	RRS08-41
				Date Sampled	27-Oct-2016	24-Apr-2018	28-May-2018	28-Oct-2016	21-Jun-2018	28-Oct-2016	31-May-2018
Parameter	Lowest Detection Limit	Units	CCME	BC WQ							
Dissolved Metals (Water)											
Aluminum (Al)-Dissolved	0.0010	mg/L	0.1	0.1	0.0048	0.0049	0.0035	0.0348	0.0387	0.0051	0.0047
Antimony (Sb)-Dissolved	0.00010	mg/L			0.00014	0.00012	0.00012	0.00022	0.00091	0.00018	0.00016
Arsenic (As)-Dissolved	0.00010	mg/L	0.005		0.0004	0.00045	0.00043	0.0008	0.00095	0.0013	0.00047
Barium (Ba)-Dissolved	0.000050	mg/L			0.00904	0.0108	0.00971	0.011	0.0150	0.0118	0.00569
Beryllium (Be)-Dissolved	0.000020	mg/L			<0.000020	<0.000020	0.00002	<0.000020	<0.000020	<0.000020	0.000967
Bismuth (Bi)-Dissolved	0.000050	mg/L			<0.000050	<0.000050	0.00005	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Dissolved	0.010	mg/L	29		0.0120	0.012	0.013	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)-Dissolved	0.0000050	mg/L	0.001	*variable* [2]	<0.0000050	<0.0000050	0.000005	<0.0000050	0.0000135	0.0000176	0.0000614
Calcium (Ca)-Dissolved	0.050	mg/L			10.0000	11.2	10.5	4.3400	3.41	16.3000	17.6
Chromium (Cr)-Dissolved	0.00010	mg/L			0.00036	0.00068	0.00031	0.00051	0.00028	0.00080	0.00016
Cobalt (Co)-Dissolved	0.00010	mg/L			<0.00010	<0.00010	0.0001	0.0003	0.00025	<0.00010	0.00016
Copper (Cu)-Dissolved	0.00020	mg/L	*variable* [2]		<0.00020	<0.00020	0.0002	0.0020	0.00631	0.0011	0.0700
Iron (Fe)-Dissolved	0.010	mg/L	0.3	0.35	<0.010	<0.010	0.01	0.0580	0.030	<0.010	<0.010
Lead (Pb)-Dissolved	0.000050	mg/L	*variable* [2]		<0.000050	<0.000050	0.00005	0.0003	0.000108	0.0007	0.000596
Lithium (Li)-Dissolved	0.0010	mg/L			0.0011	0.0010	0.0010	0.0023	<0.0010	0.0023	0.0019
Magnesium (Mg)-Dissolved	0.10	mg/L			24.8000	29.0	25.9	13.3000	31.8	24.8000	30.8
Manganese (Mn)-Dissolved	0.00010	mg/L			0.0004	0.00030	0.00021	0.0044	0.0130	0.0029	0.00517
Mercury (Hg)-Dissolved	0.0000050	mg/L	0.000026		<0.0000050	<0.0000050	0.000005	<0.000025	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)-Dissolved	0.000050	mg/L	0.073		0.0018	0.00190	0.00176	0.0008	0.000536	0.0015	0.00132
Nickel (Ni)-Dissolved	0.00050	mg/L	*variable* [2]		<0.00050	<0.00050	0.0005	0.0199	0.00836	0.0075	0.00256
Phosphorus (P)-Dissolved	0.050	mg/L			<0.050	<0.050	0.05	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	0.10	mg/L			1.1700	1.31	1.18	0.6700	0.64	1.2200	1.71
Selenium (Se)-Dissolved	0.000050	mg/L	0.001	0.001	0.000064	0.000056	0.000114	0.000099	0.000056	0.000165	0.000138
Silicon (Si)-Dissolved	0.050	mg/L			3.7000	3.83	3.64	5.6100	2.88	7.6500	7.98
Silver (Ag)-Dissolved	0.000010	mg/L	0.00025		<0.000010	<0.000010	0.00001	0.000011	0.000067	<0.000010	<0.000010
Sodium (Na)-Dissolved	0.050	mg/L			3.1400	3.60	3.24	11.3000	0.861	5.3200	0.778
Strontium (Sr)-Dissolved	0.00020	mg/L			0.2540	0.299	0.276	0.0486	0.0385	0.1300	0.138
Sulfur (S)-Dissolved	0.50	mg/L			2.2400	1.83	2.01	2.2200	1.15	2.2900	1.74
Thallium (Tl)-Dissolved	0.000010	mg/L	0.0008		<0.000010	<0.000010	0.00001	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Dissolved	0.00010	mg/L			<0.00010	<0.00010	0.0001	0.0003	0.00101	0.0004	<0.00010
Titanium (Ti)-Dissolved	0.00030	mg/L			<0.00030	<0.00030	0.0003	0.0029	0.00101	<0.00030	<0.00030
Uranium (U)-Dissolved	0.000010	mg/L	0.033		0.0014	0.00151	0.00148	0.0007	0.000110	0.0013	0.00131
Vanadium (V)-Dissolved	0.00050	mg/L			0.00089	0.00112	0.00093	<0.00050	<0.00050	0.0011	0.00130
Zinc (Zn)-Dissolved	0.0010	mg/L	0.03		<0.0010	<0.0010	0.001	0.0030	0.0031	0.0015	0.0059
Zirconium (Zr)-Dissolved	0.00030	mg/L			<0.00030	<0.00030	0.0003	0.0003	<0.00030	<0.00030	<0.00030

Sample Station	SURFACE WATER SC-05	SC-05	SC-05	SC-01	SC-01	SC-01	SCT-10	SCT-10	SCT-10	RC-05	RC-05	RC-05	CC-05	CC-05	CC-05	LSC-05	LSC-05	LSC-05	LSC-06	LSC-06	LSC-06	SPRING	SPRING	SPRING
Parameter	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dissolved Metals (Water)																								
Aluminum (Al)-Dissolved	0.0043	0.0748		0.0037	0.0891		0.0037	0.0491		0.0094	0.0516		0.0065	0.137	0.072	0.0027	0.0468		0.002	0.0471		<0.001	0.0067	
Antimony (Sb)-Dissolved	<0.0001	0.00021		0.00011	0.00021		<0.0001	0.00017		<0.0001	<0.00010		0.00013	0.0002		0.0001	0.00019		0.0001	0.00019		<0.0001	<0.00010	
Arsenic (As)-Dissolved	0.00046	0.00082		0.00044	0.0009		0.0004	0.00058		<0.0001	0.0001		0.00055	0.0007		0.0005	0.00119		0.0005	0.00115		0.00048	0.00062	
Barium (Ba)-Dissolved	0.00874	0.0313		0.00829	0.0243		0.00775	0.0234		0.00313	0.00598		0.012	0.0209		0.00486	0.0165		0.0054	0.0188		0.00526	0.00589	
Beryllium (Be)-Dissolved	<0.00002	<0.000020		<0.00002	<0.000020		<0.00002	<0.000020		<0.00002	0.000021		<0.00002	<0.000020		<0.00002	<0.000020		<0.00002	<0.000020		<0.00002	<0.000020	
Bismuth (Bi)-Dissolved	<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	<0.000050	
Boron (B)-Dissolved	<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010		<0.01	<0.010	
Cadmium (Cd)-Dissolved	<0.000005	0.0000091		0.0000052	0.0000166		<0.000005	0.0000079		<0.000005	0.0000132		<0.000005	<0.0000050		0.0000177	0.0000251		0.0000139	0.0000235		<0.000005	<0.0000050	
Calcium (Ca)-Dissolved	5.6	27.2		4.6	18.6		6.51	21.7		2.27	6.01		6.17	15.5		6.76	27		6.99	26.8		19.4	24.6	
Chromium (Cr)-Dissolved	0.00047	0.00074		0.00019	0.00097		0.00017	0.00034		0.00018	0.00036		0.00049	0.00115		0.00015	0.00026		0.00011	0.00035		0.00068	0.00084	
Cobalt (Co)-Dissolved	<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010	
Copper (Cu)-Dissolved	0.00028	0.00102		0.00026	0.00141		0.00021	0.00075		0.00023	0.00059		0.0006	0.00151		0.00033	0.00118		0.00035	0.00118		<0.0002	<0.00020	
Iron (Fe)-Dissolved	<0.01	0.049		<0.01	0.062		<0.01	0.03		<0.01	0.014		<0.01	0.105		<0.01	0.016		<0.01	0.024		<0.01	<0.010	
Lead (Pb)-Dissolved	<0.00005	0.000068		<0.00005	0.000091		<0.00005	<0.000050		<0.00005	<0.000050		<0.00005	0.000129		<0.00005	0.000068		<0.00005	0.000057		<0.00005	0.000052	
Lithium (Li)-Dissolved	<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	<0.0010		<0.001	0.0015	
Magnesium (Mg)-Dissolved	5.87	14.1		5.58	16.9		2.52	7.49		0.48	1.4		7.68	16		1.2	5.42		1.62	6.01		2.54	3.03	
Manganese (Mn)-Dissolved	<0.0001	0.00181		<0.0001	0.00103		<0.0001	0.00076		<0.0001	0.00034		<0.0001	0.0022		0.00027	0.00107		0.00029	0.00191		<0.0001	0.00014	
Mercury (Hg)-Dissolved	<0.000005	<0.0000050		<0.000005	0.0000073		<0.000005	0.0000056		<0.000005	<0.0000050		<0.000005	0.0000071		<0.000005	<0.0000050		<0.000005	<0.0000050		<0.000005	<0.0000050	
Molybdenum (Mo)-Dissolved	0.0002	0.000924		0.000171	0.000657		0.000182	0.000752		0.000258	0.000722		0.000298	0.000927		0.00344	0.00964		0.00317	0.00806		0.000943	0.00147	
Nickel (Ni)-Dissolved	0.00185	0.00574		<0.0005	0.00888		0.00053	0.00125		<0.0005	<0.00050		0.00551	0.0118		<0.0005	0.0009		0.00053	0.0018		<0.0005	<0.00050	
Phosphorus (P)-Dissolved	<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050		<0.05	<0.050	
Potassium (K)-Dissolved	0.69	2.04		0.61	1.7		0.76	1.83		0.4	0.73		0.65	0.92		0.6	1.66		0.61	1.7		1.05	1.11	
Selenium (Se)-Dissolved	<0.00005	0.00007		<0.00005	0.000068		<0.00005	0.000072		<0.00005	<0.000050		<0.00005	0.000054		0.000072	0.000283		<0.00005	0.000245		<0.00005	<0.000050	
Silicon (Si)-Dissolved	7.29	9.75		7.45	9.89		6.83	9.48		3.61	6.78		7.87	9.96		3.88	7.51		4.12	8.46		5.45	5.63	
Silver (Ag)-Dissolved	<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010	
Sodium (Na)-Dissolved	0.963	2.29		0.841	2.28		1.15	2.75		0.799	1.73		1.07	1.79		1.24	4.53		1.25	4.7		1.95	2.38	
Strontium (Sr)-Dissolved	0.0445	0.174		0.0384	0.129		0.0528	0.174		0.0361	0.0886		0.059	0.138		0.0495	0.164		0.0512	0.176		0.203	0.257	
Sulfur (S)-Dissolved	<0.5	2.93		<0.5	2.61		<0.5	2.74		<0.5	0.76		<0.5	1.46		0.86	5.62		1	5.05		0.65	1.17	
Thallium (Tl)-Dissolved	<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010		<0.00001	<0.000010	
Tin (Sn)-Dissolved	<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010		<0.0001	<0.00010	
Titanium (Ti)-Dissolved	<0.0003	0.00199		<0.0003	0.00224		<0.0003	0.00105		<0.0003	0.0005		<0.0003	0.00357		<0.0003	0.00062		<0.0003	0.00094		<0.0003	<0.00030	
Uranium (U)-Dissolved	0.000042	0.000314		0.000047	0.000181		0.000029	0.000186		0.000044	0.000128		0.000166	0.000769		0.000082	0.000299		0.000078	0.000303		0.00021	0.000369	
Vanadium (V)-Dissolved	0.0006	0.00119		0.00057	0.00107		0.00053	0.00108		<0.0005	0.00063		<0.0005	0.00072		<0.0005	0.00086		<0.0005	0.00085		0.00192	0.00225	
Zinc (Zn)-Dissolved	<0.001	0.0053		<0.001	0.0035		<0.001	0.0034		<0.001	0.0054		<0.001	0.0053		<0.001	0.0062		<0.001	0.0024		<0.001	0.0021	
Zirconium (Zr)-Dissolved	<0.0003	0.00033		<0.0003	0.00036		<0.0003	0.00031		<0.0003	<0.00030		<0.0003	0.00061		<0.0003	<0.00030		<0.0003	<0.00030		<0.0003	<0.00030	

Footnotes:

1) Varies depending on background, duration, and whether water flowing is clear or turbid

2) Hardness dependent

3) Chloride dependent

4) Used Aquatic Life-Lakes (Salmonids Are Predominant Fish Species)

5) Unquantifiable due to unmeasured component- Methylmercury

(pink)	exceeds CCME
(green)	exceeds BC WQ
(yellow)	exceeds both

2.8 SEDIMENT QUALITY

2.8.1 BASELINE STUDY DESIGN

Details of the sediment quality baseline program for the RRIMM Project are reported in *Baseline Aquatic Monitoring Studies, 2016-2017 Record Ridge Magnesium Property* (Azimuth 2018; Appendix 2-G). The baseline program was designed and implemented according to the objectives outlined by the BC Ministry of Environment and Climate Change Strategy (BC ENV) in the *Water and Air Baseline Monitoring Guidance for Mine Proponents and Operators* (BC MOE 2016)[2]. This document provides guidance for the collection, analysis, and interpretation of data collected in support of mine development in BC.

Sediments in freshwater creek environments support aquatic life by providing habitat for various invertebrate species and microorganisms, as well as substrate for periphytic algae to colonize. Sediments are also a sink for contaminants in aquatic ecosystems and, therefore, a source of direct exposure for lower trophic level receptors in contact with sediment. Ideally, depositional areas would be targeted for sampling due to the propensity for fine particulate sediments to bind contaminants. However, most of the creek habitat where biological sample collection was completed is considered erosional rather than depositional. The sampling method (guzzler pump or spoon) was used to preferentially collect fine particulate sediments (generally three replicate samples for each EA/AEMP station and one for EA-only stations). Metals, pH, total organic carbon (TOC), and grain size analyses were completed on the <63 micrometre (µm) fraction of sediment, as recommended by BC MOE (2016). Finer sediments have greater affinity for binding metals; therefore, higher concentrations of metals are expected in the <63 µm fraction compared with the < 2 mm fraction. Chemical analyses were completed by ALS Environmental Ltd. (ALS) in Burnaby, BC, a certified laboratory.

Sediment sampling was completed in August 2016 as part of the aquatic resources baseline sampling program. Sampling occurred at eight stations along three creeks: two stations along Little Sheep Creek (LSC-05 and LSC-06), one station at Record Creek (RC-05), and five stations along Sophia Creek (SC-01 and SC-05; and at the upper reaches of the drainage, WS01, SOP2, and SOP3) (Figure 2.7-1; Table 2.8-1). Note that as sediment is considered a sink for contaminants and integrates conditions over time, a single event is considered satisfactory to characterize baseline conditions. In addition, the lack of samples in the ephemeral Corral Creek (CC-05) is not considered a spatial gap in the baseline data set since that watershed is not anticipated to receive any inputs from the proposed development and other reference stations are included (i.e., those designated as "Control" in Table 2.8-1).

Selection of sampling stations for the aquatic baseline program was based on a number of considerations:

- Proximity to future infrastructure – Control stations were selected in areas unaffected by current Project plans (e.g., upstream or in adjacent watersheds), while impact stations were selected downstream of any proposed Project activities on all watercourses.

[2] BC Ministry of Environment (Ministry of BC MOE) was renamed BC Ministry of Environment and Climate Change Strategy in 2017 (BC ENV). Documents prepared by the Ministry prior to the name change in 2017 will be cited as "BC MOE".

- Likelihood of year-round flow – Stations were selected in areas that were considered likely to be flowing year-round in an effort to avoid disruptions in the SWQ dataset and confounding influence on benthic communities.
- Presence of monitoring media – If possible, station locations were located in areas with abundant stream habitat to accommodate the aquatic effects monitoring program (sediment, periphyton, and benthic invertebrate sampling), and at locations suitable for hydrometric monitoring. Compatibility of site selection between the various disciplines was of interest, to aid in creating synoptic data sets.

Table 2.8-1: Summary of Sediment Quality Sampling

Station	Station Type[1]	Control/Impact[2]	Rationale/Purpose of Site	Sample		Monitoring Component		
				Date	Size (n)	Particle Size	Organic Carbon	Metals[3]
LSC-06	EA/AEMP	Impact	Little Sheep Creek downstream from confluence with Sophia Creek	Aug 2016	3	✓	✓	✓
LSC-05	EA/AEMP	Control	Little Sheep Creek upstream from confluence with Sophia Creek	Aug 2016	3	✓	✓	✓
SCT-10	EA/AEMP	Control	South Sophia Creek – Tributary	Aug 2016	3	✓	✓	✓
RC-05	EA/AEMP	Control	Record Creek reference station	Aug 2016	3	✓	✓	✓
CC-05	EA/AEMP	Control	Corral Creek, drainage southwest of Project	Not sampled		No flow		
SC-01	EA/AEMP	Impact	Sophia Creek near-field exposure station	Aug 2016	3	✓	✓	✓
SC-05	EA/AEMP	Impact	Sophia Creek mid-field exposure station	Aug 2016	3	✓	✓	✓
SOP2	EA	NA	Sophia Creek reach 2	Aug 2016	1	✓	✓	✓
SOP3	EA/AEMP	Impact	Sophia Creek reach 3	Aug 2016	1	✓	✓	✓
WSO-01	EA/AEMP	Impact	West Sophia Creek reach 1	Aug 2016	1	✓	✓	✓

Notes:
1. EA/AEMP station designation for sites outside the project footprint that may be used in development of long-term monitoring aquatic environmental monitoring program; EA station designation to characterize loss of habitat due to construction of site infrastructure (i.e., stations situated within footprint)
2. Control/impact designation. Applicable only for long-term monitoring stations (EA/AEMP).
3. Metal analysis completed on the 63 µm sediment fraction

Note that the “Control/Impact” designation shown in Table 2.8-1 is a function of the planned development (i.e., “Impact” stations are downstream of the proposed development) and not current conditions. It is hard to categorize baseline conditions as “un-impacted” by previous anthropogenic activities since one or more of logging, road development/maintenance, powerline/pipeline construction, linear developments, and/or residential construction, have occurred in each of the watersheds (Figure 2.7-1). However, from a practical perspective, all the watersheds, with the exception of Little Sheep Creek, are considered un-impacted; Little Sheep Creek has received inputs from residential construction and road development/maintenance activity situated in the upper watershed.

Details of the sediment collection methods and QA/QC program (methods and results) are provided in Appendix 2-G.

2.8.2 SEDIMENT QUALITY RESULTS

Sediment chemistry results were screened against provincial working sediment quality guidelines (WSQG) as a qualitative measure of exposure for sediment-dependent aquatic life (Table 2.8-2). Screening results need to be interpreted cautiously because: (a) the WSQG are based on chemistry results for the <2 mm sediment fraction and (b) depositional microhabitats are rare at most stations (i.e., so they are not representative of prevailing habitat). Sophia Creek stations had the highest concentrations of chromium, iron, manganese, and nickel compared to the data from Little Sheep Creek and Record Creek. Concentrations of chromium, iron, manganese, and nickel exceeded the lower WSQG (or interim sediment quality guideline [ISQG]) and, occasionally, the upper WSQG (or probable effect level [PEL]). Chromium, as well as nickel, magnesium, and manganese, are well known to occur at comparatively high concentrations in mineralized areas characterized by ultramafic rock (Oze et al. 2004), so it is likely that this pattern is due to local mineralization characterizing the RRIMM Project.

Arsenic, cadmium, copper, mercury, and silver were also elevated above the ISQG (and sometimes PEL), with the highest concentrations occurring in Little Sheep Creek (Table 2.8-2). These metals are likely associated with historical mining in the upper Little Sheep Creek watershed.

Table 2.8-2: Working Sediment Quality Guidelines in British Columbia

Parameter (µg/g dry weight)	BC Working Sediment Quality Guidelines[1]		Notes[2]	Source
	Lower	Upper		
Arsenic	5.9	17	Lower = ISQG; Upper = PEL	CCME (1999)
Cadmium	0.6	3.5	Lower = ISQG; Upper = PEL	CCME (1999)
Chromium	37.3	90	Lower = ISQG; Upper = PEL	CCME (1999)
Copper	35.7	197	Lower = ISQG; Upper = PEL	CCME (1999)
Iron	21,200	43,766	Effect levels based on SLC	Jaagumagi (1993)
Lead	35	91	Lower = ISQG; Upper = PEL	CCME (1999)
Manganese	460	1,100	Effect levels based on SLC	Jaagumagi (1993)
Mercury	0.17	0.49	Lower = ISQG; Upper = PEL	CCME (1999)
Nickel	16	75	Effect levels based on SLC	Jaagumagi (1993)
Selenium	2		Alert concentration[2]	Nagpal and Howell (2001)

Parameter (µg/g dry weight)	BC Working Sediment Quality Guidelines[1]		Notes[2]	Source
	Lower	Upper		
Silver	0.5		Ontario sediment guideline	Ontario MOEE (1993)
Zinc	123	315	Lower = ISQG; Upper = PEL	CCME (1999)

Notes:
1. Working Guidelines for Sediment Quality (ENV 2017).
2. Notes:
   SLC = screening level assessment
   ISQG = interim sediment quality guideline
   PEL = probable effect level
3. Weight of evidence; lowest published toxicity thresholds; no uncertainty factor applied; insufficient data for derivation of WSQG.

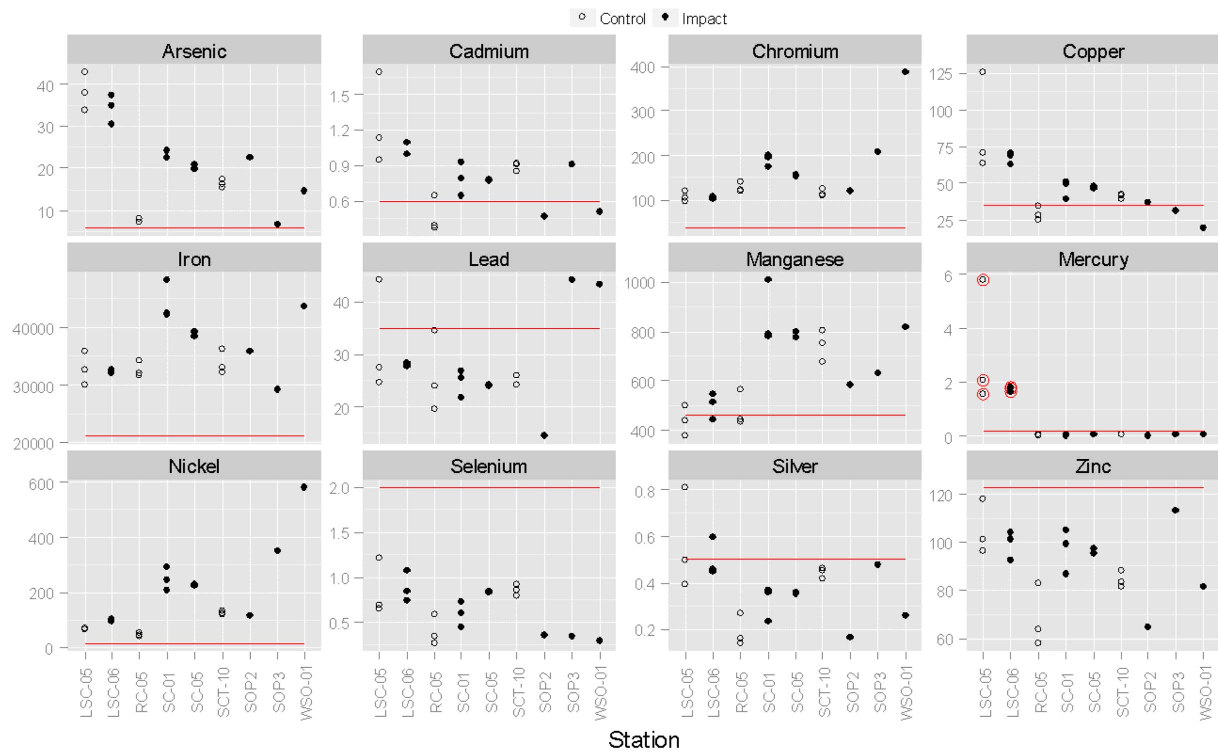


Figure 2.8-1: Sediment metal concentrations (< 63 µm; µg/g dry wt) compared against BC Working Sediment Quality Guidelines

Note: Red lines for each metal represent the Lower Working Sediment Quality Guideline value. Red circled data points for mercury were flagged as unreliable in the QA assessment.

(Figure source: Azimuth 2018; Appendix 2-G)

2.9 FISHERIES AND AQUATIC RESOURCES

2.9.1 PERIPHYTON AND BENTHIC INVERTEBRATE COMMUNITY MEASURES

2.9.1.1 Baseline Study Design

Periphyton and benthic invertebrates were selected as receptor groups for evaluating the health of lower trophic levels in creeks within the RRIMM Project area. Methodology and results of the periphyton and benthic invertebrate sampling are provided in the report, *Baseline Aquatic Monitoring Studies, 2016-2017 Record Ridge Magnesium Property* (Azimuth 2018; Appendix 2-G). "Lower" trophic levels are the foundation of aquatic food webs, providing food for higher trophic level consumers such as fish and aquatic-dependent birds. Two types of stations were targeted: "AEMP" (i.e., those likely to be used for a long-term aquatic effect monitoring program [AEMP]) and "EA" (i.e., those unlikely to be used for long-term monitoring); both types of sampling stations were used to characterize baseline conditions.

Replicate periphyton (n=10) and benthic invertebrate (n=3) samples were collected from Little Sheep Creek (LC-05 and LC-06), Record Creek (RC-05), and Sophia Creek (SC-01 and SC-05) in 2016. Benthic invertebrate samples were also collected from stations in the upper reaches of the Sophia Creek drainage (WS-01, SOP2, and SOP3) in 2016. The scope of the 2017 baseline sampling program for periphyton and benthic invertebrate sampling was limited by extreme dry conditions; sufficient flow for sampling was only present in Record Creek (RC-05) and Little Sheep Creek (LSC-05 and LSC-06). Note that while two years of data was targeted for these programs, the small size of Sophia Creek (particularly in the upper portion of the drainage) may make it hard to routinely sample those stations due to their ephemeral flows; as such, this should not be considered a significant temporal gap. In addition, the lack of any samples in the ephemeral Corral Creek (CC-05) is not considered a spatial gap in the baseline data set since that watershed is not anticipated to receive any inputs from the proposed development and other reference stations are included (i.e., those designated as "Control" in Table 2.8-1).

Figure 2.7-1 shows the locations where periphyton and benthic invertebrate samples were collected for taxonomy. Note the "Control/Impact" designation shown in Table 2.8-1 is a function of the planned development (i.e., "Impact" stations are downstream of the proposed development) and not current conditions. It is difficult to categorize baseline conditions as "un-impacted" by previous anthropogenic activities since one or more of logging, road development/maintenance, powerline/pipeline construction, linear developments, and/or residential construction, have occurred in each of the watersheds. However, from a practical perspective, all the watersheds with the exception of Little Sheep Creek are considered un-impacted; Little Sheep Creek has received inputs from residential construction and road development/maintenance activity situated in the upper watershed.

Periphyton sampling was conducted using a fixed-area sampling device to remove periphyton adhered to rocks in riffle or glide habitat. Periphyton samples were collected for taxonomy (i.e., density, richness, and biomass), loss on ignition (LOI) and chlorophyll-a. Benthic invertebrates were sampled using the kick net method outlined in the Canadian Aquatic Biomonitoring Network (CABIN) approach for sampling benthic invertebrates in stream environments and analyzed for abundance and richness. Methods for sampling periphyton and benthic invertebrates are consistent with those outlined in the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (BC MOE 2016).

Details of the collection methods and QA/QC program (methods and results) are provided in Appendix 2-G. Periphyton taxonomic identification was completed at Plankton-R-Us (Winnipeg, MB); and benthic invertebrate taxonomy samples were sent to Biologica Environmental Services Ltd. (Victoria, BC). Chemistry samples were sent to ALS (Burnaby, BC).

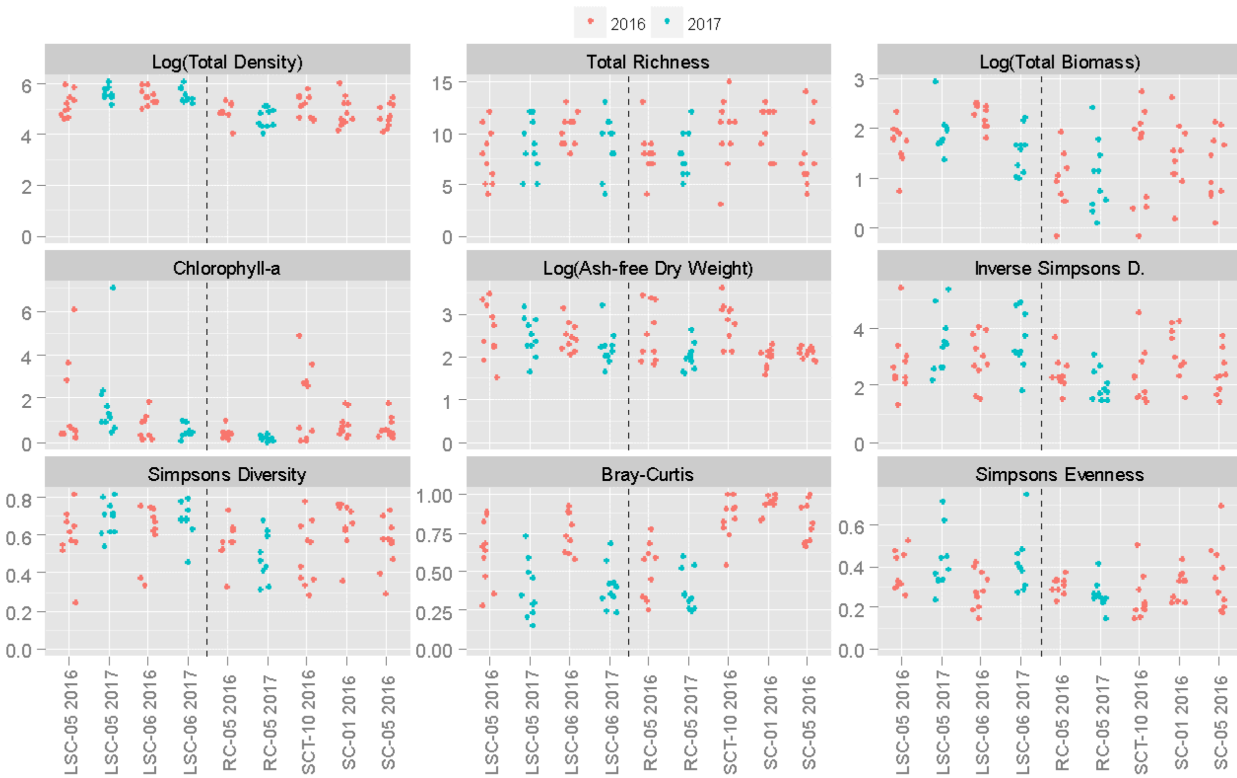
2.9.1.2 Periphyton and Benthic Invertebrate Community Results

Periphyton Community – Periphyton taxonomy data were analyzed by grouping species data into major taxa groupings. Periphyton community data were assessed by comparing total richness and biomass metrics among stations and between years (where available). Taxonomic richness in periphyton samples are generally consistent within, and among, stations for samples collected in 2016 and 2017. Cyanophytes and diatoms comprise the majority of taxa present in a given sample. Cyanophytes also comprise a major proportion of the total biomass. Diatoms, while comparatively rich as a taxonomic group, were a minor contributor to periphyton biomass, except at one station on Sophia Creek. It's worth noting that richness was fairly consistent among the stations sampled in both 2016 and 2017, in spite of the extreme dry conditions in 2017 and slightly offset sampling period (September vs August).

Within-station taxonomic biomass estimates were variable in 2016 and 2017, a reflection of natural heterogeneity of this metric caused by differences in nutrient availability, stream discharge, depth, aspect, light availability, season, competition among groups for colonization, and other factors. As expected, the lower reach of Little Sheep Creek (LC-06), with lower flow rates and less canopy cover, tended to have higher biomass than the other monitoring stations when looking across all 10 replicate samples (Figure 2.9-1). LS-06 was the only location where there was evidence of an annual decrease in biomass, consistent with hot and dry summer conditions in 2017.

Results of taxonomy, chlorophyll-a, and LOI indicate lower periphyton productivity at the upstream reference area RC-05 and at stations within the Sophia drainage compared to stations on Little Sheep Creek (LC-05 and LC-06; Figure 2.9-1). These findings are consistent with the type of community expected in higher elevation, higher canopy cover, higher gradient, faster flowing streams, such as Record Creek and Sophia Creek. The prolonged dry season likely played a significant role in annual variability, as well as natural within-station variability in biomass (and density) recorded in 2017. The high degree of within-station variability in density and biomass metrics strongly suggest bottom-up forces, such as light, substrate, and flow, may be contributing to the variability in periphyton community endpoints seen across all stations.

Benthic Invertebrate Community – Benthic invertebrate community assemblages are defined by the underlying habitat characteristics within the reach, such as slope, percent canopy cover, characteristics of the watershed (e.g., % ice cover) and water depth, to name a few. These habitat variables form the basis of the Reference Condition Approach (RCA) used in data analysis according to the CABIN method. At present, a new reference model for the Okanagan region has been developed but has not yet been integrated into the online CABIN analytical framework. Consequently, interpretation of benthic community results followed a more traditional approach (e.g., comparing patterns of total and major taxa group abundance and taxa richness among stations).



Note: Data points are horizontally 'jittered' (offset) to minimize masking. The vertical dashed line separates Little Sheep Creek Stations (left) from Record Creek and Sophia Creek Stations (right). See Appendix 2-G for descriptions of key metrics and units. Chlorophyll-a (µg/cm2) and ash-free dry weight (µg/cm2) are also indicators of biomass.

Source: Azimuth 2018; Appendix 2-G

Figure 2.9-1: Periphyton results for the Record Ridge, 2016-2017 – Key Metrics

Creek habitat is quite different between Little Sheep Creek and Record/Sophia Creeks. Habitat differences are the primary reason for designing the sampling program with separate reference areas for Sophia Creek (RC-05 and SCT-10) and Little Sheep Creek (LSC-05). Record Creek and Sophia Creek systems are higher order streams (2 or 3) in areas with higher % grade, more frequent intermittent flow (as evidenced by no samples in 2017), greater canopy cover, and, in general, more heterogeneous stream habitat throughout the sampling reaches compared to Little Sheep Creek.

Benthic invertebrate communities in Little Sheep Creek, Record Creek and Sophia Creek are comprised primarily of aquatic insects from the Orders Diptera (chironomids), Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa comprise a significant proportion of the total benthic invertebrate community abundance in the aquatic environment surrounding Record Ridge, with the exception of upgradient locations sampled in the Sophia Creek drainage in 2016 (i.e., which have finer substrates and lower flows; Figure 2.9-2). Benthic invertebrate abundance in Record and Little Sheep Creek stations ranged between 60% and 90% EPT compared with the Sophia Creek stations where the percent EPT ranged between 30% and 60%. Lower relative abundance of EPT taxa coincided with increased abundance of chironomids (Chironomidae), likely as a result of habitat differences between smaller upgradient stations (SCT-10, SCP3, and WSO-01) and downgradient or larger stations.

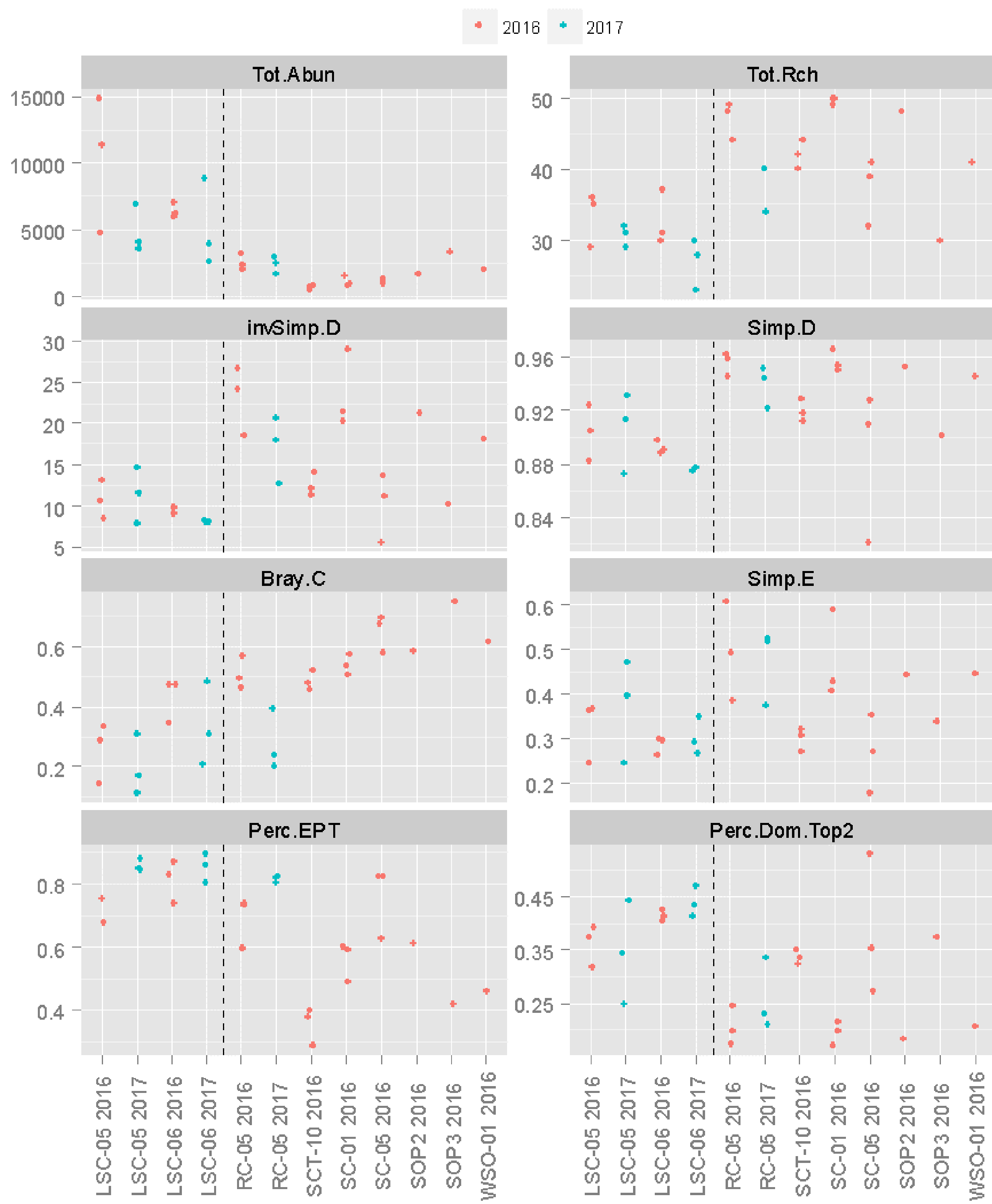
2.9.2 FISH AND FISH HABITAT

2.9.2.1 Baseline Study Design

Baseline fish and fish habitat sampling was conducted to help characterize the aquatic environment. Methodology and results of fish and fish habitat sampling are provided in the report, *Record Ridge Magnesium Property Fish and Fish Habitat Baseline Report* (Smithson and Robinson 2018; Appendix 2-I). Specific objectives of the fish and fish habitat baseline program were to:

- Characterize aquatic resources potentially affected through development of the Project (i.e., existing environment).
- Provide baseline information necessary to support permitting and any potential future effects assessment (e.g., mine design considerations and effects assessment).
- Facilitate design of monitoring programs that will allow before and after comparisons, and comparisons between reference (or control) sites and test sites.

These objectives were met primarily through baseline sampling, although existing information was used to supplement baseline findings. Baseline sampling was used to describe potential fish distribution, both spatially and temporally, and habitat quality in potentially affected areas regardless of fish-bearing status. Data presented describe existing conditions prior to mining and will provide information to inform management and monitoring plans, as required.



Note: Each symbol represents a single replicate. In general, three replicates were collected at each site for each sampling event at each station. One replicate was collected at SOP2, SOP3, WSO-01. Data points are horizontally 'jittered' (offset) to minimize masking. The vertical dashed line separates Little Sheep Creek from Record and Sophia Creeks when comparing the metrics. See Appendix 2-G for a description of the metrics.

Source: Azimuth 2018; Appendix 2-G

Figure 2.9-2: Benthic Invertebrate Community Results for CABIN Samples, 2016–2017

Field studies were completed in July and August 2016 which focused on portions of Little Sheep Creek, Sophia Creek, South Sophia Creek, West Sophia Creek, Record Creek, and Corral Creek. Fish and fish habitat sampling occurred within 12 sampling sites throughout those six streams (Figure 2.9-3). Of the six sites sampled, Record Creek and Corral Creek are identified as reference streams because they are not downstream of proposed mining. However, it is difficult to categorize baseline conditions as "un-impacted" by previous anthropogenic activities since one or more of logging, road development/maintenance, powerline/pipeline construction, linear developments and/or residential construction have occurred in each of the watersheds. From a practical perspective, all the watersheds with the exception of Little Sheep Creek are considered un-impacted; Little Sheep Creek has received inputs from residential construction and road development/maintenance activity situated in the upper watershed.

The baseline program includes the following components:

- overwintering fish habitat survey
- spring fish spawning survey
- fish inventory (reconnaissance-level fish and fish habitat assessments)
- fish community (fish density estimates and detailed fish habitat assessments)
- Level 1 Fish Habitat Assessment Procedures (FHAP)

Details of the fish and fish habitat collection methods and QA/QC program (methods and results) are provided in Appendix 2-I.

2.9.2.2 Fish and Fish Habitat Results

Two species of fish were observed, or reported to occur, in the RRIMM Project area according to the Provincial fisheries database (BC MOE 2018a):

- Eastern Brook Trout (*Salvelinus fontinalis*); and
- Rainbow Trout (*Oncorhynchus mykiss*).

Neither of these fish species are a provincially listed species (red or blue-listed), federally listed species (Committee on the Status of Endangered Wildlife in Canada [COSEWIC], and *Species at Risk Act*), or are suspected to be populations that are genetically distinct. Rainbow trout are likely native to the area, but eastern brook trout are an introduced species. Eastern brook trout were introduced into Little Sheep Creek through a government stocking program in the 1950's (BC MOE 2018a). Both species are documented by the BC Provincial database to occur within the area. Field sampling confirmed both species to be present (Table 2.9-1). Eastern brook trout dominated Little Sheep Creek while Sophia Creek was dominated by rainbow trout. No fish were captured in Record Creek, nor in South and West Sophia creeks; however, eastern brook trout have been previously documented in Record Creek (provincial fisheries database; BC MOE 2018a). Ephemeral conditions precluded sampling in Corral Creek, although eastern brook trout have been previously documented to occur in Corral Creek (provincial fisheries database; BC MOE 2018a).

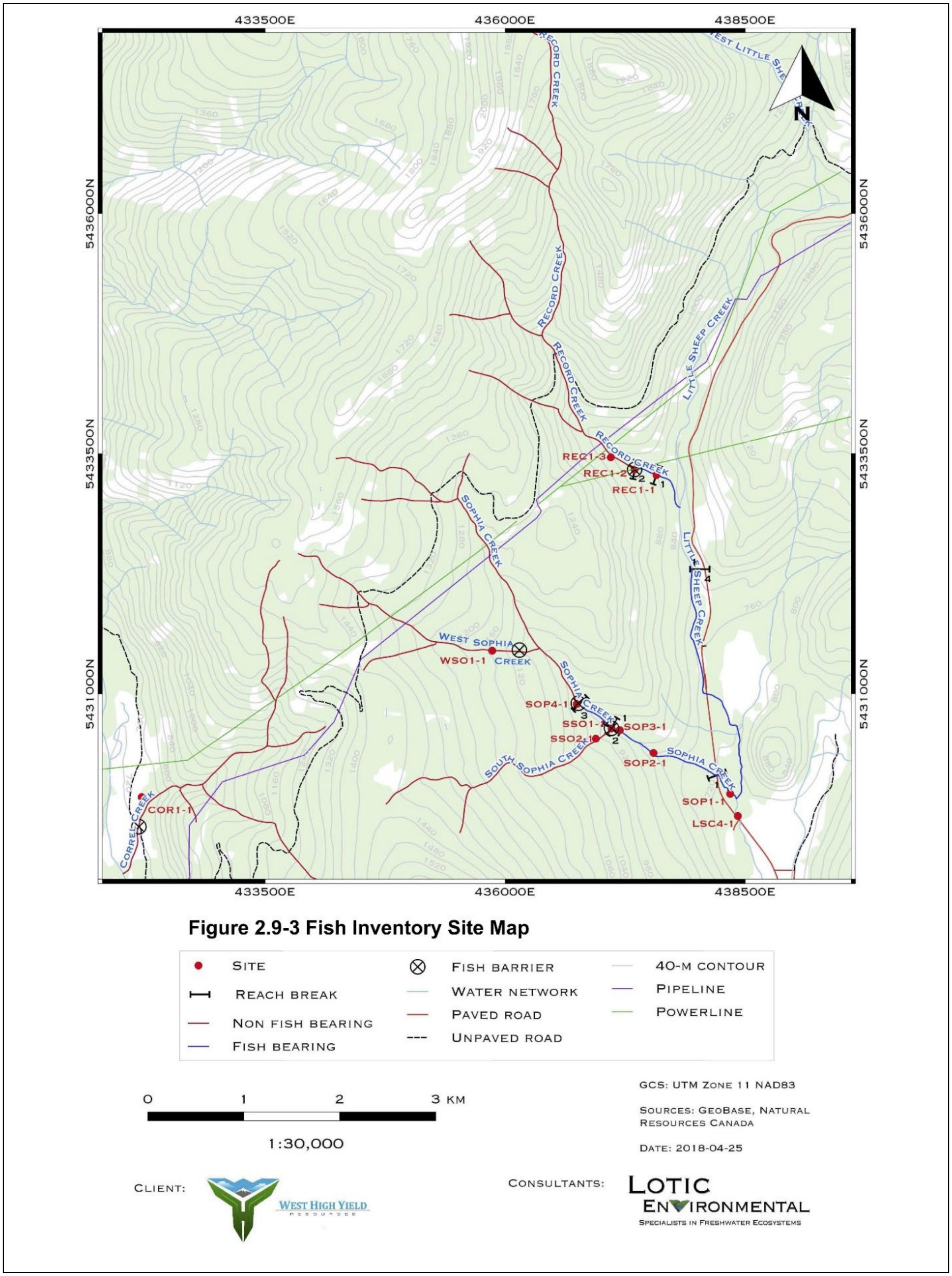


Figure 2.9-3: Fish Inventory Site Map

Table 2.9-1: Fish species documented in the Aquatic Study Area waterbodies

Waterbody	Eastern Brook Trout	Rainbow Trout
Sophia Creek	✓	✓
South Sophia Creek	-	-
West Sophia Creek	-	-
Record Creek*	✓	-
Little Sheep Creek	✓	✓
Corral Creek*	✓	-

(✓) = present; (-) = not previously documented or observed; * = results reported in the Provincial database but not verified during baseline sampling

A total of 24.8 km of stream were surveyed, of which 7.9 km were determined to be fish-bearing. Sophia Creek and Little Sheep Creek are the only streams where fish were captured. Little Sheep Creek was dominated by Eastern brook trout. These fish tend to inhabit low-gradient streams with flat-water habitat, like glides and pools (McPhail 2007), which the Level 1 – FHAP survey confirmed were the most common habitat types. Eastern brook trout also prefer streams with high proportions of groundwater influence, which was exhibited by ice-free overwintering conditions and suitable water temperatures in Little Sheep Creek during the overwintering survey. Little Sheep Creek was also observed to have the highest likelihood of salmonid spawning potential in the RRIMM Project area due to suitable substrate size and low gradients. Sophia Creek had a higher abundance of Rainbow trout than Eastern brook trout, likely due to the steeper gradients. This tributary habitat was found to primarily provide juvenile rearing habitat, with limited spawning or overwintering potential. Sophia Creek - Reach 1 was found to dewater by late summer.

Groundwater expression into Sophia Creek is expected to occur primarily in the upper portions of the watershed. As shown in Figure 2.6-3 groundwater discharge is expected to occur in the non-fish-bearing Sophia Creek – Reach 4. This elevational gradient is consistent with observations of stream flow in Sophia Creek Reaches 1, 2 and 3 over the study period. Upper Reaches (reaches 2 and 3) were found to maintain surface flow year-round, while Reach 1 was found to dewater in late summer. Groundwater is particularly important for overwintering habitat. However, upper reaches are considered to be poor overwintering habitat due to high gradient and lack of pools. As such, no areas of higher groundwater discharge resulting in higher value fish habitat were identified in Sophia Creek. Flows in Little Sheep Creek were suspected as having a higher proportion of groundwater. This was supported by overwintering observations where Little Sheep Creek was found to be flowing ice-free with a temperature greater than 2°C.

As shown in Figure 2.5-1, mine infrastructure is proposed to be located high in the Sophia Creek watershed, on the height of land between Sophia Creek and West Sophia Creek. As such, mine infrastructure, including, but not limited to, roads, utilities, and waste piles, will not directly interact with fish-bearing reaches of Sophia Creek. However, there is the potential for the project to indirectly interact with fish through the mechanical ore extraction scenario that includes a diversion channel that will drain the sedimentation pond and discharge directly to Sophia Creek in a non-fish-bearing reach. The assessment of potential effects is provided in Section 6.5.

The database collected to date allows for an adequate description of fish and fish habitat baseline conditions including fish distribution. The baseline program has assessed both streams immediately downstream of the proposed Project infrastructure, as well as secondary receiving environments (i.e., Little Sheep Creek).

2.9.3 TISSUE RESIDUES

Tissue chemistry data were collected for periphyton, benthic invertebrates, and fish (rainbow trout and eastern brook trout) from the AEMP locations in Little Sheep Creek (LSC-05 and LCS-06), Record Creek (RC-05), and Sophia Creek (SC-01, SC-05, and SCT10) in 2016 (Figure 2.7-1 in Section 2.7). Fish were only present in the main stem of Sophia Creek at two stations (SC-01 and SC-05) and in Little Sheep Creek. Periphyton and benthic invertebrate samples were collected using the same methods for collecting sample for taxonomy with the objective of collecting enough sample mass for reliable analysis of metals. Fish tissue sampling was conducted at the same time fish community and habitat assessments were completed in August 2016. Tissue samples were submitted to ALS for analysis of metals concentration in whole body and fillet (i.e., muscle) samples for both rainbow trout and eastern brook trout. Methodology and results are provided in the report, *Baseline Aquatic Monitoring Studies, 2016-2017 Record Ridge Magnesium Property* (Azimuth 2018; Appendix 2-G).

Interpretation of the tissue chemistry results focused on:

- Exploring spatial patterns among stations and tissue types.
- Comparing fish tissue results for the RRIMM Project area to uncontaminated lakes in BC (Rieberger 1992).
- Comparing benthos and fish tissue concentrations to BC tissue residue guidelines (TRG) for the protection of wildlife.
- Comparing fish tissue concentrations to BC tissue guidelines for the protection of human health.

Key results are as follows:

1. Concentrations were highly variable. Arsenic, cadmium, mercury, and selenium were generally higher in biota from Little Sheep Creek than the other creeks; this pattern was similar for sediment and may reflect historical industrial activity higher in the drainage. In contrast, chromium and manganese were higher in biota from Sophia Creek and Record Creek than in Little Sheep Creek (Figure 2.9-4. This latter pattern appears natural and likely reflects local mineralization characterizing with the Record Ridge serpentinized, ultramafic unit (Record Ridge Ultramafic Body).

2. Rainbow Trout and Eastern Brook Trout collected from the site were compared to Rainbow Trout from Rieberger (1992). Overall, fish tissue concentrations were generally within the distribution of the Rieberger data; key exceptions are phosphorus (3 of 14 samples elevated) and zinc, mercury, calcium, and barium (each with 1 of 14 samples elevated). Elevated mercury was identified in one eastern brook trout caught in Little Sheep Creek.

3. Benthos and fish tissue mercury concentrations exceeded the TRG (0.033 μg/g wet weight) in all samples from Little Sheep Creek and in some fish samples from Sophia Creek. The majority of tissue samples were below the selenium TRG (1 μg/g wet weight), except for several fish samples from Little Sheep Creek (Figure 2.9-5).

4. Based on fish tissue concentrations from the RRIMM Project area, there would be no consumption restrictions based on the BC tissue guidelines due to selenium and only minor consumption restrictions due to mercury (Figure 2.9-6).

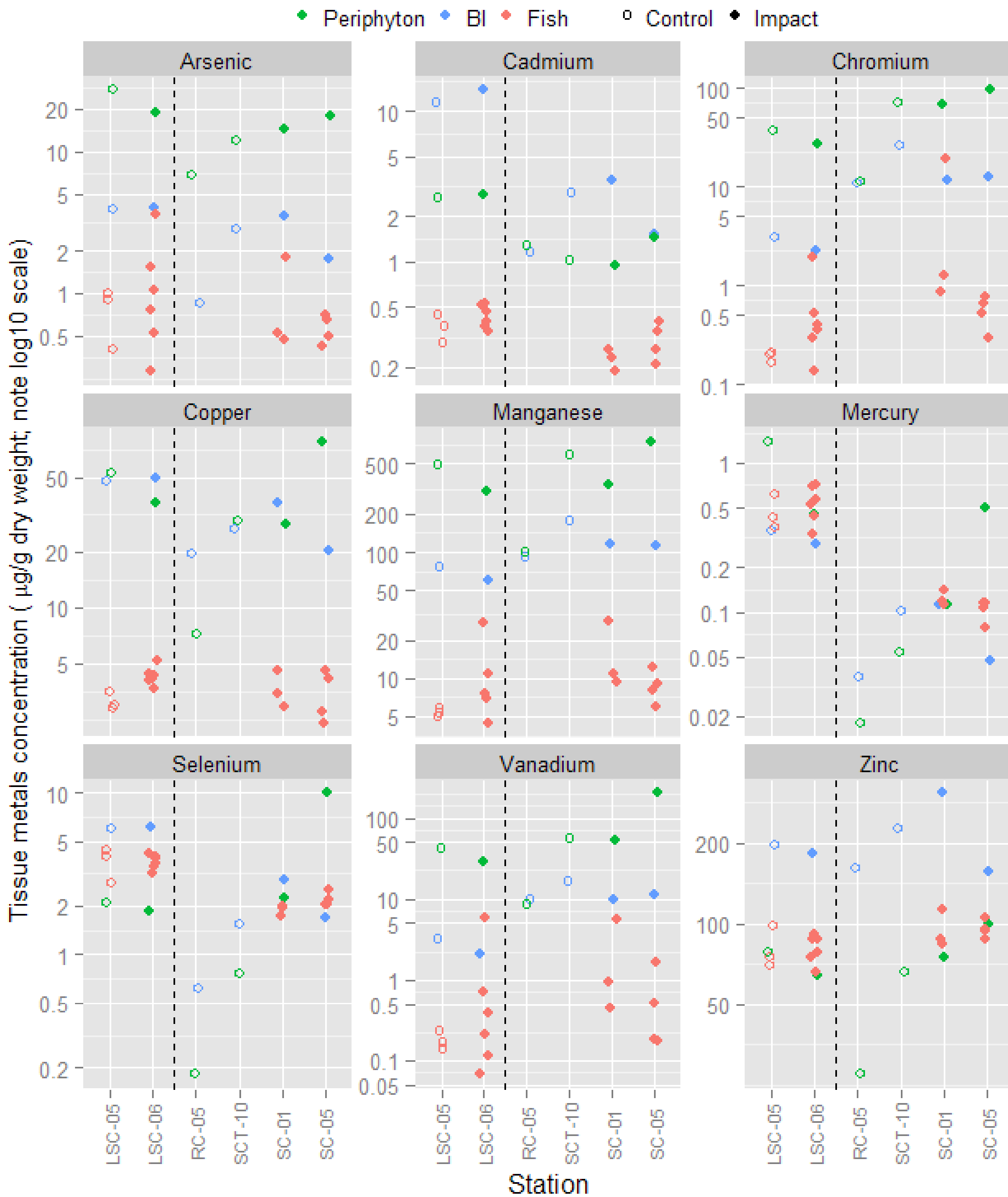


Figure 2.9-4: Metal concentrations (µg/g dry wt; log10 scale) in periphyton, benthic invertebrates and whole-body fish collected from Little Sheep Creek, Record Creek, and Sophia Creek in 2016

Notes: The data points are horizontally "jittered" to avoid masking. The vertical dashed line distinguishes between Little Sheep Creek stations and those on Record Creek and Sophia Creek. RC-05 and SCT-10 are non-fish-bearing locations.

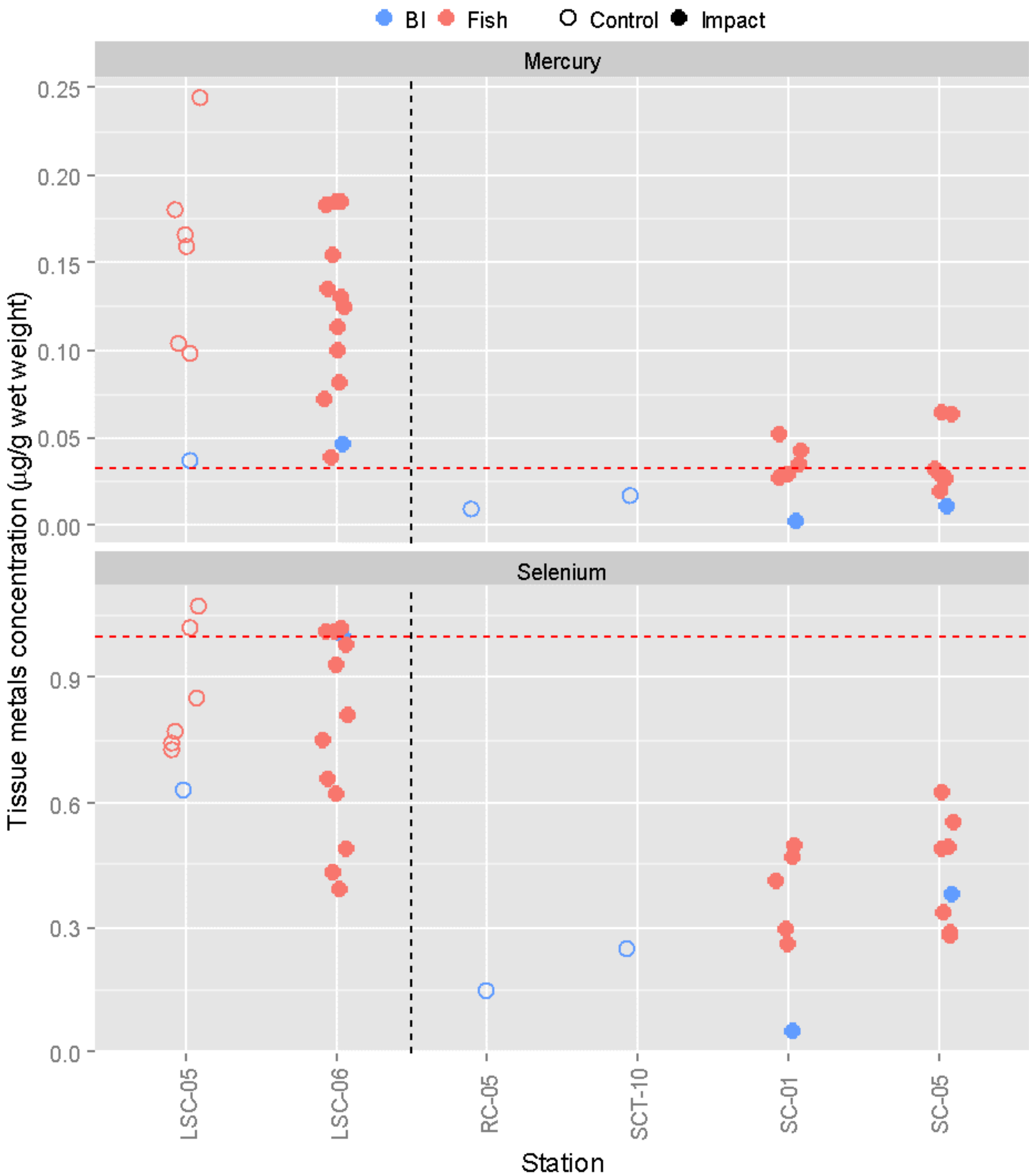


Figure 2.9-5: Mercury and selenium concentrations (µg/g wet wt) in benthic invertebrates and fish (whole body and fillet) collected from Little Sheep Creek, Record Creek, and Sophia Creek in 2016 compared to BC tissue guidelines to protect wildlife

Notes: Red dashed lines correspond to the mercury wildlife tissue residue guideline (0.033 µg/g wet wt) and the dietary and whole body fish tissue guideline for selenium of 4 µg/g. The tissue guideline for selenium was converted from dry weight (4 µg/g) to wet weight (1 µg/g) assuming a moisture content of 75% (mean moisture reported in whole body rainbow trout and eastern brook trout analyzed in 2016)

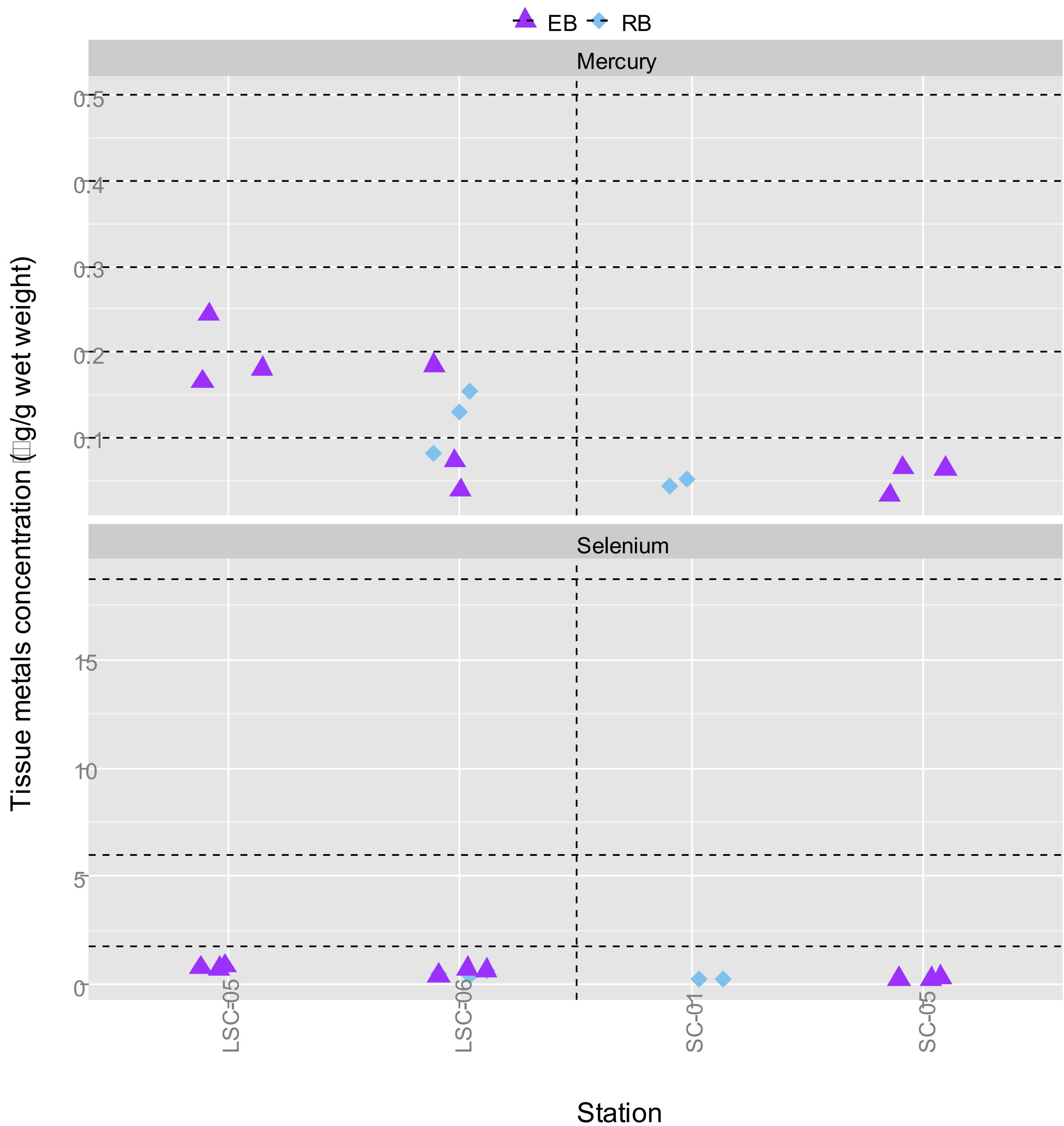


Figure 2.9-6: Mercury and selenium concentrations (µg/g dry wt) in rainbow trout and eastern brook trout (fillet) collected from Little Sheep Creek and Sophia Creek in 2016 compared to BC tissue guidelines for human consumption.

Notes: The data points are horizontally "jittered" to avoid masking. The vertical dashed line distinguishes between Little Sheep Creek stations and those on Sophia Creek. The horizontal lines represent the mercury and selenium concentrations in the edible portion of fish corresponding to levels of safe consumption. For mercury, the guideline values decrease from 0.5 µg/g to 0.1 µg/g, as weekly consumption increases from 210 g/week to 1050 g/week. Three guidelines for selenium are based on low, moderate, and high fish consumption in terms of g/day. Refer to Appendix 2-I.

2.10 VEGETATION AND WILDLIFE

2.10.1 VEGETATION STUDIES

2.10.1.1 Terrestrial Ecosystem Mapping

Terrestrial Ecosystem Mapping (TEM) is used to classify ecosystems by stratifying the landscape into map units based on ecological features, including climate, physiography, surficial material, bedrock geology, soil, and vegetation (Province of BC 1998). TEM was conducted for the regional study area (RSA; i.e., TEM study area in Keefer Ecological Services Ltd. 2017a; Appendix 2-J) following BC Standards, classifying terrestrial and wetland ecosystems following the Biogeoclimatic Ecosystem Classification (BEC). BEC is a hierarchical classification system where biogeoclimatic zones are the basic unit, which are further divided into subzones reflecting regional differences (BC MFLNRO 2015). Ecosystems are grouped into site series, which are all sites within the subzone capable of developing into the same mature or climax vegetation unit.

Four subzones, describing the regional climate of the area based on vegetation, soil, and topography, were identified within the RSA, which lies in the Arrow Boundary Forest District: Interior Cedar – Hemlock (ICH) Very Dry Warm (ICHxw), ICH West Kootenay Dry Warm (dw1), ICH Granby Moist Warm (mw5), and Engelmann Spruce – Subalpine Fir Moist Hot (ESSFmh). Ecosystem classification adhered to the provincial Resource Inventory Committee (RIC) Standards (Province of BC 1998). Field sampling was conducted during the summer of 2016 to guide ecosystem classification using *The Field Guide to Site Classification and Identification for Southeast British Columbia: The South-Central Columbia Mountains* (MacKillop and Ehman 2016).

A total of 295 polygons were delineated in the RSA (1,691.1 ha) for an average polygon size of 5.7 ha. The ICHxw, ICHdw1, ICHmw5, and ESSFmh covered 8%, 39%, 45%, and <9% of the total RSA, respectively. Among forested site series, the 101 site series dominated within each of these subzones, whereas the moist 111 site series represented <1% within each subzone. Among non-forested site series, urban dominated in the ICHxw (6% of the subzone); roadway dominated in ICHdw1 (2% of the subzone); rock outcrop dominated in ICHmw5 (4%) of the subzone; and grassland dominated in ESSFmh (25% of the subzone). Wetlands were only identified within ICHmw5 and ESSFmh subzones, representing <1% in each.

2.10.1.2 Plants and Ecological Communities At Risk

A summer survey was conducted in the RSA to identify listed plant species and ecological communities at risk (Keefer Ecological Services Ltd. 2017b; Appendix 2-K). Prior to conducting field surveys, species at risk and at-risk ecological communities with potential to occur in the RSA were identified by reviewing the BC Conservation Data Centre (CDC) database (BC CDC, 2018). Prospective assessment areas for listed species were determined based on knowledge of habitat requirements of listed plants potentially occurring in the RSA, aerial photos, existing predictive ecosystem mapping (PEM) information, and a site reconnaissance, with focus placed on wetlands and grasslands. Grasslands presumed to be influenced by serpentine geology were identified and targeted because they typically support unique non-forested ecosystems.

Sites with high potential to support listed plants and ecological communities were assessed in June 2016. Ecosystem classification conducted through TEM was used to identify ecological communities at risk which may occur within the RSA.

Two blue listed perennial herb species were identified within the RSA: nettle-leaved giant-hyssop (*Agastache urticifolia*) and Sutherland's larkspur (*Delphinium sutherlandii*). Two other listed species were known to the site but not detected (Appendix 2-K): red-listed plant steer's head (*Dicentra uniflora*), and blue-listed plant false mermaidweed (*Floerkea proserpinacoides*). A non-listed sensitive species, purple oniongrass (*Melica spectabilis*), was identified in a single grassland area in the RSA. This species was provincially blue listed prior to 2016 and subsequently removed; however, it is still considered 'sensitive' within Canada.

Additional rare plant surveys were conducted on May 24, June 13, and June 14, 2018, by Keefer Ecological Services Ltd. (Cascara Environmental Ltd. 2023; Appendix 2-U). Mountain holly fern (*Polystichum scopulinum*), a species that is provincially red-listed (BC CDC 2023a) and federally listed as Threatened on Schedule 1 of the *Species a Risk Act* (SARA) and Threated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), was located at 9 locations of the RSA, with multiple individuals identified at each location.

An updated search of the BC CDC was conducted in March 2023 by a Qualified Professional from Greenwood Environmental Inc. and the results showed that all species mentioned above, except for mountain holly fern, are no longer red- or blue-listed (BC CDC 2023a); rather, they are all yellow listed (i.e., "apparently secure and not at risk of extinction; BC CDC 2023b). The list of species recorded during baseline surveys identified in Appendix 2-J was checked against the updated BC CDC database search and no plant species recorded during field surveys are currently red- or blue-listed.

A search of ecological communities at risk in the BC CDC database revealed seven at-risk ecological communities with potential to occur in the RSA. Of the seven, three were mapped in the RSA based on TEM classification:

- Douglas-fir/tall Oregon-grape/parsley fern ecological community is red-listed and has potential to be present within subzones ICHdw1 and ICHxw in the 102 site series, spanning approximately 17.0 ha in the RSA. As well, rock outcrop and rock talus site series within these subzones were also identified as encompassing the Douglas-fir/tall Oregon-grape/parsley fern ecological community, as pockets of the 102 site series may be present within these rock classes.
- Subalpine fir/white-flowered rhododendron/Sitka valerian ecological community is blue-listed and in the RSA. It occurs in BEC subzone ESSFmh within riparian ecosystems (110 and 111 site series), spanning approximately 4.0 ha in the RSA.
- Western redcedar–- western hemlock/common horsetail ecological community is blue-listed and has potential to be present in subzone ICHmw5 within the 111 and 112 site series, which spans approximately 19.6 ha in the RSA.

Based on an updated BC CDC database search conducted in March 2023, the above three ecological communities are still listed as stated.

In addition, a search for known mapped red- or blue-listed plant species and ecological communities was completed using the online provincial search tool, BC Conservation Data Centre iMap (BC CDC 2023c). There is one at-risk species, mountain holly fern, located at one location in the RSA and is a different location than that identified by Keefer Ecological Services Ltd; therefore, there are 10 occurrences of this species, that is provincially red-listed and federally listed by SARA and COSEWIC as threatened, in the RSA.

A mapped, red-listed ecological community was identified in the RSA, Idaho fescue–- bluebunch wheatgrass–- silky lupine–- junegrass (*Festuca idahoensis*–- *Pseudoroegneria spicata*–- *Lupinus sericeus*–- *Koeleria macrantha*). Grassland was mapped in the TEM, with the mapcode 'Gg', but was not identified to plant association/assemblage. This community was last confirmed in 2015 (BC CDC 2023c) and looking at the grassland plant species identified in the TEM report (Keefer Ecological Services Ltd. 2017a; Appendix 2-J), it matches the description and classification of the known mapped, red-listed community. The imagery within this mapped grassland appears to have existing disturbance within them, e.g., existing trails.

In addition to this red-listed ecological community, grasslands in general are considered one of BC's most endangered ecosystems (GCC 2017; Iverson 2004 *in* Keefer Ecological Services Ltd. 2017a; Appendix 2-J). Grasslands within the RSA have been documented as unique and occur in approximately 56.7 ha, the majority of which is in the ESSFmh.

Specific wetland fens identified under the BC CDC as at risk (scrub birch/water sedge, narrow-leaved cotton-grass - shore sedge, tufted clubrush/golden star-moss) were not identified in the RSA. However, a wetland fen, estimated at 0.2 ha, was mapped in the RSA.

Old forest occurs in the RSA, mapped as structural stage 7 in the TEM, covering 49.3 ha.

2.10.1.3 Plants of Potential Importance to Local First Nations

Plants species that occur within the RRIMM Project area were identified that are of potential cultural importance to local First Nations, including the Okanagan, Secwepemc, and Sinixt First Nations (in alphabetical order; Keefer Ecological Services Ltd. 2017c; Appendix 2-L). The Master Species List, compiled from the floristic data collected during the TEM and listed plant surveys, was reviewed to identify plants of cultural importance based on ethnobotanical texts. Based on the literature, use of each cultural plant was noted as medicine, food, technology, dye, and/or other.

Among 172 vascular plant species recorded during TEM and listed plant surveys, 96 were found to have documented traditional use value as identified in the literature:

- 76 plants are or were used for medicinal purposes by the Okanagan, Secwepemc, and/or Sinixt First Nation
- 50 plants are or were used for food plants
- 26 are or were used for technological purposes, such as baskets, fish traps, and pelt stretchers
- Three are, or were, used for as dyes
- 36 were used for other purposes, such as ceremony, paint, and insecticide.

2.10.1.4 Invasive Plant Species

One invasive plant species was identified in the RSA. Spotted knapweed (*Centaurea stoebe*) is a plant species listed as noxious on the BC *Weed Control Act.*

2.10.1.5 Baseline Vegetation and Soil Chemistry

Vegetation and soil samples were collected at 35 locations in July 2016 within the RSA for metal analysis to determine baseline metal concentrations (Keefer Ecological Services Ltd. 2018; Appendix 2-M). Plants selected for analysis were based on their importance as: forage for bear and herbivores (e.g., elk, deer, and snowshoe hare); consumption by humans (traditionally and current); and/or grassland species influenced by serpentine geology. Species included: timber milk-vetch (*Astragalus miser*), yellow glacier lily (*Erythronium grandiflorum*), large fruited desert parsley (*Lomatium macrocarpum*), purple oniongrass (*Melica spectabilis*), thimbleberry (*Rubus parviflorus*), soopolallie (*Shepherdia canadensis*), and black huckleberry (*Vaccinium membranaceum*). There were no exceedances of guidelines.

A clear delineation was found between soils collected from grasslands understood to be influenced by serpentine geology and soils from forest ecosystems in terms of metal concentration and essential nutrient levels. Soil samples collected within grassland ecosystems were found to have significantly higher concentrations of metals, including chromium, cobalt, nickel, and iron, than those collected in forest ecosystems. Further, grassland soils were found to have significantly higher magnesium levels than calcium, indicating the likelihood of a diminished calcium to magnesium (Ca:Mg) ratio. Grassland soils were also found to have comparatively lower concentrations of phosphorous and potassium. Collectively, these conditions indicate the likelihood of serpentine syndrome in these locations, which is identified by Brady et al. (2005) as poor plant productivity, high rates of endemism, and vegetation types distinct from those of neighbouring areas.

2.10.2 Wildlife Studies

Wildlife desktop studies were conducted to determine the potential occurrence of wildlife species within the RSA. The following desktop studies were conducted:

- Birds (Keefer Ecological Services Ltd. 2017d; Appendix 2-N)
- Furbearers (Keefer Ecological Services Ltd. 2017e; Appendix 2-O)
- Grizzly bear (Keefer Ecological Services Ltd. 2017e; Appendix 2-P)
- Ungulate (Keefer Ecological Services Ltd. 2017g; Appendix 2-Q)

Field studies for amphibians, reptiles, and bats were conducted in 2016 (E. Wind Consulting and Ophiuchus Consulting 2017; Appendix 2-R). Bird field studies were conducted in spring/summer of 2018, while field studies for furbearers and ungulates were initiated in 2018.

2.10.2.1 Birds

Available studies and literature were reviewed, and professional knowledge of the area was used to assess the potential occurrence of bird species within the RSA (Keefer Ecological Services Ltd. 2017d; Appendix 2-N). A list of at-risk provincial and federal bird taxa known to occur within the Arrow Boundary Forest

District was obtained and cross-referenced with a list of West Kootenay birds obtained from the BC Breeding Bird Atlas. Potential occurrence was estimated based on professional knowledge of the area and habitat mapping, with estimated likelihood of occurrence in the RSA being summarized into three categories, likely, possible, and unlikely.

Of the total 189 bird species identified as potentially occurring within the West Kootenay/Arrow Boundary Forest District, 84 are considered “likely” and 38 are considered “possible.” Of the “likely” and “possible” to occur species, eight taxa (northern goshawk, black swift, olive-sided flycatcher, barn swallow, great blue heron, western screech-owl, prairie falcon, and peregrine falcon) are provincially red or blue listed by the BC CDC, and eight taxa (black swift, evening grosbeak, peregrine falcon, common nighthawk, olive-sided flycatcher, bank swallow, barn swallow, and western screech-owl) are federally listed as at-risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Additionally, 38 of the ‘Likely’ and ‘Possible’ to occur bird species have a BC Conservation Framework Priority ranking of 2 or higher, indicating an increased conservation concern for these species.

2.10.2.2 Furbearers

Available studies, literature and data pertaining to furbearers which may occur near the RSA were reviewed (Keefer Ecological Services Ltd. 2017e; Appendix 2-O). Focus was placed on assessing regionally or locally known populations, provincial distributions, and harvest data from Wildlife Management Unit (WMU) 4-09, within which the RSA is located. Additionally, ecosystem compatibility was assessed based on the applicable BEC subzones, which included ICHdw1 (covering 39% of the RSA), ICHmw5 (covering 46% of the RSA), ICHxw (covering 8% of the RSA) and ESSFmh (covering 7% of the RSA). Furthermore, an interview with a local resident of the City of Rossland was conducted to gain insight into the presence of furbearer species in the area (Appendix 2-O). Collectively, information assessed was used to determine a level of confidence per species regarding their presence in the RSA.

Twenty local furbearer species were examined including badger (*Taxidea taxus jeffersonii*), bobcat (*Lynx rufus*), lynx (*Lynx canadensis*), wolverine (*Gulo gulo*), beaver (*Castor canadensis*), black bear (*Ursus americanus*), marten (*Martes americana*), mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), cougar, coyote, ermine, fisher, wolf (*Canis lupus*), grizzly bear (*Ursus arctos*), river otter (*Lutra canadensis*), raccoon (*Procyon lotor*), red fox (*Vulpes vulpes*), red squirrel (*Tamiaciurus hudsonicus*) and snowshoe hare (*Lepus americanus*). Of these, seven are rated “likely” to occur within the RSA, eleven are rated as “possibly” occur, and 2 are rated as “unlikely” to occur. Of the 20 species examined in the desktop study, four are provincially listed as at-risk: badger is red-listed and wolverine, fisher, grizzly bear are blue-listed. The remaining species are all provincially yellow listed. Three of the 20 species are federally listed by COSEWIC and the *Species at Risk Act* but none of which were identified in Appendix 2-O or Appendix 2-P as being likely to occur in the RSA: badger is listed as endangered and wolverine and grizzly bear are considered special concern.

Existing and available information regarding grizzly bears, including habitat models; knowledge of ecology; status and conservation issues; and the species’ relationship with habitat and human activity, was evaluated to understand potential implications of the RRIMM Project on the health and connectivity of trans-boundary grizzly bear populations (Keefer Ecological Services Ltd. 2017e; Appendix 2-P). This included populations that exist in the US where the grizzly bear is listed under the *Endangered Species Act*. In the Kettle-Granby grizzly bear population unit (GBPU), within which the RSA falls, the species is considered "threatened". A 1997 population survey of the Kettle-Granby GBPU estimated a density of 8.4 bears per 1,000 square kilometers (km^2), while a more recent Granby-Kettle GBPU survey conducted in 2015 survey (Mowat et al. 2017) indicated a population increase to 13.2 bears per 1,000 km^2.

Using the 2015 survey data and a pre-existing spatial model of grizzly bear abundance and distribution, it was determined that the RSA is not associated with high-suitability landscape for grizzly bears and does not fall within a key population core area or linkage landscape (Keefer Ecological Services Ltd. 2017e; Appendix 2-P). Results are consistent with the lack of anecdotal evidence for the area and with results of five nearby sampling sites (approximately 10 km radius) for the 2015 population survey, in which no grizzly bears were detected. Within a 10 km radius, the model predicts a low density of grizzly bears (5.9 bears per 1,000 km^2).

2.10.2.3 Ungulates

Available studies, literature and data pertaining to Rocky Mountain bighorn sheep (*Ovis canadensis*), moose (*Alces alces*), Rocky Mountain elk (*Cervus canadensis nelson*), woodland caribou (*Rangifer tarandus caribou*), mountain goat (*Oreamnos americanus*), Rocky Mountain mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginiainus*) were reviewed (Keefer Ecological Services Ltd. 2017g; Appendix 2-Q). Focus of the study was on assessing regionally or locally known populations, provincial distributions, and harvest data for WMU 4-09, within which the RSA is located. Additionally, ecosystem compatibility was assessed based on the BEC subzones occurring within the RSA, which included ICHdw1 (covering 39% of the RSA), ICHmw5 (covering 46% of the RSA), ICHxw (covering 8% of the RSA) and ESSFmh (covering 7% of the RSA). Furthermore, an interview with a local resident of the City of Rossland was conducted to gain insight into the presence of ungulate species in the area. Collectively, information assessed was used to determine a level of confidence regarding the presence of each species within the RSA.

The RSA contains viable ecosystems that support moose, elk, mule deer and white-tailed deer populations. It also contains viable ecosystems that may support big horn sheep and mountain goat populations, although there is no evidence that these species currently inhabit the area and are considered as being "possible but unlikely" to occur in the RSA. The RSA does not contain viable ecosystems that could support caribou populations and there is no evidence suggesting that they currently inhabit the area; as such, this species is reported as "unlikely" to occur (Keefer Ecological Services Ltd. 2017f; Appendix 2-Q).

2.10.2.4 Amphibians

Five species of amphibian have potential to occur in the RSA based on range maps: northern pacific treefrog, long-toed salamander, western toad, Coeur d'Alene salamander, and Columbia spotted frog. Methodology and results of the amphibian baseline study are provided in the report *Record Ridge Project Summary of Baseline Work for Amphibians, Reptiles, and Bats* (E. Wind Consulting and Ophiuchus Consulting 2017; Appendix 2-R). None of the five species are considered to be at risk within BC (i.e., they are yellow listed) but two are federally listed as special concern, western toad and Coeur d'Alene salamander, the former of which was confirmed adjacent to the RSA during baseline studies.

In fall 2016, visual surveys of 13 areas within the RSA confirmed two individuals of two different amphibian species during baseline reconnaissance surveys: adult northern pacific treefrog and adult long-toed salamander. Both species are aquatic-breeding, utilizing a variety of water bodies for egg laying, including temporary ponds, wetlands, and lakes. During surveys conducted in early summer 2018, an adult male western toad (a federally listed at-risk species) was observed along the Old Rossland-Cascade Highway south of the study site during a night road survey.

A few small seeps and streams were identified and a shallow ditch pond but no standing water bodies suitable for amphibian breeding were identified to occur within the RSA based on ortho images or during fall and summer field surveys. Outside of the RSA, three small wetlands occur within 500 m of the site based on Google Earth imagery, which is within the migratory and dispersal distances of most local aquatic-breeding amphibian species.

An additional three wetlands occur within 2 km of the RSA and a large stream and wetland complex occurs 3 km west of the site which are within the annual movement distances of adult western toads. The relatively low density of lentic water bodies in the RSA likely affects the density and distribution of amphibians.

2.10.2.5 Reptiles

Seven reptile species may occur in the RSA based on available range maps: northern alligator lizard (*Elgaria coerulea*), North American racer (*Coluber contrictor*), terrestrial gartersnake (*Thamnophis elegans*), common gartersnake (*Thamnophis sirtalis*), painted turtle (*Chrysemys picta*; Population; Intermountain – Rocky Mountain Population), western skink (*Eumeces skiltonianus*), and northern rubber boa (*Charina bottae*). Three of the seven species are considered to be at risk within BC: provincially blue-listed North American racer, painted turtle, and western skink. Four are listed federally, one listed as threatened: North American racer; and three listed as special concern: painted turtle, western skink, and northern rubber boa. Methodology and results of the reptile baseline study are provided in the report *Record Ridge Project Summary of Baseline Work for Amphibians, Reptiles, and Bats* (E. Wind Consulting and Ophiuchus Consulting 2017; Appendix 2-R).

Four reptile species were confirmed in the RSA during baseline reconnaissance surveys in fall 2016, based on visual surveys and turning over cover objects within rock outcrops and talus slopes (northern alligator lizard, North American racer, terrestrial gartersnake, and common gartersnake). Of the four confirmed species, northern racer is considered at risk. Shed skins of this species were found in a talus slope south of the Old Rossland-Cascade Highway. Northern alligator lizard was the most common reptile species encountered during fall surveys in 2016. This species is found in a patchy distribution across the southern third of the province, but they can be locally abundant, as they appear to be within the RRIMM Project RSA.

In early summer 2018, an adult female northern rubber boa (a federally listed at-risk species) was observed along the Old Rossland-Cascade Highway south of the study site during a night road survey.

The RSA contains numerous rocky outcrops and talus slopes utilized by reptiles. Three likely reptile den sites were located in fall 2016 all south of the Old Rossland-Cascade Highway.

2.10.2.6 Bats

Nine bat species may occur in the RSA based on range maps. Two species, California myotis (*Myotis californicus*) and western long-eared myotis (*Myotis evotis*), were confirmed in the area in late September and early October 2016 based on one Anabat bat detector installed for 18 days near Sophia Creek at the location of an old mine site. Both species are yellow listed (at the least risk of being lost) within BC and reside year-round, hibernating in caves, mines, or deep fractures in bedrock. Methodology and results of the bat baseline study are provided in the report *Record Ridge Project Summary of Baseline Work for Amphibians, Reptiles, and Bats* (E. Wind Consulting and Ophiuchus Consulting 2017; Appendix 2-R).

Seven bat species have likely potential to occur in the RSA (Appendix 2-R):

- Long-legged myotis (*Myotis volans*);
- Little brown myotis (*Myotis lucifugus*), federally listed as endangered;
- Yuma myotis (Myotis yumanensis)
- Big Brown Bat (*Eptesicus fuscus*);
- Hoary Bat (Lasiurus cinereus);
- Silver-haired Bat (*Lasionycteris noctivagans*); and
- Townsend's Bigeared Bat (*Corynorhinus townsendii*), provincially blue-listed.

Roosts and hibernacula are the most important habitats for bats with veteran trees and rock outcrops representing the most common ecological features used. Anthropogenic features, such as buildings and mines, are often used by bats for roosting and hibernating. Opportunities for hibernacula in the RSA are few, limited to fractured rock escarpments. At least one likely occurring bat species (hoary bat) is migratory, spending its winters in warmer climes. Wetlands and riparian areas are the most well used foraging habitats for bats.

2.11 LAND STATUS AND USE

There are a dozen diverse types of land tenures and uses that are either overlapping or proximal to the RRIMM Project. Details relevant to these land uses are provided in the report *Desk-based Land Use Baseline for the Record Ridge Project* (Dialectic Research Services Inc. 2018; Appendix 2-S); a summary of which is provided below. Land uses were identified through desk-based research, including government, local, regional, provincial, non-government organizational sources. Spatial data were gathered from provincial databases. Figure 1.3-3 (in Section 1.3) shows an overview of land use within, and proximal, to the RRIMM Project.

2.11.1 Land Management Areas

There are several relevant management plans at the local and regional level that pertain to the area in and around the RRIMM Project. In particular, the Kootenay Boundary Land Use Plan (KBLUP), Arrow Regional Management Zone (AMZ), and Rossland's municipal community plans contain important objectives, directions, and considerations pertaining to the RRIMM Project.

2.11.1.1 Kootenay Boundary Land Use Plan

In the 1990s, the provincial government undertook comprehensive and intensive land use planning efforts across a wide range of land use stakeholders and First Nations throughout the province. This was done in the Kootenay-Boundary region in the early 1990s culminating in the Kootenay-Boundary Land Use Plan (KBLUP), signed in 1995 (FLNRO 1995). The plan is generally supportive of mining activities and acknowledges the region's reliance on the mining industry, including the smelter in Trail. Other industries the plan addresses are forestry, agriculture (along with mining as the top three industries in the region), as well as tourism and recreation. Much of the plan focuses on how to increase employment to the region.

With an eye to social, economic, and environmental sustainability, 78.8% of lands (or 3.3 million hectares) in the region allow for commercial uses, such as mining (FLNRO 1995). A key focus of the land use plan at that time was to revive the forest industry in the region. These lands are divided into three categories based on their ability to accommodate industrial activities. The RRIMM Project overlaps with one of the most common categories: Integrated Resource Management Zone, which is designated as an area with low to moderate sensitivity to resource development (FLNRO 1995). The other two categories allow for more or less development based on important values.

2.11.1.2 Arrow Regional Management Zone

The province established Resource Management Zones (RMZs) within the Kootenay-Boundary Higher Level Plan Order in January 2001. In particular, the Arrow RMZ is a landscape unit that allows for more detailed direction from the provincial government beyond the general objectives of the KBLUP, including a focus on mature forests and caribou. In particular, Area N501 within the RMZ overlaps with the Project and has a low rating for biodiversity emphasis.

The caribou habitat areas in the Arrow RMZ (FLRNO 2002) are northeast of the RRIMM Project study area and do not interact with the proposed development site. The order provides mapping and direction on grizzly bear habitat, particularly connectivity corridors. One such area is proximal to the RRIMM Project with the main objective of maintaining mature and/or old forests along connectivity corridors. The Higher Level Plan Order has directions regarding consumptive use streams. There are several of these areas east and west of the RRIMM Project area, mainly associated with private properties. The requirements address stream side management.

As with all these objectives, the plan clarifies that they "are not intended to have an impact on the permitting of subsurface resource exploration and development. Furthermore, this higher level plan order does not restrict the authority of the Chief Inspector of Mines to approve the issuance of a Special Use Permit…" (FLNRO 2001).

2.11.1.3 Regional District of Kootenay Boundary Area 'B'

The Regional District of Kootenay Boundary Area 'B' is the regional district of British Columbia responsible for local government system within the RRIMM project area. British Columbia established a framework of Regional Districts by the *Local Government Act*. This legislation set-out, on a Province wide context, the administration and delivery of local government on a consistent basis by elected representative familiar with local needs and wants.

The Regional District of Kootenay Boundary (RDKB) is made up of five electoral areas and eight municipalities. The five Regional Districts are modeled as a federation composed of municipalities, electoral areas, and in some cases, Treaty First Nations, each of which have representation on the regional district board. The RRIMM Project falls within Electoral Area 'B'/Lower Columbia – Old Glory of the Regional District of Kootenay Boundary, with headquarters in Trail (Figure 2.11-1). W.H.Y. Resources will continue to coordinate with and seek the advice and guidance of this regional governing body in the development of the RRIMM project.

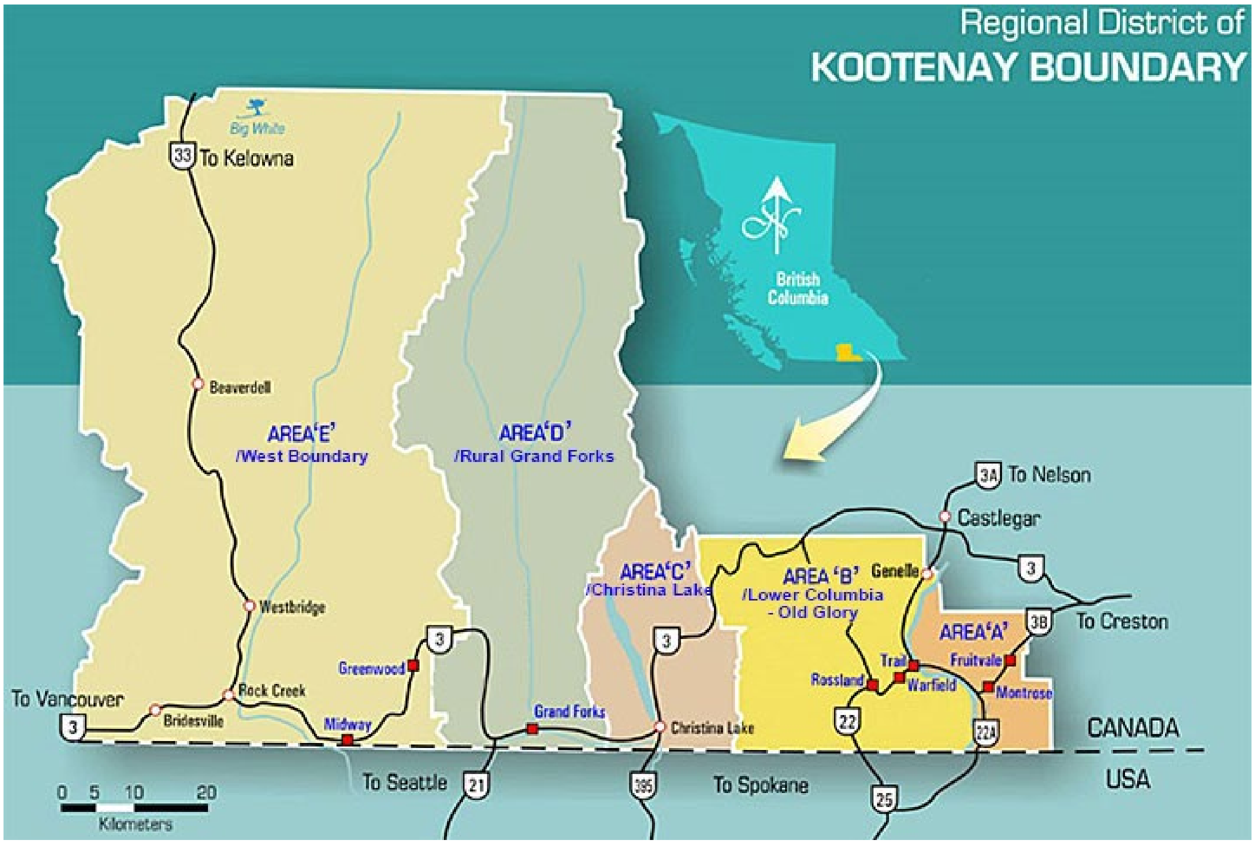


Figure 2.11-1: Regional District of Kootenay Boundary

2.11.1.4 Rossland Muncipal Plans

The City of Rossland developed an Official Community Plan which was approved in 2007. Most of the objectives pertain to land uses and issues within the city limits; however, a few address land uses and issues related to mining activities and traffic levels in town. One policy speaks specifically to mining activities by stating a desire to be involved in the provincial regulatory processes: "collaborate and cooperate with provincial authorities to ensure appropriate mining practices are undertaken" (City of Rossland 2007).

In addition, the Rossland Strategic Sustainability Plan, which pertains to land uses within the city's limits, also has a few objectives that are relevant to the area in and around the RRIMM Project. In particular, part of Parks and Trails section, Policy 15.2.17 proposes plans to "[s]upport collaboration with the region's municipalities to identify and develop offroad pedestrian/cycling routes, specially a Rossland to … Christina Lake via the Old Cascade Highway" (City of Rossland 2008). This plan would be anticipated to intersect with the proposed RRIMM Project.

2.11.2 Parks and Protected Areas

The most proximal provincial park is King George VI, 5 km southeast of the RRIMM Project near the US border. It was established in 1937 and is 162 ha in size (BC Parks 2017). Its primary purpose is to protect rare plants (i.e., the Douglas-fir, Oregon grape, and parsley fern plant) and important bird habitat (BC Parks 2003). Although there were original plans for camping and day-use, especially for cross-border users, the park does not currently provide any recreational facilities or values.

The largest provincial park close to the RRIMM Project is Gladstone Provincial Park at the northern end of Christina Lake, which covers 39,322 ha and is located 25 km northwest from the RRIMM Project area. It offers forecountry recreational activities, such as camping, fishing, and boating as well as backcountry opportunities, such as hiking and backpacking along an extensive network of trails (BC Parks 2001). There are no known protected areas in and around the RRIMM Project.

2.11.3 Resource Uses

Resource development, specifically mining, has been a key component of Rossland and the region at large. The closest operating mine in the Kootenay Region is Lime Creek Mine owned and operated by Imasco Minerals, Inc., which produces limestone (MEMPR 1989). It is located 40 km northwest of the Project. There are 11 mineral claims that exist around the Project. WHY Resources has 29 claims covering an area of 8,792 ha. Section 1.3.3 summarizes location of mineral tenures and licenses within, and proximal to, the RRIMM Project.

The RRIMM Project falls within the Arrow Timber Supply Area (TSA) that stretches from lower to upper Kootenay with several Tree Farm Licenses farther north in the Kootenays. There are two cutblocks within two kilometers of the RRIMM Project. One of the cutblocks is located west of the mine site and is owned by Kalesnikoff Lumber Co. Ltd. The other cutblock is located east of Highway 22 and is owned by Atco Wood Products Ltd. There are 10 parcels of managed forest land in the vicinity of the RRIMM Project. Managed forest lands account for 51% of a broader category of private forest land (also includes forested farmland and forested residential land). The obligations of owners who have managed forest lands are annual fees for and accounting of tree harvesting activities in exchange for benefits of lower land assessment value and guaranteed rights to harvest timber. The purpose of this arrangement is to incentivize private owners to make long-term investment in land, including re-forestation requirements, in exchange for stability.

There are four non-legal Old Growth Management Areas (OGMA) proximal to the RRIMM Project, including one that overlaps with the proposed mine site. OGMAs are spatially defined areas usually for ecological or cultural preservation purposes that inform forestry planning and operational activities. Figure 2.11-2 shows nearby forest tenure cutblocks, managed forest lands, and OGMAs.

Besides forestry and mining, agriculture is the third most important economic driver in the region. Agricultural lands in this area exist in valley bottoms and along gentle grades. There are four range pastures west of the RRIMM Project, which are defined as enclosed grazing areas using fences. These consist of the Santa Rosa (ID 5045-4), Powerline (ID 5045-3), Mastadon (ID 5045-2), and Castle (5045-1) leases.

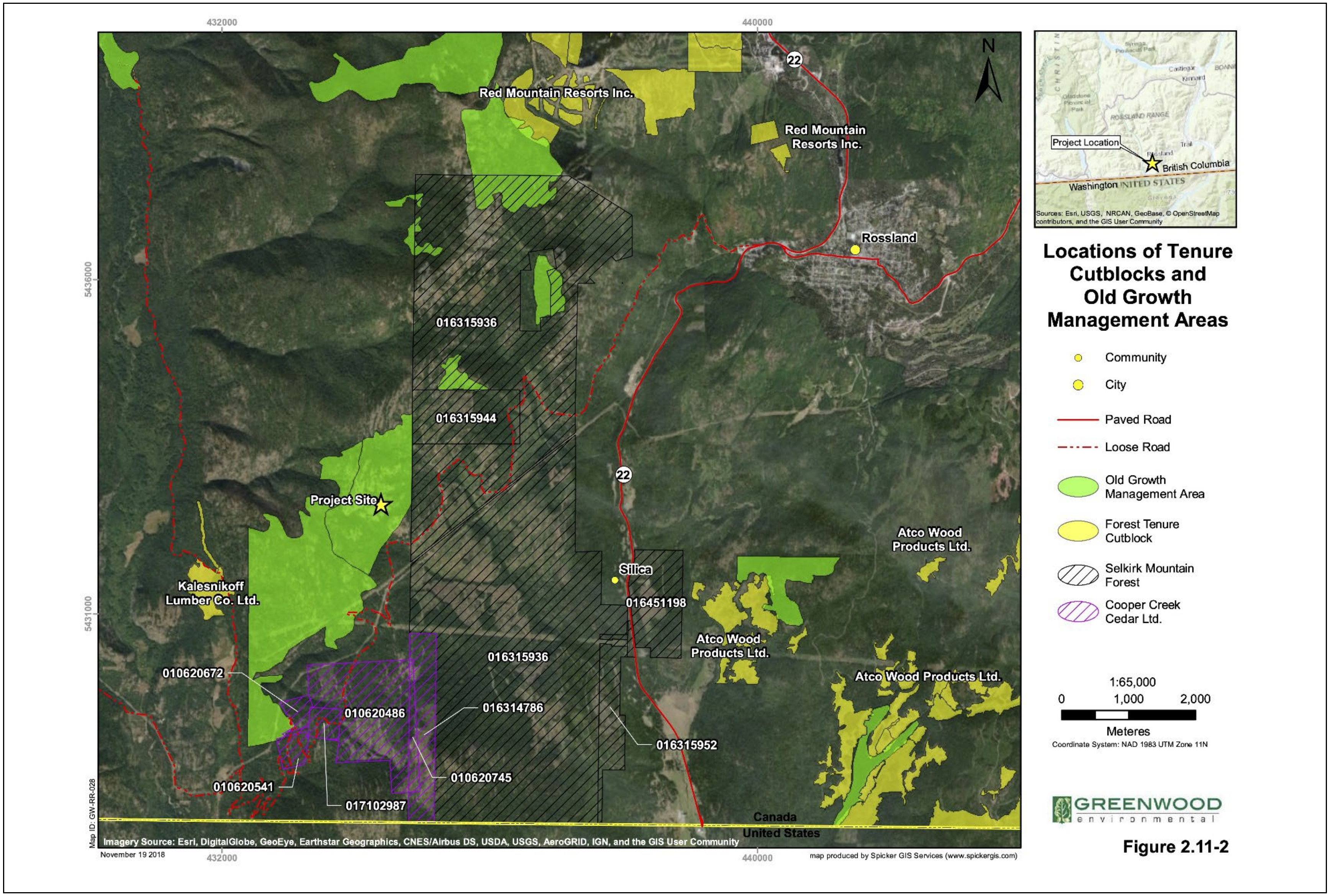


Figure 2.11-2: Locations of Tenure Cutblocks and Old Growth Management Areas

The closest one is the Santa Rosa lease, which is 8.5 km away from the RRIMM Project with the remainder between 9 and 10 km away. The size of these pasture areas ranges between 296 ha and 2,747 ha. No range pastures overlap with the RRIMM Project.

2.11.4 RECREATION AND TOURISM

In general, the Kootenay region is well-known for its year-round recreational opportunities for local residents and as a destination for tourists. FLNRORD maintains a Recreational Features Inventory, which rates areas from a sensitivity and significance perspectives, including low, moderate, high, and very high ratings. The RRIMM Project overlaps with high sensitivity and very high significance from a recreational perspective (Figure 2.11-3).

About 21.5 km by road or 5 km straight line distance north of the RRIMM Project is the land tenure for Red Mountain Resorts Inc. The resort is located west of Rossland and provides 2,877 acres of skiing accessed by lifts with 110 runs across three mountains. Red Mountain has an average of 150,000 visitors a year.

Three regionally significant trails overlap with the RRIMM Project area, including the Seven Summits, Dewdney, and Record Ridge trails, having high recreational and historical values. The trails are used primarily in summer for hiking and mountain biking; however, locals enjoy winter use of them, mainly for ski touring. The Seven Summits trail is locally popular and world renowned, including designation by International Mountain Bike Association as one of 46 worldwide “Epics.” There are two operators that hold temporary licenses of occupation (LOO) along Seven Summits and Dewdney trails, including Sacred Rides Mountain Bike Holidays Ltd. and Trans BC Enduro with annual packages and events, respectively.

WaCanId is a 6-day biking event along Highway 22, the transportation route between Rossland and the US border, covering nearly 600 km in September every year. It draws about 500 participants.

Two recreation sites (more than 5 km west of the Project) include Santa Rosa Creek and Big Sheep Creek Recreation Sites. They have one campsite and picnic bench each and support overnight stays for small parties.

2.11.5 HARVESTING

Resident hunting is also an important activity in the area. Species with the highest number of annual kills among resident hunters in WMU 4-09 (that overlaps with the site) are bears, elk, and moose. There is a generally high level of effort among an average of 52 resident hunters per year with a low rate of harvest, including 11 bears and 10 elk annually.

One guide, Barry Brandow of Granby Guide and Outfitters, has operated in an area 10 km west of the RRIMM Project (Figure 2.11-4) for nearly 40 years. He has focused on bears (519 kills), followed by cougars (123 kills), and sheep (50 kills).

One trapline (TR409T001) overlaps with the RRIMM Project area whose primary focus is harvest of beavers, martens, and weasels with a low rate of recorded harvest. This trapline covers a large landbase and is adjacent to five other traplines, including TR0815T001, TR0408T002, TR0408T001, TR0409T003, and TR0414T001 (Figure 2.11-5).

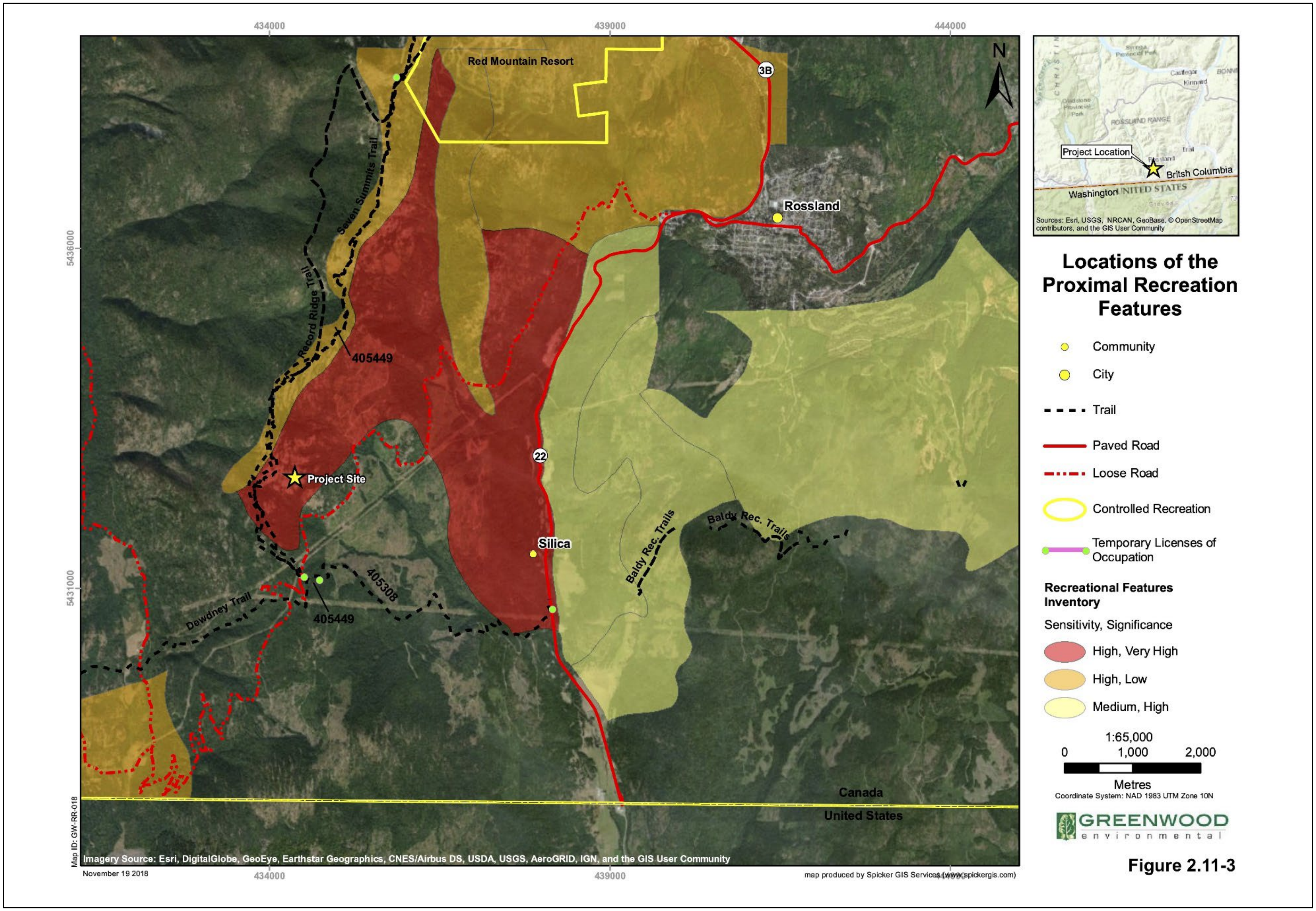


Figure 2.11-3: Locations of Proximal Recreation Features

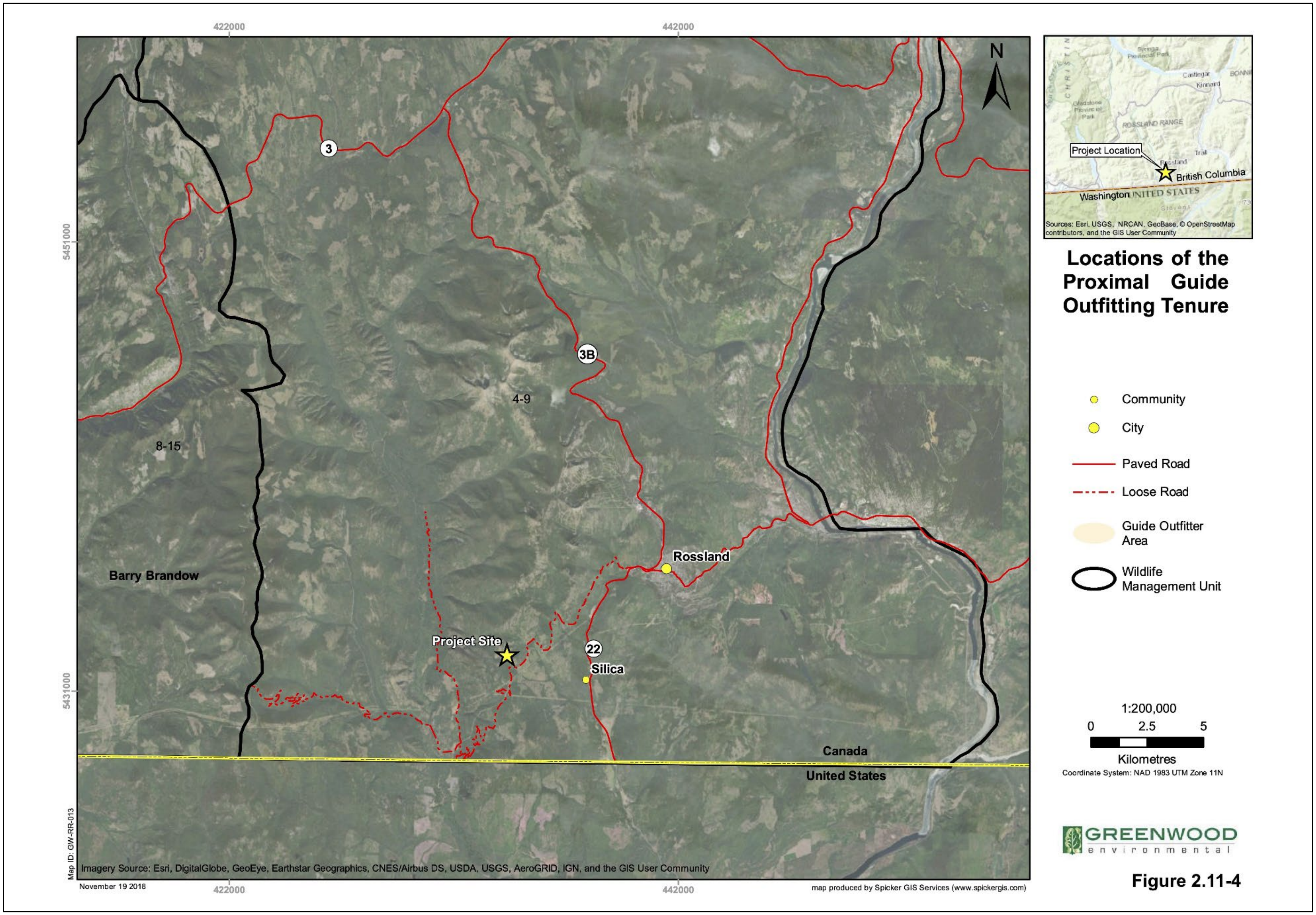


Figure 2.11-4: Locations of Proximal Guide Outfitting Tenure

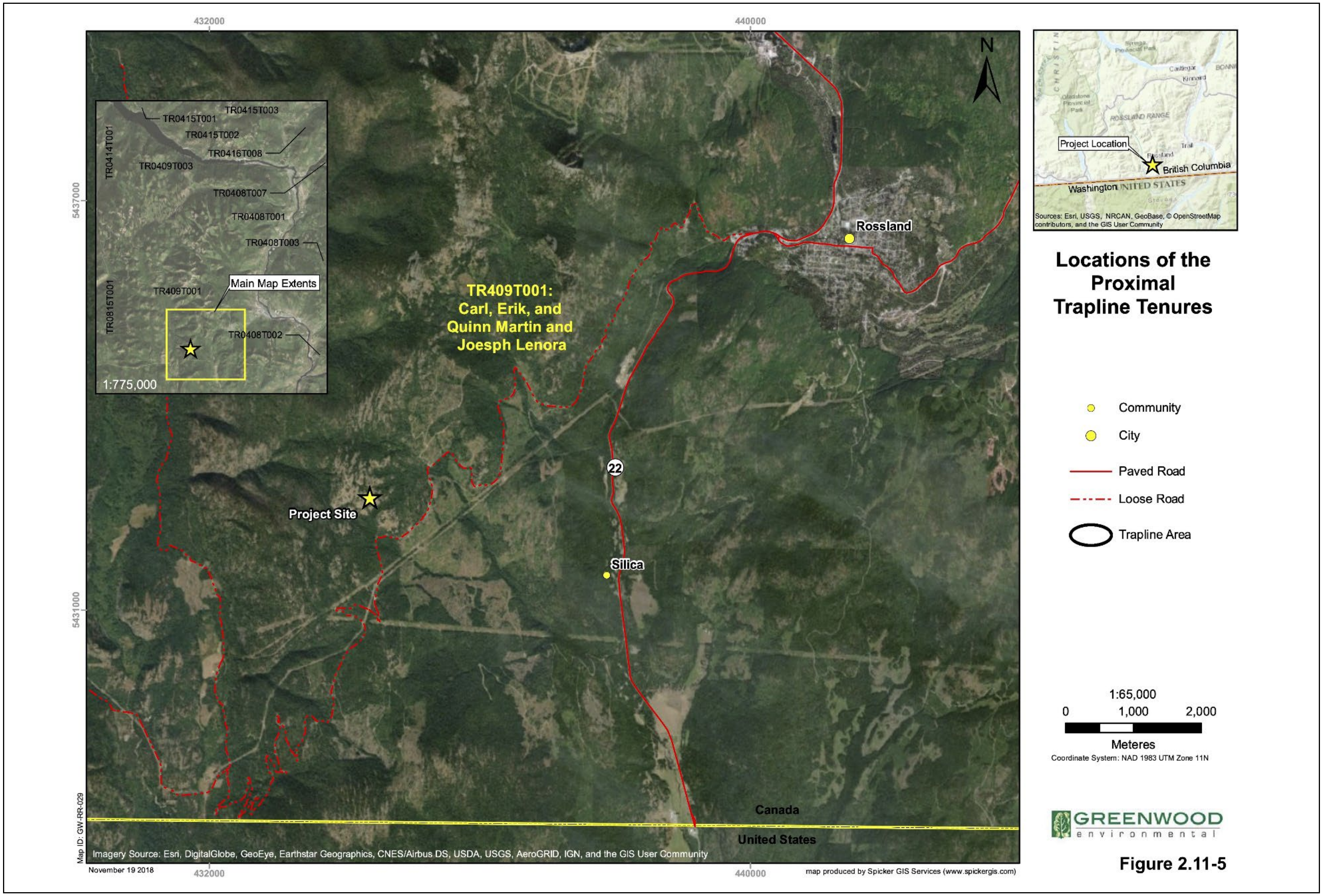


Figure 2.11-5: Locations of Proximal Trapline Tenures

2.11.6 Residential

Private Properties

There are a total of 60 properties that fall within a 1-km zone of influence of the RRIMM Project and the transportation route. These lands contain 43 buildings, mostly 1 to 2-storey houses built between 1920 and 2013. There are also 27 properties that are vacant land without any buildings. Property land size ranges from 1 to 320 acres. Figure 2.11-6, Figure 2.11-7, Figure 2.11-8 depict the locations of the properties with homes and those that are vacant in relation to the RRIMM Project and the transportation route.

Groundwater from the RRIMM Project will not affect water rights to the west as this is across the water divide for Record Ridge and the properties occur at a lower elevation range of 680 to 840 m. Additionally, properties are mainly upstream of the intersection of Sophia Creek with Little Sheep Creek and thus have limited interaction with groundwater from the RRIMM Project. The properties located downstream of the intersection of Sophia Creek with Little Sheep Creek occur at an elevation range of 680 to 920 m; whereas the RRIMM Project area is located at 1,300 to 1,550 m elevation.

Water Licenses

Given the number of private properties proximal to the RRIMM Project, there are several water conduits, pipelines, pumps, and licensed springs along Highway 22 east of the Project area. To the west of the RRIMM Project, two tanks, a licensed spring, and two water conduits and pipelines exist (Figure 2.11-9).

2.11.7 Utilities and Infrastructure

There are two main travel corridors in the area of the RRIMM Project, Old Rossland Cascade Highway and Highway 22. Old Rossland Cascade Highway is a year-round government-maintained gravel highway that runs approximately 72 km through the Monashee Mountains, between Christina Lake and Rossland. This highway was superseded by construction of Highway 3 and now the Old Rossland Cascade Highway is a forestry road, maintained for several kilometers from each end with current users for recreation, including cyclists, vehicles with 4-wheel drive and hikers.

Highway 22 is a two-lane highway stretching from the US-Canada border at the terminus of Washington State Highway 395 to downtown Rossland. Highway 22 joins with Highway 3B in Rossland and connects with Trail.

Two large-scale utility infrastructures intersect the RRIMM Project site. BC Hydro maintains a 500 kV transmission line, Vaseux-Selkirk Line, that runs through the RRIMM Project area. This transmission line extends between Vaseux Lake and Selkirk, approximately 1,629 Km, and undergoes regular maintenance activities including brushing and clearing.

FortisBC maintains the Southern Crossing Pipeline Project, a 312-km pipeline with 24-inch diameter, that overlaps with the RRIMM Project area (crosses Sophia Creek in the vicinity of the Project). It transports natural gas along a 312-kilometer line between Yahk in the East Kootenay and Oliver in the South Okanagan (BC Gas Utility 1998).

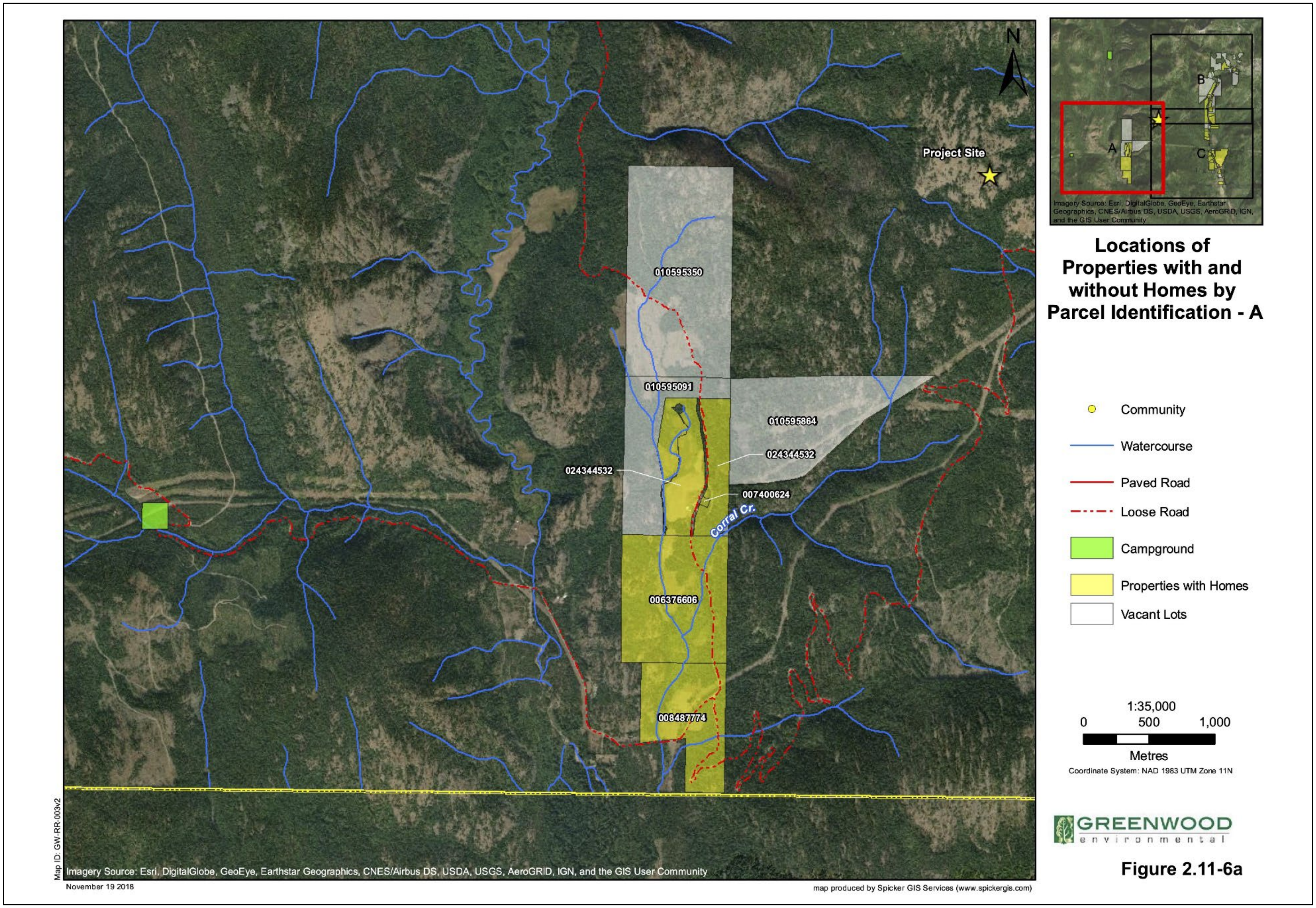


Figure 2.11-6: Locations of Properties With and Without Homes by Parcel Identification

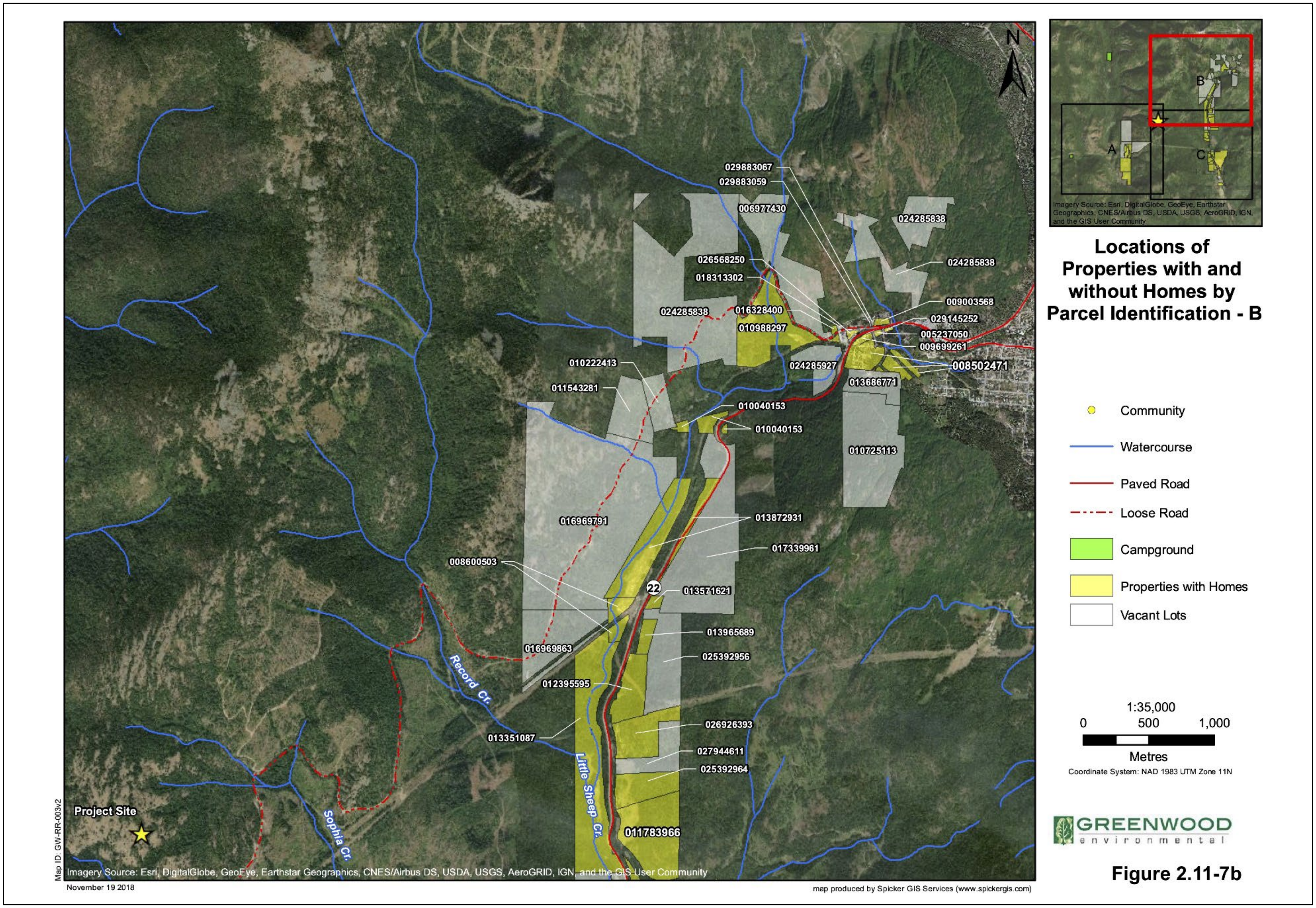


Figure 2.11-7: Locations of Properties With and Without Homes by Parcel Identification

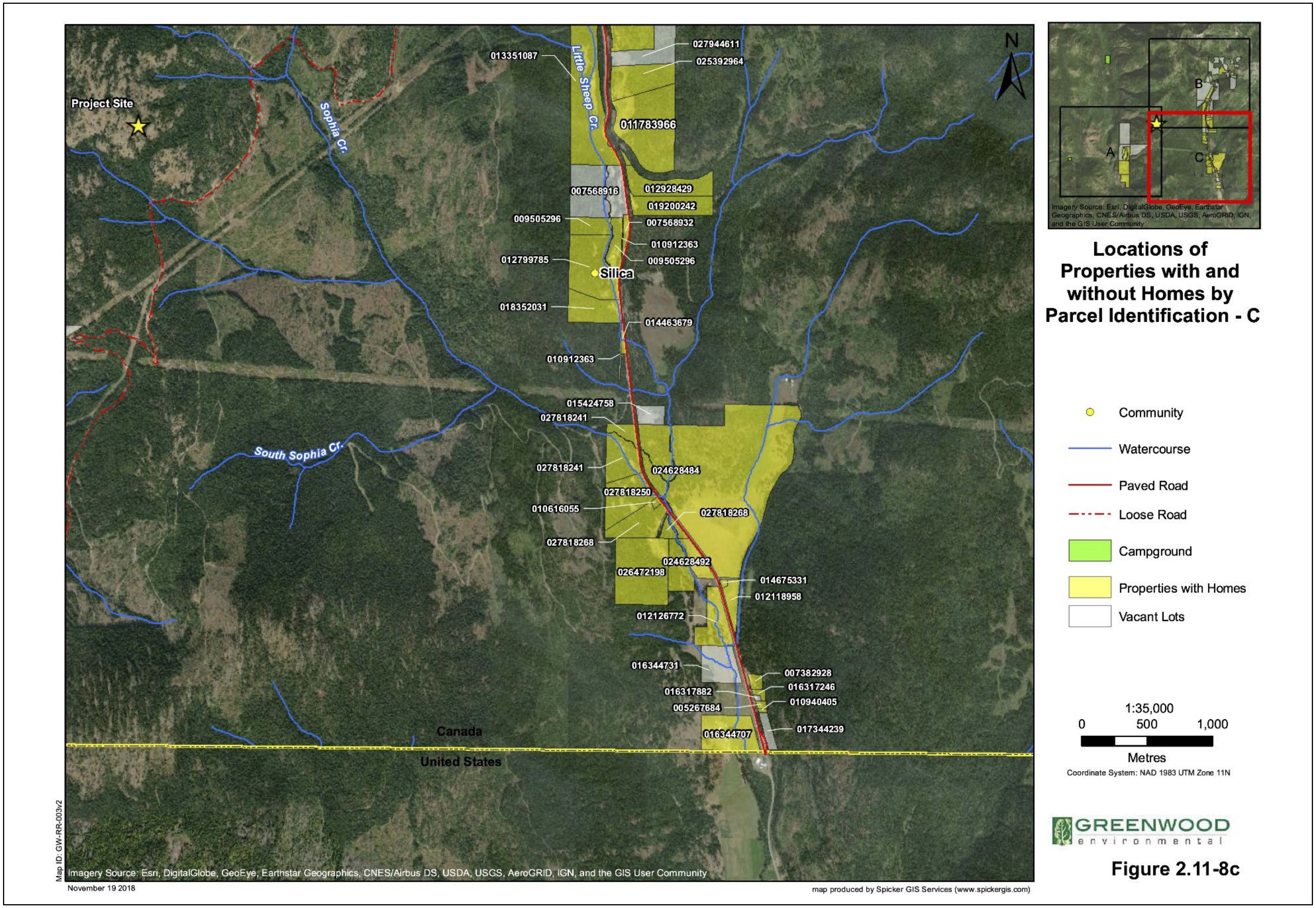


Figure 2.11-8: Locations of Properties With and Without Homes by Parcel Identification

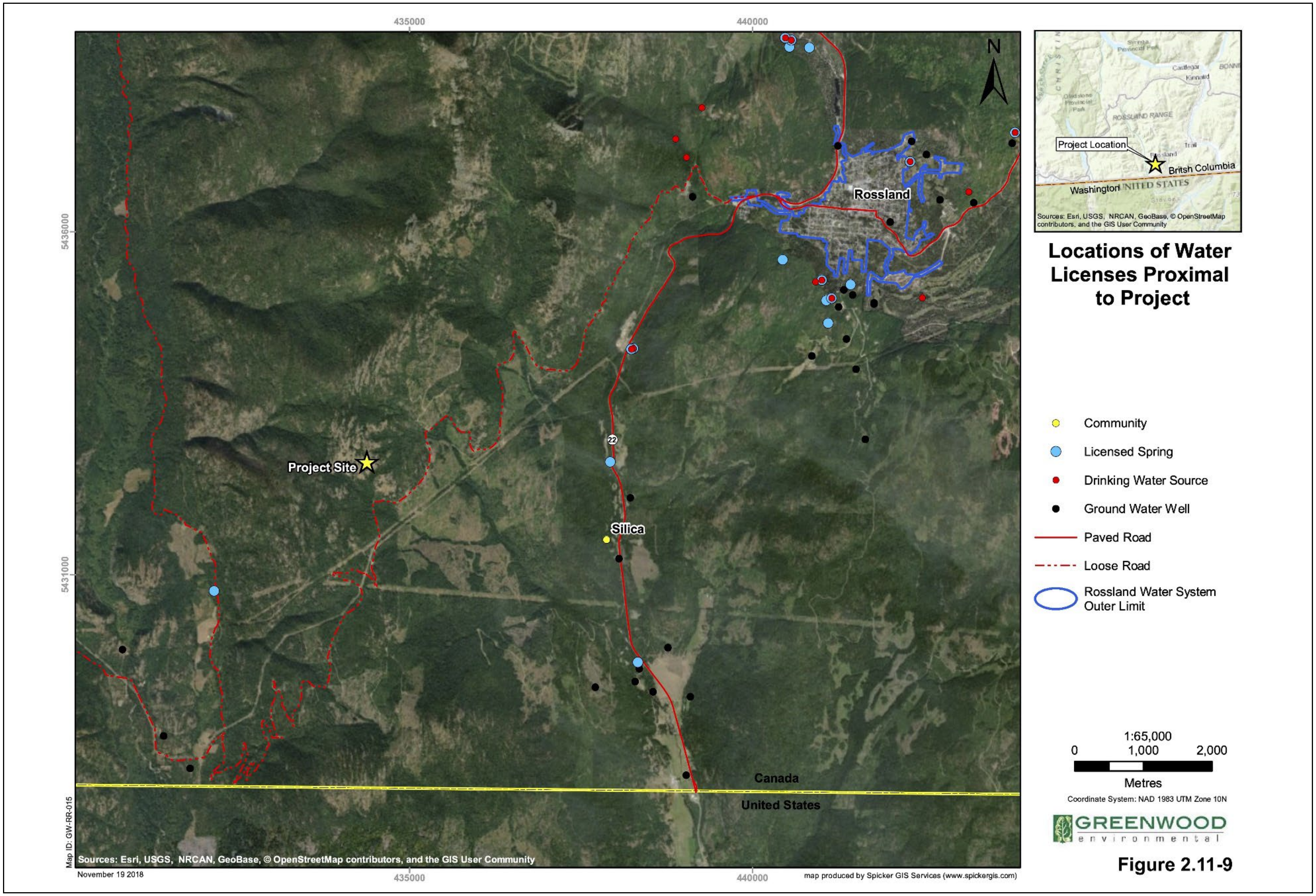


Figure 2.11-9: Locations of Water Licenses Proximal to RRIMM Project

2.12 LAND CAPABILITIES

The majority of the area in the vicinity of the RRIMM Project is comprised of lower elevation forested land of the ICH biogeoclimatic zone. Upper elevations are primarily drier ESSF forests with bedrock outcrops. The RRIMM Project area is primarily mature coniferous forest, with areas in the vicinity previously harvested and are now young regenerating forests. Tree species diversity is high overall. Resource roads and skid trails are common.

Common land uses in the vicinity of the RRIMM Project include forest harvesting, wildlife habitat, and recreation, although the recreation trails are outside of the proposed mine area. Wildlife that use the area primarily include ungulates (deer) and numerous bird species. The RRIMM Project area is not associated with high-suitability landscape for grizzly bears and does not fall within a key population core area or linkage landscape. Land capability in the area is forestry and wildlife habitat. Once mining is complete, the mine will be reclaimed and returned to pre-existing wildlife habitat.

2.13 ARCHAEOLOGY

2.13.1 OVERVIEW

An archeological overview assessment (AOA) was completed to identify any archeological concerns associated with the RRIMM Project (Ursus Heritage Consulting 2016; Appendix 2-T). Objectives of the AOA were to identify and evaluate any areas of archaeological potential within the RRIMM Project area and to provide recommendations regarding the need and appropriate scope of further archaeological studies prior to any proposed construction. The AOA was conducted in accordance with the *British Columbia Archaeological Impact Assessment Guidelines* (Apland and Kenny 1998) issued by the Archaeology Branch at the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

2.13.2 PREVIOUS ARCHEOLOGICAL STUDIES AND NEARBY RECORDED ARCHEOLOGICAL SITES

Previous archaeological field studies in the area have been limited to archaeological investigations related to the BC Gas Utility Limited Southern Crossing Pipeline, which included reconnaissance survey of the pipeline route, which is near the proposed mine (Bussey et al. 1997, Bussey et al. 1998, Bussey and Handly 2000). An Archaeological Overview of the Arrow Forest District (Handly and Lackowicz 1998) identified an area of moderate potential for the presence of archaeological sites close to the current RRIMM Project area.

No previously recorded archaeological sites within the RRIMM Project area were identified through an online search of the BC Remote Access to Archaeological Data (RAAD) database. The closest recorded archaeological site DgQl-1 is located approximately 2.3 km northeast of the mine site, about 700 m lower down in the Valley on the east side (left bank) of Little Sheep Creek and consists of an isolated find (projectile point) recorded in 1982 (Baker 1982) in an area reported to contain further privately collected artifacts and possible cultural depressions.

The historic Dewdney Trail (DgQm-1) is located south of the Old Rossland-Cascade Highway, with sections having been rebuilt for recreation purposes (Bussey et al. 1998). The trail is designated as a heritage trail under the *Heritage Conservation Act* and as a recreation trail under the Forest Practices Code of BC (Management Plan 1996). Although noted in previous archaeological studies (Bussey et al. 1997; Bussey et al. 1998; Bussey and Handly 2000), a precise location or map of this section of historic trail location is not available and the current recreational route does not completely mirror the historic route.

2.13.3 AOA Results

The AOA identified two areas with moderate potential to contain archaeological sites (Figure 2.13-1):

- AOP 1 is located in the northern half of the mine site, consisting of the uppermost southeastern flanks of the unnamed summit at the south end of Record Ridge.
- AOP 2 is located within the stockpile and crusher area, encompassing the margins of Sophia Creek and one of its unnamed tributaries.

The AOA potential assessment is based on a desktop review and a refinement of the assessment would be possible by conducting a Preliminary Field Reconnaissance (PFR) of AOP 1 and AOP 2. Additionally, it is likely that the historic route and designated heritage trail, the Dewdney Trail, is located in proximity to the project area (Figure 2 *in* Appendix 3-16; Management Plan 1996). If evidence of the historic trail route was present within, or in proximity to, the Project, a PFR survey would allow for its location to be determined and mapped in relation to the Project. A draft management plan has been developed to protect the trail, which is defined as a 200 m wide corridor, 100 m to either side of the trail centerline (Bussey et al. 1997).

Outside of the identified areas of potential (AOP 1 and AOP 2) and the portion of the project area in proximity to the Dewdney Trail, the remainder of the project area is set on undulating, sloping valleyside terrain and at a distance from major water features. Additionally, previous industrial logging and road building have impacted a majority of the landscape. As a result, the archaeological potential is considered to be low and no further archaeological investigation is warranted for the areas outside of the identified areas of potential (AOP 1 and AOP 2) and the portion of the RRIMM Project area in proximity to the Dewdney Trail (Ursus Heritage Consulting 2016; Appendix 2-T).

All archaeological remains in BC are protected from disturbance, intentional or inadvertent, by the *Heritage Conservation Act*. The Company understands any archaeological impact assessment (AIA) requires a Section 14 Heritage Inspection Permit issued by the Archaeology Branch of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development. Section 9.15 provides the Archaeological Management and Impact Mitigation Plan for the RRIMM Project, including description of chance find procedures.

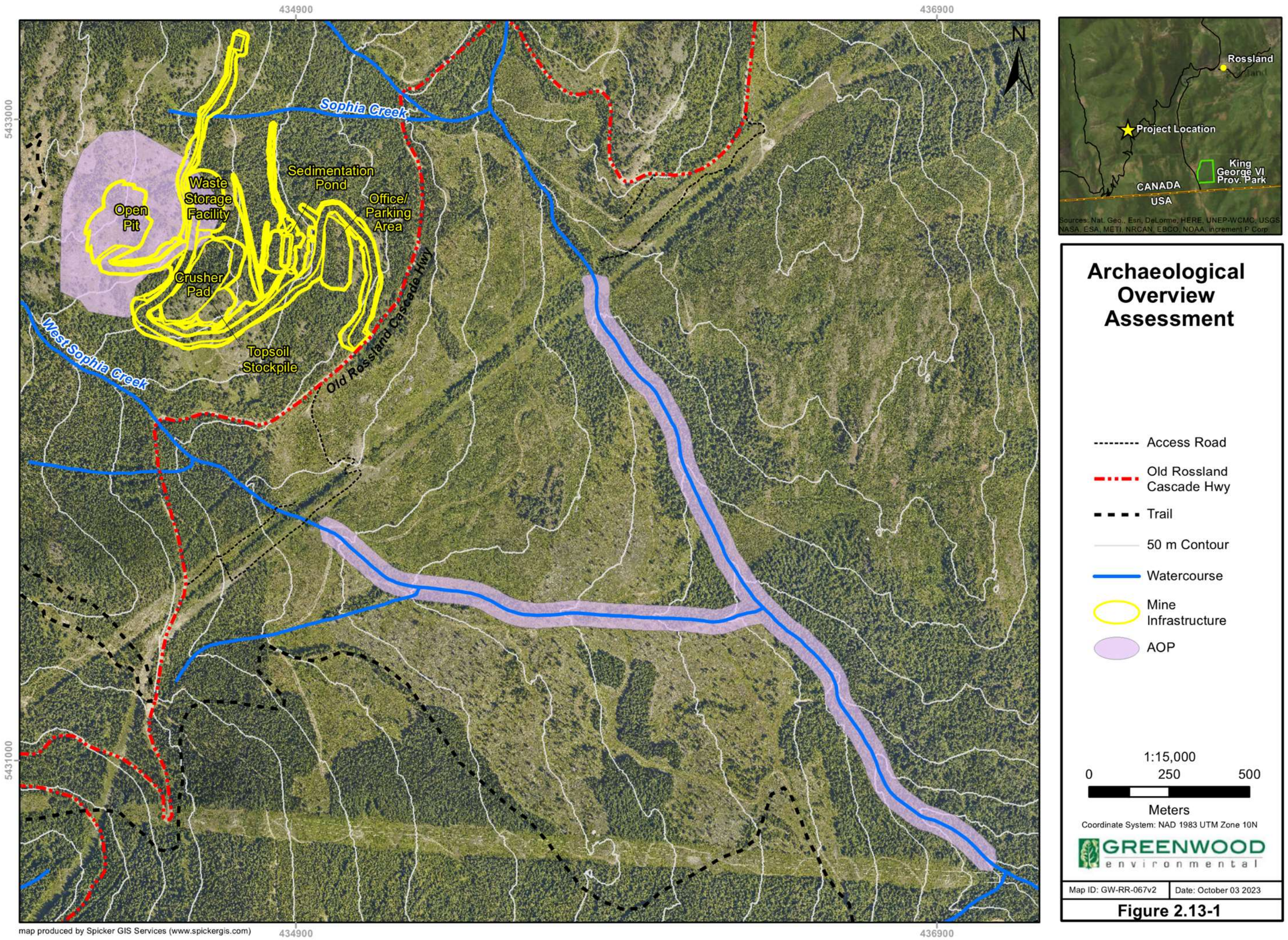


Figure 2.13-1: Archaeological Overview Assessment

2.14 CULTURAL USE

The area in, and around, the proposed RRIMM Project has been, and continues to be, used by several First Nation groups, including the Syilx/Okanagan, Sinixt, and Secwepemc/Shuswap people. These uses entail a range of past and current activities, such as fishing, hunting, trapping, and plant harvesting, important for consumption and cultural purposes. The summary of traditional activities of the three First Nations provided below document that the majority of these traditional activities have been, or continue to be, practiced in areas proximal to the proposed project site.

2.14.1 OKANAGAN PEOPLE

"The Syilx/Okanagan territory … extends over approximately 69,000 km^2. The northern area of this territory was close to the area of Mica Creek, just north of modern day Revelstoke, BC, and the eastern boundary was between Kaslo and Kootenay Lakes. The southern boundary extended to the vicinity of Wilbur, Washington and the western border extended into the Nicola Valley" (Okanagan Nation Alliance 2018). The Syilx/Okanagan community closest to the Project is Osoyoos Indian Band (OIB).

The seasonal round of the Syilx/Okanagan people entailed rotating between different sites for hunting, fishing, and plant gathering during summer and fall seasons. During the winter, they undertook important ceremonies and celebrations in family-based villages (Hudson 1990). The Syilx/Okanagan people closest to the Project have been, and are, more focused on hunting than fishing (Kennedy and Bouchard 1998).

The species of focus during hunting expeditions were, and continue to be, elk, moose, black and grizzly bears, mountain goats and sheep (Kennedy and Bouchard 2004). Smaller furbearers, such as marmots, beaver, rabbits, marten, and porcupine, are also caught using traps.

Besides hunting for big and small game, the Okanagan people also participated in annual trips to Kettle Falls (now in Washington State) in July and August to fish for chinook, coho, and sockeye salmon (Kennedy and Bouchard 2004 and Hudson 1990). Important ceremonies supporting this harvest focused on rituals associated with the first salmon caught (Kennedy and Bouchard 1998).

Okanagan people also gather a variety of berries and roots, with a particular focus on bitterroot and Saskatoon berries for consumption and medicinal purposes. Roots and berries were supplementary food during salmon-fishing periods (Hudson 1990 and Turner et al 1980). Cultural ceremonies associated with the first harvest of berries and roots to mark the shift from winter to spring.

The main form of traditional transportation for Syilx/Okanagan people was the canoe. They used sturgeon-nosed canoes made from white pine (Kennedy and Bouchard 1998).

2.14.2 SINIXT PEOPLE

Sinixt territory extends from Revelstoke in the north to Kettle Falls in Washington State to the south (Sinixt Nation 2018). Sinixt people prioritized meat over fish. Sinixt hunting focuses on several large game animals, including elk, moose, caribou, mule deer, white-tailed deer, big horn sheep, and mountain goat. Sinixt people conducted seasonal hunts in the spring (mountain goats, big horn sheep, and deer), fall (bears, moose, deer, and big horn sheep), and winter (moose, caribou, and deer).

Sinixt people also fish a variety of species during particular seasons. Spring entails harvest of chinook salmon and steelhead trout, while summer months include fishing for sockeye, pink, and coho salmon (Sinixt Nation 2018).

2.14.3 SHUSWAP PEOPLE

"The territory of the Secwepemc [also known as Shuswap] extends from the Columbia River Valley on the east slope of the Rocky Mountains to the Fraser River on the west and from the upper Fraser River in the north to the Arrow Lakes in the south" (Shuswap Nation 2018). Secwepemc territory covers an approximate area of 180,000 km^2. The two Secwepemc communities closest to the Project are Splats'in First Nation and Shuswap Indian Band.

In the past, the Secwepemc/Shuswap people were highly mobile, moving in seasonal rounds for fishing, hunting, and plant gathering purposes. The Secwepemc/Shuswap people have, and continue to, harvest deer, moose, elk, caribou and fishing several species of salmon (Shuswap Nation 2018). They also harvested diverse types of plants for consumption and medicinal purposes. The Secwepemc/Shuswap people exercise a complex set of cultural and spiritual ceremonies to honour and manage various aspects of their land and various species to be in right relations with them. In the past, the Secwepemc/Shuswap people rotated in a seasonal manner throughout their territory, with winter months spent in kinship villages using pit house construction and the rest of the year hunting, fishing and plant gathering (Shuswap Nation 2018).

3.0 MINE PLAN

3.1 MINE PLAN OVERVIEW

The proposed Record Ridge Industrial Mineral Mine (RRIMM) Project mine plan will be a conventional truck and shovel open pit operation which will include ripping, loading, and hauling of magnesium-bearing serpentinite. The mine is designed to supply two years of plant feed material at a rate no greater than 200,000 tonnes per year. The mine product material will have primary and secondary crushing on-site before being loaded on to highway dump trucks for transport to a rail loadout in Trail, BC. In an effort to reduce noise, dust and health and safety impacts on communities and project stakeholders, drilling and blasting to support operations will not be the primary means of rock fragmentation; however, drilling and blasting may be required as an alternative method of fragmentation in any areas where the planned mechanical rock breaking equipment is ineffective or if mechanical breakage proves to not be feasible for geotechnical or productivity reasons.

Facilities that will be constructed include the open pit and adjacent waste rock storage facility, an access road from the Old Rossland Cascade Highway to the open pit and waste rock storage facility, a soil stockpile, a level pad for primary and secondary crushing, as well as a maintenance pad, dry, and an office building (Figure 3.2-1). Details of the mine facility designs, and development are provided in Section 9.

The quarry excavation has a maximum height of 30 m and is designed to be mined in 6 m benches. Bench face angles will vary between 60-70°, while 8.0 m wide catch berms are left every 12 m to achieve an inter-ramp wall angle of 35-44°. The excavation is designed to be free draining to the southwest.

The proposed RRIMM Project does not entail underground workings, on-site processing plant (mill) and associated facilities, or a low-grade ore stockpile. Figure 3.2-1 illustrates the completed development of the site access roads, waste rock storage facility (WRSF), quarry, ore/crusher pad, soil stockpile, and sedimentation pond.

The complete Record Ridge Industrial Mineral Mine – 2023 Mine Plan (SRK October 2023b) is located in Appendix 3-B.

3.2 DEVELOPMENT SEQUENCE AND SCHEDULE

The Development Sequence and Schedule is provided in Section 5 of the Record Ridge Industrial Mineral Mine – 2023 Mine Plan (SRK October 2023b) is located in Appendix 3-B.

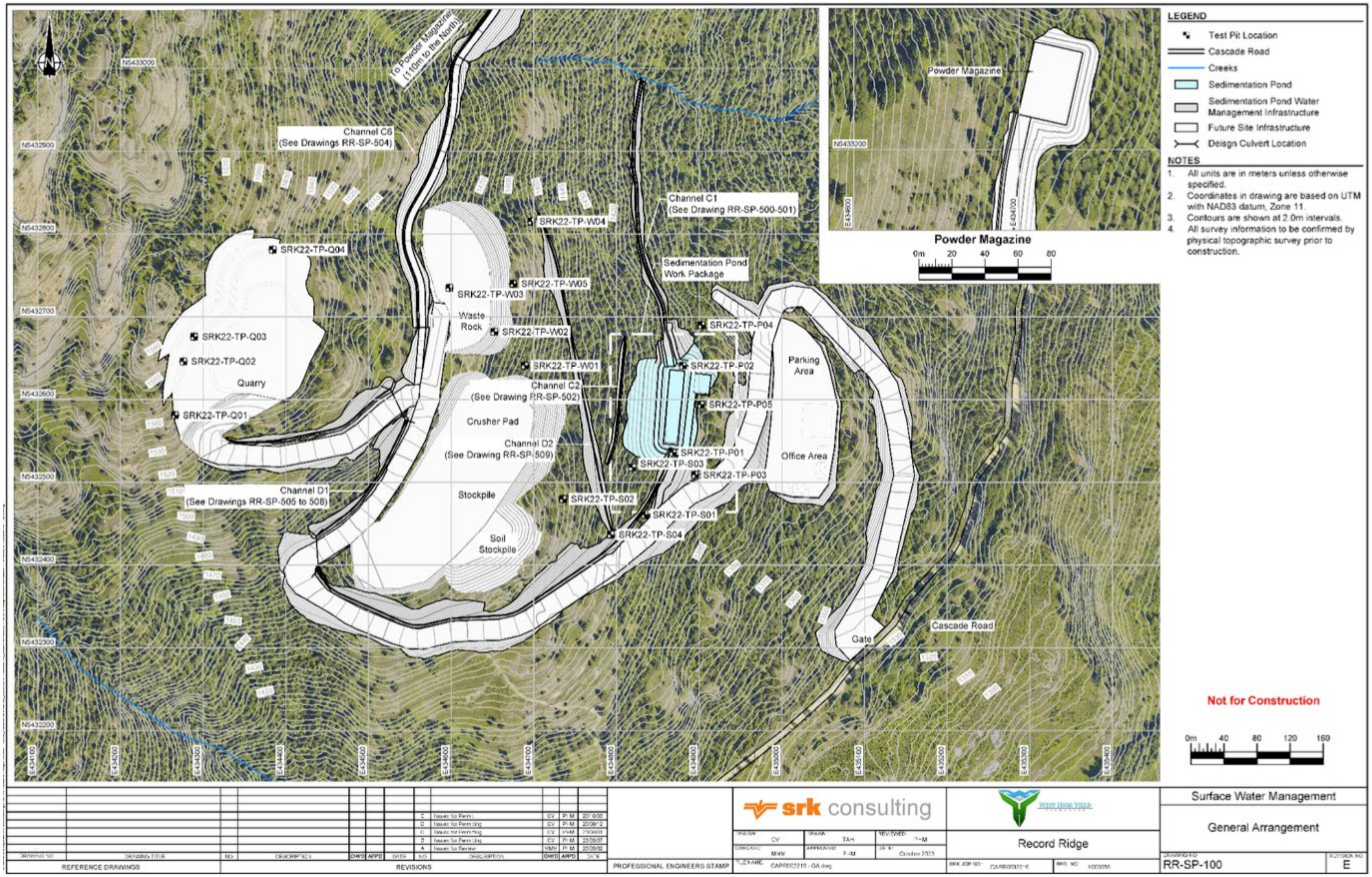


Figure 3.2-1: Mine Site Layout

3.3 EXISTING DEVELOPMENT

There is no existing development within the proposed Project footprint with the exception of diamond drill hole pads accessed via skidder trails.

3.4 DETAILED FIVE-YEAR MINE PLAN

The mine plan for the RRIMM Project includes a construction period, two years of production followed by site reclamation, see Appendix 3-B.

Construction Period

Before production can begin, an approximately three month construction period is required to mobilize equipment, establish site access, and prepare required site facilities. The primary task in the construction period is building the site access haul road, crusher pad, and office/maintenance pad. In addition to road and pad construction, topsoil from the site footprint will be stripped and placed in the soil stockpile.

Production Period

Production period of the mine is two years mining at a rate no greater than 200,000 tonnes of mineralized material per year along with varying amounts of waste rock. The open pit will be mined as a single phase on 6 m benches. Mineralized material will be hauled to the crusher pad and waste rock will be used for construction of the crusher pad, haul roads and/or placed at the WRSF.

Reclamation Period

After the production period, mine site facilities will be reclaimed according to Project's reclamation plan.

3.5 CONCEPTUAL LIFE OF MINE PLAN

The Life of Mine Plan is presented within the Detailed Five-Year Mine Plan.

3.6 MINE FACILITY DESIGNS AND DEVELOPMENT

Details of the Mine Facility Designs and Development is provided in Section 9 of the Record Ridge Industrial Mineral Mine – 2023 Mine Plan (SRK October 2023b), located in Appendix 3-B.

4.0 RECLAMATION AND CLOSURE PLAN

4.1 END LAND USE AND CAPABILITY OBJECTIVES

4.1.1 CURRENT CONDITIONS AND LAND USE

The RRIMM Project area is primarily mature coniferous forest, grassland, and exposed bedrock. Some regenerating forest cutblocks are located close to, but outside of, the proposed disturbance area and skid trails are common in these areas. Tree species diversity is high overall, consisting of mixes of western redcedar, Douglas fir, western hemlock, lodgepole pine, grand fir, western white pine, western larch, ponderosa pine, paper birch, and trembling aspen. Subalpine fir and hybrid white spruce are found in the upper elevations with outcrops of bedrock exposure. Grasslands consist of fescues, bluebunch wheatgrass, and a mix of drought-tolerant forbs (Keefer 2017a; Appendix 2-J).

Common land uses within, and in the vicinity of, the RRIMM Project area include wildlife habitat, recreation, and forest harvesting although the recreation trails and forest harvesting are outside of the mine area. The area in, and around, the proposed RRIMM Project have been, and continues to be, used by several First Nation groups, including the Syilx/Okanagan, Sinixt, and Secwepemc/Shuswap people. These uses entail a range of past and current activities, such as fishing, hunting, trapping, and plant harvesting, important for consumption and cultural purposes. Wildlife that use the area primarily include ungulates (deer and elk), reptiles, and numerous bird species, including forest and grassland passerines and raptors. The RRIMM Project area is not associated with high-suitability landscape for grizzly bears and does not fall within a key population core area or linkage landscape.

4.1.2 END LAND USE AND CAPABILITY OBJECTIVES

Under the BC *Mines Act* and Health, Safety, and Reclamation Code for Mines in BC, the primary objective of the closure and reclamation plan will be to return areas disturbed by mining operations to acceptable land use and capability.

The following goals are implicit in achieving this primary objective:

- Long-term preservation of water quality downstream of decommissioned operations.
- Long-term stability of engineered structures, including the open pit.
- Removal and proper disposal of access roads, structures, and equipment that will not be required after the end of the mine life.
- Long-term stabilization of exposed erodible materials.
- Natural integration of disturbed areas into the surrounding landscape, and restoration of a natural appearance to the disturbed areas after mining ceases.
- Establishing a self-sustaining cover of vegetation that is consistent with existing forestry and wildlife needs.

The reclamation plan incorporates current practices to return the landscape to similar slopes and structure with revegetation practices and prescriptions that facilitate pioneering vegetation communities and establishment of natural successional trajectories. End land use and capability objectives are based on pre-development site conditions and include target eco-sites to support the following land uses and capabilities:

- Wildlife habitat for the following indicator species or groups:
  - Birds (including migratory birds, passerine species, and raptors)
  - Rocky Mountain elk
  - Rocky Mountain mule deer
  - Black bear
  - Reptiles
  - Bats.
- Forested land (no forestry/forest harvesting objectives)
- Traditional use plants and wildlife habitat of hunted and trapped wildlife species, and
- Recreation.

The post-closure landscape will reflect current conditions with ecosystems and habitats reflecting a mix of forested land, grassland, and exposed rock.

Section 4.2.3, supported by Appendix 4-A, provides the end land use objectives and the predicted post reclamation ecosystems by mine component with revegetation prescriptions to meet end land use objectives and corresponding post reclamation ecosystems. Figure 4.2-1 shows the broad end land use objectives for each mine component.

4.2 RECLAMATION APPROACHES

4.2.1 SOIL RESOURCES

SOIL SALVAGE AND SUITABILITY

A soil survey was conducted of the RSA (Section 2.3.5; and Yole 2018 Appendix 2-C). Soil for use in reclamation will be salvaged from footprint areas prior to construction of the RRIMM Project, except the soil stockpile location itself. Table 4.2-1 presents a description of Soil Map Units (SMU) that occur in the RSA. Suitability for salvage, salvage depth and an explanation of the limitations of each SMU is presented.

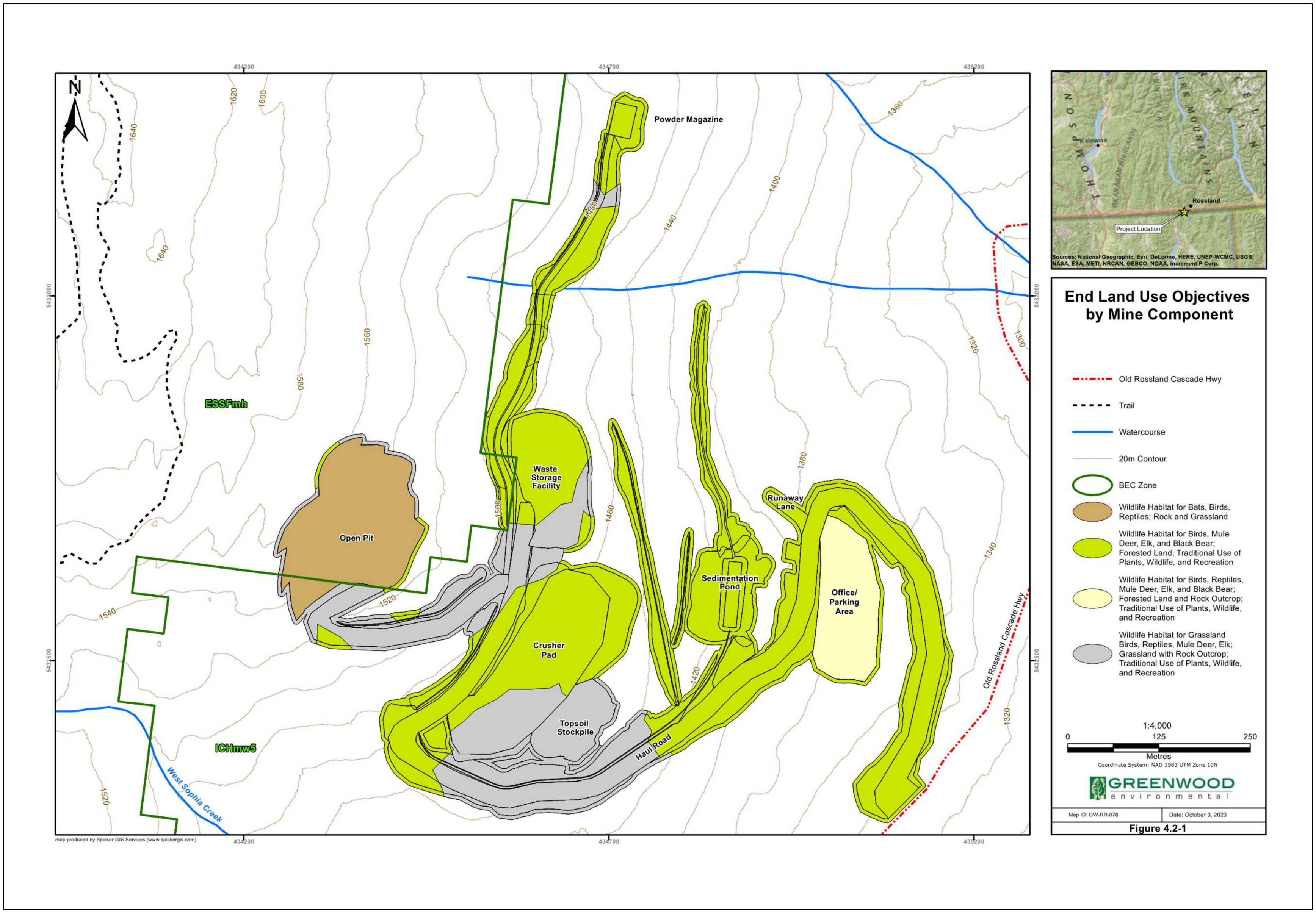


Figure 4.2-1: End Land Use Objectives by Mine Component

Table 4.2-1: Suitability of Soil for Salvage by Soil Map Unit (SMU)

SMU	Suitability Rating	Mean Soil Depth (m) for Salvage	Soil Suitability Limitations for Salvage
1	Good to Fair	0.36	Coarse fragment content variable, 0-40 CF%
1B	Good to Fair	0.29	Moist locations; compaction expected; gravelly > 30 cm
2	Fair to Low	0.18	Very gravelly (>60% volume) shallow soils; subject to drought; low nutrient status
2A	Good	0.42	Significant black Ah horizon; shallow
3	Fair	0.33	Often moderately steep sloping areas and highly erodible soils; near steep-sided stream channels; moderate nutrient content
4	Low to Unsuitable or Nil	0.30	Steep to very steep landscapes; very high % CF; low cohesion and excessively droughty as salvage material
4A	Unsuitable	0.18	Coarse rubbly/blocky; steep
4B	Fair	0.20	Lower/toe slope; wet
5	Unsuitable to Very Low	0.16	Bedrock-dominated; saprolite often breakable and usable; often high coarse fragment content in saprolite
6	Fair to Low	0.34	Coarse sandy gravelly sgFG materials; soil layers with "brown" colour worth salvaging
7	Fair to Good as amendment	0.27	Wet organic veneers associated with wetlands
8	Good	0.37	Adjacent to creeks; prone to seasonal flooding; high to very high erosion potential

Soil survey results determined that the majority of soils in the infrastructure footprint areas are suitable for salvage to depths that vary from 0.16 to 0.37 m. Soil map units for each mine facility is presented on Figure 4.2-2. Limitations to soil salvage may occur in small, localized areas where fractured bedrock is at the ground surface. Table 4.2-2 presents the area and depth of soil to salvage for each type of mine infrastructure.

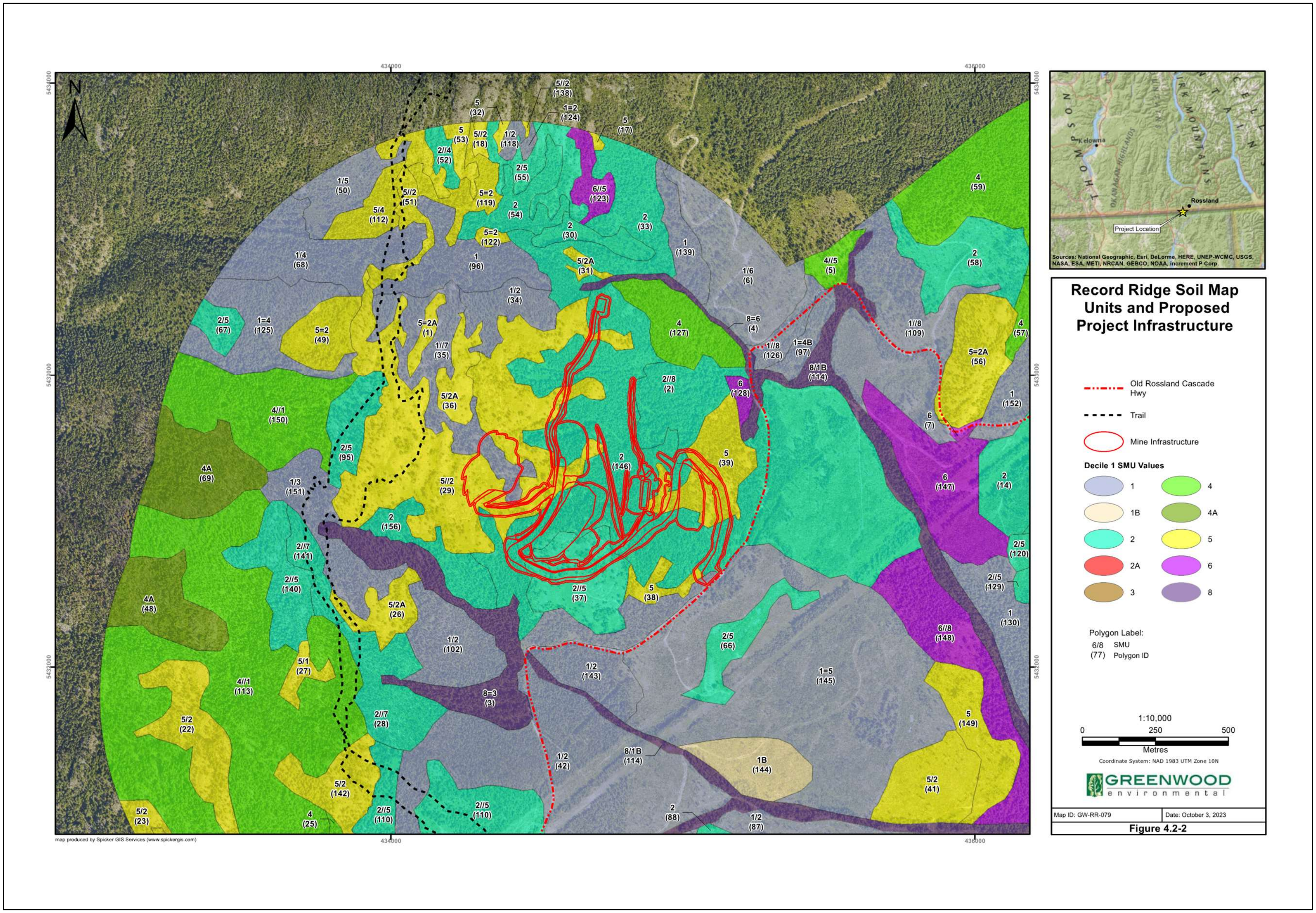


Figure 4.2-2: Soil Map Units by Mine Component

Table 4.2-2: Soil Available for Salvage from Mine Infrastructure Areas

Infrastructure	SMU	Area (m^2)	Depth of Salvage (m)	Volume Salvaged
Open Pit	1	9,469.2	0.36	3,408.9
	2	3,708.5	0.18	667.5
	5	14,834.1	0.16	2,373.5
	7	2,367.3	0.27	639.2
Crusher Pad	2	34,473.8	0.18	6,205.3
	5	2,098.2	0.16	335.7
Waste Storage Facility	2	12,654.0	0.18	2,277.7
	5	3,286.2	0.16	525.8
Topsoil Stockpile	2	6,347.8	0.18	1,142.6
	5	1,427.0	0.16	228.3
Powder Magazine	2	2,555.4	0.18	460.0
Parking/Office Area	2	6,656.6	0.18	1,198.2
	5	9,649.7	0.16	1,544.0
Sedimentation Pond	5	1,003.5	0.16	160.6
	2	11,884.4	0.18	194.5
Runaway Lane	2	1,080.6	0.18	194.5
Haul Roads[1]	1	929.0	0.36	334.4
	2	65,344.7	0.18	11,762.0
	5	32,045.1	0.16	5,127.2
	7	3.9	0.27	1.1
	8	253.0	0.37	93.6
Water Management Infrastructure (channels/ditches)	1	168.3	0.36	60.6
	2	14,199.2	0.18	2,555.9
	5	3,249.0	0.16	519.8
	7	42.1	0.27	11.4
Disturbance Buffer	1	1,259.7	0.36	453.5
	2	36,961.8	0.18	6,653.1
	5	15,320.8	0.16	2,451.3
	7	244.7	0.27	66.1
	8	99.4	0.37	36.8
Total		**293,617.0**		**53,627.7**

[1] Haul roads include the access road to the Powder Magazine
[2] Disturbance buffer is not anticipated to be stripped but is accounted for as part of the maximum disturbance footprint.

Soil Replacement Strategy

Soil will be stored in the designated stockpile until needed for reclamation. During storage, erosion control measures will be implemented to prevent soil loss and sedimentation. These measures will include a rough and loose surface, scattering of woody debris, and seeding with native species.

The characteristics of soil salvaged from the footprint that supported the pre-existing ecosystem are expected to be similar to the soil characteristics required to restore the target ecosystem because the footprint is small and thus salvage and replacement distances are short, plus the duration of soil storage is short (two years). Therefore, salvaged soil is expected to support the same ecosystem targeted post-closure.

The soil replacement strategy will begin once the two years of mining is complete. Once the waste rock is back hauled into the open pit soil will be removed from the stockpile with an excavator and placed in haul trucks. Soil will then be hauled to the open pit and placed on top of the waste rock and pit floor and spread in a rough and loose manner to a thickness between 0.1 and 0.2 m using an excavator.

The crusher, stockpile, explosives storage and office areas will be deep ripped to decompact the surface. Overburden that was sidecast to create a level surface for operating equipment will be brought back to re-create the contours that existed pre-mining. Soil will be hauled to these areas using a haul truck and spread by excavator to a thickness between 0.1 and 0.2 m in a rough and loose manner. Replacement of soil with an excavator will minimize creating compaction issues.

Once the haul roads are no longer needed to access sites for soil placement they will be deep ripped to decompact the surface. Sidecast overburden and soil will be returned and spread on the haul roads using an excavator to blend into the cut slope.

Volume of soil salvaged during construction compared to volume required for replacement during reclamation to thicknesses that range from 0.1 to 0.2 m (a result of the rough and loose soil preparation prescription) is presented in Table 4.2-3. There is sufficient soil available for salvage to cover disturbed area during reclamation with some extra available to use in any particularly challenging or sensitive locations that are identified during closure.

Table 4.2-3: Volume of Soil Salvaged Compared to Replacement Volume Required

Soil	Volume (m^3)	Area Salvaged/Replaced (m^3)	Depth of Salvage (m)	Depth of Replacement
Salvaged	53,628	293,617	0.16 to 0.37 (0.18*)	
Replaced	53,628	293,617		0.10 to 0.20 (0.15**)

*Weighted average of soil salvage depth was used to reflect the frequency of occurrence of various soil salvage depths in the mine area.
**Normal average was used because the method of soil placement and preparation will be uniform for all mine areas.

Given that the soil is stored for a short duration, degradation of soil nutrient status is expected to be minimal and soil amendments will not be required.

4.2.2 Landform Design and Erosion Control

Given the small scale of this proposed project, it will not produce any large waste dumps, large open pits or tailings management facilities that would typically require landform engineering to meet the closure objectives. The closure activities proposed herein integrate the principals of landform engineering and are all designed to eliminate or limit erosion through the construction of engineered slopes and accepted revegetation practices.

Most areas in the mine site will be returned to their original contours by replacing cut-fill overburden and soil, except for the open pit. The waste rock will be backhauled to the open pit and placed against the pit wall and floor. The floor of the open pit will be sloped so that water does not collect in the bottom. Soil placed on all disturbed areas will be revegetated to prevent erosion and support the end land use objectives.

4.2.3 Re-vegetation Strategy

4.2.3.1 Revegetation Principles and Goals

The primary goal of the RRIMM Project's revegetation component of the reclamation plan is to meet the end land use objectives outlined in Section 4.1 by establishing a native pioneering plant community that will facilitate natural succession. Specifically, the goal is to establish ecosystem units associated with the ICHmw5 and ESSFmh biogeoclimatic subzone variants.

Natural succession in the Project area varies between the forested and grassland areas and are discussed separately. Exposed rock (or rock outcrop) is limited to bryophytes that will establish naturally over time and will not be revegetated as part of the reclamation program. An adaptive strategy approach will be implemented throughout the reclamation program.

Forested Land Capability

Natural succession in the forested areas begins with establishing woody, deciduous shrubs and trees, such as Sitka alder (*Alnus crispa ssp. sinuata*) or mountain alder (*Alnus incana*), willow species (*Salix* sp.), and black cottonwood (*Populus balsamifera ssp. trichocarpa*) or balsam poplar (*Populus balsamifera ssp. balsamifera*). Unless direction and guidance is specifically provided by government for the Selkirk Forest Managed area, these species will be used in revegetating the areas that have forested land capability, as indicated in Figure 4.2-1. Using these local species in the areas with forested land capability is important because they are colonizers that:

- germinate quickly
- stabilize the soil
- fix nitrogen in the soil (e.g., *Alnus* sp.)
- contribute nutrients to the soil from deciduous leaf litter
- contribute to microhabitat complexity with providing shade for other native species to establish beneath
- assist in invasive species prevention by inhabiting disturbed areas and creating shade that is typically intolerable for common invasive herbaceous plants.

These species also play a valuable role in supporting forest productivity and providing wildlife food and habitat (Delong and Sanborn 2000), for example forage for ungulates. Willows grow on dry to very wet sites (Porter 1990, *cited in* Delong and Sanborn 2000), and the establishment of willow on disturbed sites can increase the rate and success of recovery of those ecosystems and re-establishment of natural ecological complexity (Kuzovkina and Quigley 2005). Delong's study indicated that mechanical mineral soil exposure provided the most suitable habitat for willow germination and found that approximately 20 kg/ha/yr of nitrogen could be returned to the site from the decomposition of the willow leaf fall (Forest Renewal Project OP96073-RE (no date), *cited in* Delong and Sanborn 2000). It is reasonable that this could be the case for other similar deciduous shrubs.

Willow and black cottonwood have high growth rates, which increases their importance in reclaiming disturbed sites. Microclimatic changes following the colonization of willows, can increase native species establishment and diversity by factors such as adding shade on site, annual input of leaf debris onto the ground and soil, increased root action and contributing to the formation of humus which improves soil structure and nutrient status (Stott 1992, *cited in* Kuzovkina and Quigley 2005). This microsite heterogeneity combined with the rough and loose surface preparation increases microhabitats for various native species to establish with different site requirements (e.g., soil moisture, soil nutrient, temperature, etc.). This approach together with the scattering of coarse woody debris helps to reduce surface erosion, reduce invasive plant invasion, and facilitates natural ecosystems establishment and diversity (Polster 2017, 2012 pers. comm.).

Grassland Land Capability

Natural succession in the graminoid grassland areas starts and climaxes with fescues, bluebunch wheatgrass, and a mix of drought-tolerant forbs (Keefer 2017a; Appendix 2-J). The following species are some key species that make up the graminoid grassland of the RSA: Idaho fescue (*Festuca idahoensis*), bluejoint reedgrass (*Calamagrostis canadensis*), hair bentgrass (*Agrostis scabra*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and junegrass (*Koeleria macrantha*).

4.2.3.2 Revegetation Prescription and Assumptions

Specific revegetation prescriptions are provided in Appendix 4-A. The general assumptions and practices that will be implemented throughout the reclamation areas are described for the forested, grassland, and exposed bedrock end land use capabilities. Vegetation monitoring will be implemented, as outlined in Section 4.2.6.

For the forested land capability areas, the following practices will be implemented:

- Between 0.1 and 0.2 m of soil placed on the forested land capability areas.
- Once the soil is placed, the area will have rough and loose preparations (i.e., micro surface mounding) prior to revegetation to create microsites and slightly mix mineral soil and organics similar to natural disturbances (e.g., root turns).
- Alder seeding to establish woody pioneer vegetation.
- Live staking will be implemented where feasible and appropriate:

- Live-stakes (willows, black cottonwood, and/or balsam poplar,) will be harvested at suitable size that (a) do not adversely impact the donor plant and (b) be of sufficient size to facilitate successful establishment.
- Live-stakes are to be 60 to 75 cm in length, and minimum 30 mm in width measured at the base of the stake and free of foliage/branching; live stakes should be soaked (fully submerged) in freshwater for a minimum of 5 days prior to installation, and when installed, be such that about ⅔'s of the total length is buried in the ground.
- Staking will be implemented at approximately 1.5 m to 3 m inter-spacing and approximately 4,500 stems/ha, where implemented.
- Staking and/or planting will be conducted during spring and/or fall when plants are dormant.
- Coarse woody debris, including logs, stumps, and root wads (if available) will be placed throughout the reclaimed area to reduce surface erosion, enhance wildlife use, and provide a long-term organic source for soil nutrients, soil stability, and to increase biodiversity values. Approximate scattering of coarse woody debris will be 100 m^3/ha and placed in a manner to allow ungulate movement.
- Where feasible, collection and scattering of leaf litter and cones from adjacent forests throughout the restoration site will be implemented to aid in the re-establishment of the nutrient cycling process.
- Planting conifer and deciduous trees and shrubs suitable for the site capability.

In the grassland capability areas, the following practices will be implemented:

- Between 0.1 and 0.2 m of soil will be placed on the disturbance areas with grassland capability.
- Grass seeding of certified weed-free native grasses at a rate of approximately 50 kg/ha, with species such as:
    - Idaho fescue
    - bluejoint reedgrass
    - hair bentgrass
    - bluebunch wheatgrass.

In the exposed rock capability areas, no reclamation material will be placed as these areas will be left as exposed rock.

4.2.3.3 Post Closure Ecosystems

Reclaimed lands within the proposed footprint will be characterized by landscapes of varying slope gradient, aspect, and slope positions, primarily within the ICHmw5, with a minor component within the ESSFmh. The projected post-closure ecosystems will be dependent on these characteristics and soil moisture and nutrient regimes of the material available for reclamation. It is anticipated that most of the reclaimed lands will be relatively dry with poor soil moisture and nutrient regimes. This influences the reclaimed ecosystems likely to develop. Figure 4.2-3 provides a baseline Terrestrial Ecosystem Mapping (TEM) for the area and

Figure 4.2-4 provides the conceptual post-reclaim TEM at the same scale. The baseline contours will be the same post-closure except for the open pit project component, which will have flat areas, benching, and a rock wall along the western and northwestern edge.

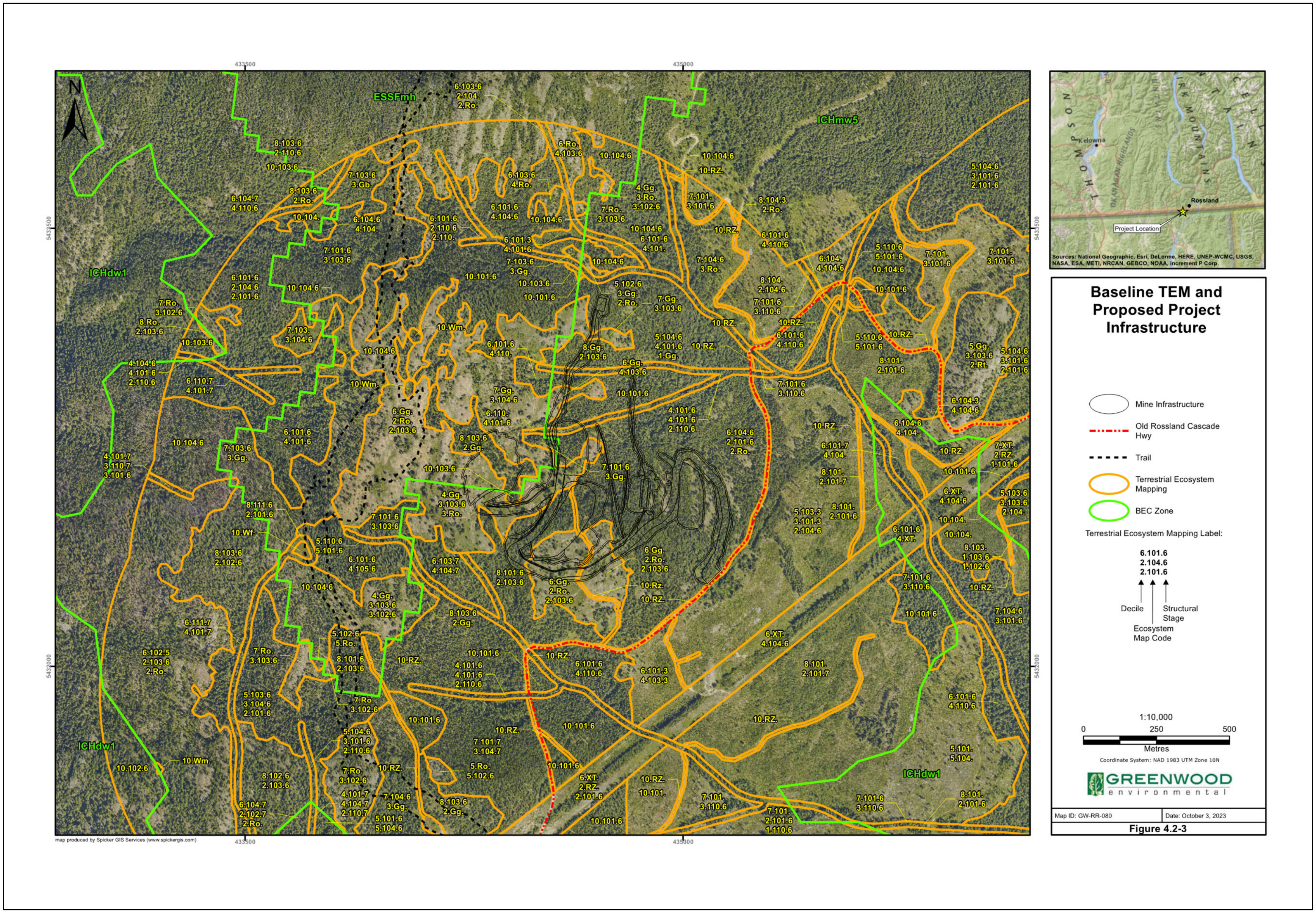


Figure 4.2-3: Baseline TEM and Proposed Project Infrastructure

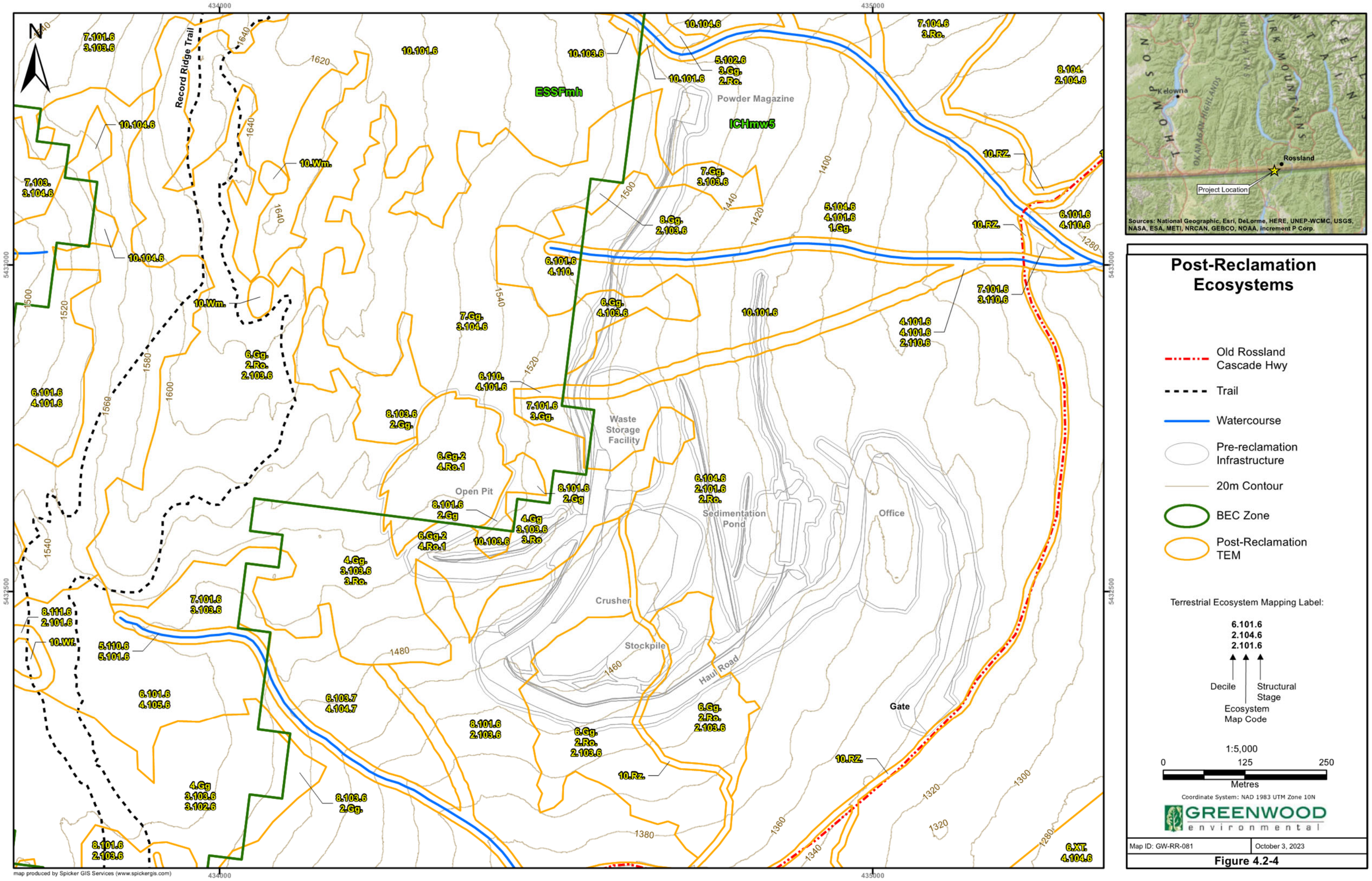


Figure 4.2-4: Post Reclamation Ecosystems

Table 4.2-4 provides the area (in hectares) of each ecosystem type pre- and post-reclamation within the Project area. The presence of the open pit at closure increases the area of exposed rock by 1 ha more than was present pre-mining. This represented the greatest percent change in post-reclamation ecosystems compared to pre-mine ecosystems. In general, slightly drier ecosystems are predicted post-reclamation compared to baseline due to early successional stage plants not providing shade until they are more mature.

A summary of revegetation by mine component is provided below based on the general revegetation principles and practices outlined in Section 4.2.3, with consideration of the predicted land capability (e.g., site and soil conditions). See Appendix 4-A for a tabular summary of the following items by component:

- End land use objectives.
- Overall site and expected soil conditions per component, including soil moisture and nutrient.
- Revegetation prescription suitable to the expected site and soil conditions to support the predicted ecological communities (site series) and densities (plants per hectare (/ha).

Open Pit

The end land use capability objectives of the open pit are approximately 60% graminoid grassland and 40% rock. The land use objectives are to provide wildlife habitat for bats, birds, and reptiles. Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately 56% ESSFmh/Gg, 37% ESSFmh/RO, 4% ICHmw5/Gg, and 3% ICHmw5/RO. These areas with soil placement will be planted with weed-free native grass species mix. The revegetation prescription provided in Appendix 4-A will provide native vegetation, including graminoid-dominated wildlife habitat.

Waste Rock Storage Facility and Soil Stockpile

The end land use capability objective of the waste rock storage facility is approximately 74% forested land, 18% grassland, and of the soil stockpile it’s 80% grassland and 20% rock. The forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation. For the grassland and rock land use objectives, these areas will support wildlife habitat for grassland birds, reptiles, ungulates (Rocky Mountain mule deer and elk) and traditional use of plants, wildlife, and recreation.

Given the site and soil conditions, the predicted post-reclamation ecosystems for the waste rock storage facility include approximately:

- 64% ICHmw5/104 (Douglas-fir western redcedar – falsebox – prince’s pine) and 7% ICHmw5/101 (western hemlock western redcedar - falsebox) forested land, and 3% ICHmw5/103 (Douglas-fir Douglas maple – falsebox)
- 18% grassland; and
- 8% rock.

Given the site and soil conditions, the predicted post-reclamation ecosystems for the soil stockpile include approximately 80% ICHmw5 grassland and 20% rock.

The revegetation prescription provided in Appendix 4-A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions.

Table 4.2-4: Record Ridge Baseline and Post-Reclamation Ecosystems within the Footprint

BEC Unit	Ecosystem Name	Site Map Code	Baseline Area (ha)	Post-Reclamation Area (ha)	Difference
Vegetated					
ESSFmh	Subalpine fir Engelman– spruce - rhododendron - foamflower	101	0.1	0.1	0.0
ESSFmh	Subalpine fir Douglas-fir huckleberry - falsebox	103	1.3	0.1	-1.2
ESSFmh	Douglas-fir western redcedar – falsebox – prince’s pine	104	0.2	0.1	-0.1
ESSFmh	Graminoid grassland	Gg	1.5	1.9	0.4
Vegetated ESSFmh Subtotal			3.1	2.2	-0.9
ICHmw5	Western hemlock western –redcedar - falsebox	101	6.5	6.5	0.0
ICHmw5	Douglas-fir Douglas maple – falsebox	103	2.5	2.4	-0.1
ICHmw5	Douglas-fir western redcedar – falsebox- prince's pine	104	8.4	8.4	0.0
ICHmw5	Western redcedar western–hemlock - oak fern	110	0.1	0.1	0.0
ICHmw5	Graminoid grassland	Gg	4.0	4.0	0.0
Vegetated ICHmw5 Subtotal			21.4	21.5	-0.1
Vegetated Total			24.6	23.6	-1.0
Unvegetated					
ESSFmh	Rock	Ro	0.1	1.1	1.0
ICHmw5	Rock	Ro	4.3	4.3	0.0
ICHmw5	Road	Rz	0.4	0.4	0.0
Unvegetated Subtotal			4.8	5.8	1.0
Total Area			**29.4**	**29.4**	**0.0**

Office and Equipment Maintenance Pad

The end land use capability objectives of the office and equipment maintenance pad is approximately 80% forested land, and 20% rock. The forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation. For the grassland and rock land use objectives, these areas will support wildlife habitat for reptiles.

Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately 80% ICHmw5/104 (Douglas-fir western redcedar – falsebox – prince's pine) 20% ICHmw5/RO (rock). The revegetation prescription provided in Appendix 4-A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions.

Explosives Magazine

The end land use objectives of the explosive magazine is 100% forested land. The forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation.

Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately 90% ESSFmh/104 (subalpine fir lodgelpole pine – falsebox - grouseberry) and 10% ESSFmh/101 (subalpine fir engelmann spruce - rhododendron - foamflower) forested land. The revegetation prescription provided in Appendix A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions.

Ore Stockpile

The end land use objectives of the ore stockpile (including the crusher pad footprint) is approximately 72% forested land, 22% grassland, and 6% rock. The forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation. For the grassland and rock land use objectives, these areas will support wildlife habitat for grassland birds, reptiles, ungulates (Rocky Mountain mule deer and elk) and traditional use of plants, wildlife, and recreation.

Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately 72% ICHmw5/103 (Douglas-fir Douglas maple – falsebox), 22% ICHmw5/Gg (graminoid grassland); and 6%

ICHmw5/RO (rock). The revegetation prescription provided in Appendix 4-A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions.

Water Management Infrastructure (Channels/Ditches)

The end land use capability objective of the water management infrastructure (channel/ditches) is approximately 79% forested land, 15% grassland, and 6% rock. The forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation. For the grassland and rock land use objectives, these areas will support wildlife habitat for grassland birds, reptiles, ungulates (Rocky Mountain mule deer and elk) and traditional use of plants, wildlife, and recreation.

Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately:

- 44% ICHmw5/104 (Douglas-fir western redcedar – falsebox – prince's pine), 32% ICHmw5/101 (western hemlock western redcedar - falsebox), and 2% ICHmw5/103 (Douglas-fir – Douglas maple – falsebox) forested land;
- 1% ESSFmh/101 (Subalpine fir Engelman– spruce - rhododendron - foamflower) forested land;
- 31% grassland; and
- 11% rock.

The revegetation prescription provided in Appendix 4-A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions.

Sedimentation Pond

The end land use capability objective of the sedimentation pond is approximately 100% forested land and the forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation.

Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately:

- 87% ICHmw5/101 (western hemlock western redcedar - falsebox), and
- 13% ICHmw5/104 (Douglas-fir western redcedar – falsebox – prince's pine) forested land;

The revegetation prescription provided in Appendix 4-A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions.

Haul Roads

The end land use objectives of the access haul road is approximately 68% forested land, 25% grassland, and 7% exposed bedrock. The forested land use objectives are to provide wildlife habitat for birds, Rocky Mountain mule deer, Rocky Mountain elk, and black bear, as well as support traditional use of plants, wildlife, and recreation. For the grassland and rock land use objectives, these areas will support wildlife habitat for grassland birds, reptiles, ungulates (Rocky Mountain mule deer and elk) and traditional use of plants, wildlife, and recreation.

Given the site and soil conditions, the predicted post-reclamation ecosystems include approximately:

- 57% ICHmw5/104 (Douglas-fir western redcedar – falsebox – prince's pine), 8% ICHmw5/101 (western hemlock western redcedar - falsebox), ICHmw5/103 (Douglas-fir – Douglas maple - falsebox) and 1% ESSFmh/101 (subalpine fir Engelmann spruce - rhododendron - foamflower) forested land.
- 25% ICHmw5/Gg (graminoid grassland).
- 7% ICHmw5/RO (rock).

The revegetation prescription provided in Appendix 4-A will provide native vegetation, including shrub-dominated wildlife habitat that will support ungulate browse, black bear, and birds during the first 20 to 40 years post revegetation. The anticipated early seral and mature forest habitat that will establish in the forested areas beyond 40 years will provide habitat for forest birds, thermal cover for ungulates, black bear, and traditional use practices (berry collection, hunting, and recreation). Forestry is not considered a viable land use once forests reach maturity because these forests are predicted to be low productivity (poor growth rates and height limitations) given the site conditions

4.2.4 Progressive Reclamation/Sequencing

Given the short duration of the mine life (2 years) there are limited opportunities for progressive reclamation. The only locations that are not continually disturbed by mining activity are the soil stockpile and the ditches along the access haul road. The soil stockpile will be used as the location for research trials (see section 4.2.5) and the ditches will be seeded to prevent erosion. These two actions will constitute the progressive reclamation at the site.

Research trials will be installed as soon as the soil stockpile is no longer receiving soil from construction activities. This is anticipated to be about two months following initiation of construction. Ditches will be seeded as soon as the road is finished construction which is anticipated to be one month following initiation of construction.

Used oils, greases and other lubricants generated through regular equipment maintenance will be removed from the project area concurrent with operations.

4.2.5 Reclamation Research

Due to the short operations period of the Project, sufficient time for design, installation, monitoring and interpretation of research trial results is limited. Reclamation research trial will be installed on the soil stockpile, however insufficient time exists to use this information to guide the detailed reclamation plan presented here. Thus, this reclamation plan is based on the results of natural successional trajectory research trials conducted at other disturbed locations such as those reported in Polster (2017).

The research trials on the soil stockpile will be based on the natural recruitment of tree species and success of seeding. The revegetation at closure will compare the results of the research trials to demonstrated success at other sites (Polster 2017) and be adjusted accordingly. For example, tree and shrub seedling planting may be removed, reduced, or increased, depending on whether the natural processes are successfully initiated.

The rough and loose surface preparation mimics disturbed sites at small (e.g., root turns) and large (e.g., landslide) scales, which is the intent of any natural successional approach to land reclamation. Polster (2017) recommends no planting of trees and shrubs and focussing on creating a mounded, rough and loose surface with Sitka alder seeding to allow natural ingress to occur. This concept is the intention of the reclamation plan with the exception that trees and shrubs will be planted.

The research trial on the soil stockpile will follow the detailed revegetation prescription in Appendix 4-A for the Waste Rock Storage Facility. In brief, the trial will involve creating a rough and loose surface, placement of coarse woody debris, direct seeding of Sitka alder, planting woody stakes, and tree and shrub seedlings. The trial will be established in an easily accessible location as soon as the soil stockpile is no longer receiving soil from construction activities. This is anticipated to be about two months following construction activities.

4.2.6 Reclamation Monitoring

Reclamation monitoring will include quantitative and qualitative assessments by a qualified professional of successful seed germination, a qualitative assessment of all planted stock, a photo-point monitoring program, and an evaluation of trace element content within restored vegetation. The program will be conducted annually for four years following reclamation to confirm establishment of natural succession and pioneering vegetation communities. Monitoring will include the following:

- Plant species composition, stem densities and percent cover for native species.
- Height of vegetation by life form (e.g., tree, shrub, herb).
- Plant health (e.g., presence/absence and type of disease, poor growth, or excessive browsing).
- Natural regeneration success (i.e., native species that establish and grow naturally).
- Forest site index measurements.

- Invasive species presence and abundance and any management strategies required to control or remove invasive species from site.
- Adaptive management strategies required, such as additional planting and/or seeding and application of fertilizer or mulch.
- Wildlife use of reclaimed area surveys.
- Plant tissue trace element concentrations.

If poor growth or stressed vegetation is observed during the vegetation surveys, soil sampling may be completed to assess whether typical soil and landscape issues are affecting productivity.

4.3 TRACE ELEMENT UPTAKE IN SOILS AND VEGETATION

Baseline characterization of this site determined that certain trace elements (e.g., primarily arsenic, chromium, cobalt, iron, magnesium, and nickel) are naturally elevated in soils near the deposit (Keefer 2017a; Yole 2018; Appendix 2-C). Soils more strongly influenced by serpentine geology showed clear elevations of these elements and distinctive plant communities (i.e., pockets of grassland habitat within a predominantly forested area), which has also been found elsewhere (Brady et al. 2005; Holt 2007). Brady et al. (2005) note that exposure to elevated metals, skewed Ca:Mg ratios and lower nutrients can lead to "serpentine syndrome", which is characterized by poor plant productivity, high rates of endemism and vegetation types that are distinct from those of neighbouring areas.

Baseline plant tissue chemistry results generally reflected the underlying soil conditions, with plants found in the serpentine-influenced grassland habitat (e.g., timber milk-vetch [*Astragalus miser*], yellow glacier lily [*Erythronium grandiflorum*], large fruited desert parsley [*Lomatium macrocarpum*], purple oniongrass [*Melica spectabilis*], containing higher concentrations of arsenic, chromium, cobalt, iron, magnesium, and nickel than plants found elsewhere on the site (Keefer 2017a). These results demonstrate that local plants are naturally bioaccumulating these elements from the serpentine-rich soils.

The proposed development is being planned to minimize discharges to the environment. Key potential sources of metals related to the development are dust and land application of mine contact water. Dust will be actively managed (Section 9.15). Under the scenario where explosives are required, mine contact water will primarily contain nitrogen-related blasting residues (Section 5.0); acid rock drainage and metal leaching is not expected to occur at this mine, so metals concentrations are predicted to be low.

Monitoring to verify the status of trace elements in soils and plants will be as follows:

- *Pre-construction* – baseline sampling will be extended to include areas planned to receive land application of mine contact water, under the scenario where blasting is required. Soils and vegetation will be sampled to characterize pre-discharge conditions. Methods will follow those used in the baseline studies targeting soils and plants (Keefer 2017a; Yole 2018; Appendix 2-C).
- *Operations* – annual sampling of soils and plants within the land application discharge zone under the scenario where blasting is required to track changes; and compare results to baseline conditions.
- *Post-Closure* – Results of baseline monitoring will be used to help inform reclamation design (e.g., optimize reclamation to minimize trace element uptake by plants). Verification monitoring of reclaimed

areas will be conducted after three years (i.e., after allowing sufficient time for plant communities to re-establish); results compared to baseline.

The monitoring described above will provide timely information to implement contingencies should significant changes in soil or plant tissue chemistry be identified. First of all, the significance of identified changes to ecological receptors or humans will be evaluated using risk assessment. Should unacceptable risks be identified, risk management measures will be implemented. For example, fencing and signage can be used to prevent access by humans. Another option would be the use of soil amendments to reduce metals uptake by plants should that prove to be an exposure pathway in need of active management. In summary, the combination of active monitoring and informed reclamation should result in the early identification or prevention of metals-uptake-related issues at this site.

4.4 CONTAMINATED SITE REQUIREMENTS

The project site currently has no known contaminated sites. Given the nature and short duration of this project the likelihood of creating contaminated sites as a result of this development is minimal. All reagents associated with the project will be limited to additives that may be needed to ensure acceptable discharge of contact water to the environment. All explosives and limited amounts of fuels and lubricants will be managed in accordance with existing regulations and best management practices. Accidental hydrocarbon spills will be cleaned up following the Fuel Management and Spill Control Plan (Section 9.5).

The water management strategy throughout operations of the mine will follow two scenarios. The use of mechanized equipment will be the primary means for ore extraction, under this scenario water from the sedimentation pond will be discharged via a diversion channel to Sophia Creek. If the Seven Summits Trail relocation is undertaken, the environmental considerations related to the original plan for blasting are satisfactory and W.H.Y. Resources encounters technical or economic reasons to make blasting during operations preferable, on a land application of mine effluent to the upper reaches of the Sophia Creek Catchment. A water quality model was developed to predict discharge quality (Appendix 5-A).

Results of the water quality model were compared to the Generic Numerical Water Standards (Schedule 3.2) of the BC Contaminates Sites Regulation (CSR WQS). The CSR WQS include standards for different water uses, including irrigation, livestock watering, aquatic life and drinking water. Protocol 21 for Contaminated Sites, by the BC Ministry of Environment provides guidance on water use determination. Potential uses of water flowing in Sophia Creek, which is the ultimate receiving water body include aquatic life, irrigation, and livestock watering, but not drinking water use.

The groundwater investigations to date indicate an upward groundwater gradient as one moves down slope from the proposed project, which indicates the groundwater passing through the site will discharge to the creek systems prior to reaching the valley. The closest groundwater well is located approximately 5 km downstream of the area in a location that is upgradient from Sophia Creek. Protocol 21 defines current drinking water use as groundwater or surface water used for drinking water that are located within 500 m of the site property boundary. The closest water license points of diversion that are registered as domestic licenses are located on Little Sheep Creek downstream of the confluence with Sophia Creek. Other licenses are registered as irrigation licenses. Future water use was deemed not to include drinking water because the land ownership within a 500 m radius of the Project area is privately held forestry land and installation of drinking water wells within that area were not considered a reasonable possibility.

Should higher than acceptable concentrations of contaminants be identified in the effluent, mitigation measures proposed in Chapter 5 and 6 will be implemented to ensure that the discharge is within acceptable limits. The operational monitoring program for both surface and ground water will ensure that no contaminated sites are created.

4.5 DISPOSAL OF CHEMICALS, REAGENTS, HAZARDOUS MATERIALS, CONTAMINATED MATERIALS

All chemicals, reagents, hazardous materials, and contaminated materials associated with the project will be returned to the supplier and/or removed from site and properly recycled and/or disposed of at a licensed off-site facility. This will include unused ammonium nitrate and fuel oil (ANFO) (under a scenario where explosives are used), used batteries, used fuels, used lubricants and water treatment reagents. The water treatment reagents will be limited to flocculant and the coagulant Ferric Chloride.

4.6 GROUNDWATER WELL DECOMMISSIONING

Groundwater monitoring wells established as part of the operations phase of the monitoring program will remain in place to allow for groundwater monitoring to continue and confirm that groundwater quality has been protected. Once monitoring is no longer required, wells will be decommissioned by grouting to surface. Surface completions (steel pipe “stickups”) would be removed, and a cement plug and cap emplaced, then buried at least 0.5 m below surface to remove potential hazard to people travelling through the area.

4.7 RECLAMATION AND CLOSURE PRESCRIPTIONS

4.7.1 STRUCTURES AND EQUIPMENT

Once mining is complete, all equipment and buildings (trailers) will be removed from the mine site. Materials that cannot be re-used (i.e., sedimentation pond liner), and garbage, will be hauled to an approved landfill. If concrete foundations remain, they will be broken up and covered with waste rock to allow drainage, followed by replacement of soil and revegetation (section 4.2.3).

4.7.2 WASTE ROCK STORAGE FACILITY RECLAMATION

As discussed in Chapter 2 and Appendix 9-D acid rock drainage and metal leaching is not a concern with this project. Waste rock excavated from the open pit will be back hauled from the temporary stockpile to the open pit once mining ends. The volume of waste rock is insufficient to fill the open pit, but it will raise the bottom of the open pit to minimize the collection of water in the bottom. Soil salvaged during construction will be placed on top of the waste rock in the open pit and on the floor of the open pit. The footprint of the waste rock stockpile will be the same contour as existed pre-mining and surface drainage will return to pre-mining condition (Figure 4.2-2). The soil that was salvaged from the footprint of the waste rock stockpile will be replaced and revegetated to meet end land use objectives and to prevent erosion (see section 4.2.3).

Given the nature of this project, the site will be returned to pre-mining land use as well as pre-mining topography therefore the expected configuration at closure is essentially that of pre-mining conditions. There will be no remnant stockpiles following closure.

The operational life of the project consists of two summer seasons over the course of two calendar years, therefore the waste and soil stockpiles will be exposed to winter conditions for one winter prior to initiating closure activities, therefore there is limited concern with snow retention throughout operations and during implementation of the closure plan.

In addition, there will be no long-term water management features needed to support operations and therefore none will exist following closure activities.

4.7.3 Tailings Storage Facility Reclamation

No tailings will be produced.

4.7.4 Open Pit Reclamation Prescriptions

The open pit will be mined so that it drains naturally and does not hold water and the water quality of this drainage will meet BC water quality guidelines. As described in section 4.7.2, waste rock will be backhauled to the open pit. Soil will be placed on the waste rock and floor of the open pit. The open pit will be revegetated to create habitat for birds, bats, and reptiles as detailed in section 4.2.3. Trace elements in vegetation will be monitored as described in section 4.3.

4.7.5 Watercourse Reclamation Prescriptions

Surface water diversion ditches will be backfilled with sidecast overburden and soil during reclamation. The diversion ditches will be revegetated to create the same habitat that is in the adjacent undisturbed land.

4.7.6 Road Reclamation

Roads constructed to access the open pit, waste rock and growth medium stockpiles, and buildings will be decommissioned once no longer needed for reclamation activities. It is anticipated that post closure monitoring will be completed by accessing the site via all-terrain vehicles from the cascade highway following implementation of the closure activities. Side-cast material will be pulled back to fill the cut bank and recontoured to blend into the surrounding landscape with soil placed on the surface. Any culverts installed during construction of the road will be removed and natural drainage patterns returned. Former roads will be revegetated as described in section 4.2.3.

4.7.7 Schedule

Full reclamation of the project as described herein will be initiated immediately following the completion of the two year project during the snow-free period. A schedule of reclamation activities in presented in Table 4.7-1.

Table 4.7-1: Schedule of Major Reclamation Activities

		Year 1 Snow-free Months					
Post Closure Year 1	**Activity**	**1**	**2**	**3**	**4**	**5**	**6**
Land Application Area	Dismantle pipes and application system						
Waste Rock Facility	Backhaul into open pit						
	Cover with soil						
	Revegetate						
Explosive Storage	Removal of explosives						
	Remove building						
	Recontour sidecast overburden						
	Cover with soil						
	Revegetate						
Crusher and Stockpile Area	Dismantle equipment and remove						
	Deep rip surface						
	Cover with soil						
	Revegetate						
Office and Dry	Dismantle support infrastructure and remove building						
	Deep rip surface						
	Recontour sidecast overburden						
	Cover with soil						
	Revegetate						
Sediment Pond	Remove liner						
	Recontour sidecast overburden						
	Cover with soil						
	Revegetate						
Roads and Runaway Lane	Deep rip surface						
	Recontour sidecast overburden						
	Cover with soil						
	Revegetate						
Gatehouse	Remove building						
	Deep rip surface						
	Cover with soil						
	Revegetate						

4.8 DETAILED FIVE-YEAR MINE RECLAMATION PLAN

The Project entails a two year construction and operation period, followed by closure and reclamation. All closure activities will be completed within the snow-free season of the first year following completion of the project, followed by four years of monitoring. Due to the simple nature of the operation and short two year mine life, the five year mine reclamation plan and the life of mine plan are the same and thus not repeated here. Sections 4.2 and 4.7 provide the reclamation plan for the next five years, along with detailed schedule of closure and reclamation activities (Table 4.7-1), timing of progressive reclamation (Section 4.2.4), and the reclamation research program (Section 4.2.5). Liability cost estimate is provided under separate cover to the Chief Inspector, in a confidential report in accordance with Part 10.1.4(8) of the Code.

4.9 RECLAMATION COST ESTIMATE

The expected cost estimate to implement the five-year mine closure and reclamation plan is provided under separate cover to the Chief Inspector, in a confidential report in accordance with Part 10.1.4(8) of the Code.

4.9.1 Post-Closure Monitoring

Post-closure monitoring will occur twice annually, once during the spring and once prior to the onset of winter beginning one year following completion of revegetation activities for a duration of four years. Each mine area that was previously disturbed will be monitored for soil erosion and revegetation success. In addition, soil and vegetation samples will be collected post-closure to monitor for trace elements as per Section 4.3. Soil samples will be collected a year following reclamation. Vegetation samples will be collected three years following planting/seeding to allow time for plants to grow and not be detrimentally affected by the tissue sampling.

Water quality monitoring will continue quarterly post-closure in the same locations as baseline data collection for a duration of four years.

Records will be kept of all post-closure monitoring activities and results, all of which will be reported as part of Annual Reclamation Reporting requirements as stipulated by *Mines Act* permit.

4.9.2 Post-Closure Maintenance (excluding water treatment)

Since the mine site roads, diversion ditches will be fully reclaimed as part of reclamation prescriptions and the waste rock will be backhauled to the open pit, there are no anticipated post-closure maintenance requirements for mine components. Post-closure maintenance activities may include supplemental planting and fertilizing applications if the results of the monitoring conducted in section 4.9.1 indicate unsuccessful or inadequate revegetation. Depending on the reasons for lack of revegetation (e.g., drought, poor plant stock, browsing by wildlife, insufficient nutrients, etc.), an appropriate response will be undertaken to improve success, such as replanting/reseeding or addition of nutrients.

4.9.3 Post-Closure Maintenance (water treatment)

Water treatment will not be required for this mine post-closure and water quality is expected to meet BC water quality guidelines (Chapter 6.0).

5.0 MODELLING, MITIGATION, AND DISCHARGES

5.1 SUMMARY

Water within the RRIMM Project area will be managed according to established best management practices, including provisions for diverting clean water around the Project area and to capture and manage contact water in appropriately designed channels, sumps, and sedimentation pond. This section describes most aspects of water management for the Project, including storm water management, assessment of water quality and potential implications for the downstream aquatic environment, as well as proposed water quality mitigation methods, safe discharge practices, and proposed discharge quality limits.

5.1.1 MINE PLAN OVERVIEW

The proposed RRIMM Project mine plan will be a conventional truck and shovel open pit operation which will include drilling, blasting, loading, and hauling of magnesium-bearing serpentinite. The mine is designed to supply two years of plant feed material at a rate no greater than 200,000 tonnes per year. Mine product material will have primary and secondary crushing on-site before being loaded on to highway dump trucks for transport to the processing facility located in the United States.

Mine components that will be constructed include the open pit and adjacent waste rock storage facility, an access road from the Old Rossland Cascade Highway to the open pit and waste rock storage facility, a soil stockpile, a level pad for primary and secondary crushing, as well as a maintenance pad, dry, and an office building.

The quarry excavation has a maximum height of 30 m and is designed to be mined in 6 m benches. Bench face angles will vary between 60° to 70°, while 8.0 m wide catch berms are left every 12 m to achieve an inter-ramp wall angle of 35° to 44°. The excavation is designed to be free draining to the southwest.

The proposed RRIMM Project does not entail underground workings, on-site processing plant (mill) and associated facilities, or a low-grade ore stockpile.

5.1.2 WATER MANAGEMENT OVERVIEW

The main water management infrastructure for the RRIMM Project consists of channels for collecting contact water and for diverting clean runoff around the Project site, a sedimentation pond, and a discharge system via land application (where blasting is required for ore extraction). Mine contact water is runoff and seepage flowing from:

- Waste rock and soil stockpile area
- Crusher and ore stockpile area
- Open pit
- Access roads and office area.

Seepage and runoff from the waste rock area, crusher/ore stockpile pad and runoff from the open pit are expected to be the primary sources of water quality parameter loadings to the mine contact water.

Management of water from each of the mine components is discussed in the Sediment Pond Design Report (SRK 2023a; Appendix 3-A) and Safe Discharge Plan (SRK 2023g; Appendix 9-C).

The water quality model developed for the RRIMM Project was used to estimate loading sources, evaluate the quality of contact water on the Project site and assess potential effects on the downstream receiving environment (SRK 2023e; Appendix 5-A).

5.1.3 Development Sequence and Schedule

Mine development sequence includes a three-month construction period, which includes construction of site access haul roads and pads, as well as scavenging and stockpiling topsoil from the project disturbed areas and mobilization of required project equipment. Site facilities constructed during the pre-construction period include: a site security gate, parking area, maintenance pad, site offices, dry buildings, mobile crusher pad and explosives magazine. Site haul roads and pads constructed for offices, maintenance areas, and mobile crusher will be constructed as cut and fills, supplementing with crushed clean run of mine rock, if required, with no planned externally quarried construction materials.

Production phase of the project includes two years of mining at a rate no greater than 200,000 tonnes per year of mineralized material which will be delivered to the crusher pad before being hauled off-site. A maximum total of approximately 400,000 tonnes of waste stripping (waste rock and topsoil) will be mined over the two-year mine life and stockpiled in the waste storage facility until mine reclamation. Additional information regarding development sequencing of the RRIMM Project is included in Chapter 3.0: Mine Plan (Appendix 3-B).

5.2 EFFLUENT STORAGE AND DISCHARGE

5.2.1 Construction Water Management

A six-month construction period is required to mobilize equipment, establish site access, clear and prepare the crusher pad, stockpile area, topsoil and waste rock storage areas, the office area and parking lot. Topsoil excavated as part of the site preparation will be salvaged and placed in the topsoil stockpile.

During construction, surface erosion prevention and sediment control measures will include the following:

- Mine access and haulage roads: During road construction, erosion will be controlled using standard construction methods, including silt fences, mulch, mats, geotextiles, etc. on an as-needed basis as determined by the RRIMM Project team. Dust suppression measures (i.e., road watering) will control dust from constructed roads.
- Pads: During pad construction, erosion will be controlled using standard construction methods (e.g., silt fences, mulch, mats, geotextiles, etc.) on an as-needed basis.
- Soil stockpile: Prior to construction, soil will be salvaged from footprint areas and will be placed in a stockpile. The soil stockpile will be seeded with a weed-free erosion control seed mix.

During construction, the environmental monitoring personnel will inspect all erosion control measures daily or several times daily after significant runoff-producing rainfall event. Silt fences, sediment basins, ditches, culverts, and the sediment control ponds will be visually inspected for the following:

- Performance in accordance with design intent
- Sediment build-up or blockages
- Structural/physical integrity
- Anticipated wear and tear.

Sediment removal and proper disposal will be performed as required. Additional information about sediment and erosion management is provided in the Surface Erosion Prevention and Sediment Control Plan (Section 9.4; Appendix 9-B; SRK 2018c).

5.2.2 Water Control Infrastructure

As discussed in Section 5.1.2 the main water management features for the RRIMM Project include:

- Clean water diversions that collect and route runoff from undeveloped catchments around the Project area.
- Contact water collection channels and culverts that convey water from the open pit, soil stockpile and waste rock area, ore stockpile and crusher pad to the sedimentation pond.
- Sedimentation pond and Sophia Creek diversion channel.
- Discharge system, which pumps water from the sedimentation pond to the upper sections of the Project area catchments for land application.

The design of clean water diversion channels, contact water collection channels and the sedimentation pond are described in the Sediment Pond Design document, which is included in Appendix 3-A (SRK 2023a).

5.2.2.1 Diversion Channel Design

Diversion and collection channels are designed to accommodate a 1 in 200-year 24-hour storm event. Details concerning channel design are provided in the Sediment Pond Design Memo (SRK 2023a; Appendix 3-A).

5.2.2.2 Sedimentation Pond Design

Design criteria for the sedimentation pond is detailed in the Sediment Pond Design Memo (SRK 2023a; Appendix 3-A).

5.2.2.3 Sedimentation Pond Operation

Procedures for the safe operation of the Sedimentation Pond are detailed in the Operations, Maintenance, and Surveillance Manual for Sedimentation Pond Report (SRK 2023d; Appendix 3-E).

5.2.3 Water Balance and Water Quality Predictions

The water balance and water quality model developed for the RRIMM Project was used to estimate loading sources, evaluate the quality of contact water on the Project site and assess potential effects on the downstream receiving environment, the complete Water Quality Modelling Report is located in Appendix 5-A (SRK 2023e).

5.3 MITIGATION METHODS

5.3.1 MITIGATION MEASURES AND WATER TREATMENT

5.3.1.1 Source Control

Implementation of source control is considered to be best practice for water quality management for mining operations and is preferred over implementation of mitigation measures, when possible. Most of the water quality parameter loadings reporting to contact water at the RRIMM site are leached from waste rock and ore after it is broken up and mined from the open pit. Leaching can be minimized by reducing percolation of water though the mined material. This can be done by minimizing the footprint of waste rock dumps or by construction of covers.

During active construction of the waste rock area, crusher pad/ore stockpile area and the office area, it is not workable to cover the material. However, since the RRIMM Project only operates in the open water season from May to October, the waste rock can be covered by a synthetic (plastic) liner in the fall and remain covered over the winter period. Covering the waste rock in the fall prevents late season rains and melting snow in the spring from infiltrating through the dump. This will also ensure that the freshet flows be unaffected by loadings from the waste rock.

Under a scenario where blasting is required, ANFO explosives used for development of the open pit and mine infrastructure is the source of ammonia, nitrate, and nitrite in the contact water. If properly detonated, all ammonium and nitrate is converted to nitrogen gas and oxygen. However, misfired blast holes, ANFO spills or improper use of the explosives can significantly increase loadings of residual nitrogen nutrients in the contact water. Therefore, proper housekeeping and well-trained blast crews that diligently follow proper handling, loading, and blasting practises are important source control measures. Examples of proper blasting practices include:

- Use of emulsion or packaged explosive in wet holes
- Diligent procedures for clean-up of spills
- Minimizing ANFO residence time in blast holes
- Diligent loading, stemming and priming.

Proper blasting practises for the RRIMM Project will be spelled out in the Ammonium Nitrate and Explosives Management Plan, which will be developed in collaboration with the blasting contractor. In W.H.Y.'s opinion, this Plan needs to be tailored to the work flow and specific practises of the blasting crew and should therefore not be developed without the explicit guidance and input of the blasting contractor. Therefore, the Plan will be developed after a blasting contractor has been retained, prior to construction, and is therefore not provided with this Application.

5.3.1.2 Mitigation Methods and Application of Best Achievable Technologies

Water quality predictions for the Project indicate:

- Total aluminum and total beryllium associated with TSS in contact water has the potential to cause exceedances of applicable guidelines of standards for effluent and for receiving waters.
- Under the scenario where explosives are used, ammonia, nitrite and to a lesser extent nitrate concentrations in the receiving environment could exceed the BC WQG FAL.

Mitigation measures developed for the Project are discussed in the Safe Discharge Plan, which is included in Appendix 9-C (SRK 2023g).

5.3.2 Sedimentation Pond Discharge

Proposed discharge limits, including monthly discharge volumes, discharge volume during storm events, discharge concentrations, and monitoring methods are described in Section 3.0 of the Safe Discharge Plan located in Appendix 9-C (SRK 2023g).

5.3.3 Discharge System Design

The discharge system for the RRIMM Project is an irrigation system that pumps water collected in the sedimentation pond to a series of sprinklers that will irrigate the uppermost vegetated catchments of the Project area. The land application requires the following equipment:

- Two discharge pumps + one standby discharge pump
- One 8” pipeline: bottom section schedule 40 steel pipe, top section DR11 High-density polyethylene (HDPE) pipe
- Six irrigation sprinklers
- Valves for isolating pumps and sprinklers.

The two installed discharge pumps will connect to a single 8” schedule 40 steel pipe. During normal operating conditions, only one pump will operate. Both pumps will be required during storm events. The steel pipe will convey the discharge to an elevation of approximately 150 m above the pump elevation. At this point, the pipe transitions to a DR11 HDPE pipe. The HDPE pipeline will deliver water to all six sprinklers, each of which will be operated by manual shut-off valves. A standby pump will be stored on site and installed in short order in the event of a pump failure.

The 8” pipeline will require air and vacuum release valves at the highest point in the pipeline, to purge air at start-up and to prevent collapse of the pipe due to vacuum when the line is drained. The complete irrigation design is located in Chapter 2 of the Safe Discharge Plan, Appendix 9-C (SRK 2023g).

5.3.4 Discharge Monitoring

5.3.4.1 Surface and Groundwater Monitoring

Flow of effluent will be monitored on an ongoing basis by a mechanical flow meter installed on the discharge pipe in proximity to the discharge pump. Totalizer values will be recorded daily.

Effluent water quality samples for on-site analysis will be collected daily from the settling pond and analyzed for ammonia, nitrite and TSS/turbidity using a Hach DR 900 multiparameter handheld colorimeter, since these parameters are most likely to approach the proposed discharge standards. Water quality samples for off-site laboratory analysis will be collected weekly.

In addition to effluent sampling and monitoring, groundwater and surface water samples will be collected for off-site laboratory analysis as part of the discharge monitoring program. Proposed monitoring locations downstream of the land application catchment (groundwater and surface water monitoring) and downstream of the catchment west of the RRIMM area are depicted in the Safe Discharge Plan (SRK 2023g; Appendix 9-C). The monitoring locations were selected to allow for detection of any Project-related discharges in the receiving environment immediately downstream of the mine.

5.4 SITE CONTAMINATION

5.4.1 Current Soil and Groundwater Contamination

There is no known current soil and/or groundwater contamination in the RRIMM Project Area.

5.4.2 Potential for Soil and Groundwater Contamination

The sedimentation pond at the RRIMM site intended to collect all contact water from the open pit, waste rock and soil storage area, as well as the crusher pad/ore stockpile area. Model predictions of the contact water quality was compared to the general CSR WQS. Except for total aluminum concentrations, which will be removed with TSS in the sedimentation pond, the predicted water quality parameter concentrations are expected to remain below the relevant water quality standards. Because the contact water concentrations are below the standards, there is no potential to contaminate soil or groundwater within or outside of the Project area.

Limited soil contamination could occur because of accidents or malfunctions. For example, minor oil or diesel spills could occur due to unexpected equipment malfunctions such as a broken fuel line or hydraulic oil line. Proper equipment maintenance and establishment of safe equipment operating procedures is the main safeguard against such accidents or malfunctions as described in the spill contingency management plan.

5.4.3 Remedial Strategies

Prevention of contamination is the main remedial strategy for the RRIMM Project. Any soil or water contamination caused by accidents and malfunctions will be dealt with immediately and will completely and verifiably be remediated in accordance with the spill contingency management plan.

5.5 DOMESTIC WATER/SEWAGE TREATMENT

The office and dry trailers at the Project site will have self-contained septic tanks that will be serviced by local contractors. Therefore, on-site sewage treatment or disposal will not be required.

6.0 ENVIRONMENTAL ASSESSMENT PREDICTIONS

Section 6.1 through 6.5 present an assessment of potential effects on aquatic resources. Section 6.6 presents an assessment of potential effects on terrestrial resources.

6.1 SUMMARY OF GROUNDWATER, SURFACE WATER, AND AQUATIC RECEPTORS

This section predicts effects of the project on groundwater quantity and quality, surface water quantity and quality, and on aquatic receptors. Key conclusions are as follows:

- Effects of the project on local and regional groundwater flows are expected to be minimal, and effects on groundwater quality are expected to be insignificant as discharge water from the sedimentation pond is predicted to meet relevant Contaminated Site Regulation (CSR) standards.
- Effects on surface water flows are expected to be minimal or negligible.

The potential for chronic effects of nitrite, nitrate and dissolved copper are expected to be negligible for all receptor groups, as follows:

- Fish populations – Effects on fish populations are expected to be negligible. Nitrite is expected to marginally exceed water quality guidelines in fish-bearing waters in limited months, and the maximum predicted concentrations are below those associated with chronic effects to individual fish. Effects to individual fish are therefore unlikely, and effects on fish populations are very unlikely. Predicted concentrations of nitrate exceed water quality guidelines in fish-bearing waters in only one case (one location in one month, under dry conditions), and the concentrations are below levels where effects to rainbow trout would be expected. Predicted concentrations of dissolved copper exceed guidelines in fish-bearing waters but are far below the toxicity data for trout, and therefore effects of copper on fish are not expected.
- Benthic invertebrate community – Effects on the benthic invertebrate community are expected to negligible. None of the three COPCs would be expected to affect individual invertebrates at the maximum predicted concentrations, although data are more limited for nitrite and nitrate than for copper, so there is more uncertainty for those cases.
- Periphyton – Effects on the periphyton community are expected to be negligible. Evidence suggests that periphyton are less sensitive than other taxonomic groups to nitrite. For nitrate, no toxicity information is reported by BC or CCME (2012) for plants or algae – according to the CEQG (CCME 2012), nitrate is the primary source of nitrogen for aquatic plants in oxygenated systems such as creeks. Predicted concentrations of dissolved copper exceed are far below the toxicity data for algae and macrophytes, and therefore effects of copper on periphyton are not expected.
- Amphibians – Effects on individual amphibians are expected to be negligible. Nitrate and copper would not be expected to affect amphibians at the maximum predicted concentrations. There is uncertainty about nitrite, as no toxicity data were found in the guideline documents or other literature reviewed.

6.2 GROUNDWATER QUANTITY AND QUALITY

6.2.1 STUDY BOUNDARIES AND ASSESSMENT ENDPOINTS

Groundwater in the Project area will be monitored in the upgradient catch basin to establish non-contact water quality, and any seasonal changes that may occur as seasonal infiltration changes during the year. Down gradient water quality and discharge locations will be monitored with the current and proposed groundwater wells and in relation to surface water sampling. Seasonal creek sampling will be assessed to determine proportion of flow that is from groundwater discharge (baseflow).

Impacted groundwater is expected to discharge to surface down slope of the open pit. The upwards gradient measured in the recently installed monitoring well (DDH-01A-2018) supports this conceptualisation of the flow field on the slope. Groundwater is not expected to reach the slope toe and will have discharge up slope from that area.

6.2.2 PREDICTED IMPACTS ON GROUNDWATER

Groundwater in the Project area is not expected to be negatively affected by the development of the open pit mine. The mine is designed to be free draining at closure and will not act as a groundwater infiltration point. During operation, water will discharge into the open pit but groundwater inflow to the pit will be limited due to the small size of the up-gradient catchment and due to the position of the mine near the top of the ridge. Groundwater discharging to the open pit will be collected in a sump along with any surface runoff within the pit area. The sump will overflow into the contact water collection channels, which will convey it to the lined sedimentation pond. The sedimentation pond liner will prevent infiltration of the contact water into the groundwater system. Some infiltration may occur along the contact water channel alignments. However, flows are expected to be minimal and inconsequential for the local and regional groundwater quality.

Discharge from the sedimentation pond will be land applied in the upper catchments of Sofia Creek by big gun irrigation sprayers. Application of contact water will likely result in infiltration and some local groundwater recharge, which may result in a local change in groundwater quality. However, a comparison of predicted water quality to the British Columbia CSR groundwater quality standards indicated that all dissolved constituent concentrations in the land-applied discharge will be lower than applicable standards (see Safe Discharge Plan, Appendix 9-C). Also, because the Project is intended to operate for 2 years, any change to water quality within the local groundwater aquifer will be temporary. Therefore, any effects on local groundwater are expected to be insignificant.

6.2.3 DATA GAPS

Surficial and bedrock conditions at site are discussed in detail in Section 2.3 (Geology). The mine area and recharge catchment have a thin veneer of colluvium and glacial till, overlying metamorphosed volcanic and sedimentary lithology, dominated by intrusive bodies (ore zone). These rock types will have low primary hydraulic conductivity and storage ranges, with flow systems controlled by secondary features related to structural deformation. Although site characterisation data are limited, this allows for conceptualisation of the probable flow paths based on understanding of the structural controls, which are well mapped in the Rossland mining district.

Current data gaps in the hydrogeological understanding of the site are the lack of monitoring points down gradient of the mine location, in particular along probable structural elements. To rectify this, a drill program was completed in October 2018. The program was focused on obtaining additional Hydrogeological data and allow for an expansion of the ongoing groundwater monitoring program. The drilling and installation program consisted of testing hydraulic conductivity and the installation of permanent monitoring wells which would be sampled on a quarterly basis to provide baseline and operational data along the assumed primary groundwater pathway down gradient of the mine. As the geological understanding of the Project area increases additional monitoring points can be added to provide more comprehensive monitoring.

6.3 SURFACE WATER QUANTITY AND QUALITY

6.3.1 WATER QUANTITY

6.3.1.1 Potential Effect on Stream Flow due to Project Development

As described in Section 6.3.1.2, the development of the RRIMM Project is expected to have marginal or negligible effects on the local water balance. The development of the open pit is expected to increase the rate of groundwater discharge

Effects on the local water balance are expected to be minimal or negligible. The developed mine areas that report to the sedimentation pond is approximately 18 ha. This area corresponds to about 8% of the total catchment area for station SOP3 (226 ha), and about 2.5% of the total catchment area for station SOP-2 (738 ha), which are the nearest receiving water monitoring stations (Figure 6.3-1). Most of the contact water collected will be returned to the upper catchment of Sofia Creek via the land application discharge system and is therefore not lost from the local catchment. However, during dry conditions it is possible that most of the contact water collected will be used for dust suppression on site or along the Cascade Highway. Groundwater discharge to the open pit is expected to be the greatest source of contact water during dry conditions. Although some of that groundwater would eventually have reported to Sofia Creek, the overall reduction in streamflow at stations SOP-3 and SOP-2 is expected to be less than the proportion of catchment area affected (i.e., less than 8% and 2.5% change, respectively). It is not possible to reliably estimate the magnitude of streamflow changes due to groundwater extraction from the open pit area.

6.3.1.2 Site Water Balance

Currently, the RRIMM site in undeveloped except for a few dirt roads used to access the site. The water balance for the area can therefore be characterized by the baseline hydrological conditions. The cool temperate climate in the region drives the hydrological cycle, which is characterized by high freshet flows followed by low flow over the warm and drier summer months and early fall. September is typically the driest month of the year and November the wettest. Snow begins to accumulate in late October and the last snowfall is typically recorded in April. Flow from the site catchment follows the hydrological cycle.

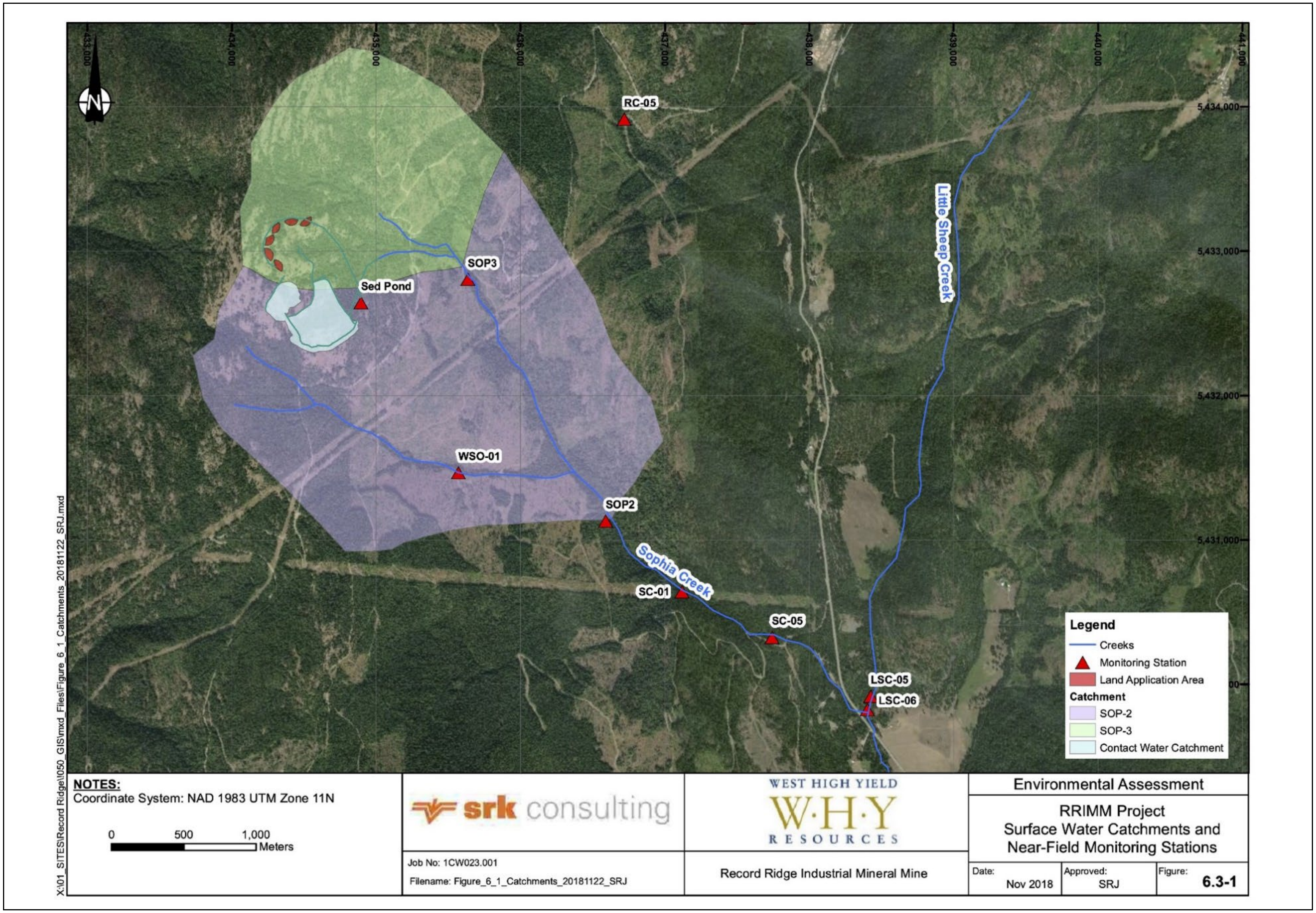
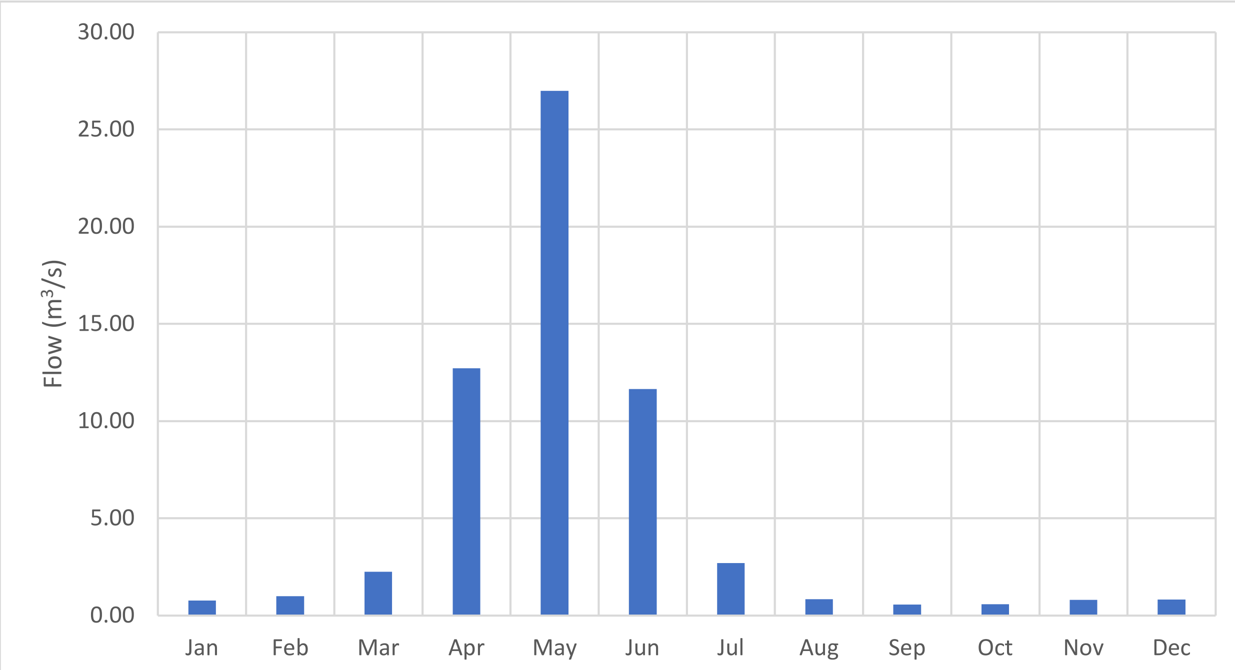


Figure 6.3-1: RRIMM Project Surface Water Catchments and Near-Field Monitoring Stations

Figure 6.3-2 shows average monthly flows recorded at Environment Canada's hydrometric monitoring stations on Big Sheep Creek (Water Survey of Canada Station 08NE039). Flows tend to peak in May while summer and winter low flow occur in September and January, respectively. The average catchment runoff recorded at Big Sheep Creek is 454 mm/year, which corresponds to about 65% of the annual average total precipitation of 775 mm/year.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Monthly Flow (m^3/s)	0.77	0.99	2.3	12.7	27.0	11.6	2.7	0.84	0.57	0.58	0.80	0.82

Figure 6.3-2: Daily Maximum Flow for Big Sheep Creek Hydrometric Station

6.3.1.3 Potential Effects of Mine Development and Discharge on Water Balance

The site water balance for the RRIMM Project was evaluated as part of the water quality model assessment, which is described in the water quality model report (Appendix 5-A). Water use and discharge is discussed in the Safe Discharge Plan (Appendix 9-C).

The site water balance for the RRIMM Project area is expected to be net positive, meaning that water is likely to be discharged from the site throughout the operational phase and post-closure. Operational use of water is limited to dust suppression. Most inflows to site (precipitation, surface run-on or groundwater discharge) will be discharged locally via the land application discharge system.

Operational use of water is limited to any water required for dust suppression around the active project area and along the cascade highway. The estimated daily water use for dust suppression along the road is approximately 250 m^3/day. Other dust suppression measures are expected to consume less than 50 m^3/day. Water supply for the dust suppression will be sourced from contact water collected in the sedimentation pond. Groundwater discharge to the open pit is expected to range between 0.3 L/s and 4.5

L/s. A flow of 3.5 L/s (or 300 m^3/day) would be sufficient to supply water for all dust suppression requirements.

6.3.1.4 Predicted Effects on In-Stream Flow

Effects on stream flow are expected to be very minimal – less than 8% decrease at SOP3 and less than 2.5% decrease at SOP2 (see Section 6.3.1.1). The decrease would be even lower in the downstream fish-bearing reaches. Consequently, changes to stream flows are not considered a stressor (see Section 6.4.2).

6.3.1.5 Effect of Regional Trends on Permit Conditions

The proposed duration of the operational phase of the RRIMM project is 2 years. Regional streamflow trends tend to occur over a time-scale of decades. Therefore, any emerging regional trends to streamflow are not expected to affect permit conditions.

6.3.1.6 Potential Effects of Climate, Land Use, Water Allocation and Withdrawal

Potential effects of climate, land use and water use on the development of the project and on water management in particular was considered in the development of the Safe Discharge Plan (Appendix 9-C) and Water Quality Model assessment for the Project (Appendix 5-A).

A range of precipitation and evaporation estimates were used along with the land cover characteristics to estimate runoff and the site water balance. The water balance was in turn used to assess rates of discharge from site and were used to derive water quality estimates both within and downstream of the project area. Downstream water use, current and potential future water use, was a key consideration in the selection of the water quality guidelines that were used for evaluation of potential water quality risks in the receiving environment.

6.3.2 WATER AND SEDIMENT QUALITY

6.3.2.1 Study Area Boundaries and Measurement Endpoints

Water quality is a measurement endpoint for the risk-based evaluation of predicted effects in Section 6.4 below. Sediment quality is excluded as a measurement endpoint, although baseline data have been collected and sediment quality is an optional component of the Aquatic Effects Monitoring Program (AEMP) described in Section 7. Water quality, and other elements of the AEMP, are evaluated throughout the Sophia Creek drainage, as well as in Little Sheep Creek above and below the confluence with Sophia Creek. Reference areas are located within Sophia Creek drainage as well as in other drainages (Record Creek and Corral Creek), as described in the AEMP in Section 7.

6.3.2.2 Key Discharges and Seepages

Key discharges and seepages from the RRIMM Project area are discussed in the Water Quality Model report (Appendix 5-A) and in the Safe Discharge Plan (Appendix 9-C). These include:

- Discharge from the sedimentation pond to upper catchments of Sofia Creek via a diversion channel under a scenario where mechanized equipment is used for ore extraction.

- Discharge from the sedimentation pond to upper catchments of Sofia Creek via land application under a scenario where blasting is required for ore extraction.
- Water applied to the land-application area will infiltrate or seep through the vegetated land area and ultimately report to Sofia Creek. The majority of nutrients (ammonia, nitrate, and nitrite) in the water discharged from site are expected to be assimilated as it comes into contact with vegetation and soil.
- Runoff and seepage from the office area and lower access roads, which report to the collection channels along the Cascade highway and eventually to Sofia Creek.

The sedimentation pond will be lined with a synthetic liner so seepage from the pond is expected to be negligible.

6.3.2.3 Conceptual Model for Contaminant Transport

Figure 6.3-3 shows a schematic of the conceptual contaminant transport model used for the water quality model where blasting is required for ore extraction. Precipitation falling on waste rock, the soil stockpile, crusher pad (including the ore stockpile) and office pad area picks up water quality constituent loadings and flow as seepage or surface runoff to the sedimentation pond. The sedimentation pond will be lined with a synthetic liner material so seepage from the pond to the downstream environment is expected to be negligible. Some contact water may infiltrate along the collection channels but seepage bypassing the sedimentation pond is expected to be minor.

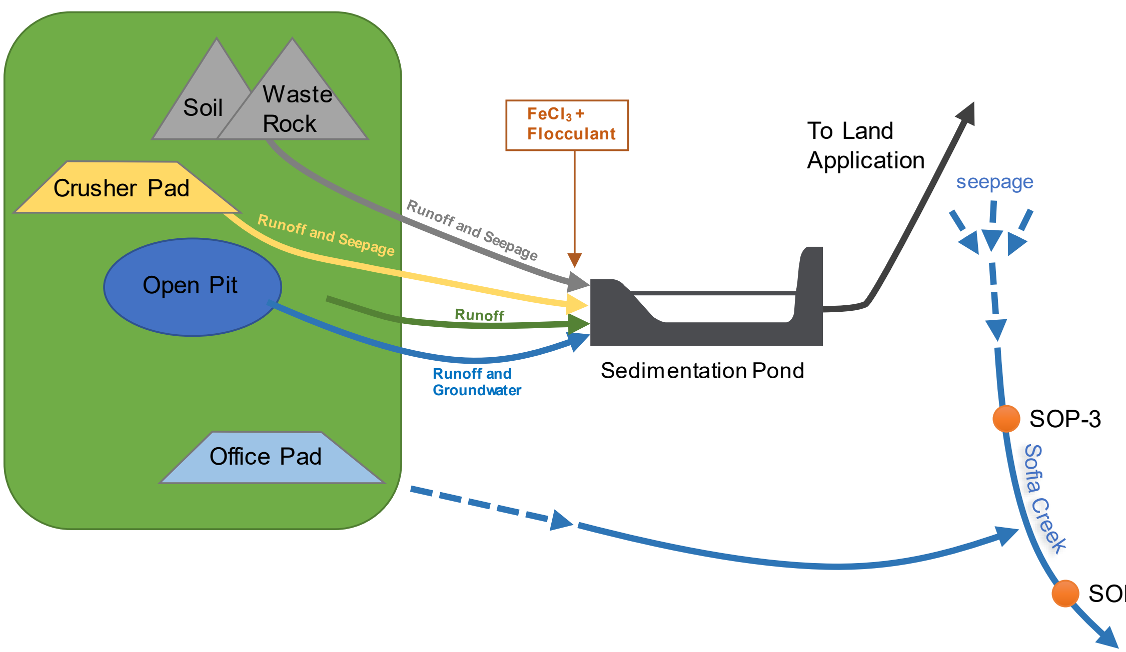


Figure 6.3-3: Contaminant Transport Schematic, Water Quality Model (Blasting Scenario)

6.3.2.4 Critical Effluent Discharge Scenarios

The month of September is most likely to be the lowest flow month and therefore the most critical time for protection of water quality in the receiving environment. However, any of the months in the open water season following freshet (July to October) could be critical low flow months. Further details regarding which water quality parameters are predicted to exceed guidelines in the receiving environment in which months under which scenarios are provided in Section 6.4 below.

6.3.2.5 Worst-Case Water Quality Scenario

The worst-case water quality scenario is expected to occur under conditions resembling 1 in 4 dry months in August, September and October under either the mechanized ore extraction scenario or blasting scenario. Under such conditions, precipitation and surface flow is limited but some discharge from site will likely still be required. In periods with no rainfall, any soluble water quality constituents contained in mined rock or ore (such as metals, nitrogen nutrients, sulphate) remain associated with the mined material. Therefore, the first rainfall that follows a prolonged dry period is more likely to solubilize a greater load of constituents, which would result in higher constituent concentrations in the seepage and runoff. In other words, a dry scenario that is just wet enough to require discharge was considered the worst-case water quality scenario.

Water quality predictions for a 1 in 4-year dry month scenario are described in the Water Quality Model report (Appendix 5-A).

If conditions are drier than 1 in 4-year dry months, it is unlikely that discharge from the project area will be necessary. Any groundwater collected from the open pit will likely be required for dust suppression.

6.3.2.6 Potential Effect of Contact Water Discharge to Groundwater

Potential effects on groundwater quality resulting from land application of contact water was evaluated by comparing predicted contact water quality to the water quality standards for groundwater listed in the British Columbia Contaminated Sites Regulations (CSR) (see Safe Discharge Plan, Appendix 9-C). Predicted effluent concentrations were lower than the CSR groundwater standards for all dissolved parameters. Since there is no direct withdrawal or use of groundwater within the Project area and since development of future groundwater drinking wells within the land application area was not considered credible, the assessment concluded that there would be no potential effect on groundwater other than the potential for relatively short-term signatures on groundwater quality due to infiltration of land applied discharge form the mine.

6.3.2.7 Water Quality Model Predictions

Water quality model predictions are described in the Water Quality Model Report, which is included in Appendix 5-A.

6.3.2.8 Safe Discharge Plan

The proposed Safe Discharge Plan for the Project is included in Appendix 9-C.

6.3.2.9 Management and Mitigation Options

Water management and mitigation options are described in the Safe Discharge Plan for the Project (section 9.8; Appendix 9-C).

6.3.2.10 Potential Effects on Downstream Water Quality

Potential effects on downstream water quality, in terms of potential change to water quality parameter concentrations, are described in the Water Quality Model report (Appendix 5-A).

6.3.2.11 Contaminant Transport: Probability of Occurring

The conceptual model for contaminant transport is described in Section 6.3.2.3. The contaminant transport pathways described are expected to occur and was the basis for the development of the Safe Discharge Plan (Appendix 9-C). Aside from potential accidents and malfunctions, no other contaminant transport is expected to occur.

6.3.2.12 Gaps and Uncertainties of Surface Water Effects Assessment

The water quality model assessment conducted for the project is an order-of-magnitude evaluation of potential water quality effects that could occur because of the development of the RRIMM Project. Such model evolutions are a highly simplistic representation of a complex set of physical and chemical transformations and interactions between water, inorganic minerals and organic materials and are therefore inherently uncertain. Because of this uncertainty, it is standard practice to rely on relatively conservative assumptions for the model inputs such that predicted concentrations are likely to be higher than actual future concentrations. This water quality model for the RRIMM project followed this approach.

One possible exception to the conservative model approach is predicted concentrations of ammonia, nitrate, and nitrite, under the scenario where blasting is required for ore extraction. The primary source of these constituents is residual (i.e., undetonated) ammonium nitrate fuel oil (ANFO) explosives. The potential loss of undetonated ANFO differs from blast to blast and in contingent on a multitude of factors. Although the estimated overall loss and dissolution of ANFO likely is conservative, which means that predicted monthly concentrations are conservative, it is possible that short-duration pulses of dissolved ANFO can cause short-duration spikes in ammonia, nitrate, and nitrite concentrations. However, land application of the nutrient-rich contact water makes such spikes inconsequential. Even though concentrations may be high when considering aquatic life water quality guidelines for nitrogen nutrients, concentrations are still orders of magnitude lower than fertilizer solutions commonly applied to vegetation in agriculture and forestry.

6.4 AQUATIC RESOURCES AND OTHER RECEPTORS

This section predicts effects to aquatic resources, based on characterization of the project-related stressors and the receptors of concern that could be affected by those stressors. Screening of water quality data considers other relevant water uses as well, but as shown below aquatic life is the driver for any potential concerns in the receiving environment. Results are presented for Blasting, with discussion of differences for Mechanical Ore Extraction. The most important difference for Mechanical Ore Extraction is that the results for explosive residues are not relevant.

6.4.1 Study Area

The specific creeks that are within the scope of analysis include:

- Little Sheep Creek above and below the confluence with Sophia Creek
- Sophia Creek and its tributaries
- Record Creek (upstream reference, tributary to Little Sheep Creek)
- Corral Creek (reference in an adjacent drainage)

Locations of sampling stations are described in detail in Section 7 as part of the Aquatic Effects Monitoring Program.

6.4.2 Contaminants of Potential Concern

Contaminants of Potential Concern (COPCs) for aquatic resources are associated with mine waters that are discharged via surface water, groundwater, or seepage into the receiving environment. These include:

- Metals – Contact water from the site could contain elevated concentrations of metals associated with quarry rock.
- Explosive residues (i.e., nitrogen species) for Blasting only.
- Suspended sediments for Mechanical Ore Extraction only. For Blasting, water that is discharged from the sedimentation pond will be land applied, and that water will enter groundwater before seeping towards Sophia Creek, thus removing any suspended sediments.

Water quantity is not considered a stressor because predicted changes to water flows in the receiving environment are minimal (see section 6.3.1.1). Water temperature is evaluated separately as a potential stressor in Section 6.6, Appendix 5-C.

COPCs were identified by:

- Comparing predicted values in the sediment pond (Chapter 5) to CSR generic water standards for all water uses except drinking water – human health was not considered relevant, based on a water use determination (Chapter 5.0). Irrigation water standards are only applicable for Blasting but for simplicity during initial screening the standards were applied to both Blasting and Mechanical Ore Extraction. A pH of 7 was assumed for the sedimentation pond (Chapter 5; SRK 2023), for purposes of calculating the subset of CSR standards that are dependent on pH. Hardness was provided directly in sedimentation pond predictions (Chapter 5).
- For both Blasting and Mechanical Ore Extraction, comparing the predicted receiving environment water quality (Chapter 5) under all flow scenarios against provincial water quality guidelines (WQGs) for the protection of aquatic life, wildlife drinking water, and livestock drinking water (BC ENV 2023)[3] . These guidelines were reviewed in Chapter 2.0 and include updates to September 2023. Human health was

[3] Guidelines for aquatic life and wildlife were read directly from the BC ENV online data base in September 2023. Guidelines for livestock watering were checked against the data manually, as there are only a few cases where they are lower than wildlife guidelines. Guidelines for human health drinking water and recreational use were not applied (see water use determination in Chapter 5). The copper aquatic life guideline was implemented using the downloadable Biotic Ligand Model.

not considered relevant, based on a water use determination (see Chapter 5.0). For guidelines dependent on pH, temperature, DOC or hardness, the following assumptions were made:

- pH 7.8 in the receiving environment, which is approximately the median of baseline and the mid-point of the predicted range.
- Temperature 15°C, a conservative upper limit almost equal to the maximum observed in upper Sophia Creek.
- DOC 1.25 mg/L, a conservative value equal to less than the 10^{th} percentile of baseline.
- Hardness is included in the predictions, so no assumptions were needed.

- Use of conservative assumptions for temperature and DOC, while using a median value for pH, results in guidelines that are conservative in all cases, while avoiding compounding conservatism that would result if conservative assumptions were made simultaneously for multiple toxicity modifying factors.

Identified COPCs were as follows:

- In the sedimentation pond: only total aluminum exceeded a relevant CSR standard, specifically the standard for irrigation water and livestock watering. Exceedances were marginal, with 7 instances across all flow scenarios and a maximum predicted concentration of 5.4 mg/L, compared to the standard of 5 mg/L. This standard is relevant for Blasting given planned land application of the sedimentation pond water). However, total suspended solids (TSS) treatment will eliminate these exceedances (see discussion below in the context of guidelines). Consequently, no COPCs are retained based on evaluation of the sedimentation pond.
- In the receiving environment: nitrite, nitrate, aluminum, beryllium, chromium, and copper all exceeded the BC long-term average (LTA) aquatic life guidelines, but none exceeded the BC short-term maximum (STM) aquatic life guidelines, or the guidelines related to wildlife drinking water.

The initial list of COPCs in the receiving environment is provided in Table 6.4-1.

Table 6.4-1: Initial List of COPCs in the Receiving Environment

COPC	Non Fish-Bearing Reaches (SOP3 and/or SOP2)	Fish-Bearing Reaches (SC-01, SC-05 and/or LSC-06)
Nitrite	> BC LTA	> BC LTA
Nitrate	> BC LTA	
Aluminum	> BC LTA	> BC LTA
Beryllium	> BC LTA	
Chromium	> BC LTA	> BC LTA
Copper	> BC LTA	> BC LTA

Predicted and observed concentrations of the initial COPCs are shown in Figure 6.4-1, with the exception of copper. Copper is addressed separately because it requires application of a Biotic Ligand Model, and it is therefore retained and evaluated for potential predicted effects later in this section. Of the 6 initial COPCs, chromium, beryllium and aluminum are not retained based on the following rationale:

- Chromium: Total chromium is naturally elevated and does not appear to be influenced by the Project, because observed concentrations from baseline sampling are essentially the same as predicted concentrations at matched stations, and maximum predicted concentrations are within the range of observed concentrations.
- Beryllium: Total beryllium only marginally exceeds the guideline, and in any case, beryllium will be removed by TSS treatment and therefore the predicted concentrations are overestimates (see Chapter 5.0). It is expected that removal of TSS in the sedimentation pond will remove much of the beryllium and that concentrations in the receiving environment will be below the guideline (SRK 2023e; Appendix 5-A).
- Aluminum: Total aluminum is predicted to exceed the BC LTA guideline for protection of aquatic life by up to a factor of almost 10 at SOP-3, and to a lesser extent further downstream, using the relatively conservative inputs for toxicity modifying factors for the guideline equation. Predicted aluminum concentrations in the receiving environment are driven in part by natural surface water concentrations that occasionally exceed guidelines at every baseline sampling location, and partly by natural groundwater. In groundwater samples collected to date, the average concentration of dissolved aluminum is very low (less than 0.010 mg/L) while the average total aluminum concentration is relatively high (> 6 mg/L), which shows that nearly all aluminum in the samples is particular-bound (Chapter 5). As discussed in Chapter 5, it is expected that removal of TSS in the sedimentation pond will remove the particular-bound aluminum and that concentrations in the receiving environment will be similar to background (SRK 2023e; Appendix 5-A).

We note that magnesium is predicted to be elevated in the sedimentation pond, relative to observed baseline conditions. There are no standards or guidelines for magnesium. In the receiving environment, predicted concentrations are similar to observed baseline conditions in fish-bearing reaches, and slightly elevated upstream at SOP3. We would not expect magnesium to be a concern because predicted concentrations are within the range of natural waters in Canada[4].

The final list of COPCs includes nitrite, nitrate, and dissolved copper. These are retained for evaluation of predicted long-term chronic effects as none of the COPCs exceed BC STM guidelines (i.e., short-term acute effects are not expected).

[4] Health Canada. 1978. Guidelines for Canadian Drinking Water Quality: Supporting Documents – Magnesium.

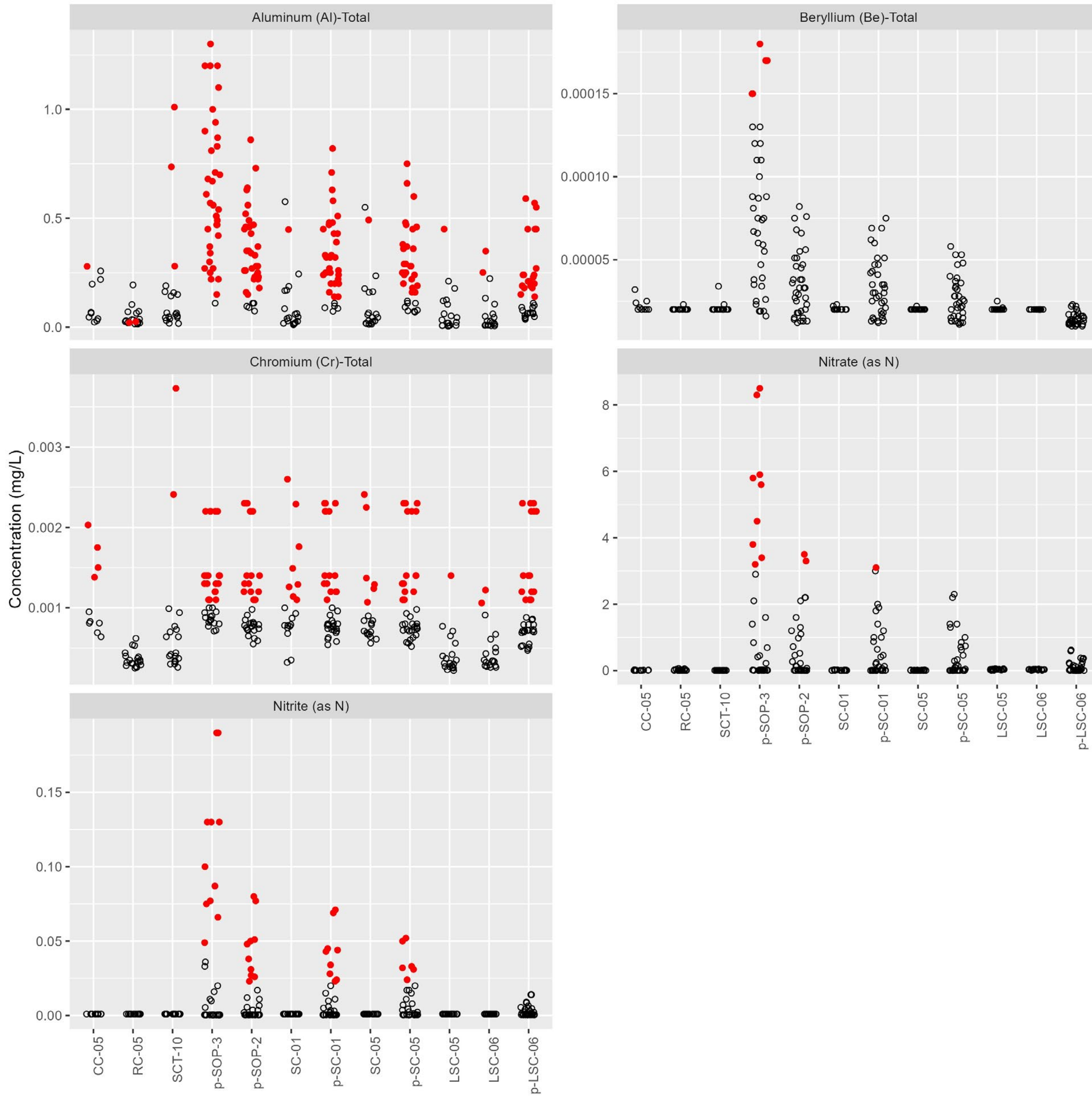


Figure 6.4-1: Predicted and Observed Concentrations of Key Water Quality Variables

Notes: (a) predicted data are indicated by "p-"before the station name. All other data are measured 2016-2017 data. (b) red symbols indicated data that exceed long-term average (i.e., chronic) water quality guidelines for protection of aquatic life in the receiving environment. In some cases, the guidelines are not fixed values, but instead vary depending on pH, temperature and/or chloride. (c) Predictions cover all three flow scenarios. (d) dissolved copper is not plotted but is addressed in the text and tables.

6.4.3 Receptors of Concern

Aquatic receptors of concern in the project area are those associated with the stream environments of the Sophia Creek drainage and Little Sheep Creek. These include:

- Fish – As discussed in Section 2.8, the two fish species found in the project area are Rainbow Trout and Eastern Brook Trout – both of these are common species. The conservation status of Rainbow Trout in BC is yellow-listed, meaning that it is secure and not at risk of extinction[5]. There is no conservation status for Eastern Brook Trout in BC because it is an introduced species from the east coast[6].
- Lower trophic level organisms (invertebrates, periphyton) and abiotic media (water, substrate) that support fish populations.
- Amphibians that are directly exposed to creek water.

Wildlife other than amphibians are not included. Wildlife are not expected to be affected via drinking water because there are no predicted exceedances of wildlife drinking water guidelines. Wildlife consumers of fish and lower trophic level organisms are not expected to be affected, because the project is not expected to be a source of bioaccumulative metals (i.e., mercury, selenium), and the only metals predicted to exceed water quality guidelines in the receiving environment are naturally elevated (i.e., chromium), or marginally above guidelines (i.e., beryllium, plus copper as discussed below), or are expected to be mitigated with TSS treatment prior to discharge (i.e., chromium, beryllium, and aluminum; see Chapter 5.0 and SRK 2023e).

Crops (via irrigation water), livestock and wildlife are not included as receptors of concern for two reasons:

- There are no predicted exceedances of relevant standards in untreated pond water with the exception of total aluminum, which is predicted to be only rarely and marginally above the standard for crops and livestock and will be mitigated as part of TSS treatment.
- There are no predicted exceedances of relevant guidelines for wildlife and livestock in the receiving environment.

Humans are also not included as receptors of concern based on the water use determination in Chapter 5.0.

6.4.4 Exposure Pathways and Conceptual Site Model

A Conceptual Site Model (CSM) is provided in Figure 6.4-2 that shows COPC sources, exposure pathways and receptors.

The main source of COPCs to the aquatic receiving environment for Blasting is seepage of groundwater that has received COPCs associated with land application of water from the sedimentation pond. There is also a possibility of seepage or runoff from the office pad, which is not captured in the sedimentation pond.

[5] BC Species and Ecosystems Explorer – https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/species-and-ecosystems-explorer

[6] Freshwater Fisheries Society of BC – gofishbc.com

The key exposure pathways that are relevant include:

- Direct exposure of fish to stressors in surface water.
- Direct exposure of fish food supply (benthic invertebrates, and indirectly periphyton) to stressors in surface water.
- Direct exposure of amphibians to water.

For Mechanical Ore Extraction, direct discharge from the sedimentation pond to surface water is also relevant. Otherwise, exposure media, pathways and receptor groups are the same.

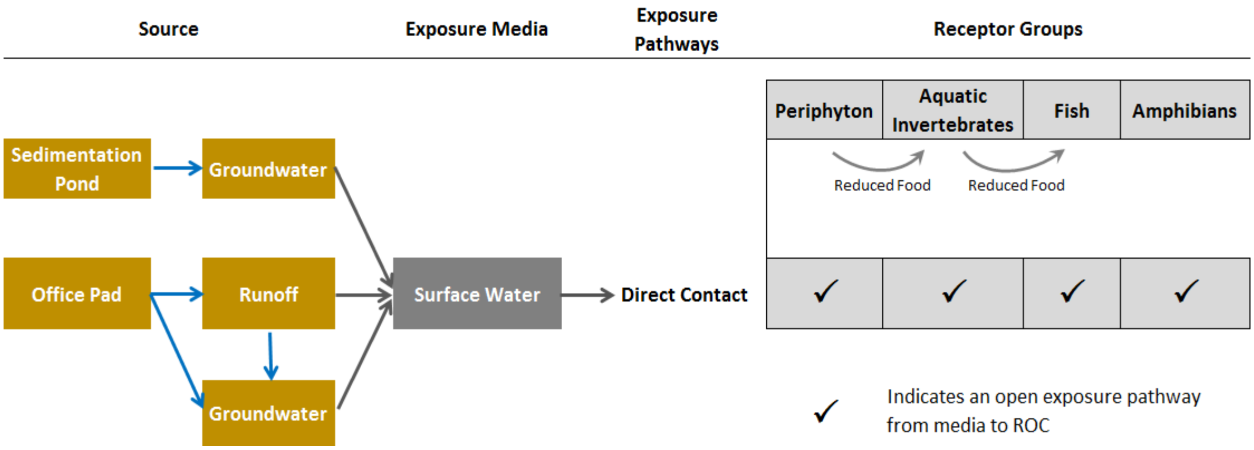


Figure 6.4-2: Conceptual Site Model for Blasting, Indicating Potential Contaminant Sources, Key Exposure Media, Exposure Pathways, and Receptor Groups.

Note: The conceptual site model for Mechanical Ore Extraction is identical, except for the addition of the sedimentation pond as a direct source to surface water.

Exposure pathways that have purposely been excluded are:

- Direct exposure of benthic invertebrates to stressors in sediments – Accumulation of project-related sediments in the receiving environment is not anticipated because (a) TSS treatment will be implemented in the sedimentation pond; (b) for Blasting, sediments would be removed as land-applied water moves into groundwater; (c) the receiving environments are predominantly lotic in nature with few depositional areas, (d) there is very little fine sediment as substrate is dominated by cobble, gravel and boulders; and (e) any sediments associated with direct runoff would be very fine particles that will be regularly flushed from the system due to natural flow regimes.
- Exposure of wildlife or livestock to water-borne stressors via drinking water – There are no stressors predicted to exceed guidelines for wildlife drinking water or livestock watering. Future monitoring results will be compared to wildlife drinking water and livestock watering guidelines to ensure that the potential for risks via this pathway remains negligible.
- Exposure of wildlife to COPCs via dietary consumption of fish, invertebrates or periphyton – the project is not expected to be a source of metals or any other COPCs that could accumulate in diet items.

6.4.5 Assessment Endpoints, Measurement Endpoints, Protection Goals, Critical Effect Sizes

An assessment endpoint is an explicit expression of an attribute of a receptor group that is to be protected. The assessment endpoints set the stage for exactly what variables will be monitored.

The assessment endpoints for aquatic resources are:

1. Fish populations and fish habitat (including food)
2. Amphibian health

The focus of Assessment Endpoint 1 on fish populations and habitat, rather than individual organisms, is based on the fact that both fish species in the project area are common species, and as such are protected at the population level in BC, not at the level of individual organisms.

For any single assessment endpoint, one or more measurement endpoints are used as specific, measurable indicators of the assessment endpoint. Measurement endpoints can only be interpreted if there is a clear understanding of what level of change is acceptable, and protection goals are needed for this purpose. Given an assessment endpoint that focuses on fish populations and fish habitat, protection goals can be different in fish-bearing reaches and non-fish bearing reaches.

Fish-bearing reaches downstream of the project area are:

- Sophia Creek to the end of reach 3, between the confluence with South Sophia Creek and the confluence with West Sophia Creek. This reach is best represented by AEMP station SC-01, which is located in this reach. AEMP station SC-05 is located in reach 2, downstream of the confluence with West Sophia Creek.
- Little Sheep Creek downstream of the Sophia Creek confluence. This reach is represented by AEMP station LSC-06.

Within the fish-bearing reaches, SC-01 and SC-05 represent mid-field stations, and LSC-06 represents a far-field station. Stations that would be considered ‘near-field’ occur higher in the watershed where there are no fish. Station SOP3 is further upstream and is the most appropriate location for monitoring the immediate potential downstream receiving environment. Given that the size of a sampling station for biological endpoints is typically 100 m or more (to fit in three CABIN replicate samples and up to 10 periphyton replicate samples), the location of SOP3 is ideal. As SOP3 is in the mainstem of Sophia Creek, it is likely to have flowing water at most times and will be amenable to sampling. There may be some years like 2017, when late summer flows were so low (almost zero) that biological sampling would not be possible.

Station SOP2 is also non fish-bearing and is located further downstream than SOP3. SOP2 is maintained as an additional AEMP station because of the possibility of seepage or runoff from the office pad into the reach between SOP3 and SOP2 (see Section 7.6 regarding the AEMP).

In addition to potential project-related inputs above SOP2 and SOP3, there is also a conceivable project-related influence on surface water in West Sophia Creek. The near-field station in that drainage is WSO-

01. This station could serve as a reference if there is no change in water quality in West Sophia Creek, but otherwise will be assumed to be a potential exposure station. West Sophia Creek is not fish-bearing.

Narrative protection goals were established using the Biological Condition Gradient (BCG; Davies and Jackson 2006), depicted in Figure 6.4-3.

The BCG establishes six tiers of biological condition using a number of attributes. For Assessment Endpoint 1, a protection goal of tier 2 condition seems reasonable for any measurement endpoints directly linked to fish themselves, which implies minimal changes to fish populations. A protection goal of tier 4 seems reasonable for endpoints not directly linked to fish, but rather to potential effects on food – this implies that moderate changes to the structure of periphyton or benthic invertebrate communities are acceptable provided that there is minimal changes to their function as food.

Protection goals are operationalized by defining quantitative critical effect sizes (CES). For water quality variables, data are commonly compared to water quality guidelines or other benchmarks. For biological variables, CES are usually defined as a change or difference relative to reference. The concepts for CES embedded within federal Environmental Effects Monitoring (EEM) guidance have been adopted here and are explained in more detail in Section 7.6.

The measurement endpoints for each assessment endpoint are provided in Table 6.4-2, along with rationale, description of supporting variables, and description of protection goals and associated critical effect sizes. Supporting variables are important – there are many metrics that are measured as part of periphyton and benthic invertebrate community assessments, and these provide important detail and context for interpreting the findings of the key variables used as measurement endpoints. There are also additional supporting variables for which baseline data have been collected, and that could be monitored to investigate potential issues in more detail.

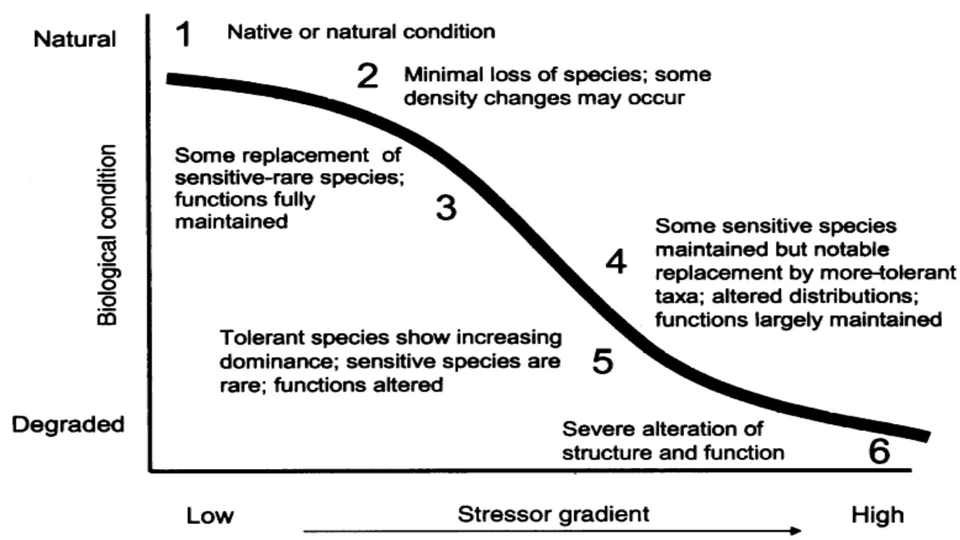


Figure 6.4-3: Conceptual Model of Change in Biological Conditions in Response to an Increasing Stressor Gradient

Biological Condition Gradient (Davies and Jackson 2006)

Table 6.4-2: Assessment Endpoints, Measurement Endpoints, Supporting Variables, Protection Goals and Critical Effect Sizes

Note: Endpoints marked with an asterisk (*) are not recommended as part of routine monitoring in future – see Chapter 7 for discussion.

Assessment Endpoint	Measurement Endpoint	Rationale	Supporting Variables	Protection Goals and Critical Effect Sizes
1. Fish populations and fish habitat	Concentrations of water quality stressors (nutrients, TSS, metals), compared to water quality guidelines, or other benchmarks.	Water quality can directly affect fish and lower trophic levels. There are water quality guidelines and other benchmarks available for interpreting water quality.	Chemistry associated with potential sources: discharge water quality; groundwater quality. Bioassays associated with the discharge or receiving environment	BCG Tier 2 for potential effects on fish at exposure stations SC-01, SC-05, LSC-06. This is interpreted to mean that concentrations should not exceed relevant benchmarks for fish. BCG Tier 4 for potential effects on periphyton and benthic invertebrates at all exposure stations. This is interpreted to mean that concentrations occasionally exceeding relevant benchmarks for lower trophic levels are acceptable, provided that effects on biological measurement endpoints below are not expected to exceed acceptable effect levels.
	Benthic invertebrate abundance, compared to reference in a BACI design.	Abundance is one indicator of community health, and food production for fish.	Abundance of major taxonomic groups.	BCG Tier 4 for potential effects on benthic invertebrates at all exposure stations. This is interpreted to mean a BACI effect size equal to two standard deviations relative to reference (consistent with EEM guidance), and statistically significant at p=0.10 (two-tailed test because changes in either direction could be of concern). If this CES is exceeded, overall conclusions about benthic invertebrates should draw on findings for other measurement endpoints, including the CABIN conclusions regarding similarity to reference conditions. See endpoint for benthic invertebrate community similarity to reference below.
	Benthic invertebrate richness – lowest practical level, compared to reference in a BACI design.	Richness is an indicator of community function and overall health.	Major taxonomic group richness; Simpson's Diversity; Simpson's evenness; percent EPT (abundance);% top 2 dominant taxa.	BCG Tier 4 for potential effects on benthic invertebrates at all exposure stations. This is interpreted to mean a BACI effect size equal to two standard deviations relative to reference (consistent with EEM guidance), and statistically significant at p=0.10 (one-tailed test because only a decrease is a potential concern). If this CES is exceeded, overall conclusions about benthic invertebrates should draw on findings for other measurement endpoints, including the CABIN conclusions regarding similarity to reference conditions. See endpoint for benthic invertebrate community similarity to reference below.
	Benthic invertebrate community similarity to reference – comparison to reference using CABIN reference model.	A CABIN reference model is expected for the region in 2018. CABIN is widely accepted as a useful method of integrating many types of information into an overall assessment of the benthic invertebrate community.	Individual CABIN metrics	BCG Tier 4 for potential effects on benthic invertebrates at all exposure stations. This is interpreted to mean that CABIN conclusions of R (reference condition) or MD (mildly divergent) are acceptable; D (divergent) is possibly acceptable but requires consideration of the other (BACI) invertebrate endpoints; HD (highly divergent) is likely to be unacceptable but also requires consideration of the other (BACI) invertebrate endpoints. Results to be interpreted together with results for specific endpoints above.
	* Periphyton biomass – taxonomy-based biomass, and Loss-On-Ignition, both compared to reference in a BACI design.	Biomass represents production as food for higher trophic levels; High biomass could occur due to excessive nutrient inputs, and may affect accessibility of habitat as well as dissolved oxygen.	Abundance and richness of major taxonomic groups; abundance; periphyton chlorophyll-a.	BCG Tier 4 for potential effects on periphyton at all exposure stations. This is interpreted to mean a BACI effect size equal to two standard deviations relative to reference (consistent with EEM guidance), and statistically significant at p=0.10 (two-tailed test because changes in either direction could be of concern).
	* Periphyton richness – lowest practical level, compared to reference in a BACI design.	Richness is an indicator of community function and overall health.	Major taxonomic group richness; Simpson's Diversity; Simpson's evenness.	BCG Tier 4 for potential effects on periphyton at all exposure stations. This is interpreted to mean a BACI effect size equal to two standard deviations relative to reference (consistent with EEM guidance), and statistically significant at p=0.10 (one-tailed test because only a decrease is a potential concern).
	Fish length-frequency – compared to baseline conditions and to reference.	Given the small size of the creeks, a non-lethal program is appropriate. Fish-length frequency provides an overall indicator of the ability of the local populations to reproduce and support survival to older age classes.	Fish density using triple-pass electrofishing	BCG Tier 2 for potential effects on fish at exposure stations SC-01, SC-05, LSC-06. Consistent with federal EEM guidance, the Kolmogorov-Smirnov (K-S) two-sample test will be used to compare the before and after periods for statistical significance at p=0.10. Statistically significant' results will be interpreted in the context of supporting variables to determine potential ecological significance.
	Fish condition as body weight vs length; compared to baseline conditions and to reference.	Given the small size of the creeks, a non-lethal program is appropriate. Fish condition provides an overall indicator of the health of individual fish.	External health assessment of individual fish.	BCG Tier 2 for potential effects on fish at exposure stations SC-01, SC-05, LSC-06. Consistent with federal EEM guidance, a weight versus length ANCOVA test will be used to compare the before and after periods for statistical significance at p=0.10 (one-tailed test, as only a decrease in condition is of concern).
2. Amphibian Health	Concentrations of water quality stressors (nutrients, TSS, metals), compared to water quality guidelines or other benchmarks relevant to amphibians.	Direct measurements of amphibian health tend to be highly uncertain; measurements of water quality can be directly related to potential toxic effects using toxicity information from the literature.	None	BCG Tier 2 for potential effects on amphibians at all exposure stations. This is interpreted to mean that concentrations should not exceed relevant benchmarks for amphibians.

6.4.6 PREDICTED EFFECTS

6.4.6.1 Approach

Potential effects of COPCs on fish, periphyton, benthic invertebrates, and amphibians are discussed here by comparing predicted water quality to relevant water quality guidelines and underlying information, as well as data compiled in literature reviews. Original studies were generally not reviewed. While BC guidelines are most relevant in BC from a regulatory perspective, for purposes of predicting effects it made sense in some cases to draw on more recent guidelines from other jurisdictions where those reflected more recent science.

Importantly, protection goals described in the previous section are explicitly considered; in other words, periphyton and benthic invertebrates are evaluated for potential effects at the community level; fish are evaluated for potential effects at the population level; and amphibians are evaluated for potential effects at the level of individual organisms (on the assumption that some amphibians may be listed species).

All three COPCs are predicted to exceed the BC LTA guidelines in non-fish bearing reaches (SOP3, SOP2) at least once under at least one flow scenario. In the downstream fish-bearing reaches, nitrite and dissolved copper are predicted to exceed the BC LTA guideline in several cases, while nitrate is predicted to exceed the BC LTA guideline in one fish-bearing reach in one month under one flow scenario. In all cases, exceedances are of the LTA guidelines only – there are no predicted exceedances of the STM guidelines, therefore acute effects are not expected. Details of predicted exceedances by station, flow scenario and month are provided in Table 6.4-3. The maximum predicted concentrations at each station for each of nitrite, nitrate and dissolved copper are considered in the assessment below.

Table 6.4-3: Predicted exceedances of water quality guidelines by station, month and flow conditions for nitrite, nitrate, and dissolved copper

Variable/Location	Station	Month	Flow Scenario	Hardness	Chloride	Concentration (mg/L)	BC LTA Aquatic Life Guideline	Ratio (Conc/ Guideline)	Notes
Nitrate.N in Fish-Bearing Reaches	SC-01	Sep	dry	100	2.4	3.1	3	1.03	Very marginal exceedance in Sept under dry conditions only
Nitrate.N in Non-Fish Bearing Reaches	SOP2	Sep	dry	100	2.6	3.5	3	1.17	Exceedances expected July to October under dry conditions, and less frequently under average or wet conditions
	SOP2	Oct	dry	69	2.8	3.3	3	1.1	
	SOP3	Jul	dry	71	3.9	4.5	3	1.5	
	SOP3	Aug	avg	100	3.5	3.8	3	1.27	
	SOP3	Aug	dry	98	4.6	5.9	3	1.97	
	SOP3	Sep	avg	99	4.6	5.8	3	1.93	
	SOP3	Sep	dry	94	6	8.5	3	2.83	
	SOP3	Sep	wet	100	3.3	3.4	3	1.13	
	SOP3	Oct	avg	69	4.7	5.6	3	1.87	
	SOP3	Oct	dry	68	6.1	8.3	3	2.77	
	SOP3	Oct	wet	70	3.5	3.2	3	1.07	
Nitrite.N in Fish Bearing Reaches	SC-01	Jul	dry	71	1.4	0.034	0.02	1.7	Exceedances expected July to October under dry conditions, and less frequently under average or wet conditions
	SC-01	Aug	avg	110	1.3	0.028	0.02	1.4	
	SC-01	Aug	dry	100	1.7	0.045	0.02	2.25	
	SC-01	Sep	avg	110	1.7	0.044	0.02	2.2	
	SC-01	Sep	dry	100	2.4	0.071	0.04	1.78	
	SC-01	Sep	wet	110	1.2	0.024	0.02	1.2	
	SC-01	Oct	avg	69	2	0.043	0.04	1.08	
	SC-01	Oct	dry	69	2.6	0.069	0.04	1.73	
	SC-01	Oct	wet	69	1.5	0.023	0.02	1.15	
	SC-05	Jul	dry	70	1.1	0.024	0.02	1.2	
	SC-05	Aug	dry	110	1.3	0.033	0.02	1.65	
	SC-05	Sep	avg	110	1.3	0.032	0.02	1.6	
	SC-05	Sep	dry	100	1.8	0.052	0.02	2.6	
	SC-05	Oct	avg	68	1.6	0.031	0.02	1.55	
	SC-05	Oct	dry	68	2	0.05	0.04	1.25	
Nitrite.N in Non-Fish Bearing Reaches	SOP2	Jul	avg	71	1.2	0.023	0.02	1.15	Exceedances expected July to October under dry and average conditions, and less frequently under wet conditions
	SOP2	Jul	dry	71	1.6	0.038	0.02	1.9	
	SOP2	Aug	avg	110	1.4	0.031	0.02	1.55	
	SOP2	Aug	dry	100	1.9	0.051	0.02	2.55	
	SOP2	Sep	avg	110	1.9	0.05	0.02	2.5	
	SOP2	Sep	dry	100	2.6	0.08	0.04	2	
	SOP2	Sep	wet	110	1.3	0.027	0.02	1.35	
	SOP2	Oct	avg	69	2.1	0.048	0.04	1.2	
	SOP2	Oct	dry	69	2.8	0.077	0.04	1.93	
	SOP2	Oct	wet	69	1.6	0.026	0.02	1.3	
	SOP3	Jul	avg	72	3.1	0.066	0.04	1.65	
	SOP3	Jul	dry	71	3.9	0.1	0.04	2.5	
	SOP3	Aug	avg	100	3.5	0.087	0.04	2.18	
	SOP3	Aug	dry	98	4.6	0.13	0.06	2.17	
	SOP3	Aug	wet	100	2.7	0.049	0.04	1.23	
	SOP3	Sep	avg	99	4.6	0.13	0.06	2.17	
	SOP3	Sep	dry	94	6	0.19	0.08	2.38	
	SOP3	Sep	wet	100	3.3	0.077	0.04	1.93	
	SOP3	Oct	avg	69	4.7	0.13	0.06	2.17	
	SOP3	Oct	dry	68	6.1	0.19	0.08	2.38	
	SOP3	Oct	wet	70	3.5	0.075	0.04	1.88	

Variable/Location	Station	Month	Flow Scenario	Hardness	Chloride	Concentration (ug/L)	BC LTA Aquatic Life Guideline	Ratio (Conc/ Guideline)	Notes
Copper (dissolved) in Fish-Bearing Reaches	LSC-06	Apr	avg	48		0.75	0.50	1.50	Exceedances expected about 5 to 6 months per year under all flow conditions
	LSC-06	Apr	dry	48		0.75	0.50	1.50	
	LSC-06	Apr	wet	47		0.75	0.50	1.50	
	LSC-06	Dec	avg	72		0.51	0.50	1.02	
	LSC-06	Dec	dry	72		0.51	0.50	1.02	
	LSC-06	Dec	wet	72		0.51	0.50	1.02	
	LSC-06	Feb	avg	68		0.57	0.50	1.14	
	LSC-06	Feb	dry	68		0.57	0.50	1.14	
	LSC-06	Feb	wet	68		0.57	0.50	1.14	
	LSC-06	Mar	avg	58		0.65	0.50	1.30	
	LSC-06	Mar	dry	58		0.65	0.50	1.30	
	LSC-06	Mar	wet	58		0.65	0.50	1.30	
	LSC-06	May	avg	39		0.61	0.50	1.22	
	LSC-06	May	dry	39		0.61	0.50	1.22	
	LSC-06	May	wet	39		0.61	0.50	1.22	
	LSC-06	Oct	avg	67		0.75	0.50	1.50	
	LSC-06	Oct	dry	67		0.74	0.50	1.48	
	LSC-06	Oct	wet	67		0.75	0.50	1.50	
	SC-01	Apr	avg	50		0.74	0.50	1.48	
	SC-01	Apr	dry	50		0.74	0.50	1.48	
	SC-01	Apr	wet	50		0.74	0.50	1.48	
	SC-01	Feb	avg	71		0.56	0.50	1.12	
	SC-01	Feb	dry	70		0.56	0.50	1.12	
	SC-01	Feb	wet	71		0.57	0.50	1.14	
	SC-01	Mar	avg	62		0.64	0.50	1.28	
	SC-01	Mar	dry	62		0.64	0.50	1.28	
	SC-01	Mar	wet	62		0.64	0.50	1.28	
	SC-01	May	avg	41		0.61	0.50	1.22	
	SC-01	May	dry	41		0.61	0.50	1.22	
	SC-01	May	wet	41		0.61	0.50	1.22	
	SC-01	Oct	avg	69		0.73	0.50	1.46	
	SC-01	Oct	dry	69		0.72	0.50	1.44	
	SC-01	Oct	wet	69		0.74	0.50	1.48	
	SC-05	Apr	avg	49		0.74	0.50	1.48	
	SC-05	Apr	dry	49		0.74	0.50	1.48	
	SC-05	Apr	wet	49		0.75	0.50	1.50	
	SC-05	Dec	dry	72		0.51	0.50	1.02	
	SC-05	Feb	avg	70		0.57	0.50	1.14	
	SC-05	Feb	dry	70		0.56	0.50	1.12	
	SC-05	Feb	wet	70		0.57	0.50	1.14	
	SC-05	Mar	avg	61		0.64	0.50	1.28	
	SC-05	Mar	dry	61		0.64	0.50	1.28	
	SC-05	Mar	wet	61		0.65	0.50	1.30	
	SC-05	May	avg	40		0.61	0.50	1.22	
	SC-05	May	dry	40		0.61	0.50	1.22	
	SC-05	May	wet	40		0.61	0.50	1.22	
	SC-05	Oct	avg	68		0.74	0.50	1.48	
	SC-05	Oct	dry	68		0.73	0.50	1.46	
	SC-05	Oct	wet	68		0.74	0.50	1.48	
Copper (dissolved) in Non-Fish Bearing Reaches	SOP2	Apr	avg	50		0.74	0.50	1.48	Exceedances expected about 5 to 6 months per year under all flow conditions
	SOP2	Apr	dry	50		0.74	0.50	1.48	
	SOP2	Apr	wet	50		0.74	0.50	1.48	
	SOP2	Feb	avg	71		0.56	0.50	1.12	
	SOP2	Feb	dry	71		0.56	0.50	1.12	
	SOP2	Feb	wet	72		0.56	0.50	1.12	
	SOP2	Mar	avg	63		0.64	0.50	1.28	
	SOP2	Mar	dry	63		0.64	0.50	1.28	

Variable/Location	Station	Month	Flow Scenario	Hardness	Chloride	Concentration (ug/L)	BC LTA Aquatic Life Guideline	Ratio (Conc/ Guideline)	Notes
	SOP2	Mar	wet	63		0.64	0.50	1.28	
	SOP2	May	avg	41		0.61	0.50	1.22	
	SOP2	May	dry	42		0.61	0.50	1.22	
	SOP2	May	wet	41		0.61	0.50	1.22	
	SOP2	Oct	avg	69		0.73	0.50	1.46	
	SOP2	Oct	dry	69		0.72	0.50	1.44	
	SOP2	Oct	wet	69		0.73	0.50	1.46	
	SOP3	Apr	avg	52		0.72	0.50	1.44	
	SOP3	Apr	dry	52		0.72	0.50	1.44	
	SOP3	Apr	wet	52		0.72	0.50	1.44	
	SOP3	Dec	avg	72		0.51	0.50	1.02	
	SOP3	Dec	dry	71		0.51	0.50	1.02	
	SOP3	Mar	avg	70		0.62	0.50	1.24	
	SOP3	Mar	dry	69		0.61	0.50	1.22	
	SOP3	Mar	wet	70		0.63	0.50	1.26	
	SOP3	May	avg	44		0.6	0.50	1.20	
	SOP3	May	dry	44		0.6	0.50	1.20	
	SOP3	May	wet	44		0.6	0.50	1.20	
	SOP3	Oct	avg	69		0.68	0.50	1.36	
	SOP3	Oct	dry	68		0.66	0.50	1.32	
	SOP3	Oct	wet	70		0.7	0.50	1.40	

NITRITE

For Blasting, Nitrite is predicted to exceed the BC LTA guideline at all receiving environment exposure stations in Sophia Creek, from SOP3 downstream, particularly during dry climatic conditions. The BC LTA guideline for nitrite is formulated for nitrite as N, abbreviated here as NO2.N.

- Fish – The maximum predicted concentration of nitrite in fish-bearing waters is 0.071 mg/L at SC-01, which exceeds the BC LTA guideline of 0.04 mg/L NO2.N at Cl 2-4 mg/L. The guideline is based on data reported by BC MOE (1986), for endpoints such as increased methemoglobin and decreased hemoglobin. These endpoints were not linked to subsequent effects on key endpoints such as survival or growth that can be more easily linked to potential effects on fish populations. Consequently, it is difficult to interpret the relevance of these data for fish populations in Sophia Creek or Little Sheep Creek. A review by Kroupova et al. (2016) indicates a 28-day LOEC for Rainbow Trout growth rate of 0.06 mg/L nitrite as N (reported as 0.2 mg/L nitrite) at 10 mg/L chloride – this is the lowest concentration in the data set associated with subchronic and chronic effects of nitrite on fish. However, our review of those data revealed that the 28-day LOEC for growth was actually at 0.3 mg/L NO2.N (i.e., 0.99 mg/L nitrite), with no mortality at lower concentrations as reported by Kroupova et al. (2016). This LOEC of 0.3 mg/L was the lowest concentration associated with chronic effects to growth or reproduction. Based on these findings, it seems unlikely that chronic effects of potential significance to fish populations would occur at concentrations of 0.071 mg/L.

Potential chronic effects of nitrite on periphyton, invertebrates and amphibians are relevant at stations SOP3 and SOP2, the first stations in the receiving environment downstream of the project. The maximum predicted concentration of NO2.N at SOP3 is 0.19 mg/L. The evaluation of potential chronic effects of this concentration on periphyton, invertebrates and amphibians is as follows:

- Periphyton – In a review of toxicity data for nitrite, Kroupova et al (2016) report that algae appear to be much less sensitive than other organisms. No growth effects on the green freshwater algae *Desmodesmus subspicatus* were observed at concentrations up to 1,314 mg/L NO2 (i.e., 400 mg/L NO2.N). We conclude, based on this information, that the potential for effects of nitrite at 0.19 mg/L NO2.N on periphyton is negligible.
- Invertebrates – No chronic data for invertebrates were reported by BC MOE (1986) or Kroupova et al (2016). However, the US EPA (2010) reported a 9-Day EC10 of 1.4 mg/L NO2.N for reproductive effects to the planktonic crustacean *Ceriodaphnia dubia*. Based on the paucity of data, it is difficult to draw conclusions about the potential chronic effects of nitrite to benthic invertebrates. However, considering that the focus is on community level functions rather than potential subtle effects on specific taxonomic groups, and noting that the chronic EC10 for *C. dubia* is 7 times higher than the predicted maximum concentration of NO2.N at SOP3, the potential for adverse effects seems low.
- Amphibians – No sublethal or chronic toxicity endpoints for amphibians were reported in the literature reviewed.

NITRATE

For Blasting, Nitrate is predicted to exceed the BC LTA guideline for protection of aquatic life of 3 mg/L NO3.N (nitrate as N) at SOP3 for July to October under dry conditions, and less frequently under average or wet conditions. It is also predicted to exceed the guideline at SOP2 for two months (September and October) under dry conditions only and is predicted to marginally exceed the guideline at SC-01 in September under dry conditions. The BC guideline (2009) was based on an outdated 2003 CEQG, which was based on growth effects to Pacific tree frog and included a safety factor of 10. Since that time, an updated CEQG (CCME 2012) was developed that ended up at the same value (3 mg/L) but based on the 5th percentile of a Species Sensitivity Distribution and incorporating several additional data points that were not available when the BC guideline was developed. The broader CEQG (CCME 2012) data set was relied on to assess the potential for adverse effects to aquatic life, as follows:

- Fish – The maximum predicted concentration of NO3.N in fish-bearing waters is 3.1 mg/L at SC-01. There were data for 5 fish species included in the CEQG (CCME 2012) derivation of a chronic guideline. The lowest effect concentration (LOEC) was 6.3 mg/L, but for purposes of guideline derivation this was converted to a Maximum Acceptable Toxicant Concentration (MATC) of 3.16 mg/L, which was for lake trout. The equivalent MATC for Rainbow Trout based on a swim-up study was 13.1 mg/L. Other species were less sensitive. Based on this information, we would not expect effects to individual Rainbow Trout at concentrations of 3.1 mg/L. Given the limited data this conclusion is somewhat uncertain; however, as the protection goal for fish is at the population level and taking into account the short duration of expected exceedances (and only under dry conditions), potential effects on fish populations are very unlikely.

Potential chronic effects of nitrate on periphyton, invertebrates and amphibians are relevant at stations SOP3 and SOP2, the first stations in the receiving environment downstream of the project. The maximum predicted concentration of NO3.N at SOP3 is 8.5 mg/L. The evaluation of potential chronic effects of this concentration on periphyton, invertebrates and amphibians is as follows:

- Periphyton – No toxicity information is reported by BC or the CEQG for plants or algae. The CEQG notes that nitrate is the primary source of nitrogen for aquatic plants in oxygenated systems. We assume that direct toxicity of nitrate to periphyton would occur at concentrations that are higher than the concentrations that would be toxic to other receptor groups.
- Invertebrates – The lowest toxicity value reported for invertebrates by the CEQG (CCME 2012) is 11.3 mg/L NO3.N, a reproduction IC25 for *C. dubia*. The same 2011 study included higher IC25 results for amphipod and midge. None of these data points were available at the time that the BC guideline was developed. Based on the invertebrate data summarized by the CEQG, we would not expect nitrate at a maximum concentration of 8.5 mg/L NO3.N to affect benthic invertebrates at the community level. However, there is uncertainty given the lack of toxicity data for EPT taxa.
- Amphibians – The CEQG (CCME 2012) chronic guideline for nitrate found amphibians to be less sensitive than fish and invertebrates. The most sensitive chronic toxicity value among three reported by the CEQG for purposes of developing a Species Sensitivity Distribution was an LC10 at 74 mg/L NO3.N. BC MOE (2009) reports the lowest individual chronic data point as an IC15 for growth of Pacific

tree frog, at a concentration of 30.1 mg/L NO3.N. Neither of these are close to the predicted maximum at SOP3 of 8.5 mg/L, therefore effects to amphibians of nitrate seem unlikely.

COPPER

Copper was evaluated separately from other substances for potential effects on aquatic life because the provincial guidelines for aquatic life are based on a Biotic Ligand Model (BLM) that requires separate processing. The BLM-based guideline was run using simplified water chemistry that required inputs for hardness, DOC, pH, and temperature (see assumptions for each earlier in this section). On that basis, copper is predicted to exceed the BC LTA guideline at all locations about 5 to 6 months per year, under any of the three flow scenarios. The exceedances are marginal, and there are no predicted exceedances of the BC STM guideline. Baseline data from 2016 and 2017 indicate that concentrations of copper are naturally variable, and a cursory evaluation shows that concentrations have been naturally lower or higher than the model predictions. It may be possible to make an argument that there is little difference between predicted and baseline copper but given the small magnitude of predicted exceedances it is simple to show why effects would not be expected.

Predicted concentrations of dissolved copper are a maximum of 1.5 times higher than the guideline. We would not expect effects to aquatic life at these levels, for several reasons:

1. The BC LTA copper guideline is based on consideration of hundreds of individual toxicity values. In deriving the guideline, individual toxicity values were used, or geometric means were used for cases where there are multiple toxicity values for the same species, endpoint, and life stage. A single pond snail data point (an EC20 for growth for 30-d exposure of newly hatched giant pond snails [*Lymnaea stagnalis*]; Brix et al. 2011) was the lowest of all toxicity values in the data set, and the guideline is based on that single data point. This approach is expected to be very conservative when applied to large data sets (i.e., using the lowest of a large number of data points). Since the release of the copper guideline BC has changed its approach and would now be likely to use a Species Sensitivity Distribution with the same data set. Irrespective of the approach, BC derives a guideline by applying a minimum safety factor of 2, so the pond snail data point was divided by 2 to derive the guideline.

2. The pond snail prefers habitats of slow-moving or stagnant water bodies, so would not be expected to be present in great densities if at all in the project creeks. This is corroborated by the two years of baseline benthic invertebrate sampling which found no snails, or any other organisms in the Phylum Mollusca, present in local receiving environments.

3. Beyond snails, the next most sensitive endpoint underlying the BC LTA guideline is for reproductive effects in the planktonic crustacean *Daphnia magna* and is approximately double the reported value for the giant pond snail, or approximately 4 times the guideline. The lowest toxicity value for any fish was three times higher than the value reported for the giant pond snail. That toxicity value was for sturgeon. Toxicity values for chronic effects to Rainbow Trout occurred at higher values. Thus, taking into account the safety factor of 2 applied to the lowest data point when deriving the guideline, we would not expect effects on individual Rainbow Trout at copper concentrations up to six times above the guideline (i.e., three times higher than the pond snail). However, this does not

account for potential chemosensory/olfaction effects, which are addressed separately in the BC guideline. We examined the data on chronic chemosensory/olfaction endpoints for Rainbow Trout provided in the Appendix to the BC LTA guideline and found that effect concentrations ranged from 5 to 160 times the guideline (n=5). In summary, we would not expect effects on Rainbow Trout at predicted concentrations. The lowest toxicity data points for algae, macrophytes and amphibians were all more than an order of magnitude higher than for invertebrates, so we would not expect effects to those receptor groups either.

In summary, adverse effects of copper on aquatic life are not expected even when making conservative assumptions about water chemistry.

6.4.6.2 Conclusions

The following summary of potential effects of COPCs applies to Blasting. For Mechanical Ore Extraction, the results for nitrite and nitrate are not relevant and can be ignored.

The potential for chronic effects of nitrite, nitrate and dissolved copper are expected to be negligible for all receptor groups, as follows:

- Fish populations – Effects on fish populations are expected to be negligible. Nitrite is expected to marginally exceed water quality guidelines in fish-bearing waters in limited months, and the maximum predicted concentrations are below those associated with chronic effects to individual fish. Effects to individual fish are therefore unlikely, and effects on fish populations are very unlikely. Predicted concentrations of nitrate exceed water quality guidelines in fish-bearing waters in only one case (one location in one month, under dry conditions), and the concentrations are below levels where effects to Rainbow Trout would be expected. Predicted concentrations of dissolved copper exceed guidelines in fish-bearing waters but are far below the toxicity data for trout, and therefore effects of copper on fish are not expected.
- Benthic invertebrate community – Effects on the benthic invertebrate community are expected to negligible. None of the three COPCs would be expected to affect individual invertebrates at the maximum predicted concentrations, although data are more limited for nitrite and nitrate than for copper, so there is more uncertainty for those cases.
- Periphyton – Effects on the periphyton community are expected to be negligible. Evidence suggests that periphyton are less sensitive than other taxonomic groups to nitrite. For nitrate, no toxicity information is reported by BC or CCME (2012) for plants or algae – according to the CEQG (CCME 2012), nitrate is the primary source of nitrogen for aquatic plants in oxygenated systems such as creeks. Predicted concentrations of dissolved copper exceed are far below the toxicity data for algae and macrophytes, and therefore effects of copper on periphyton are not expected.
- Amphibians – Effects on individual amphibians are expected to be negligible. Nitrate and copper would not be expected to affect amphibians at the maximum predicted concentrations. There is uncertainty about nitrite, as no toxicity data were found in the guideline documents or other literature reviewed.

6.4.7 Potential for Cumulative Effects

The project is expected to be in operation for only two years, and any contributions of nutrients or other COPCs will be limited to that period. With this short time frame, we can expect that the current contributions of other sources to water quality, as measured by 2016 and 2017 data, will be representative of cumulative effects on water quality during operations. In other words, there is no rationale for predicting future water quality sources for a project with only a two-year time horizon.

6.4.8 Uncertainties

There are uncertainties associated with the environmental effects predictions as discussed above. However, given the conservative nature of the water quality modeling, and the focus on worst-case (maximum) predictions, it is unlikely that potential effects associated with predicted water quality have been underestimated.

6.4.8.1 Science-Based Environmental Benchmarks

In general, for projects where water quality guidelines are predicted to be exceeded, but where those exceedances are either natural or may not cause adverse effects because of site-specific considerations, Science-Based Environmental Benchmarks (SBEBs) or equivalent Site Performance Objectives (SPOs) can be developed. The need for or scope of SBEBs or equivalent for this project should be discussed. Given that predicted effects are negligible even at maximum concentrations under all flow scenarios, it may be reasonable to simply set SBEBs at those predicted maximum concentrations. Alternatively, given the conservative nature of the water quality predictions in the receiving environment, it may be reasonable to simply use the existing water quality guidelines, and to consider formal SBEBs only if water quality in the receiving environment indicates a trend that may lead to exceedances of guidelines.

6.4.8.2 Linkages to Adaptive Management

As environmental monitoring data are generated (see Section 7.0), the results help to reduce uncertainties. For aquatic resources, monitoring results under the AEMP (Section 7.6) are directly linked to adaptive management (see Section 7.6.8), so that the information learned is used to adjust the project design and operation (e.g., mitigation) and to adjust the monitoring programs themselves.

6.5 FISHERIES RESOURCES

Fisheries Resources (Fish and Fish Habitat) were included and assessed as a receptor because of the potential to interact with specific aspects of the project, in particular the 'Mechanical Ore Extraction' *(No Blast)* scenario that would include direct discharge from the proposed sedimentation pond to Sophia Creek by way of a diversion channel. Although the proposed discharge will occur in the upper non-fish bearing reaches of Sophia Creek, there is the potential for effluent temperature and quantity to interact with fish and fish habitat downstream in the fish bearing reaches. The 'Blast' scenario, although not the preferred approach to mining for the Project, did not include any direct interactions with fish habitat due to the land application approach applied. Thus, the following assessment of fisheries resources considers only the Mechanical Ore Extraction option.

6.5.1 Assessment Boundaries

Similar to the assessment boundary applied for aquatic resources (Section 6.4), the fisheries assessment boundary included the following watercourses in the assessment of potential effects:

- Sophia Creek – The extent of fish species presence, distribution and habitat quality is summarized in Section 2.9 and the full baseline report provided in Appendix 2-I. Existing condition information from this report supported the assessment of potential effects.

6.5.2 Regulatory Setting

Fish and Fish Habitat are protected and managed in Canada and British Columbia under various legislations, policies, and guidelines. At the federal level, these are the:

- *Fisheries Act* (R.S.C., 1985, c. F-14)
- *Species at Risk Act* (S.C. 2002, c. 29)
- Fish and Fish Habitat Protection Policy Statement (DFO 2019)
- Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada (DFO 2013b)

At the provincial level, these are the:

- *Water Sustainability Act* (SBC 2014, c. 15)
- *Environmental Management Act* (SBC 2003, c. 53)
- BC Environmental Flow Needs Policy (BC Ministry of Forests, Lands and Natural Resource Operations [FLNRORD] and BC Ministry of Environment [ENV] 2016)

Of note, consideration of the *Environmental Management Act* with respect to water quality-related effects on fish is included in Section 6.4 (Aquatic Resources). Additionally, there are no federally listed (Schedule 1) at-risk fish species that occupy, or are in the vicinity of, the Project area, thus is not discussed. The relevance of other listed statutes and their applicability to the assessment of potential effects on fish and fish habitat is summarized, below.

Fisheries Act

The *Fisheries Act* provides a framework for the proper management of fisheries in Canada and for the conservation and protection of fish and fish habitat, including pollution prevention. Fisheries and Oceans Canada (DFO) is responsible for enforcement of the sections of the *Fisheries Act* that prohibit the harmful alteration, disruption, or destruction (HADD) of fish habitat (Section 35(1)) and the killing of fish by means other than fishing (Section 34.4 (1)). Fish habitat is defined as “waters frequented by fish and other areas on which fish depend directly or indirectly to carry out their life process, including spawning grounds and nursery, rearing, food supply, and migration areas”.

Under Section 35(2) of the *Fisheries Act*, The Minister of Fisheries and Oceans Canada may authorize the HADD of fish habitat after considering the following factors:

- The contribution to the productivity of relevant fisheries by the fish or fish habitat that is likely to be affected.
- Fisheries management objectives.
- Whether there are measures and standards to avoid or mitigate the death of fish and avoid or mitigate the HADD of fish habitat.
- The cumulative effects of the carrying on of the work, undertaking, or activity in combination with other works, undertakings, or activities that have been or are being carried on, on fish and fish habitat.
- Any fish habitat banks that may be affected.
- Whether any measures and standards to offset the HADD of fish habitat give priority to the restoration of degraded fish habitat.
- Traditional knowledge of the Indigenous peoples of Canada that has been provided to the Minister.
- Any other factors that the Minister considers relevant.

Other factors the Minister may consider before issuing a Section 35(2) authorization include:

- The application of the precautionary approach and an ecosystem approach.
- The sustainability of fisheries.
- Scientific information.
- Indigenous knowledge of the Indigenous peoples of Canada that has been provided to the Minister.
- Community knowledge
- Cooperation with any government of a province, any Indigenous governing body and anybody, including a co-management body, established under a land claims agreement.
- Social, economic, and cultural factors in the management of fisheries.
- The preservation or promotion of the independence of license holders in commercial inshore fisheries.
- The intersection of sex and gender with other identity factors.

Fish and Fish Habitat Protection Policy Statement

The Fish and Fish Habitat Protection Policy Statement (DFO 2019) was developed by Fisheries and Oceans Canada to explain the fish and fish habitat protection provisions of the *Fisheries Act* and to outline how the Department will implement these provisions. In particular, the Policy Statement sets out how the Department interprets and will apply the regulatory and non-regulatory tools available to support the effective and efficient conservation and protection of fish and fish habitat. The Policy Statement applies to proponents of existing or proposed works, undertakings or activities that may result in harmful impacts on fish or fish habitat, specifically the death of fish by means other than by fishing or the HADD of fish habitat.

The fish and fish habitat protection provisions of the *Fisheries Act* provide a holistic approach to conserving and protecting fish and fish habitat, supported by policies and programs that provide for the long-term sustainability of freshwater and marine resources.

The fish and fish habitat protection provisions of the *Fisheries Act* include:

- A prohibition against causing the death of fish, by means other than fishing (Section 34.4).
- A prohibition against causing the harmful alteration, disruption, or destruction of fish habitat (Section 35).
- A framework of considerations to guide the Minister's decision-making functions (Section 34.1).
- Ministerial powers to ensure the free passage of fish or the protection of fish or fish habitat with respect to existing obstructions (Section 34.3).

When applying these provisions, the Department will employ a risk-based approach to determine the likelihood and severity of potential impacts to fish and fish habitat that could result from a given work, undertaking or activity (DFO 2019).

Framework for Assessing Ecological Flow Requirements to Support Fisheries in Canada

The federal framework for assessing the ecological flow requirements to support fisheries in Canada (DFO 2013) provides advice on the management of flow regimes and water levels required to maintain the ecological functions that sustain fisheries associated with that water body and its habitat. The advice promotes the maintenance of natural flow regimes to sustain riverine ecosystems with the understanding that the probability of degrading riverine ecosystems increases with increasing alteration of the natural flow regime. To manage this risk in Canadian rivers and streams, the scientific advice recommends that assessment of alterations to the natural flow regime should be considered in a cumulative sense, not just a project-by-project basis, and that:

- Cumulative flow alterations less than 10% in amplitude of the actual "instantaneous" flow in a watercourse relative to a "natural flow regime" have a low probability of detectable impacts to ecosystems that support commercial, recreational, or Aboriginal fisheries. Such projects can be assessed with "desk-top" methodologies.
- Cumulative flow alterations that result in instantaneous flows less than 30% of the mean annual discharge (MAD) have a heightened risk of impacts to fisheries.

Given the inherent uncertainty in many ecological flow setting methods, the use of adaptive management based on long-term and follow-up monitoring with multiple control locations is recommended (DFO 2013).

BC Water Sustainability Act

The *Water Sustainability Act* (WSA) is the principal legislation in British Columbia for managing the diversion, extraction, and use of surface and groundwater in the province. The WSA includes the following sections relevant to the protection of fish and fish habitat in BC:

- Section 6 prohibits the diversion or use of surface water and groundwater unless authorized.
- Section 9 allows for the issuance of a license authorizing the diversion or use of water for one or more water use purposes.

- Section 10 allows for the issuance of an approval to divert or use water a term not exceeding 24 months.
- Section 11 allows for the issuance of an approval authorizing changes in and about a stream.

BC Environmental Flow Needs Policy

The environmental flow needs (EFN) of a stream are defined by the *Water Sustainability Act* as "**the volume and timing of water flow required for the proper functioning of the aquatic ecosystem of the stream**". The provincial water manager must consider EFN when deciding a water licence or use approval application on a stream or on an aquifer that is hydraulically connected to a stream.

The Environmental Flow Needs Policy (FLNRORD and ENV 2016) has been developed to guide the review of applications in their consideration of EFN and applies to all applications for a water licence of a use approval for short-term water use administered by ENV or FLNRORD. The policy includes a framework for assessing risk and identifying where cautionary measures could be taken or additional analysis may be needed, including developing site-specific EFN thresholds. The policy is not a method for determining environmental flows but can be applied if there is limited site-specific hydrological or biological data while making conservative estimates of cumulative withdrawal thresholds that would have minimal impacts on EFN.

Risk management measures are proposed to assess or mitigate potential effects of withdrawals from a stream. The measures are associated with risk management levels 1, 2, and 3, or special considerations and are intended to guide whether more caution may be needed in reviewing an application or making decisions. The different risk management levels are presented in Table 6.5-1.

Table 6.5-1: RosI Framework of the BC Environmental Flow Needs Policy

Risk Framework	Description
Risk Assessment Level 1	A stream, or specific flow periods, deemed to be at Risk Assessment Level 1 from withdrawals means that there is sufficient natural water availability for the proposed withdrawal period and that cumulative water withdrawals are below the specified threshold described in the Environmental Risk Assessment Framework (Appendix A of the policy). This withdrawal threshold can range from 5 to 15% of the natural or naturalized flow, with the more conservative threshold for streams or flow periods that are naturally flow sensitive. While "Level 1" does not mean "no risk", supplementary
Risk Assessment Level 2	A stream, or specific flow periods, deemed to be at Risk Assessment Level 2 from withdrawals means that the aquatic environment is flow-limited for the proposed withdrawal period; or that cumulative water withdrawals are greater than a specified threshold of concern, which ranges from 5 to 20% of the natural or naturalized flow. Supplementary information may be requested from the applicant, or the approval or
Risk Assessment Level 3	A stream, or specific flow periods, deemed to be at Risk Assessment Level 3 from withdrawals means that the aquatic environment may be very flow-limited for the proposed period of withdrawal; or that cumulative water withdrawals are greater than a specified threshold of concern, which ranges from 5% for the most flow sensitive to greater than 20% cumulative withdrawals in a low sensitivity scenario. More rigorous

Risk Framework	Description
Special Considerations	The presence of sensitive species or habitats may require "special consideration" or species-specific information which would be taken into consideration with the risk management level. Relevant considerations to this application includes: ▪ Species designated "threatened" or "endangered" under B.C. *Wildlife Act* or Federal *Species at Risk Act* ▪ Sensitive stream designation under the *Water Sustainability Act* and Water Sustainability Regulation; ▪ Wildlife Management Areas with flow related objectives; ▪ Site-specific reports identifying species or aquatic habitat with flow related concerns; and ▪ Regionally important fish species that may include red or blue-listed species and populations that are considered vulnerable in British Columbia because they are rare and (or) have limited distributions.

SOURCE:

FLNRORD and ENV 2016.

6.5.3 Project Interactions, Effect Pathways and Measurable Indicators

Fish and Fish Habitat may interact with the following other project components through including:

- **Water (Effluent) Quantity**: changes in discharge to Sophia Creek originating from the proposed sedimentation pond may interact with the availability and suitability of habitat for fish that utilize lower reaches of Sophia Creek for all, or part, of species life history.
- **Water (Effluent) Temperature**: the temperature of effluent proposed for discharge from the sedimentation pond may alter temperatures in Sophia Creek, particularly during the summer and overwintering bioperiods, which could affect fish survival including habitat use.

The assessment of fish and fish habitat focuses on recreationally or culturally important fish species (with rainbow trout [*Oncorhynchus mykiss*] the only native species present in the Project Area) and the ecosystem components that support their persistence. The assessment of fish and fish habitat considers results from the water quality model (Appendix 5-A), Safe Discharge Plan (Appendix 9-C), and Sedimentation Pond Temperature Assessment (Appendix 5-C; SRK 2023j). This is because changes to surface water quantity and quality (i.e., temperature, dissolved oxygen) could directly or indirectly affect fish population persistence/survival and/or the quantity and suitability of fish habitat upon which fish depend for all, or part, of their life histories.

The two effect pathways have been identified to encompass the pertinent Project-related interactions with fish and fish habitat. These potential effects are the changes to fish habitat associated with: (1) flow alterations (i.e., Harmful Alteration, Disruption or Destruction [HADD]) and (2) changes in fish population persistence/survival. The harmful change in fish habitat could occur through shifts in the timing, frequency, or duration of stream flows and dewatering of catchments (e.g., filling of sedimentation pond).

Table 6.5-2 summarizes the assessment endpoint, potential environmental effect of the Project on fish and fish habitat, the effect pathway, and measurable indicators considered to assess potential effects. Effect pathways are the specific project component or activity that may result in a change in fish habitat or in fish population persistence/survival. Measurable indicators are specific metrics that can be used to evaluate change (where warranted) to fish and fish habitat, to monitor/verify predicted effects, and to assess the significance of expected change that may occur because of the Project by comparing the predicted conditions to known fish habitat requirements (e.g., habitat suitability).

The assessment endpoint for fisheries resources is:

- Fish populations and fish habitat

The focus on fish population and habitat as an assessment endpoint is based on the premise that, rather than individual organisms, the primary fish species (Rainbow Trout) in the project area is a common species, and as such is protected at the population level in BC, not at the individual level. Assessment per the *Fisheries Act* considers several factors when determining whether an interaction results in a residual effect (e.g., HADD) including, (1) the productivity of a fishery, (2) fisheries management objectives, and/or (3) cumulative effects.

Table 6.5-2: Potential Effects, Effect Pathways and Measurable Indictors for Fisheries Resources

Assessment Endpoint	Potential Effect	Effect Pathway	Measurable Indicator(s) and Units of Measurement
Fish Populations and Habitat	Changes in Fish Habitat associated with Flow Alterations	Direct loss of fish habitat due to excavation, placement of material or structures in water, vegetation clearing, and the construction of site water management infrastructure. Altered flow regime, including groundwater contributions to surface water, that may occur due to construction and operation of site water management.	Distance to fish habitat (km) Stream morphology parameters that influence fish habitat suitability including perimeter (m), depth (m), and water velocity Changes in seasonal flow quantity for key fish life stages

Assessment Endpoint	Potential Effect	Effect Pathway	Measurable Indicator(s) and Units of Measurement
	Change in fish Persistence/Survival associated with stream temperature alterations	Alteration of thermal regime in Sophia Creek due to inputs from effluent discharge from sedimentation pond.	Water Temperature (°C) Dissolved Oxygen (mg/L) Pertinent fish species presence/absence and distribution Changes to optimal water temperature (and DO) for key fish life stages

6.5.4 PREDICTED EFFECTS

Fisheries Resources (Fish and Fish Habitat) are linked to the following other technical components including:

- **Surface Water Quantity** (Section 6.3) – changes in surface water quantity may affect the availability and suitability of habitat for fish (populations) using Sophia Creek for all, or part, of their life history.
- **Surface Water Quality** (Sections 2.9, 6.3) – changes in surface water quality may affect the health and persistence of fish populations.
- **Aquatic Resources** (Section 6.4) – changes to aquatic resources, including benthic invertebrates and periphyton, which if influenced by the Project, may affect the health and survival of fish.

These technical sections were applied where applicable to inform the assessment of potential effects on fisheries resources for the two identified effect pathways.

6.5.4.1 Supplemental Information to Inform the Assessment

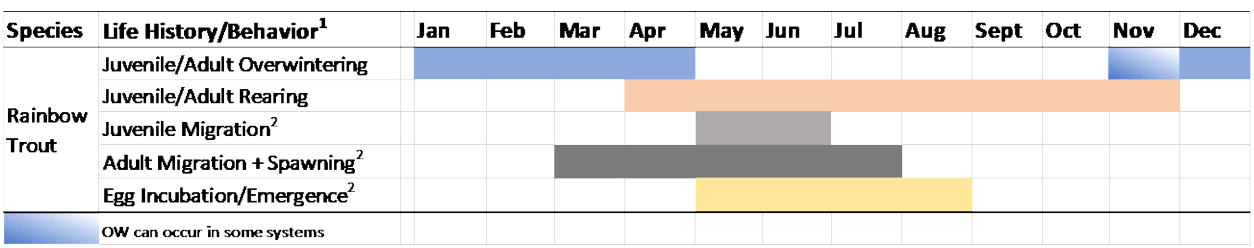
RAINBOW TROUT LIFE HISTORY

The following information was considered (where pertinent) in the assessment of the two identified effect pathways.

As discussed in Section 2.9, the two fish species found in the project area are Rainbow Trout and Eastern Brook Trout – both of these species are common species with Rainbow Trout as the predominant species occupying Sophia Creek. The conservation status of Rainbow Trout in BC is 5 (secure), meaning that it is widespread or abundant and not susceptible to extirpation or extinction. British Columbia does not apply conservation status to Eastern Brook Trout because it is an introduced species, although globally it is also considered secure, widespread, and abundant. For the purposes of the fisheries assessment, focus was placed on Rainbow Trout given their predominance occupying Sophia Creek as well as their native status.

The general life history of Rainbow Trout is illustrated in Figure 6.5-1. Rainbow trout are stream spawning, typically using smaller tributary streams of rivers or inlet or outlet streams of lakes (Scott and Crossman, 1973; Roberge et al., 2002). The age at maturity varies between systems and life histories but fish typically mature between 3 to 5 years and males usually slightly faster than females (Scott and Crossman, 1973). This fish species spawns over fine gravel substrates in streams, typically in riffle/pool areas (both above and below pools) that have vegetated banks for cover (Roberge et al, 2002; Scott and Crossman, 1973). Eggs are deposited over substrates in a prepared nest that is excavated by the female (Scott and Crossman, 1973; Roberge et al, 2001). Males will court females during the digging process and are very aggressive on the spawning grounds (Scott and Crossman, 1973). Spawning typically occurs in the early spring, when water temperatures are 10 to 15 ºC (Scott and Crossman, 1973; Roberge et al, 2002). In BC, spawning typically occurs between March and June (Roberge et al, 2002); emergence from redd's (nests) takes four to seven weeks (mid-June to mid-August, Scott and Crossman 1973; Ford et al. 1995).

In some streams, the major factor limiting salmonid densities may be the amount of adequate overwintering habitat, rather than the amount of summer rearing habitat (Raleigh et al. 1984). Winter hiding behavior in salmonids is triggered by low temperatures (Bustard and Narver 1975a,b). typically found under boulders, log jams, upturned roots, and debris when temperatures neared 4 to 8° C, depending on the water velocity (Bustard and Narver 1975a). Typically, adult rainbow tended to move into deeper pool habitat (>1m depth) while juveniles utilize shallower habitats to minimize energy expenditures and avoid predation risk/competition from larger individuals. Based on winter fish habitat surveys completed for the Project, the fish bearing reaches (reaches 2, 3) were observed to contain poor suitable overwintering habitat due to high stream gradient and a lack of suitable (deep) pools (See Section 2.9).



Sources:
[1]Periodicity dates by life history are not watercourse-specific but leveraged from scientific literature
[2]Porter et al. (2009); Roberge et al. (2002); Raleigh et al. (1984)

Figure 6.5-1: Rainbow Trout Life History and Periodicity

Canopy cover is important in maintaining shade for stream temperature control and in providing allochthonous materials to the stream. Too much shade, however, can restrict primary productivity in a stream. Stream temperatures can be increased or decreased by controlling the amount of shade. About 50 to 75% midday shade appears optimal for most small trout streams (Raleigh et al. 1984). Shading becomes less important as stream gradient and size increase.

WATER QUANTITY CONSIDERATIONS

As described in Section 6.3.1.2, the development of the RRIMM Project is expected to have marginal or negligible changes to on the local water balance. The development of the open pit is expected to increase the rate of groundwater discharge.

Effects on the local water balance are expected to be minimal or negligible. The developed mine areas that report to the sedimentation pond is approximately 18 ha. This area corresponds to about 8% of the total catchment area for station SOP-3 (226 ha), and about 2.5% of the total catchment area for station SOP-2 (738 ha), which are the nearest receiving water monitoring stations (Figure 6.3-1). Most of the contact water collected will be returned to the upper catchment of Sofia Creek via the sedimentation pond diversion channel discharge system located between stations SOP-3 and SOP-2 and is therefore not lost from the local catchment.

Although some groundwater would eventually report to Sofia Creek, the overall reduction in streamflow at stations SOP-3 and SOP-2 in Sophia Creek is expected to be less than the proportion of catchment area affected (i.e., less than 8% and 2.5% change, respectively).

6.5.4.2 Changes in Fish Habitat due to Flow Alterations

The ecological value of natural flow has been theorized that native biota and the ecosystem have evolved with natural flow fluctuations, which vary widely over time scales of days, weeks, and years, thereby creating a dependence on natural variation for survival and reproduction (Lewis et al. 2004). Select project activities have the potential to change surface flows in the receiving environment of Sophia Creek.

Potential changes to surface flow in Sophia Creek is mainly associated with the initial filling of the proposed sediment pond, once constructed. Filling of the sedimentation pond would aim to occur during spring freshet (May). Hydraulic residence time in a pond is an important factor when estimating water temperature. If water is left in a pond indefinitely, it will eventually reach a steady-state that is proportional to the ambient temperature and rates of irradiation (SRK 2023j). Based on model predictions (Appendix 5-C, SRK 2023j), residence time for average monthly inflows to the sedimentation pond are approximately 40 hours. In low flow months (e.g., January) residence time increases (~200 hours).

During the pond filling (residence time) there will be a limited amount of water held while the pond reaches capacity. Once at capacity, pond water will exit through the diversion channel and discharge back into to Sophia Creek. Table 6.5-3 summarizes the mean monthly discharge at key monitoring stations in Sophia Creek as well as the sedimentation pond contribution.

Table 6.5-3: Predicted Change (% difference) in Mean Monthly Flow (m^3/s) in Non-Fish and Fish-Bearing Reaches of Sophia Creek (Average Flow Scenario) during Sedimentation Pond Filling

		Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mine Phase	Location	unit												
Baseline	Sedimentation Pond	m^3/s	0.0033	0.0034	0.0046	0.0095	0.0159	0.0091	0.0046	0.0038	0.0035	0.0035	0.0037	0.0034
Operations	Pond Filling Volume	m^3/s	0	0	0	0	0.0009	0	0	0	0	0	0	0
Operations	Sedimentation Pond	m^3/s	0.0033	0.0034	0.0046	0.0095	0.0151	0.0091	0.0046	0.0038	0.0035	0.0035	0.0037	0.0034
% Difference		%	0	0	0	0	-5%	0	0	0	0	0	0	0
	Residence Time		196.04	191.64	142.13	68.22	40.61	71.07	142.13	170.56	185.39	183.39	174.04	191.64
Baseline	Sophia Creek at SOP-3	m^3/s	0.0099	0.0110	0.0239	0.0873	0.1746	0.0835	0.0247	0.0186	0.0121	0.0125	0.0152	0.0110
Operations	Sophia Creek at SOP-3	m^3/s	0.0099	0.0110	0.0239	0.0873	0.1737	0.0835	0.0247	0.0186	0.0121	0.0125	0.0152	0.0110
% Difference		%	0%	0%	0%	0%	-0.5%	0%	0%	0%	0%	0%	0%	0%
Baseline	Sophia Creek at SOP-2	m^3/s	0.0258	0.0288	0.0721	0.2732	0.5313	0.2618	0.0721	0.0531	0.0330	0.0342	0.0417	0.0288
Operations	Sophia Creek at SOP-2	m^3/s	0.0258	0.0288	0.0721	0.2732	0.5304	0.2618	0.0721	0.0531	0.0330	0.0342	0.0417	0.0288
% Difference		%	0%	0%	0%	0%	-0.16%	0%	0%	0%	0%	0%	0%	0%
Baseline	Sophia Creek at SC01	m^3/s	0.0288	0.0323	0.0797	0.3074	0.6072	0.2960	0.0835	0.0607	0.0368	0.0379	0.0493	0.0323
Operations	Sophia Creek at SC01	m^3/s	0.0288	0.0323	0.0797	0.3074	0.6063	0.2960	0.0835	0.0607	0.0368	0.0379	0.0493	0.0323

		Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% Difference		%	0%	0%	0%	0%	-0.14%	0%	0%	0%	0%	0%	0%	0%
Baseline	Sophia Creek at SC05	m^3/s	0.0417	0.0455	0.1100	0.4554	0.8728	0.4174	0.1138	0.0835	0.0531	0.0531	0.0683	0.0455
Operations	Sophia Creek at SC05	m^3/s	0.0417	0.0455	0.1100	0.4554	0.8719	0.4174	0.1138	0.0835	0.0531	0.0531	0.0683	0.0455
% Difference		%	0%	0%	0%	0%	-0.10%	0%	0%	0%	0%	0%	0%	0%

Table 6.5-4: Flow Sensitivity of Sophia Creek based on BC Environmental Flow Policy Risk Assessment Framework

Mine Phase														
Baseline	Sophia Creek at SOP-3	m^3/s	0.0099	0.0110	0.0239	0.0873	0.1746	0.0835	0.0247	0.0186	0.0121	0.0125	0.0152	0.0110
	Flow Sensitivity SOP-3		24%	27%	59%	216%	433%	207%	61%	46%	30%	31%	38%	27%
	Flow Sensitivity Category1		**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Baseline	Sophia Creek at SOP-2	m^3/s	0.0258	0.0288	0.0721	0.2732	0.5313	0.2618	0.0721	0.0531	0.0330	0.0342	0.0417	0.0288
	Flow Sensitivity SOP-2		21%	24%	59%	225%	438%	216%	59%	44%	27%	28%	34%	24%
	Flow Sensitivity Category1		**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Baseline	Sophia Creek at SC01	m^3/s	0.0288	0.0323	0.0797	0.3074	0.6072	0.2960	0.0835	0.0607	0.0368	0.0379	0.0493	0.0323
	Flow Sensitivity SC01		21%	23%	58%	223%	441%	215%	61%	44%	27%	28%	36%	23%
	Flow Sensitivity Category1		**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Baseline	Sophia Creek at SC05	m^3/s	0.0417	0.0455	0.1100	0.4554	0.8728	0.4174	0.1138	0.0835	0.0531	0.0531	0.0683	0.0455
	Flow Sensitivity SC05		21%	23%	56%	232%	444%	212%	58%	42%	27%	27%	35%	23%
	Flow Sensitivity Category1		**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**	**low**

[1]BCMFLNRO and ENV 2016

Based on the average flow scenario, predicted flow reduction in Sophia Creek would occur in the month of May during spring freshet when flows are highest in Sophia Creek and when residence time to fill the pond would take the least duration. During pond filling, the highest predicted change in Sophia Creek flows occurs at station SOP-3 with a 5% reduction. As flows reach the fish bearing section of Sophia Creek (~2.7 km downstream), the predicted flow change is estimated in the range of 0.10-0.14% (Table 6.5-3). Thus, the predicted change in flow (magnitude, frequency, duration) in Sophia Creek during pond filling is considered negligible and not expected to alter Rainbow Trout habitat suitability downstream in fish bearing reaches.

The predicted flow change in Sophia Creek was also evaluated in terms of flow sensitivity as described in the BC Environmental Flow Policy (MFLNRO and ENV 2016) EFN Risk Assessment Framework. The framework assumes that mean monthly discharge:

- Greater than 20% long-term Mean Annual Discharge (lt MAD) represents low flow sensitivity;
- Between 10 and 20% lt MAD represents moderate flow sensitivity; and
- Less than 10% of lt MAD represent high flow sensitivity.

Because monthly flows are predicted to be greater than 20% lt MAD (Table 6.5-4) across all months, they fall within the '*low flow sensitivity'* category. This category defines a stream, or specific flow periods, deemed to be at Risk Assessment Level 1 meaning that there is sufficient natural water availability for the proposed withdrawal period and that cumulative water withdrawals are below the specified threshold described in the Environmental Risk Assessment Framework. There are no fish species that require 'special consideration' given Rainbow Trout are the predominant fish species occupying Sophia Creek, the only native species present, and are located approximately 2.8 km downstream from the Project area where the predicted surface flow changes are in essence immeasurable.

The predicted flow change in the fish bearing reaches of Sophia Creek was further evaluated against DFO (2013). With flow alterations predicted to be considerably lower than 10% in amplitude of the actual instantaneous flow relative to the Sophia Creek's natural flow regime, there is low probability of any potential residual effect to be detected.

Given the above, a detailed environmental flow needs study is not considered necessary at this time as changes to Rainbow Trout habitat suitability in Sophia Creek for the species key biperiods (e.g., overwintering, spawning/incubation, rearing) are not expected. Hence, no harmful alteration, destruction, or disruption (HADD) is expected.

6.5.4.3 Changes in Fish Persistence/Survival associated with Stream Temperature Alterations

Stream temperatures could be modified by the loss/interception of runoff (flow), redirection, or storage, of mine-influenced (treated) or clean water; by all activities associated with site preparation, waste rock placement, the implementation of the site Water Management Plan, or due to heating or cooling of mine-treated water through ambient exposure (e.g., sedimentation pond). Changes to stream temperatures could affect the thermal regime within Sophia Creek such that water temperatures could fall outside of the thresholds tolerated by Rainbow Trout, ultimately influencing how habitat is utilized by Rainbow Trout including their survival if thermal thresholds are exceeded. Modifications to stream temperatures can influence the suitability of overwintering, spawning, and rearing (foraging) habitats, food supply, life history cues (i.e., incubation, migration), that may ultimately affect the ongoing productivity of Rainbow Trout including their ability to maintain a self-sustaining population.

Many streams experience diel temperature flux and a range in daily temperature of more than 5°C is common. However, the high latent heat of water can cause stream temperatures to vary much more narrowly on a daily basis than air temperatures (Hauer and Lamberti 2006). Factors such as groundwater input and riparian shading can have a large influence on stream temperature (Hauer and Lamberti 2006,) leading to high variation in stream temperatures between habitats only a few meters apart (Hauer and Lamberti 2006). Fish move throughout waterbodies, in response to changes in temperature: as water temperature declines in the fall, juveniles move downstream seeking out deep pool habitat and other protected areas to overwinter (Jakober et al. 1998).

A sedimentation pond will be constructed to collect all water (contact, non-contact) associated with the mine and will be treated prior to discharge. Of the two discharge scenarios being considered for the Project (blasting, mechanical ore extraction), only mechanical ore extraction is assessed given the associated direct discharge to Sophia Creek by way of a diversion pipe (SRK Safe Discharge Plan 2023g; Appendix 9-C) with this mining option.

Construction of the pond will increase surface area and may result in subtle water temperature alterations to the sedimentation pond water prior to discharge to Sophia Creek depending on the season and the extent to which groundwater (and surface runoff) is intercepted. For details regarding the sedimentation pond size etc., please refer to the Safe Discharge Plan (SRK 2023g; Appendix 9-C).

Heat transfer to and from water in a sedimentation pond is a process that involves many variables, including the difference between ambient and water temperatures, relative humidity, wind speed, sun and long-wave radiation intercepted (or emitted) by the pond, pond residence time, as well as ground temperature (SRK 2023j; Appendix 5-C).

The potential effects of an increase in the sedimentation pond water temperature and its influence on Sophia Creek temperatures downstream of the project were evaluated by estimating the total flow contribution to the nearest fish presence downstream of the Project area (SRK 2023j; Appendix 5-C). The following information were included in the assessment:

- catchment area of the sedimentation pond (18.9 ha),
- the location of the nearest fish presence in Sophia Creek downstream of the RRIM Project area (2.8 km downstream),
- the natural catchment area upstream of the nearest fish presence (827 ha),
- Existing stream temperature and dissolved oxygen (DO) data for Sophia Creek, and
- Rainbow trout life history/bioperiod information including optimum RBT temperature ranges.

As earlier described, the sedimentation pond catchment contributes 2.2% of the total flow at the upper fish (Rainbow Trout) distribution limits in Sophia Creek. Baseline stream temperatures in Sophia Creek during the summer months (July-September) range between 9.2°C and 15.6°C (Table 6.5-5; Figure 6.5-2).

Table 6.5-5: Range of Sophia Creek (A) Temperature (monthly) and (B) Dissolved Oxygen (low flow bioperiods) values

A.	SC-01[1]	Date	SC-05[1]	Date
Temp (°C)				
Minimum	0	Dec-16	0	Dec-17
Maximum	15.6	Aug-17	15.3	Aug-17

[1]measurements taken from established water quality stations on Sophia Creek

B.	Reach 1[2]	Reach 2[2]	Reach 3[2]	Reach 4[2]	Mean	Min	Max
DO (mg/L)							
Aug-16	7.28	9.38	9.64	7.63	8.48	7.28	9.64
Mar-16	11.90	13.65	13.05	-	12.87	11.9	13.65

[2]in-situ dissolved oxygen measurements in reaches delineated during fish habitat surveys with specific emphasis on low flow bioperiods (i.e., summer, winter). Note: Reach 3 is upper limit of RBT distribution in Sophia Creek

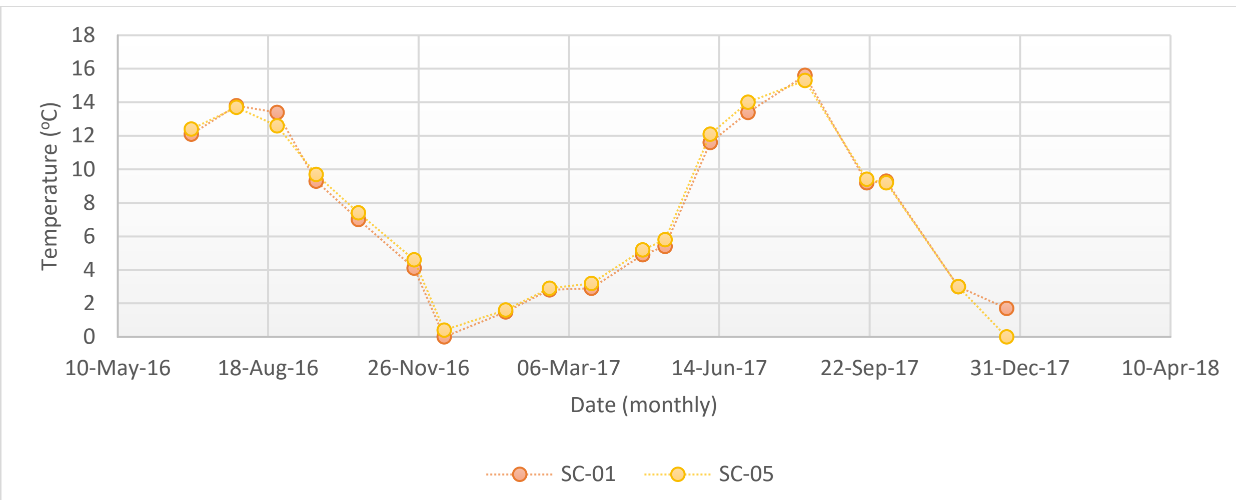


Figure 6.5-2: Sophia Creek Temperature Profile by Month over 2016 and 2017

The temperature assessment focused primarily on the summer low flow period when stream flows are typically low, temperatures elevated, and dissolved oxygen (DO) concentrations inversely related to stream temperature (e.g., high temp = lower DO).

As noted, the sedimentation pond catchment contributes approximately 2.2% of the total flow at the upper fish distribution limits. The maximum baseline stream temperature measured in upper Sophia Creek during the warm summer months are 15.6°C. Based on model predictions (SRK 2023j), if water in the sedimentation pond were to increase from 10°C to 17°C in the warm summer months, the resulting increase in temperature in the fish bearing reaches, would increase by approximately 0.15°C, which would increase the maximum stream temperature to 15.75°C. If the pond water temperature were to increase from 10°C to 22°C the theoretical increase in stream temperature would be 0.22°C, which would increase the maximum stream temperature to 15.82°C.

The above-noted Sophia Creek temperature change predictions were evaluated against the optimum temperature range(s) for Rainbow Trout (Table 6.5-6). The summer rearing bioperiod is most applicable. The predicted range of temperature change (15.75°C to 15.82°C) continues to fall below the Rainbow Trout optimum rearing temperatures (16-18°C). Additionally, the predicted change in temperature is less than 1°C thus the subtle increase is not expected to affect sensitive life history stages over short time frames (i.e., hourly).

Table 6.5-6: Optimum Temperature Ranges of Specific Life History Stages for Rainbow Trout that Occupy the Project Area

Species	Incubation (°C)	Rearing (°C)	Migration (°C)	Spawning (°C)
Rainbow Trout	10.0-12.0	16.0-18.0	N/A	10.0-15.5

Source: BC Water Quality Guidelines for Temperature (2001)

Based on the temperature predictions, a residual effect to Rainbow Trout or habitat (water quality) conditions are not expected given the subtle shift in stream temperature. Furthermore, with the negligible change in temperature, it is expected that dissolved oxygen concentrations throughout Sophia Creek will remain within documented (and acceptable) values, particularly given f the documented steep channel gradient and associated high turbulence that should maintain sufficient dissolved oxygen levels in Sophia Creek.

Given the above, no residual effect to Rainbow Trout persistence and/or survival are expected based on the small, predicted shift in Sophia Creek's thermal regime.

6.5.5 Potential for Cumulative Effects

Given the predicted subtle changes (magnitude, frequency, duration) in surface flow to Sophia Creek during the sediment pond infilling and the Risk Assessment Level I (i.e., low sensitivity to flow alterations per the BC Environmental Flow Policy), no residual effect to fish populations and fish habitat are expected. Additionally, the predicted change to Sophia Creek water temperature is also predicted to be negligible during the highest risk period (i.e., summer low flow/RBT rearing bioperiod). Thus, no residual effect to the Rainbow Trout population and associated fish habitat are expected. Given these findings, no cumulative effects assessment is necessary.

6.5.6 Uncertainties and Prediction Confidence

The assessment of potential Project-specific effects on the assessment endpoint (Fish populations and habitat) is largely based on predicted changes in flow provided through water balance and predicted changes to water quality (stream temperature) through other model predictions (e.g., sedimentation pond temperature). Each of these models has inherent uncertainty in the input data, scenarios, and assumptions used to construct, calibrate, and validate the models. Despite these uncertainties, the assessment of potential effects to fish and fish habitat due to the changes in stream flows and water quality predicted by these models has been assumed to be an accurate reflection of what may occur should the Project be constructed, operated, and reclaimed. Conservatism has been incorporated into the models to reduce these uncertainties whenever possible.

Temperature data collected from Sophia Creek was based on in-situ measurements collected monthly at established stations. Although the data collected over two years appears to reflect a level of low seasonal variability, it is possible there are days in each month that temperatures are lower or higher than those documented. Thus, there is a level of uncertainty if the current characterization of stream temperature in Sophia Creek is accurate. However, the predicted change in temperature in Sophia Creek is extremely low, thus will not likely adversely contribute additional thermal stress to Rainbow Trout inhabiting Sophia Creek.

6.5.7 FOLLOW-UP AND MONITORING

Given the described uncertainties around stream temperature in Sophia Creek and the ongoing risk associated with climate change, it is proposed to include continuous monitoring temperature gauges at established hydrometric stations and/or installed and tracked separately in fish bearing reaches. The inclusion of such monitoring would be integrated int the proposed Aquatic Effects Monitoring Plan; the data collected would be used to verify the thermal predictions as well as identify and mitigate in the event monitoring data poses an elevated risk.

6.6 TERRESTRIAL RESOURCES

6.6.1 VEGETATION RESOURCES

6.6.1.1 Assessment Boundaries

The terrestrial Surface Footprint includes the area of Project infrastructure, where clearing and Project activities will be located, with a buffer applied to capture in-between areas and a 5 m buffer. This Surface Footprint is where direct effects are predicted to occur. The assumption is that this 27.5 ha area will be cleared of vegetation for the life of mine (Figure 4.2-3 in Section 4.2.3 for the spatial extent of the Project infrastructure and the TEM). However, as indicated in the management plans and mitigations (Chapter 9), this is a conservative approach and not all of this area will be cleared. Retention of vegetated areas will occur within the Surface Footprint.

In addition, a 100 m buffer from the terrestrial Surface Footprint has been applied, termed the local study area (LSA; 81.3 ha) for vegetation resources, which is the potential outermost area of indirect edge effects from the Surface Footprint. The TEM area is used to provide regional context of effects and consideration of potential cumulative effects, termed the regional study area (RSA) for vegetation resources, covering 1,691.1 ha.

6.6.1.2 Indicators and Endpoints

The assessment endpoints for vegetation and ecosystems are:

- Ecosystems of management concern, including red- or blue-listed ecological communities (ecosystems) by the BC CDC; old forest; and wetland communities.
- At-risk plant species, including red- or blue-listed species by the BC CDC, SARA, or COSEWIC.
- Plants of potential importance to local First Nations.

The indicators (metrics) used in the assessment of vegetation and ecosystem endpoints are as follows:

- Areal extent (in ha) directly lost or indirectly exposed to the risk of edge effects for ecosystems and plants of management concern.
- Abundance (count) of species of management concern directly lost or indirectly exposed to the risk of edge effects.
- Areal extent (in ha) directly lost or indirectly exposed to the risk of edge effects for vegetated areas that have potential to support plants of potential importance to local First Nations.

6.6.1.3 Exposure Pathways for Potential Effects

Exposure pathways for potential effects to vegetation and ecosystem assessment endpoints (receptors) include:

- Loss of ecosystems of management concern through ground disturbance and removal of vegetation.
- Loss of plants of management concern through ground disturbance and removal of vegetation.
- Loss of plants of potential importance to local First Nations through ground disturbance and removal of vegetation.
- Edge effects that can change the quality or condition of vegetation, including changes in soil conditions (moisture and temperature), changes in hydrology; increase or spread of invasive plants; and/or dust deposition from construction activities and road use).

The *Weed Control Act* (1996) and its regulations define which plant species are considered noxious provincially and regionally. The Invasive Plant Council of BC identifies species which are of management concern within that includes both noxious weeds identified in the *Weed Control Act* and non-noxious species. One invasive species, spotted knapweed (*Centaurea stoebe*), was identified in the RSA and is considered a provincial noxious weed.

6.6.1.4 Predicted Effects

Table 6.6-1 provides the areas (in hectares) of mapped ecological communities in the Surface Footprint and the proportion lost from the RSA. Up to 24.5 ha of vegetated ecological communities (i.e., 2% of vegetated ecological communities in the RSA) will be removed during construction and remain unvegetated until mine closure, until revegetation establishes during closure and post-closure of the Project. One red-listed ecological community, which is mapped as graminoid grassland (Gg) in the TEM but mapped by BC CDC (2023) as Idaho fescue – bluebunch wheatgrass – silky lupine – junegrass, occurs in 5.5 ha of the Surface Footprint, 10% of its occurrence in the RSA. Of this, the majority (4.0 ha) occurs in the ICHmw5 and the remainder (1.5 ha) occurs in the ESSFmh (Figure 6.6-1).

No other red- or blue-listed ecological communities occur in the Surface footprint. No wetland or old forest ecological communities occur in the LSA; therefore, these ecosystems of management concern are not predicted to be impacted (loss or edge effects) from the Project infrastructure or activities.

Potential edge effects could occur in up to 46.0 ha (3%) of vegetated ecological communities of the RSA, in the area between the Surface Footprint and the LSA boundary (Table 6.6-2). There are up to 9.7 ha (17% of the RSA occurrence) of the known red-listed graminoid grassland, Idaho fescue – bluebunch wheatgrass

– silky lupine – junegrass in the ICHmw5, that occurs in the LSA outside of the Surface Footprint (i.e., the area potentially subject to edge effects), the majority of which (5.5 ha) is in the ICHmw5 and the remainder (4.3 ha) is in the ESSFmh.

Table 6.6-1: Record Ridge Ecosystems – Area (ha) in the Surface Footprint and Proportion of RSA

BEC Unit	Site Map Code	Ecosystem Name	Surface Footprint	RSA	Proportion (%) Lost in RSA1
			Area (ha)		
Vegetated					
ESSFmh	101	Subalpine fir Engelmann spruce–- rhododendron - foamflower	0.1	48.7	0.3
	103	Subalpine fir Douglas-–fir huckleberry - falsebox	1.3	31.9	3.9
	104	Douglas-fir western redcedar – falsebox – prince’s pine	0.2	11.5	1.8
	Gg	Graminoid grassland2	1.5	36.6	4.1
Vegetated ESSFmh Subtotal			3.1	137.3	2.3
ICHmw5	101	Western hemlock western redcedar - falsebox	6.5	365.0	1.8
	103	Douglas-fir Douglas maple – falsebox	2.5	113.3	2.2
	104	Douglas-fir western redcedar – falsebox - prince's pine	8.4	129.5	6.5
	110	Western redcedar – western hemlock - oak fern	0.1	13.4	0.6
	Gg	Graminoid grassland3	4.0	20.1	19.7
Vegetated ICHmw5 Subtotal			21.3	680.0	3.1
Vegetated Total1			24.5	1,555.1	1.6
Unvegetated					
ESSFmh	RO	Rock	0.2	7.8	3.0
ICHmw5	RO	Rock	4.3	28.1	15.2
	Rz	Roadway	0.4	19.2	2.0
Unvegetated Subtotal[1]			4.9	136.0	3.6
Total Area			**29.4**	**1,691.1**	**1.2**

1 Subtotals and totals of the RSA vegetated and unvegetated include other BEC Units and site map codes/ecosystem names than those in the Surface Footprint.

2 The graminoid grassland unit in the ESSFmh may be the red-listed ecological community, Idaho fescue - bluebunch wheatgrass - silky lupine – junegrass,.

3 The graminoid grassland unit in ICHmw5 in the footprint is a red-listed ecological community, Idaho fescue - bluebunch wheatgrass–- silky lupine - junegrass (BC CDC 2023c; Section 2.10.1.2 of Chapter 0).

Table 6.6-2: Record Ridge Ecosystems – Area (ha) of Potential Edge Effects

BEC Unit	Site Map Code	Ecosystem Name	Area (ha) of Potential Edge Effects	RSA	Proportion (%) Affected in RSA[1]
			Area (ha)		
Vegetated					
ESSFmh	101	Subalpine fir Engelmann spruce–- rhododendron - foamflower	1.0	48.7	2.1
	103	Subalpine fir Douglas-–fir huckleberry - falsebox	1.4	31.9	4.5
	104	Douglas-fir western redcedar – falsebox – prince’s pine	1.3	11.5	11.5
	110	Subalpine fir–- rhododendron - oak fern (subalpine fir/white-flowered rhododendron/Sitka valerian) [2]	0.4	1.6	23.9
	Gg	Graminoid grassland[3]	4.3	36.6	11.6
Vegetated ESSFmh Subtotal			8.4	137.3	6.1
ICHmw5	101	Western hemlock w–stern redcedar - falsebox	14.0	365.0	3.8
	102		0.1	37.3	0.2
	103	Douglas-fir Douglas maple – falsebox	4.6	113.3	4.1
	104	Douglas-fir western redcedar – falsebox - prince's pine	13.0	129.5	10.1
	110	Western redcedar –western hemlock - oak fern	0.3	13.4	2.5
	Gg	Graminoid grassland[3]	5.5	20.1	27.2
Vegetated ICHmw5 Subtotal			37.6	680.0	5.5
Vegetated Total[1]			46.0	1,555.1	3.0

BEC Unit	Site Map Code	Ecosystem Name	Area (ha) of Potential Edge Effects	RSA	Proportion (%) Affected in RSA[1]
			Area (ha)		
Unvegetated					
ESSFmh	Ro	Rock	0.3	7.8	3.4
ICHmw5			5.1	28.1	18.3
	Rz	Roadway	0.6	19.2	3.0
Unvegetated Subtotal[1]			6.0	136.0	4.4
Total Area			52.0	1,691.1	3.1

[1] Subtotals and totals of the RSA vegetated and unvegetated include other BEC Units and site map codes/ecosystem names than those in the Surface Footprint.

[2] The name presented in this table aligns with the naming convention in MacKillop and Ehman (2016) but it is equivalent of the blue-listed ecological community, subalpine fir/white-flowered rhododendron/Sitka valerian (CDC 2023a).

[3] The graminoid grassland unit in LSA is a red-listed ecological community, Idaho fescue - bluebunch wheatgrass–- silky lupine – junegrass mapped by the BC CDC (2023c; Section 2.10.1.2).

There is 0.4 ha (i.e., 24% of its occurrence in the RSA) of a blue-listed mature forested ecological community subalpine fir/white-flowered rhododendron/Sitka valerian, that occurs within the area for potential edge effects, i.e., between the Surface Footprint and LSA.

One at-risk species, mountain holly fern, was identified at three locations in the LSA (Section 2.10.1.2); the closest of which is 26 m from the Surface Footprint (Figure 6.6-2), specifically the west side of the open pit. Each identified location is considered a “population” comprised of more than one individual mountain holly fern plant. In addition, there is potential that rare plants exist that have not been identified in the Surface Footprint and mitigation measures have been incorporated to reduce risk of effects to these potential occurrences (Section 9.12). Potential edge effects could occur to these three populations and given the close proximity of these plants to the Surface Footprint, there is a potential for loss of these occurrences without proper mitigation and management strategies in place.

Plants of potential importance to First Nations occur in vegetated ecological communities throughout the Surface Footprint, LSA, RSA. Therefore, the 24.5 ha (2% of the vegetated RSA) that will be lost means there is potential loss of these plants of potential importance to First Nations. Indirect effects from edge effects may occur in up to 46.0 ha (3% of the vegetated RSA) of vegetated ecological communities that support plants of potential importance to First Nations.

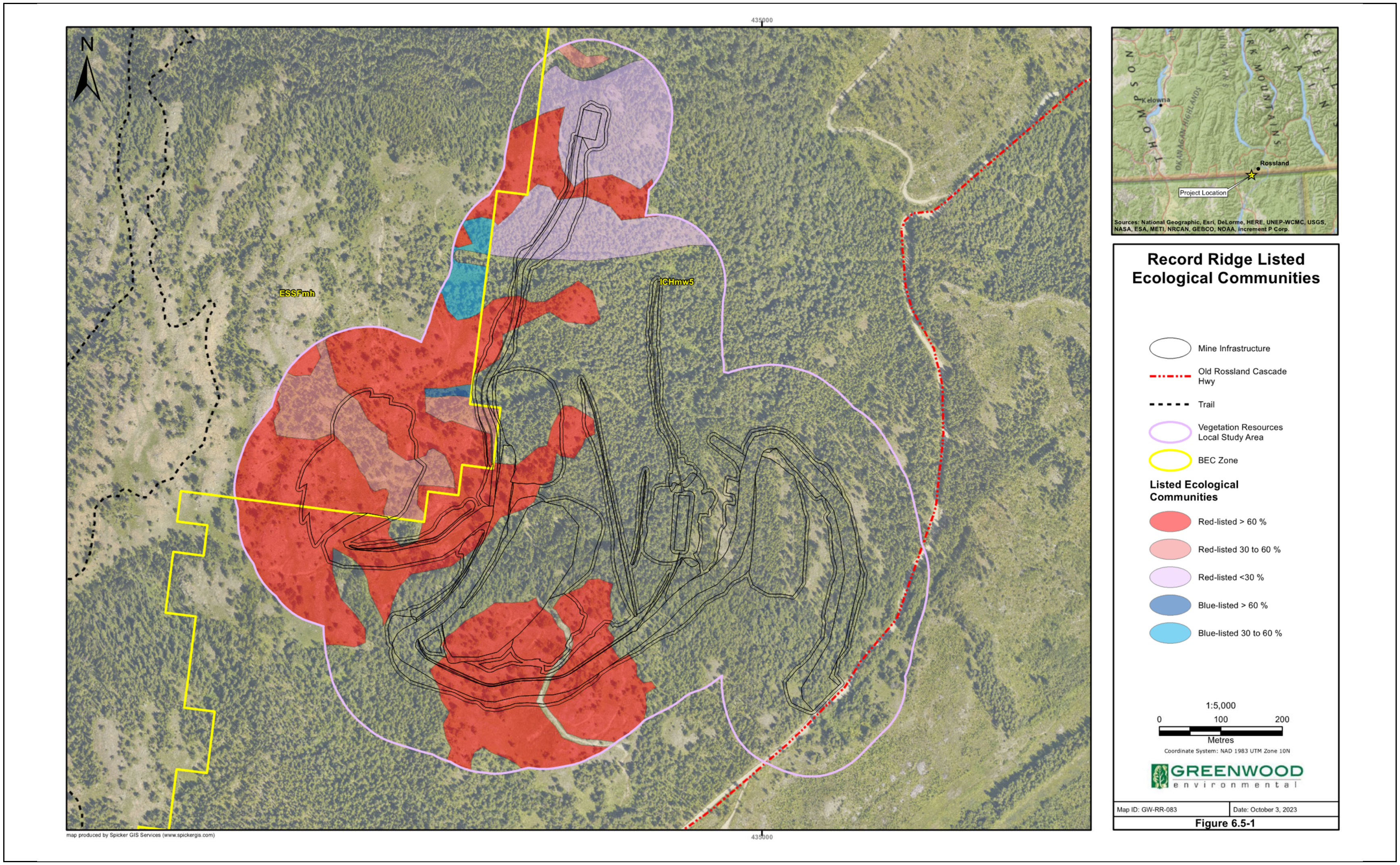


Figure 6.6-1: Record Ridge Listed Ecological Communities

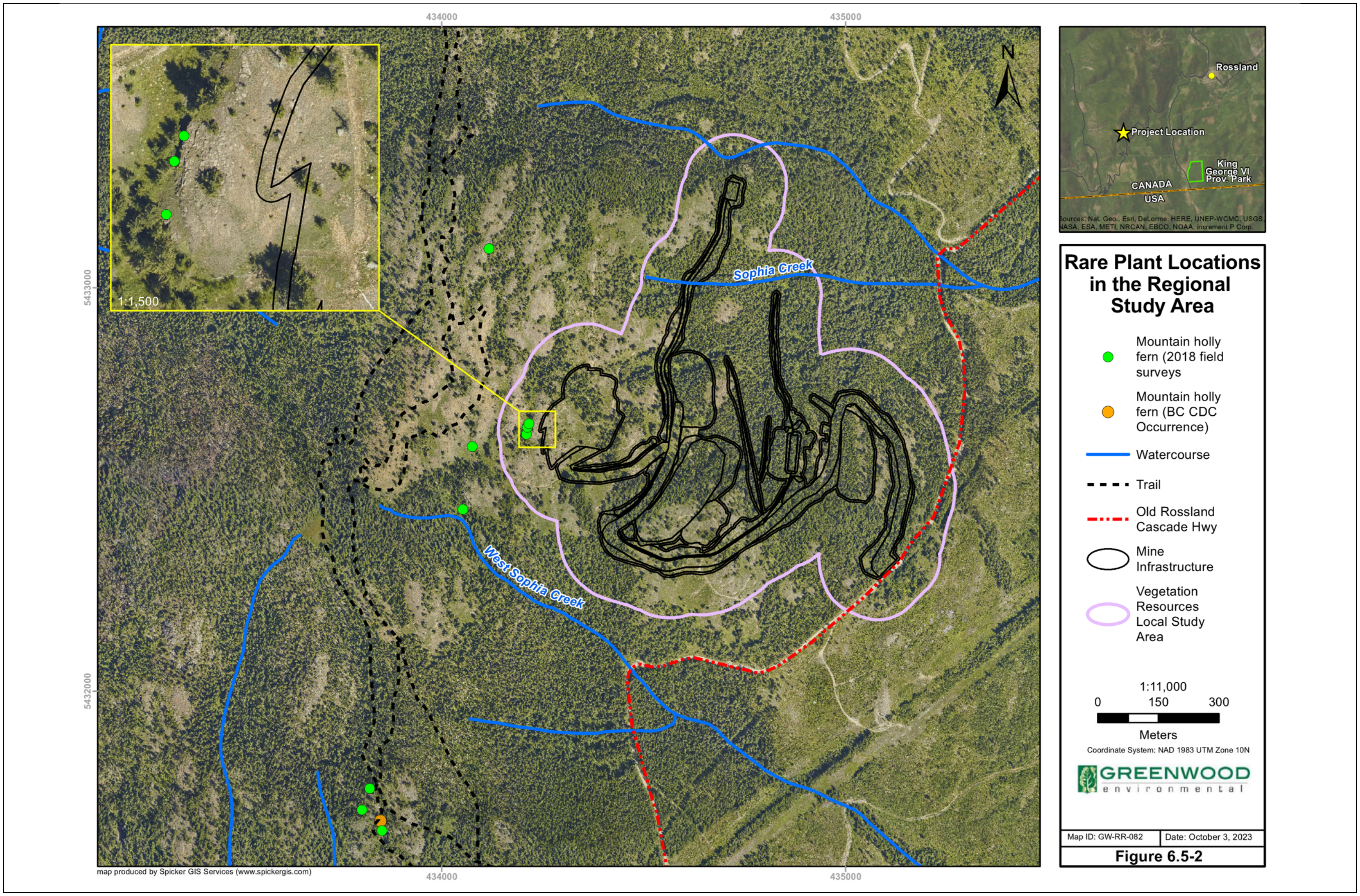


Figure 6.6-2: Rare Plant Locations in the Regional Study Area

6.6.1.5 Risk Reduction

The BC Mitigation Policy and Procedures (BC Ministry of Environment 2014a, 2014b) recommends the mitigation hierarchy to avoid, minimize, and restore on site and this will be implemented for the Project. Removal of vegetation and ecosystems from the terrestrial Surface Footprint is not avoidable; therefore, the risk is unavoidable for vegetated ecological communities (including plants of potential importance to First Nations). However, reclamation of the site will restore these vegetation communities to native vegetation, including restoring the red-listed graminoid grassland community and including species of importance to First Nations.

Where disturbance areas are unavoidable, the Vegetation Management Plan and its mitigation measures will be implemented (see Section 9.12), and reclamation of the site will restore vegetation communities to native vegetation as per the Reclamation and Closure Plan (see Section 4.0).

6.6.1.6 Residual and Cumulative Effects Considerations

Ecosystems of Management Concern

The potential risks of loss of ecosystems of management concern is considered moderate in magnitude because there will be temporary loss of a red-listed ecological community, but it is not anticipated to impair the viability of its occurrence in the RSA. Potential edge effects to these ecosystems is low to negligible in magnitude.

The loss will occur in a single event and would be reversible through reclamation (see Section 4). Reclamation will re-establish early seral stages of native vegetation, including plants of potential importance to First Nations, that will initiate a natural successional trajectory to develop pre-disturbance vegetation. However, potential effects may take several years to re-establish post-reclamation. The indirect edge effects are anticipated to occur continuously throughout all phases and cease at the end of closure and reclamation. Ecosystems of management concern affected by edge effects will be short-term, reversible, and resilient. These ecosystems are considered resilient because they can recover from a perturbation due to edge effects, and they are common to the RSA and BEC units in which they occur.

Plants of Management Concern

Given the mitigation and management strategies in place for the at-risk plant species, mountain holly fern (Section 9.12 Vegetation Management Plan), particularly avoiding the species that occurs adjacent to the Project Surface Footprint and monitoring for edge effects, the risk of loss of mountain holly fern is considered not applicable. The risk of edge effects to mountain holly fern is moderate in magnitude because any residual adverse effects to this species is risky to the viability of the plants adjacent to the Surface Footprint; however, it is not anticipated to impair the viability of its occurrence in the RSA.

The indirect edge effects are anticipated to occur continuously throughout all phases, peaking particularly during construction and closure activities, and will cease at the end of closure and reclamation. Plant species of management concern affected by edge effects will be short-term, reversible, and thought to be resilient, i.e., can recover from a perturbation due to edge effects, and are distributed throughout the RSA. The plant occurrences within the LSA will be closely monitored and adaptive management strategies identified by a Qualified Professional will be implemented if any edge effects are identified through monitoring.

PLANTS OF POTENTIAL IMPORTANCE TO FIRST NATIONS

The potential risks of loss of vegetation communities (including plants of potential importance to First Nations) are considered low magnitude because these terrestrial resources in the context of their occurrence in the landscape are widespread and common within the RSA and BEC units.

The predicted loss of vegetated area from the Surface Footprint clearing is up to 24.5 ha (2% of the vegetated RSA), with a potential for edge effects (primarily from dust deposition and potential invasive plant introduction or spread) that could occur in up to 46.0 ha (3% of the vegetated RSA).

Areas that are cleared of vegetation will be reclaimed and revegetated in accordance with the reclamation plan. Reclamation will re-establish early seral stages of native vegetation, including plants of potential importance to First Nations, that will initiate a natural successional trajectory to develop pre-disturbance vegetation. The loss will occur in a single event and will be reversible through reclamation. The indirect edge effects are anticipated to occur continuously throughout operations and cease at the end of closure and reclamation of the mine. Vegetation communities affected by edge effects will be long-term (to end of mine) and reversible. Vegetation communities affected are considered resilient because they can recover from a perturbation, and they are common to the area and BEC units of the LSA (ESSFmh and ICHmw5).

CUMULATIVE EFFECTS CONSIDERATIONS

No other projects occur in the RSA; however, forestry activities overlap the RSA. There is no predicted cumulative loss of the red-listed graminoid grassland, Idaho fescue - bluebunch wheatgrass–- silky lupine - junegrass, nor the mountain holly fern, because it is low to no probability that forestry activities would occur in these ecological community types (e.g., non-forested). However, there could be cumulative edge effects to the blue-listed ecological community, subalpine-fir – rhododendron – oak fern, with the Project's contribution predicted to be 0.4 ha (24% of its occurrence in the RSA).

The loss of vegetation that supports plants of potential importance to First Nations have the potential to interact cumulatively for plants occurring in forested ecological communities.

Overall, the temporary loss and edge effects on vegetation and ecosystems of management concern from the Project, are not anticipated to result in substantive irreversible residual Project or cumulative effects on vegetation. The red-listed ecological community will be closely managed and monitored in the areas outside of the clearing area to minimize the disturbance to this at-risk community. As well, the red-listed and SARA and COSEWIC listed mountain holly fern will be avoided through mitigation and will be closely managed.

6.6.2 WILDLIFE RESOURCES

6.6.2.1 Assessment Boundaries

Both temporal and spatial assessment boundaries are considered in predicting potential effects on wildlife and wildlife habitat. The temporal assessment for the Project is two years of Project construction and operations activities and less than one year of closure activities, which, given this relatively short-term timeframe, means many of the typical direct and indirect effects from mining activities on wildlife and wildlife habitat have lower potential to apply for the Project. The potential effects considered and predicted are described within spatial boundaries within the 3-year timeframe for Project activities.

The Surface Footprint (29.4 ha) includes both the existing and new disturbance area where Project components and/or activities will occur and associated potential direct wildlife habitat effects (e.g., loss of vegetated ecosystems). Existing disturbances are captured as part of baseline, or existing, conditions. The vegetation and ecosystems LSA is used to determine some potential effects, such as alteration of habitat, and the study area used for the TEM (Appendix 2-J) is considered as the RSA for a regional context. These study area boundaries provide context and considerations of potential disturbance effects to wildlife and wildlife habitat, as well as potential for cumulative interactions.

6.6.2.2 Indicators and Endpoints

Key species or groups of species are identified as the focus for the effects assessment, as it would be impossible to assess potential effects to all species. Wildlife focal species groups are used as indicators in the effects assessment as potential for interaction with the Project components or activities.

Table 6.6-3 provides the wildlife and wildlife habitat indicators and endpoints considered in the assessment predictions. Section 2.10.2 provides the known, likely, or possible species within each focal group based on desktop and/or field surveys.

Table 6.6-3: Wildlife and Habitat Indicators and Endpoints Considered in Effects Predictions

Indicator – Focal Wildlife Group	Potential Effect	Endpoint
• Birds • Furbearers • Ungulate • Amphibians[1] • Reptiles • Bats	Loss or alteration of wildlife habitat[2]	Areal extent (in hectares) of habitat lost (quantitative and qualitative analysis) Areal extent (in hectares) of where quality of habitat may change (quantitative and qualitative analysis)
	Sensory disturbance or behavioural alterations[3]	Changes to wildlife movement related to Project infrastructure or activities (qualitative analysis)
	Mortality[4]	Increased mortality of wildlife species from Project activities (qualitative analysis) Wildlife exposure to hazardous chemicals through ingestion (qualitative analysis)

[1] Amphibian health is included as an endpoint in the assessment of effects of COPCs on amphibians (section 6.4.5)

[2] Habitat loss occurring through vegetation clearing or removal of habitat features and alteration of habitat is change to the quality of habitat (e.g., from fugitive dust deposition, addition of attractants, fragmentation)

[3] Sensory disturbance or behavioural alterations is due to noise, light, or human presence that affects the energy expenditures or behaviour of animals and deters wildlife from accessing habitat they would otherwise access

[4] Mortality (e.g., vehicle collision, ingestion of contaminants/hazardous chemicals, human-bear interactions resulting in killing the animal for safety concerns)

6.6.2.3 Exposure Pathways for Potential Effects

Potential Project interactions may occur with wildlife and wildlife habitat through construction, operations, and closure activities. Construction activities, including clearing and preparing sites, installation of infrastructure, use of explosives, and use of roads, may result in:

- Loss or alteration of habitat (e.g., loss from vegetation clearing or removal of habitat features or alteration from fugitive dust deposition, addition of attractants, fragmentation.
- Sensory disturbance or behavioural alterations due to noise, light, or human presence that affects the energy expenditures or behaviour of animals and deters wildlife from accessing habitat they would otherwise access).
- Mortality (e.g., vehicle collision, ingestion of contaminants/hazardous chemicals, human-bear interactions resulting in killing the animal for safety concerns).

Operations activities, including crushing, equipment and vehicle movement and noise, use of explosives, and use of roads, may result in the same effects to wildlife as in the above bullet for construction activities. As well, waste refuse management during construction, operations, and closure may result in:

- Sensory disturbance or behavioural alterations due to noise, or human presence that affects the energy expenditures or behaviour of animals [e.g., attractants to garbage] and deters wildlife from accessing habitat they would otherwise access).
- Mortality (e.g., ingestion of contaminants or human-bear interactions).

6.6.2.4 Predicted Effects

The effects predictions from the Project on wildlife and wildlife habitat is based on the assessment of existing baseline desktop and field studies, Project TEM, and available and recent imagery. Section 6.6.1.4 provides the areas that are directly lost from Project components by ecosystem unit type. Up to 24.5 ha of vegetated habitat will be lost through construction clearing activities, which is 2% of the vegetated habitat in the RSA. This will be maintained until closure, after which revegetation of the site will initiate re-establishment of vegetation (section 4.2.3).

The following additional effects on wildlife have the potential to occur from the Project within the 3-year timeframe:

- Sensory disturbance or behavioural alterations
- Mortality

There is potential for cumulative effects of habitat loss or alteration, sensory disturbance and mortality may occur in combination with the following past, present, or future activities and/or infrastructure in the RSA:

- Forestry (e.g., harvesting, planting, monitoring and maintenance activities, roads)
- Transmission lines
- Rural/Urban development
- Recreation activities.

A total of 96.2 ha (6%) of the RSA were mapped as urban, roadway, or transmission line (Appendix 2-J). This in combination of the 24.5 ha (2% of the RSA) of vegetated habitat from the project is approximately 120.7 ha (7% of the RSA) of cumulative loss or alteration of wildlife habitat. Project mitigations (see section 9.13 [Wildlife Management Plan] will help to mitigate any potential cumulative effects from the interaction with the other activities and their effects on wildlife and wildlife habitat.

6.6.2.5 Risk Reduction

The BC Mitigation Policy and Procedures (BC Ministry of Environment 2014a, 2014b) recommends the mitigation hierarchy to avoid, minimize, and restore on site and this will be implemented for the RRIMM Project.

Wildlife is managed on site according to the wildlife management plan (refer to Section 9.13), which includes several policies and mitigations that will avoid or reduce impacts to wildlife and wildlife habitat.

The primary goals of the plan are to avoid and minimize impacts on wildlife in the mine area with particular reference to focal species. Implementation of this plan involves a realistic and achievable approach to adaptive wildlife management that is effective and flexible to meet changing conditions and to incorporate new information. The wildlife management plan includes measures that avoid and minimize the potential effects of the RRIMM Project on wildlife and wildlife habitat. In addition to implementation of policies and practices, a wildlife monitoring program is implemented to either confirm that practices are effective or identify the need and requirements of any additional mitigative actions that may be necessary for particular species. Reclamation of the site will restore vegetation communities to native vegetation as per the Reclamation and Closure Plan (see Section 4.0).

6.6.2.6 Residual and Cumulative Effects Considerations

BIRDS

The primary concern relating to surface disturbance activities for birds (i.e., migratory birds and raptors) is the removal of vegetation and the potential for disruption of nesting. Other potential impacts such as sensory or behavioural disturbance and mortality effects may result in displacement or loss of a few individual animals but is likely low occurrence given the mitigation measures in place (see section 9.13) and overall is anticipated to have a low magnitude effect on the local bird populations and distributions. Prior to construction activities within the nesting season, nest surveys will be completed by a Qualified Professional with recommended mitigations and avoidance of construction activities implemented where nests are identified. As per the wildlife management plan (Section 9.13) implications and requisite management actions for such occurrences will be assessed prior to development, in consultation with the management agencies involved.

FURBEARERS

Furbearer habitat supporting a wide range of species, including small furbearers that are typically abundant where they occur and are important prey species (e.g., snowshoe hare, red squirrel), to mid-sized carnivores (e.g., bobcat, marten) and large-sized carnivores (e.g., black bear, cougar) that range widely and naturally occur at low densities exists or possibly exists in the Surface Footprint and/or RSA (Appendix

2-O and Appendix 2-P). The loss of 24.5 ha of vegetated habitat associated with the project is considered low magnitude, short-term, and reversible, as reclamation activities are predicted to restore furbearer habitat (see section 4.1.2). Other potential impacts such as sensory or behavioural disturbance and mortality effects may result in displacement or loss of a few individual animals but is unlikely given the mitigation measures in place (see section 9.13) and overall is anticipated to have a negligible effect on the local furbearer populations and distributions.

UNGULATE

Ungulate habitat supporting moose, Rocky Mountain elk, Rocky Mountain mule deer, and white tailed deer, exists in the Surface Footprint and/or RSA. The loss of 24.5 ha of vegetated habitat associated with the project is considered low magnitude, short-term, and reversible, as reclamation activities are predicted to restore ungulate habitat (see section 4.1.2).

Other potential impacts such as sensory or behavioural disturbance and mortality effects may result in displacement or loss of a few individual animals but is unlikely given the mitigation measures in place (see section 9.13) and overall is anticipated to have a negligible effect on the local ungulate populations and distributions.

AMPHIBIANS

Loss or alteration of amphibian aquatic breeding habitat is the primary concern for effects to amphibians and no wetlands will be lost or directly impacted from the Surface Footprint. Streams may be impacted but the effect on amphibian health from CPOCs are included separately in the aquatic resources effects assessment (section 6.4). However, upland habitat that may support migration or dispersal habitat may be impacted. Five amphibian species occur or have potential to occur in the RSA and the Surface Footprint may support migration or dispersal habitat for (Appendix 2-R): northern pacific treefrog, long-toed salamander, Columbia spotted frog, western toad, and Coeur d'Alene salamander, the latter two of which are at-risk species (i.e., federally listed as special concern).

The loss of 24.5 ha of vegetated habitat that may support migration or dispersal habitat associated with the project is considered negligible to low magnitude, short-term, and reversible, as reclamation activities are predicted to restore vegetated habitat (see section 4.1.2). Other potential impacts such as sensory or behavioural disturbance and mortality effects may result in displacement or loss of a few individual animals but is unlikely given the habitat types and mitigation measures in place (see section 9.13). Overall, it is anticipated to have a negligible effect on the local amphibian populations and distributions.

REPTILES

Reptile habitat supporting the following seven species exists or potentially exists in the Surface Footprint and/or RSA (Appendix 2-R):

- Northern alligator lizard, confirmed present in the RSA.
- North American racer (provincially blue-listed and federally listed as threatened), confirmed present in the RSA.

- Terrestrial gartersnake, confirmed present in the RSA.
- Common gartersnake, confirmed present in the RSA.
- Painted turtle (Intermountain – Rocky Mountain Population; provincially blue-listed and federally listed as special concern), not likely (or possible) to be in the Surface Footprint but potential to be in or adjacent the RSA.
- Western skink (provincially blue-listed and federally listed as special concern), not confirmed in the RSA but likely to be in or adjacent the RSA.
- Northern rubber boa (federally listed as special concern), confirmed just outside, to the south, of the RSA along the Old Rossland-Cascade Highway.

Loss or alteration of reptile habitat, particularly den sites, is the primary concern for effects to the likely reptiles in the RSA and no dens were identified in the Surface Footprint, nor were any talus slopes (likely den sites) identified in the Surface Footprint.

The project activities, including removal of vegetation (24.5 ha), is considered negligible to low magnitude on reptile and reptile habitat and the effects are considered short-term and reversible, as reclamation activities are predicted to restore vegetated habitat (see section 4.1.2). Other potential impacts such as sensory or behavioural disturbance and mortality effects may result in displacement or loss of a few individual animals but is unlikely given the habitat types and mitigation measures in place (see section 9.13). Overall, it is anticipated to have a negligible effect on the local reptile populations and distributions.

BATS

Nine bat species that occur or are likely/potentially to occur in the Surface Footprint and/or RSA (Appendix 2-R) are as follows (Appendix 2-R):

- California myotis, confirmed present in the RSA
- Western long-eared myotis, confirmed present in the RSA
- Long-legged myotis
- Little brown myotis, federally listed as endangered
- Yuma myotis
- Big brown bat
- Hoary bat
- Silver-haired bat
- Townsend’s bigeared bat, provincially blue-listed.

Loss or alteration of bat roosting and hibernating habitat is the primary concern for effects to the likely bats in the RSA. Roosts and hibernacula are the most important habitats for bats and old trees and rock outcrops are the most common ecological features used. No roosts were detected in the RSA, but the primary uncertainty for bat habitat is detecting specific roosts. The opportunities for hibernacula in the RSA and surrounding area are few, limited to abandoned mines and fractured rock escarpments (Appendix 2-R). No old forest occurs but there may be suitable trees in the area that were not identified in the field or in old forest mapping. As well, anthropogenic features (e.g., buildings, fractures in bedrock in open pit walls, etc.) that are created during construction and operations may create temporary habitat and mitigations will be implemented to minimize effects to bats from these potential circumstances.

The project activities that may remove roosting and hibernating roosts is considered low magnitude on bat habitat and the effects are considered short-term and reversible, as reclamation activities are predicted to restore habitat to pre-existing conditions (see section 4.1.2).

Other potential impacts such as sensory or behavioural disturbance and mortality effects may result in displacement or loss of a few individual animals but is unlikely given the habitat types and mitigation measures in place (see section 9.13). Overall, it is anticipated to have a low magnitude effect on the local bat populations and distributions.

SUMMARY

Overall, the incremental temporary loss of 24.5 ha (i.e., 2% of the vegetated habitat in the RSA) associated with the Project Surface Footprint is anticipated to result in negligible to low magnitude, short-term, and reversible effects to wildlife and wildlife habitat and are not considered substantive residual effects on wildlife and wildlife habitat. This applies for potential residual cumulative loss of wildlife habitat. Sensory disturbances and mortality effects are also anticipated to be negligible to low magnitude, short-term, and reversible effects, as are the potential cumulative effects.

6.6.3 UNCERTAINTIES

The following are key limitations and uncertainties associated with the environmental effects predictions for terrestrial resources:

- Vegetation datasets and analysis have inherent limitations from the use of TEM for quantifying ecosystems. For example, TEM polygons are spatial map delineations that assign up to three types of ecosystems in a polygon at a scale that at times does not provide exact spatial accuracy or preciseness; however, this is an acceptable level of uncertainty for predicting effects on vegetation resources.
- There are inherent uncertainties in undertaking evaluations of potential effects of the Project on plant species and ecosystems of concern and wildlife and wildlife habitat. For example, evaluation of plant and wildlife species of concern is limited to those recorded during baseline field surveys and desktop analysis but a lack of detection of any of the listed species does not imply they are not present. However, the ecosystem mapping and field survey collection reduce the uncertainties and provide a reasonable estimate of potential vegetation loss and alteration and wildlife effects.
- It is assumed that grassland that is mapped as Gg throughout the RSA is the same community; the red-listed ecological community, Idaho fescue – bluebunch wheatgrass – silky lupine – junegrass, was mapped in the LSA by BC CDC (2023c).
- Limited wildlife field surveys were conducted in and beyond the RSA; however, given the details of the desk-top surveys, the TEM, online resources, and the Wildlife Management Plan including pre-construction surveys and an adaptive management approach to implement mitigations should an

unpredicted effect be identified, the effects assessment is considered an appropriate assessment of project and cumulative effects on wildlife and wildlife habitat.

However, given the conservative nature of the prediction of effects on the ecosystems of management concern, plants of potential importance to First Nations, and the inclusion of species with likely potential to occur, as well as the focus on maximum predictions, it is unlikely that potential effects associated with project activities on terrestrial resources have been underestimated.

7.0 ENVIRONMENTAL MONITORING

This section proposes monitoring for the discharge, for groundwater, and for the aquatic receiving environment. For the latter, a comprehensive Aquatic Effects Monitoring Program (AEMP) is proposed that includes surface water chemistry, sediment chemistry, bioassays, and biological monitoring of periphyton, benthic invertebrates and fish.

7.1 DISCHARGE MONITORING

Under a scenario where mechanized equipment is utilized for ore extraction, the discharge plan for the RRIMM Project is a diversion channel from the sedimentation pond to Sophia Creek, whereas the discharge system under a scenario where explosives are used, the discharge plan is an irrigation system that pumps water collected in the sedimentation pond to a series of sprinklers that will irrigate the uppermost vegetated catchments of the project area. It will be comprised of the following equipment:

- Two discharge pumps + one standby discharge pump
- One 8” pipeline: bottom section schedule 40 steel pipe, top section DR11 HDPE pipe
- Six irrigation sprinklers
- Valves for isolating pumps and sprinklers.

Flow of effluent will be monitored on an ongoing basis by a mechanical flow meter installed on the discharge pipe. Totalizer values will be recorded daily.

Effluent water quality samples for on-site analysis will be collected daily from the settling pond and analyzed for ammonia, nitrite and TSS/turbidity using a Hach DR 900 multiparameter handheld colorimeter, since these parameters are most likely to approach the proposed discharge standards. Water quality samples for off-site laboratory analysis will be collected weekly.

Bioassays are not proposed for the discharge because the discharge is intended for land application rather than to a surface water receiving environment. Bioassays in the receiving environment are an optional component of the AEMP below.

7.2 RECEIVING ENVIRONMENT MONITORING

Receiving environment monitoring will be conducted at surface and groundwater monitoring stations downstream of the land application area. Figure 7.2-1 shows the proposed monitoring locations. These stations will be monitored weekly. Increasing trends in water quality parameter concentrations at those stations that point to a potential concern for the receiving water quality would trigger implementation of additional water quality mitigations measures as described in the Safe Discharge Plan (Appendix 9-C).

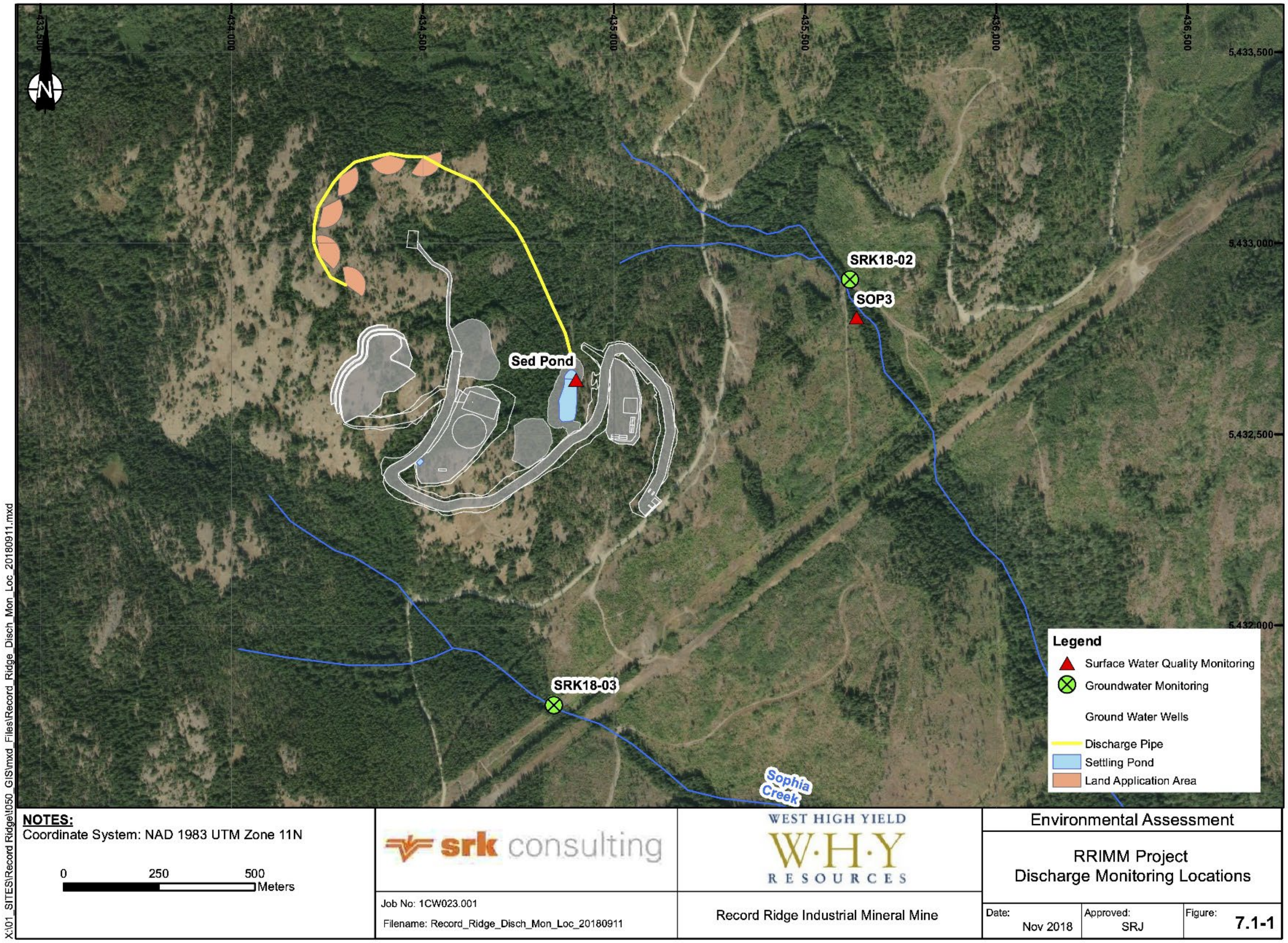


Figure 7.2-1: Discharge Monitoring Locations

7.2.1 GROUNDWATER

Groundwater in the Project area is not expected to be negatively impacted by the site activities as the mine is designed to be free draining at closure and will not act as a groundwater infiltration point. During operation, contact water will be collected in a sump and pumped to the lined site sedimentation pond for monitoring and treatment if required, so it will not re-infiltrate into groundwater system.

Groundwater inflow to the pit will be limited due to the small size of the up-gradient catchment and position of the mine near the top of the ridge. Coupled with low conductivity of the rockmass, infiltration/recharge rates that would be flowing towards the pit are expected to be low.

Groundwater samples will be collected for off-site laboratory analysis as part of receiving environment monitoring. Figure 5 of the Safe Discharge Plan (Appendix 9-C) and Figure 7.2-1 of this Chapter shows the proposed monitoring locations downstream of the sedimentation pond diversion channel, sedimentation pond diversion channel, land application catchment, and downstream of the catchment west of the RRIMM Project area. The monitoring locations are selected to allow for detection of any Project-related discharges in the receiving environment immediately downstream of the mine. Depths for monitoring will be determined once monitoring locations are established.

7.2.2 SURFACE WATER

Surface water samples will be collected for off-site laboratory analysis as part of receiving environment monitoring. The Safe Discharge Plan (Appendix 9-C) and Figure 7.2-1 of this section shows the proposed location downstream of the land application catchment, in Sophia Creek. The monitoring location is selected to allow for detection of Project-related effects of effluent discharge in the receiving environment immediately downstream of the mine.

The Safe Discharge Plan notes that monitoring of ammonia, nitrate, and nitrite concentrations will form the primary constituents of interest under the scenario where explosives are used. Additional mitigation measures will be ready for implementation if early monitoring results indicate that they are necessary. Implementation of coagulation and flocculation, with additional mitigation measures for controlling ammonia and nitrite discussed in the Safe Discharge Plan (Appendix 9-C).

7.3 RECLAMATION MONITORING AND SURVEILLANCE

Annual reclamation monitoring will be conducted as required by conditions of the *Mines Act* permit, including submission of the Annual Reclamation Report to the BC Ministry of Energy, Mines and Petroleum Resources (EMPR) by March 31 of the following year. Following mine closure, salvaged soil will be placed on disturbed areas and then revegetated. Details of reclamation monitoring are provided in Section 4.2.6. Reclamation monitoring will include quantitative and qualitative assessments by a qualified professional of successful seed germination, a qualitative assessment of all planted stock, a photo-point monitoring program, and an evaluation of trace element content within restored vegetation. The program will be conducted annually for four years following reclamation to confirm establishment of natural succession and pioneering vegetation communities.

7.4 TEMPORARY CLOSURE CARE AND MAINTENANCE AND MONITORING

For temporary closure less than one (1) year, facilities would be secured and maintained in a condition such that they could be restarted. The following measures would be initiated to secure and maintain the facilities:

- Fuel, chemicals will be secured and kept in their original containers.
- Mobile pit equipment with the exception of shovels will be parked near the mine maintenance pad. The pit shovels will be secured and remain within the pit.
- Environmental monitoring will continue according to operation practice as needed.

For temporary closure care and maintenance of greater than one (1) year, facilities will be secured and maintained such that they could be restarted after a short preparation period. In addition to the measures outline above, the following would be completed:

- All fuel, chemicals and flocculants will be removed from the site and either returned to the supplier or disposed of at a government-approved facility.
- Environmental monitoring program will be reviewed and adjusted as needed based on amount of surface development completed, permit conditions, and consultation with ENV and EMPR.

7.5 LONG-TERM AND POST-CLOSURE MONITORING

Revegetation monitoring would continue for four years following closure as detailed in Section 4.2.6.

Surface and groundwater monitoring would continue for 12 months post-closure at the same frequency and locations as during operations. Thereafter, a reduction in frequency and number of locations should be proposed if warranted based on findings.

Biological monitoring should be scaled back after closure, provided that there was no change to surface water quality during operations. A single monitoring event for core AEMP components (described in Section 7.6) is warranted post-closure, but any subsequent monitoring should only be required if there was observed changes to water quality.

7.6 AQUATIC EFFECTS MONITORING PROGRAM

7.6.1 OBJECTIVE

The objective of the Aquatic Effects Monitoring Program (AEMP) is to enable detection of potential ecologically-relevant effects on aquatic life and other relevant water uses prior to effects occurring. The results of the AEMP will be used as a feedback mechanism to determine the effectiveness of management practices in mitigating potential effects on water uses, and to determine if additional management actions are warranted to prevent or address potential impacts.

7.6.2 PROBLEM FORMULATION

The AEMP design must be driven by a clear understanding of the potential adverse effects associated with the Project. Problem Formulation is a formalized component of risk assessment frameworks in BC (SAB 2008), Canada (Environment Canada 2012) and elsewhere that aims to provide this clarity. The suitability of a risk-based approach to design of AEMPs is well recognized (INAC 2009).

A risk-based approach was used to evaluate potential environmental effects associated with the project (Section 6.4). That section clarified the following:

- Contaminants of Potential Concern (COPCs) include nutrients, TSS, and metals.
- Receptors of Concern (ROCs) include fish, lower trophic levels (periphyton and benthic invertebrates), and amphibians.
- Assessment endpoints include (1) fish populations and fish habitat, and (2) amphibian health.
- Measurement endpoints - the specific metrics that will be measured to evaluate potential effects – target both abiotic media (e.g.., water quality) and biological monitoring metrics representing aspects such as benthic community abundance and richness, periphyton community biomass and richness, fish population age structure and fish condition.
- Protection goals and associated Critical Effect Sizes (CES) for evaluating the measurement endpoints.

The key information was summarized in Table 6.4-1. Below, additional details are provided for each component of the sampling design, such as proposed sampling locations, number of replicates and frequency.

7.6.3 SPATIAL SAMPLING DESIGN

Terminology

The AEMP proposes to use of the term 'station' to refer to any creek water quality station or creek reach that is monitored. Within a station, if multiple independent samples are collected during a single sampling event to characterize within-station variability, these are referred to as 'replicates'. For example, a field crew may collect multiple spatial 'replicates' for periphyton at a station. Each replicate may be a single sample, or a composite of multiple 'subsamples' (e.g., two separate subsamples that are then combined in the field to make a single replicate). It is also possible (though not planned for routine monitoring) for subsamples to be analyzed separately by the lab, and to then pool the results (e.g., average them numerically afterwards). Subsampling may be conducted to improve the representativeness of each replicate or to characterize particular sources of variability in the data.

Important aspects of the spatial sampling design are the need for:

- One or more exposure (or 'impact') stations in the receiving environment that are close to any discharges.
- One or more exposure stations in the receiving environment that are further downstream in fish-bearing reaches.

- ‘Control’ or ‘reference’ stations against which the exposure stations can be compared, using either a before-after-control-impact (BACI) or a control-impact (CI) statistical design, or both.

Control (or ‘reference’) sampling locations should be selected carefully. First, they should be locations that will remain valid as controls in perpetuity and are unlikely to be influence by the project in future. Second, they should be as similar to the ‘exposure’ stations as possible; however, when the preferred BACI framework is used, as long as there is a reasonable amount of ‘before’ data, natural differences between control and impact locations are not as important as they would be in a CI design with no temporal component. This is because the BACI framework targets the relative changes over time between C and I locations. Nevertheless, control locations should be selected to be as similar to potential impact locations as possible.

Sampling stations that are proposed for the AEMP are shown in Figure 7.6-1 and described in Table 7.6-1. The rationale for these stations was provided in Section 6.4.

7.6.4 Experimental Design and Statistical Power

In general, the most appropriate framework for evaluation of AEMP measurement endpoints is a before-after-control-impact (BACI) that is aimed at detecting a potential impact in a particular creek in a particular time period[7]. Under the BACI framework, a given monitoring station will have a constant CI (control vs impact) designation, but the BA (before vs after) designation will vary depending on when the station comes into contact with project-related stressors. Simpler designs such as before-after [BA] or control-impact [CI] designs may be useful in some cases or unavoidable if data are limited, but they depend on assumptions that are often not valid. The BA design generally assumes that there are no natural shifts or trends over time – this may be valid for some metrics over limited time frames but is unlikely to be valid for most biological metrics. The CI design assumes that there are no systematic natural differences among locations – this is also rarely valid for most metrics. Results of these simplified designs are therefore often misinterpreted. The fundamental weakness of CI designs is the underlying assumption that any differences between C and I stations are considered an effect. BACI designs are more robust in that they track changes in C and I stations over time; the target effect is differential change at I relative to C over time.

Given the advantages of a BACI design, the baseline sampling program has included ‘before’ sampling not only for routine AEMP components but also for some components that are not proposed for routine sampling – the intent is that if an AEMP component is needed, there will be ‘before’ data available to allow application of the BACI framework.

[7] See Kilgour et al. (2007) for discussion of the advantages of BACI designs for detecting impacts.

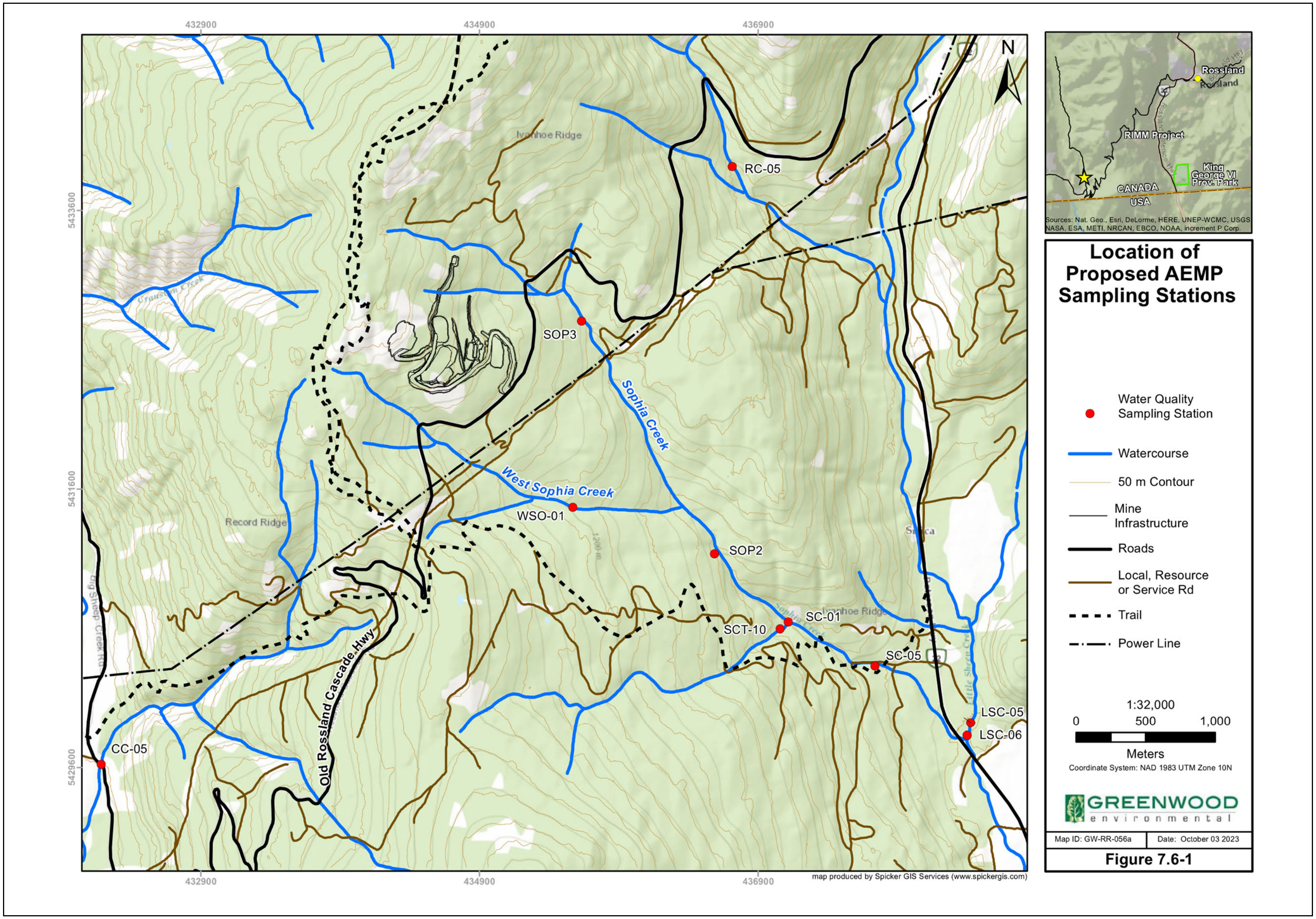


Figure 7.6-1: Location of Proposed AEMP Sampling Stations

Table 7.6-1: Description of Proposed AEMP Sampling Stations

Station	Control/Impact	Description	UTM Easting/Northing (Zone 11U)
SOP3	I	Sophia Creek near-field, downstream of land application discharge; not fish-bearing	435634 5432807
SOP2		Sophia Creek near-field, downstream of SOP3 and of office-pad seepage; not fish-bearing	436588 5431134
WSO-01	I	West Sophia Creek near-field, not downstream of discharge, not fish-bearing	435570 5431469
SC-01	I	Sophia Creek mid-field; fish-bearing	437117 5430645
SC-05	I	Sophia Creek mid-field; fish-bearing	437739 5430328
SCT-10	C	South Sophia Creek; non fish-bearing tributary to Sophia Creek that joins Sophia Creek just downstream of SC-01, and upstream of SC-05	437059 5430597
RC-05	C	Record Creek	436716 5433916
CC-05	C	Corral Creek	432185 5429622
LSC-06	I	Little Sheep Creek just downstream of confluence with Sophia Creek; larger creek, fish-bearing	438402 5429829
LSC-05	C	Little Sheep Creek just upstream of confluence with Sophia Creek; larger creek, fish-bearing	438426 5429921

Although the BACI design is preferred over the CI and BA designs, and is recommended for most measurement endpoints, there are a few cases where the CI and BA designs are likely to be used, such as:

- Water quality – In general, water quality variables are analyzed through comparison to water quality guidelines or other benchmarks. Consequently, BACI analyses are not usually warranted. Where guidelines are exceeded, simple comparisons over time (BA design) or to reference (CI design) are typically employed.
- Sediment quality – barring a severe climatic event (e.g., large storm or fire that leads to widespread erosion), temporal variability in sediment chemistry is typically low under natural conditions and a BA design should work for most cases. Alternatively, a BACI could also be used if there is any concern that a regional event did occur that would broadly affect sediment chemistry.
- Benthic invertebrates – we anticipate using a hybrid approach using methods developed by Environment Canada (Canadian Aquatic Biomonitoring Network [CABIN]) and BACI. CABIN is typically used with the reference condition approach (RCA), which is conceptually a CI design with multiple controls. The RCA is an acceptable approach for monitoring changes in the benthic invertebrate communities (BC MOE 2016).
- Data are entered into the CABIN online database, and the CABIN online tool compares the stations to regional reference conditions using a model specific to the region[8]. In addition to using CABIN, we are proposing to evaluate some measurement endpoints separately using a BACI framework. For this purpose, rather than collecting a single CABIN replicate at each station, three replicate samples were collected at each of the AEMP stations and at reference stations during the baseline period. Combining approaches will lead to a more robust analysis of potential changes to the benthic community and will help avoid erroneous conclusions regarding effects (i.e., false positives or false negatives).
- Fish condition and length-at-age – Given the mobility of fish in Little Sheep Creek, and between Little Sheep Creek and Sophia Creek, we do not anticipate that fish at the various stations will be representative of distinct populations. Consequently, we propose to evaluate these endpoints using a BA design, comparing results during the exposure (‘after’) period to the ‘before’ period.

Statistical power for AEMP monitoring components depends on several factors, the most important of which is the Critical Effect Size (CES). As introduced in Section 6.4.5, the intent is to maintain consistency with CES that are typical for monitoring programs under federal EEM programs and provincial AEMPs. As an example, the CES usually defined under federal EEM programs for benthic invertebrate community endpoints using a control-impact (CI) design is based on the estimated mean (u) plus or minus two standard deviations (SD), where SD is within reference area SD (i.e., derived from data collected across replicate samples at the reference station(s) (i.e., CES = $u \pm 2$ SD).

In this application, the CI design assumes that *prior* to impacts, the control and impact stations have the same mean and standard deviation of the measure of interest across replicate samples. An analogous CES can be formulated for the BACI design using data collected during the before period. We can use the

[8] We understand from Environment Canada that a new Okanagan-specific model has been approved and will be implemented to the system in the next year or so (S. Strachan, pers. comm. 2018)

example of CES = $u \pm 2$ SD, but where u is the before-period mean at the impact station and SD = $\sqrt{(\sigma^2[\tau\beta] + \sigma^2[\varepsilon])}$. Here, SD is defined in terms of the variance components that are station-specific, that is, natural variation in time/station differences in means, $\sigma^2[\tau\beta]$, and variation in replicate samples, $\sigma^2[\varepsilon]$. Because these components are assumed to be independent, their variances are summed to compute SD for the BACI effect size. Variation in time-specific differences, $\sigma^2[\tau]$, is not included because these effects are shared by both stations. Such effects are "controlled for" by having paired sampling events, and thus, a good BACI design includes a suitable reference station that captures temporal changes due to natural processes operating at large (i.e., across-station) spatial scales. The statistical power of the BACI design depends largely on the relative magnitude of the CES versus the variance of time-station effects, $\sigma^2[\tau\beta]$. All else equal, lower $\sigma^2[\tau\beta]$ equates to higher power.

A priori statistical power analysis is not recommended for biological measurement endpoints. The sample sizes recommended for the AEMP are beyond what is normally expected, including three CABIN kicknet replicates (where the standard is one replicate per station) and ten periphyton replicates (where the standard ranges from 5 to 10).

Power analysis under a BACI framework is complex and the level of effort would only be justified if an argument were being made to have sample sizes that are smaller than usual for AEMPs. In addition, statistical power under a BACI framework can be highly dependent on the number of 'before' years, which may increase further depending on the timing of construction and operations.

Similarly, *a priori* statistical power analysis is not recommended for water or sediment quality. The challenge with power analysis for water quality is that the critical effect size (CES) of interest is not statistically-based but is defined by where the data fall relative to a water quality guideline. Chromium at RC-05 and SC-05 (see Section 2.6) highlight this issue. At RC-05, all values are well below the water quality guidelines (WQG), and it is clear that it would be easy to detect a change in mean concentration at station RC-05 that is still below the WQG. If power analysis was used to calculate the sample size needed to detect an increase in a sustained concentration that is equal to the WQG then only four samples are needed, two in each of the 'before' and 'after' periods. This assumes a power of 0.9 (i.e., beta = 0.1), alpha = 0.1, for a two-sample, one-sided test on $\log_{10}$ data. Thus, if chromium exceeds the WQG for two consecutive months, it is unlikely to be due to chance (ignoring seasonality for simplicity).

In the case of SC-05, the difference in concentration between the site and the WQG concentration is quite small. Repeating the same analysis, the sample size needed to detect an increase equal to the difference between the site concentration and the WQG is 270. Yet, there is no difference in the quality of the data at RC-05 and SC-05. The only difference is that the data for SC-05 are much closer to the guideline. If we ignore guidelines and simply look at the power to detect change, then we can calculate the power to detect particular changes, such as 25% or 50% increases. For example, with six data points in the before and after periods, the power to detect a 25% and 50% increase in chromium at RC-05 would be 0.65 and 0.94 respectively.

There are an infinite number of *a priori* power analyses that could be conducted, but their value is limited for water quality. It is preferable to make sure that data are reliable and can support evaluation as needed in the event that guidelines are exceeded in future. Importantly, power analysis is not a suitable tool for *post hoc* analysis, as discussed by Newman (2008).

7.6.5 AEMP Components

AEMP components that are recommended to be included as routine (i.e., regularly scheduled) are surface water chemistry, groundwater chemistry, benthic invertebrate community, and fish. The components that are recommended to be used only if necessary are sediment chemistry, tissue chemistry, bioassays, and periphyton community. The rationale for a small number of routine components is three-fold. First, adverse effects on water quality are likely to be very limited because of the conservative nature of the predictions. Second, the Safe Discharge Plan (Appendix 9-C) incorporates optional mitigation measures that will be employed in the event that parameters exceed Contaminated Site Regulation (CSR) standards in the sedimentation pond discharge. Thus, adverse effects on aquatic receptors are unlikely. Third, results for benthic invertebrates will integrate not only direct effects to invertebrates themselves but also the indirect effects on their food supply (i.e., periphyton). Thus, the optional components such as bioassays and measurement of the periphyton community would be useful if needed to understand any observed effects on invertebrates or fish.

A summary of the routine and ‘as needed’ AEMP components is provided in Table 7.6-2, including sample sizes and frequencies. The specific measurement endpoints and critical effect sizes (CES) that will be used to interpret data were provided in Section 6.4.5 and are not repeated here. Similarly, field and laboratory quality assurance/quality control (QA/QC) methods will be identical to those described for the baseline sampling programs in Section 2.0 and are not repeated here.

7.6.5.1 Surface Water Chemistry

Surface water quality monitoring at the AEMP stations will follow the same methods and target the same variables as for baseline sampling (see Section 2.6.2). Results will initially be compared to the same guidelines. Some exceedances of guidelines are expected because of naturally elevated concentrations. As discussed in Section 6.4.8.1, given the short duration of the project, development of formal Science-Based Environmental Benchmarks (SBEBs) for these naturally elevated parameters may not be warranted.

7.6.5.2 Groundwater Chemistry

Refer to Section 7.2.1 for groundwater monitoring plans.

7.6.5.3 Bioassays

Bioassays are not recommended as a routine part of the AEMP because there is no expected discharge. However, bioassays could be used to evaluate potential water quality issues if they arise, or to investigate any observed or suspected effects on receptors of concern. The particular tests to be used would depend on the parameters of concern in water quality samples (i.e., relative sensitivity of different receptors to a particular parameter).

In the upstream, non-fish-bearing reaches of Sophia Creek, the protection goal is to maintain the ecological function of the lower trophic level receptors. Consequently, bioassays targeting fish should not be considered in upstream reaches. In the lower fish-bearing reaches, bioassays targeting fish are more likely to be appropriate because the protection goal is at the fish population level.

7.6.5.4 Periphyton Community

Periphyton community monitoring at the AEMP stations will be conducted only if needed based on water quality and/or benthic invertebrate community results. With a short operational time frame of two years, it is unlikely that periphyton would be a useful monitoring tool. Even with high replication within years, there is typically high station-specific inter-annual variability, such that detecting changes within 1 to 2 years is challenging. More importantly, the benthic invertebrate community results will integrate not only direct effects on the invertebrates themselves but also indirect effects on their food supply (including periphyton).

Periphyton sampling, if needed, would follow the same methods, and target the same variables as for baseline sampling (see Section 2.8.1). The variables include a wide range of metrics related to abundance, richness, and biomass. Most of these will be used as supporting information, with the key measurement endpoints being total taxa richness as well as measures of biomass, as discussed in Section 6.4.5.

Periphyton often show higher station-specific inter-annual variability than other monitoring components, which can hamper the confident detection of project-related changes. In these cases, it often takes more than one year of data to make meaningful inferences in the absence of obvious causality. Streams in the Project area are quite heterogeneous in their habitat composition and are susceptible to intermittent flow as was observed during the 2017 survey. The small spatial scale habitat heterogeneity documented in 2016 and 2017, combined with intermittent flow, likely contribute to an already large within-station variance in the periphyton community endpoints. Guidance from BC ENV (2016) recommends completing a preliminary pilot survey to estimate the number of replicate samples required to detect changes in the community. In situations where pilot studies haven't been completed, or aren't practical, guidance adopted from Biggs and Kilroy (2000) recommends collecting 10 replicates by default.

7.6.5.5 Benthic Invertebrate Community

Benthic invertebrate community monitoring at the AEMP stations will follow the same CABIN methods as for baseline sampling (see Section 2.8.1). The variables include a wide range of metrics related to abundance and richness. Most of these will be used as supporting information, with the key measurement endpoints being total abundance and total taxa richness, as discussed in Section 6.4.5.

Table 7.6-2: Overview of AEMP Components

Component	Type	Stations	Monitoring Variables	Replication and Frequency
Groundwater chemistry	Routine	See groundwater section	See groundwater section	See groundwater section
Receiving environment water chemistry	Routine	All AEMP stations	Field: TDS, conductivity, pH, temperature, DO Lab: Conventionals, ions, nutrients, total metals, dissolved metals, TSS, TOC, DOC. See Section 3.6.2 for full list.	1 sample per station; monthly
Bioassays on discharge	Only if warranted	Where relevant	Daphnia magna acute toxicity test	As needed
Periphyton community	Only if warranted	Where relevant	Taxonomy (density, richness); biovolume/biomass by taxonomic group; loss on ignition; chlorophyll a	As needed, likely 10 replicates per station
Benthic invertebrate community	Routine	All AEMP stations	CABIN kicknet sampling and all associated taxonomic outputs (e.g., density, richness).	3 replicates per station; annually late summer
Fish	Routine	Fish-bearing AEMP stations: SC-01, SC-05, LSC-05, LSC-06.	Non-lethal electrofishing sampling. All non-lethal information will be collected (length, weight, external condition).	Sampling effort to be similar to baseline program; frequency every 3 years.

As discussed above, most CABIN programs are based on a Reference Condition Approach (RCA) in which a single replicate sample is collected at each station for each sampling event. The regional reference data are collected over a period of years, with most sites not being sampled in the same year that a particular exposure station is assessed. While the RCA model will provide a broad characterization of regional conditions, it does not allow natural temporal changes to be explicitly taken into consideration. If the dry conditions that occurred in the summer of 2017 had occurred after the onset of Project development, then any changes at impact stations that year could have been erroneously attributed to the Project, when in fact benthic invertebrates were absent because the stream was dry. A BACI experimental design with multiple control and multiple 'before' period sampling events addresses these limitations by trying to differentiate the components of variation in the data – pre-existing differences between exposure and reference stations are accounted for, as are natural temporal patterns.

Consequently, long-term monitoring of benthic invertebrates will use the CABIN framework but will be expanded to also allow for a BACI approach. There are two key improvements over a standard CABIN approach:

- Local, project-specific reference stations are sampled each year
- Replicate samples (3) are collected at each AEMP stations

BC Ministry of Environment and Climate Change Strategy (ENV) guidance suggests a default of n=5 replicates for a non-CABIN approach (BC MOE 2016). This is the default found in federal EEM guidance for metal mines (Environment Canada 2012) and is based on the assumption that to detect a difference or change in the mean, a difference of 2 standard deviations is required. Thus, if the reference mean richness is 15 with a standard deviation of 3, then a sample size of 5 at reference and the exposure stations will be able to detect when the exposure station mean is equal to 9 or lower (i.e., 15 minus two standard deviations).

This approach has no regard for differences in the ability to quantify variability in the benthic invertebrate community among different types of sampling equipment. The standard deviation for CABIN replicates is much smaller than the standard deviation for Hess samples for example, because the spatial area covered in a single 3-minute travelling kick sample is large relative to the surface area of the creek sampled using a Hess. In our experience at other sites, confidence in the mean results for 3 CABIN replicates at a given station in a given year is similar to confidence in the mean results for 10 Hess replicates where each Hess replicate is a composite of 3 subsamples. Consequently, n=3 CABIN samples is expected to be sufficient to detect important differences among stations and years. Furthermore, our proposed hybrid study design using RCA and BACI statistical approaches will help put potential changes in benthic invertebrates in context from both local and regional perspectives. Moving forward, our understanding of natural spatial and temporal variation will improve each year, even in the exposure period, because the data set for control stations will continue to expand each year.

Overall, the combined CABIN RCA and BACI approach should provide a robust means of tracking and interpreting spatial and temporal trends in the benthic community in both a local and regional context.

7.6.5.6 Fish

Nonlethal sampling of fish is recommended as part of the AEMP. During baseline sampling using electrofishing, rainbow trout was the dominant species found in Sophia Creek, while eastern brook trout were more abundant in Little Sheep Creek. A nonlethal sampling program will be developed that is aimed at collecting data for nonlethal metrics such as length, weight and external condition of individual fish. These data will be used to evaluate population structure using length-frequency analysis. Specific measurement endpoints were listed in Section 6.4.5.

Baseline sampling for fish was not conducted in Record Creek and will not be part of routine monitoring. Fish could be collected if results of initial sampling are inconclusive. The location of AEMP station RC-05 is not fish-bearing, so any fish sampling in Record Creek would take place further downstream in reach 1, just above the confluence with Little Sheep Creek. That lower reach is known to have eastern brook trout (Smithson and Robinson 2018).

7.6.5.7 Sediment Chemistry

Routine monitoring of sediment chemistry is not recommended, because:

- Project-related effects on sediment chemistry are not expected.
- Creek habitats downstream of the project are predominantly lotic and erosional in nature, with substrates dominated by gravels, cobbles, and boulders.

Sediment chemistry data were collected during the baseline period (see Section 2.7). If, during the life of the project, there is a reason to suspect increases in sediment chemistry, the same sampling program could be implemented again. That program targeted the fine (<63 um) fraction of sediment from interstitial spaces using a sediment guzzler. The data can be used as an indicator of potential exposure or contaminant transport but are generally not directly relevant to conditions in the field to which receptors are exposed.

7.6.5.8 Tissue Chemistry

Routine monitoring of tissue chemistry is not recommended. The project is not expected to be a source of bioaccumulative metals (i.e., mercury, selenium), and the only metals predicted to exceed water quality guidelines in the receiving environment are those that are naturally elevated (i.e., chromium, aluminum). Tissue chemistry data were collected during the baseline period for periphyton, benthic invertebrates and fish (see Section 2.8.3). If, during the life of the project, there is a reason to suspect increases in tissue concentrations of particular contaminants, the same sampling program could be implemented again.

7.6.6 AEMP Reporting

An annual AEMP report will be produced for each calendar year of construction and operations. The proposed timing for draft reporting is April 30, so that there is sufficient time for labs to process samples and report results, prior to analysis and interpretation by W.H.Y. Resources. Assuming a short turn-around time for comments, the report would be finalized by May 31.

7.6.7 Weight of Evidence

The AEMP will evaluate potential impacts on aquatic ecosystems using information from numerous monitoring 'components' (as described above), with numerous measurement endpoints for each component. The 'weight of evidence' across all of the monitoring results is evaluated in an integrated manner to reach conclusions. Weight of evidence methods are well developed and summarized in guidance documents for Ecological Risk Assessment (e.g., Environment Canada 2012), and range from simple to highly quantitative and complex. Usually, a middle-ground is appropriate that requires formal, rigorous characterization of the information, but does not try to force the data into a quantitative model.

We propose to use a relatively simple weight of evidence approach within the AEMP that characterizes potential impacts to each assessment endpoint using four narrative categories: negligible, low, moderate, high. Recalling that the assessment endpoints are (1) fish populations and fish habitat, and (2) amphibian health, these four narrative categories can be broadly characterized as follows:

- Negligible – Effects on fish population density and viability not expected; effects on amphibian health not expected.
- Low – Effects on fish population density and viability expected to be low and not ecologically significant; effects on amphibian health expected to be marginal or absent.
- Moderate – Some effect on fish population density could occur, but population viability not expected to be at risk; some sublethal effects on amphibian health could occur.
- High – Significant effects on fish population density expected, and population viability potentially at risk; mortality of amphibians could occur.

At the same time that potential impacts are characterized, it is important to evaluate the associated uncertainty. If uncertainties are large enough that the categorization of impacts could change (e.g., if an impact characterized as 'moderate' could actually be 'high'), then those uncertainties may need to be addressed as part of adaptive management within the AEMP (see below).

7.6.8 Adaptive Management

Adaptive management is the formalized process of 'learning by doing'. Within the context of an AEMP, adaptive management can be viewed as including the following iterative steps:

1. Design and implement project plan including mitigation measures.
2. Design and implement monitoring plan.
3. Make adjustments based on the monitoring results, which may include:
    a. Adjustments to the project plan including mitigation measures.
    b. Adjustments to monitoring program design.

The project plan and mitigation options have been covered in previous sections of this report. Adjustments to monitoring program design are expected for AEMPs. An AEMP is intended to be a flexible program that is responsive to results and to changes in the project scope or operations. If potential impacts to assessment endpoints are negligible to low, and if the project's footprint and operations proceed as expected, then changes to the AEMP would be minimal. However, if there are moderate to high impacts or large uncertainties, or if the project is not proceeding as expected, many changes to the AEMP could be envisioned, such as:

- Addition of monitoring components to better characterize potential impacts or to understand the mechanism of impact.
- Increased spatial or temporal resolution of sampling in particular creeks or creek reaches, including potential addition of sampling stations.
- Deletion of monitoring components, or reduction in sampling intensity, if the information provided is not deemed to be useful.
- Deletion of sampling locations.
- Adjustments to sample sizes to ensure appropriate statistical power based on observed data.

7.7 QUALITY ASSURANCE REQUIREMENTS

Environmental monitoring programs, including site water monitoring program and Aquatic Effects Monitoring Program, described above have been developed by qualified professionals. These plans will be further developed by qualified professionals prior to construction to include details of sampling methods, sample preparation and hold times, analytical methods, quality assurance/quality control procedures (i.e.., equipment checks and calibration, blank sampling, duplicate sampling, flagging of outliers), and data analysis methods. Monitoring plans will be based on guidance documents and QA/QC procedures including:

- Water and Air Baseline Monitoring Guidance Document (BC MOE 2016)
- British Columbia Field Sampling Manual (BC MOE 2013)
- Environmental Data Quality Assurance Regulation (2017)
- British Columbia Environmental Laboratory Manual (BC MOE 2015)

8.0 HEALTH AND SAFETY

8.1 PURPOSE AND SCOPE

The Occupational Health and Safety Plan (OHSP) addresses the management objectives, applicable legislation and guidelines, controls, monitoring, and roles and responsibilities that will be implemented as practicable to avoid and minimize the risk of occupational health and safety hazards at the Project's workplace. This is a conceptual plan and will be amended with input from the construction contractor to include additional details relating to occupational health and safety measures, inspections, reporting, documentation, and details of continual improvement initiatives.

The objective of the OHSP is for the implementation of reasonable control measures to avoid and minimize adverse effects to the health, safety, and well-being of people working at the RRIMM Project site. The intent of this plan is to outline the policies and procedures W.H.Y. Resources will follow to comply with provincial and federal regulatory requirements and best management practices for workplace hazards. This plan is directly linked to the MERP (Section 9.1; Appendix 9-A), which outlines preventative measures and response procedures for emergencies related to the health and safety of people at site.

8.2 REGULATORY CONTEXT AND RESOURCES

The health and safety of workers at mines in BC is regulated under the provincial *Mines Act*, specifically the Code (BC MEM 2022), established under the *Mines Act* (1996). This applies to all BC mines and takes precedence over other provincial and federal laws and regulations pertaining to workplace health and safety. In addition to the *Mines Act* (1996), there are several legislative statute requirements, industry standards and codes of practice applicable to the health and safety of humans, including:

- BC *Workers Compensation Act* (1996)
- Occupational Health and Safety Regulation (OHSR; BC Reg. 296/97)
- Guidelines for Workers Compensation Act (WorkSafeBC 2017)
- Workplace Hazardous Materials Information System (WHMIS)

8.3 OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT PRACTICES

8.3.1 PREVENTION OF HEALTH AND SAFETY HAZARDS

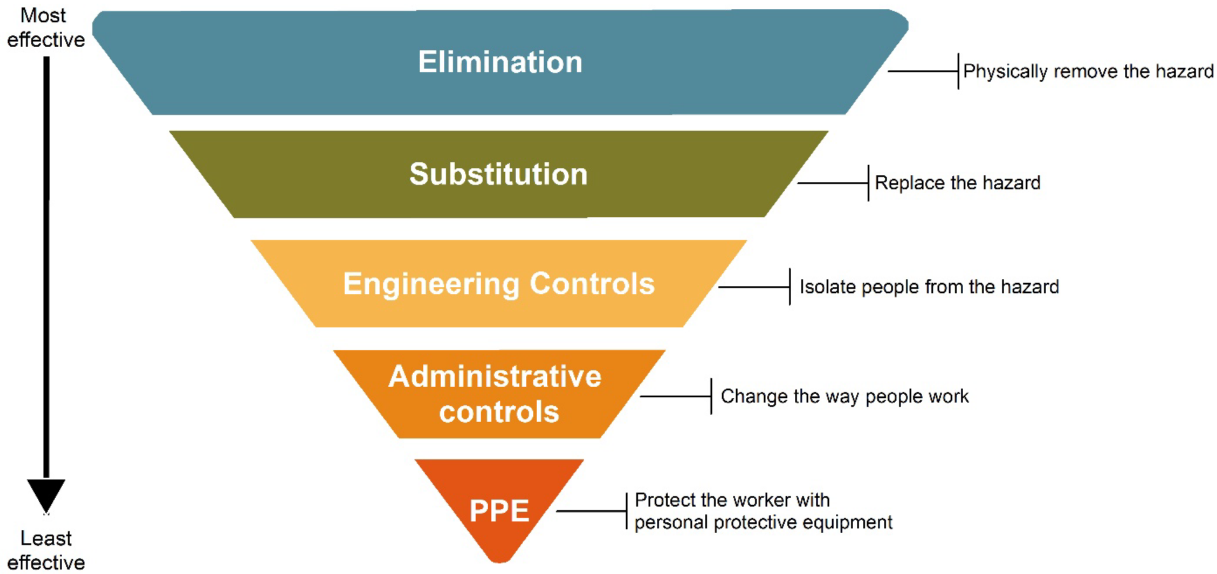
W.H.Y. Resources will follow the hierarchy of controls to reduce risks at the workplace for the RRIMM Project (Figure 8.3-1; WorkSafeBC 2017), including:

- Elimination
- Substitution
- Engineering controls
- Administrative controls

- Personal Protective Equipment (PPE)

All types of controls will be considered and implemented, and in combination, where most effective.

Hierarchy of Controls



Source: WorkSafeBC 2017

Figure 8.3-1: Hierarchy of Controls to Reduce Risks at the Workplace

8.3.2 HAZARD ELIMINATION AND SUBSTITUTION

Eliminating hazards from the Project workplace is the primary safety priority for W.H.Y. Resources. If eliminating potential hazards is not an option, substitution can help to eliminate as it involves replacing the material or process with a less hazardous alternative. Where elimination and substitution options are not successful, engineering controls will be the next priority, followed by administrative controls and PPE.

8.3.3 ENGINEERING CONTROLS

If completely eliminating or substituting a potential hazard from the Project workplace is not possible, then appropriate engineering controls would be implemented where practicable. This will minimize the risks of workers being exposed to unacceptable levels of any chemical, physical, biological, ergonomic, or other hazard. All mine infrastructure and activities would be designed by a qualified professional and would meet required and acceptable standards of practice.

8.3.4 ADMINISTRATIVE CONTROLS

Administrate controls include work procedures, such as written safety policies, rules, supervision, training, etc., which aim to reduce workplace hazards. The Project will implement appropriate administrative controls with the goal to avoid and minimize adverse health and safety effects to workers and visitors at or transporting to and from site.

Project health and safety rules include, but are not limited to, the following:

- Up-to-date mine plans would be kept at site.
- Untrained and unauthorized persons would be prohibited to enter the mine.
- Only recognized means of entry and exit would be used and clear signs would be posted.
- Known potential risks of hazards would be signed and posted clearly where appropriate and practicable.
- Age restrictions would be implemented, e.g., only workers over the age of 18 would be permitted
- Regular check-in procedures for all workers would be implemented.
- Regularly-scheduled safety meetings would be conducted to discuss the potential hazards associated with work activities and how those potential hazards are to be reasonably avoided, controlled, and emergency response procedures that apply.
- Drugs and liquor would be prohibited; impaired people would not be permitted to work.
- Improper conduct would be prohibited, which would be defined and communicated to each worker before starting (e.g., play or actual fighting, harassment, practical jokes that may create a hazard to a person).
- Tampering with safety devices and equipment would be prohibited.
- When working near machinery, equipment with moving parts, or equipment that is electrically charged, workers would be prohibited from wearing loose-fitting clothing, dangling jewelry, or long hair.
- Traffic safety rules would be communicated to workers and posted along vehicular travel routes.
- All workers would be familiar with the available safety reference materials that apply to all of their specific work activities, e.g., Job Safety Analysis forms, Standard Operating Procedures for equipment and tasks, Safe Work Practices, Safe Job Procedures, and Material Safety Data Sheets (MSDS).
- All work involved in correcting an unusual hazard would be supervised by the manager or a delegate.

8.3.5 PERSONAL PROTECTIVE EQUIPMENT

When hazard elimination, substitution, administrative controls, and engineering controls are implemented, there is still a risk to workers at the Project site. All Project workers will have and wear appropriate PPE, which is a last line of defense for protection against potential health and safety hazards. This would include head protection, foot protection, eye protection, and hearing protection. Some equipment will require additional personal safety gear, which will be provided to and worn by workers.

Workers will be prohibited from working if they refuse to wear, or use as appropriate, their PPE. Other personal safety equipment includes: first aid and survival kits, weather-appropriate clothing, communication equipment, and vehicle maintenance gear. All safety equipment would be used and maintained in accordance with manufacturer specifications.

8.4 TYPES OF HAZARDS

The Project would have several types of potential hazards applicable, for which the hierarchy of controls would be implemented, including:

- **Chemical hazards,** including but not limited to, airborne and inhalation hazards (e.g., dust, asbestos) and other hazardous materials and wastes.
- **Physical hazards,** which include but not limited to:
  - Ground or wall instability
  - Building and infrastructure
  - Vehicles, equipment, and machinery
  - Electrical
  - Noise
  - Blasting
  - Explosives
  - Worker fatigue
  - Falls from elevation
- **Biological hazards,** which include but not limited to:
  - Bacteria, viruses, and mold
  - Wildlife, insects, and plants, e.g., bears, bees
- **Ergonomic hazards,** including activities that may lead to musculoskeletal injury.
- **Bullying and harassment hazards,** including but not limited to, verbal aggression, personal attacks, and other intimidating or humiliating behaviours.

8.5 WORKER TRAINING

All employees and contractors (workers) will be trained on workplace health and safety and how to do their jobs and work equipment and machinery safely. Training would include all BMPs as per the Code (BC MEM 2017) and the final OHSP. Training on Workplace Hazardous Materials Information System (WHMIS) will be required for all employees as well as the *Mines Act* and its regulations, the Code, and emergency response procedures as per the MERP. Training would also include stop work rights and procedures for all employees, i.e., all workers on have the right to refuse unsafe work without employment consequences.

In addition to comprehensive training, health and safety orientations will be conducted for all who visit the Project site, including short-term visitors. The orientation will include the location and types of potential hazards, the emergency and first aid kit locations and procedures, and other health and safety policies, practices, and procedures.

8.6 MONITORING AND REPORTING

Certain components of the OHSP may need to be modified based on site experience or changes in legislation or best practices. All aspects of the plan shall be audited or reviewed for effectiveness and to identify components needing correction, adjustment or upgrading.

Occupational health and safety records for the Project will be kept in a reporting system, which would include details on:

- Worker training activities (i.e., records of all workers who have completed training, who they were trained by, and when, will be maintained).
- Reports of unsafe work sites or practices, accidents, and dangerous occurrences.
- Vehicle maintenance.
- Other Code (BC MEM 2022) requirements as applicable.
- Occupational health and safety statistics for the site.

The Mine Manager will be responsible for the overall implementation of the OHSP and designating an occupational health and safety committee. An occupational health and safety committee will be responsible for carrying out regular planned and unplanned safety inspections and investigations in the workplace, as well as attend safety meetings, and review the records of mechanical and electrical maintenance conducted. Meeting minutes will be recorded and filed for each regular meeting. Any health and safety concerns or incidents encountered will undergo a complete assessment and evaluation process to determine the cause, magnitude, follow-up required, and necessary reasonable changes required to avoid or mitigate hazards. These will be reported, and adjustments made to the OHSP and its procedures as applicable.

All employees, contractors, and contractor employees will be responsible for complying with the OHSP and applicable BMPs. Employment repercussions may apply if negligence of health and safety procedures, policies and protocols is determined.

An auditing program will be developed and implemented prior to the start of construction for applicable compliance checks and QA/QC. Results of the audits will be included in the reporting system, including a record of the dates the audits took place, what was checked/reviewed, corrective actions carried out, and personnel involved.

9.0 MANAGEMENT PLANS

This section of the Permit Application describes the key mine management plans developed to support construction and operations of the RRIMM Project. The mine management plans describe protection measures implemented on-site to avoid or reduce potential adverse effects and address environmental, operation and health and safety issues. The plans reflect site-specific operational management and monitoring requirements. Mine management plans are considered living documents and will be kept up to date, reviewed routinely, and be made available at the mine site at all times.

Mine management plans are developed in accordance with industry best management practices (BMP) and standards, applicable regulations, and include both general and site-specific environmental, operational and health and safety protection measures. Each management plan generally includes the following:

- Purpose and scope of the plan
- Applicable legislation, policies, BMP, and industry standards
- Mitigation measures and written proactive and standard operating procedures, and specifications that provide direction for management, mine site employees and contractors
- Monitoring (e.g., compliance and/or effectiveness) and reporting requirements
- Roles and responsibilities, including training requirements

An adaptive management approach is incorporated into the development of key management plans to demonstrate how environmental predictions will be tracked, and how the mitigation measures and/or mine plan will be adapted to accommodate differences between predicted and actual environmental outcomes. The following guiding principles for adaptive management have been considered and incorporated into plans as appropriate:

- Measurable objectives for each of the potential environmental effects
- Management alternatives (i.e., specific actions that could be taken, if necessary)
- Predictive models that will be used to inform the decision-making process
- Monitoring protocols for collecting data required to determine whether objectives are being met
- Provisional triggers that would be used to initiate a change in management practices
- Actions that would be taken if the triggers are reached

Contractors completing work on the RRIMM Project may be required to develop site-specific management or environmental work plans in addition to the plans described here. These mine management plans described below will guide and supplement any required site-specific management plans and apply to all personnel involved with the development of the RRIMM Project.

Mine management plans developed in support of the Permit Application (as guided by the provincial joint application guidance document; EMPR and ENV 2019) are listed below and described in the following sections and associated appendices:

- Mine Emergency Response Plan (Section 9.1; Appendix 9-A)
- Environmental Management Plan (Section 9.2)
- Construction Management Plan (Section 9.3)
- Surface Erosion Prevention and Sediment Control Plan (Section 9.4; Appendix 9-B)
- Fuel Management and Spill Control Plan (Section 9.5)
- Mine Site Water Management Plan (Section 9.6; Appendix 3-A and 3-E)
- Waste (Refuse) Management Plan (Section 9.7)
- Safe Discharge Plan (Section 9.8; Appendix 9-C)
- ML/ARD Characterization and Management Plan (Section 9.9; Appendix 9-D)
- Traffic Management Plan (Section 9.10)
- Chemicals and Materials Storage and Handling Plan (Section 9.11)
- Vegetation Management Plan (Section 9.12)
- Wildlife Management Plan (Section 9.13)
- Archaeological Management and Impact Mitigation Plan (Section 9.14)
- Fugitive Dust Management Plan (Section 9.15; Appendix 9-E)
- Noise Abatement Plan (Section 9.16; Appendix 9-F)
- Asbestos and Fibrous Minerals Management Plan (Section 9.17; Appendix 9-G)

9.1 MINE EMERGENCY RESPONSE PLAN

9.1.1 PURPOSE AND SCOPE

The Mine Emergency Response Plan is provided in Appendix 9-A (Greenwood 2018). This section provides a summary of the MERP, with review of complete details recommended in Appendix 9-A.

The Mine Emergency Response Plan (MERP) describes the procedures and course of action to be followed in the event of a mine emergency and addresses advance preparation and preventative measures for potential emergencies. The plan identifies those responsible for taking action immediately after discovery of and during the response to an emergency, as well as their respective duties, to ensure a prompt and coordinated response to emergencies. The plan applies to all phases of the RRIMM Project, including emergencies that result from natural hazards (e.g., forest fires), on-site Project activities (e.g., medical injury, mine fires), and uncommon and unlikely events (e.g., earthquakes).

The development of the MERP was directed by the *Mine Emergency Response Plan Guidelines for the Ministry Industry* (Ministry of Energy, Mines and Petroleum Resources 2017) and requirements pursuant to Section 3.7.1 of the *Health, Safety and Reclamation Code for Mines in British Columbia* (the Code; BC MEM 2022).

The MERP is a living document and will be reviewed, and revised as needed, to reflect changes to applicable legislation, other W.H.Y. Resources procedures, and input from company personnel, contractors or external agencies. Adequacy of the MERP will be assessed after emergency occurrences. Typically, updates will be completed on an annual basis, or when key contacts and response team members change.

The Vice President of Environment and Permitting is responsible for ensuring the MERP is maintained and distributed, with assistance from the Mine Manager and the Health and Safety Officer.

9.1.2 Regulatory Context and Resources

Development and implementation of the MERP is guided by several provincial and federal acts, regulations, and best management practices to cover all aspects of human health, safety, and environmental emergency preparedness.

The Mines Act (1996) and the Code protect workers and the public through provisions for minimizing the health, safety, and environmental risks related to mining activities (BC Ministry of Energy and Mines 2022). The *Mines Act* and the Code require that an MERP be prepared. Applicable legislation that govern W.H.Y. Resources mining activities are listed below.

Federal

- *Hazardous Products Act* (1985; WHMIS)
- *Transportation of Dangerous Goods Act* and Regulations (1992)
- *Fisheries Act* (1985) and Regulations
- *Species at Risk Act* (2002)

Provincial

- *Mines Act* (1996) and Regulations
- Health, Safety and Reclamation Code for Mines in BC (2022)
- *Workers Compensation Act* (1996) and Regulations
- *Wildfire Act* (2004) and Regulation
- *Environmental Management Act* (2003) and Regulations (Hazardous Waste, Spill Reporting)
- *Fire Services Act* (1996) and BC Fire Code Regulations
- *Water Sustainability Act* (2014)
- *Drinking Water Protection Act* (2001) and Regulations
- *Public Health Act* (2008) and Regulations

9.1.3 Emergency Response Procedures and Action Plans

Response to an emergency situation will follow action plans. Action plans are detailed in the MERP (Appendix 9-A; Greenwood 2018) for the following potential emergency scenarios and clearly stipulate the procedures to follow:

- Medical emergency
- Fires
- Evacuation
- Spills
- Landslide or Pit-Slope Failure
- Natural Disaster (Earthquake)
- Wildlife Encounter
- Search and Rescue

A component of the action plans includes the pre-planned notifications that will occur internally and externally in the event of an emergency. Internal notifications will ensure that rapid response to an emergency is initiated, and hazards are minimized and contained. On-site personnel will follow concise emergency response procedures that include identifying and reporting the emergency, monitoring the situation, and will be followed by appropriate action. External notifications will occur when management decides that outside help is needed due to escalation of the emergency, or a reporting requirement is triggered. The notification procedures will clearly and succinctly identify key personnel with assigned tasks to avoid confusion and delays.

9.1.4 Reporting Requirements

The type of emergency will dictate the necessary reporting requirements. The MERP lists the various types of emergencies and the reporting protocol for each type. A record of the annual test of the MERP will be included in the annual report submitted to the Chief Inspector of Mines. An auditing program will be developed and implemented for applicable compliance checks and QA/QC. Results of the audits will be included in the reporting system, including a record of the dates the audits took place, what was checked/reviewed, corrective actions carried out, and personnel involved.

9.1.5 Roles and Responsibilities

The MERP (Appendix 9-A; Greenwood 2018) provides detailed of the roles and responsibilities of key personnel during an emergency, below is a brief summary:

- **Vice President Safety and Environment** – ensures adequate resources are allocated to develop and maintain emergency preparedness and response procedures; as well as provide assistance to the Mine Manager to decide response involvement, undertaken notification requirements, and ensure adequate training is implemented.

- **Mine Manager** – ensure the MERP is implemented, personnel trained in emergency preparedness and response, and emergency exercises are completed, as required, and records are maintained on file. The Mine Manager is responsible to act as the Incident Commander for all significant incidents and coordinate response efforts. As well as initiate Flash Reports as needed; review, approve and circulate incident reports and ensure government and other external agencies are notified of Incidents and Dangerous Occurrences, as required.
- **Health and Safety Officer** – maintain an up-to-date list of names and head count for all personnel on site and during emergencies, fulfil Incident Communications role. As well as assist Supervisors evaluate worksite hazards and ensure safe operations, and complete incident reports as required.
- **First Aid Attendant (FAA)** – maintain first aid equipment on site, radio communications at all times and prepared for and respond to emergency calls. In the event of medical emergencies, act as On Scene Commander and direct medial response efforts, provide first aid as required, and notify the Mine Manger. Report all injuries to the Health and Safety Officer and maintain the First Aid Record Book, as required.
- **Site Supervisors** – ensure workers are adequately trained in emergency response procedures and equipment and field caches had adequate emergency response equipment. For non-medical emergencies, act as On Scene Commander and direct emergency response efforts and ensure all personnel report to the designated Muster Area during an evacuation. Respond to worker injuries and potential injuries and alert the First Aid Attendant of the situation, as required. Report all incidents and near misses to the Health and Safety Officer, and complete incident reports, as required, with the assistance from the Health and Safety Officer.
- **Workers** – be familiar with and follow the emergency response procedures and know the location of emergency response equipment and use consistent with training. Inspect and report hazardous situations to your Supervisor. Follow initial response procedures in emergency situations, as required and if initial responders are already at the scene, do not go to the scene, unless you are called by the On Scene Commander. During an emergency, shut down equipment, as required, and wait for the “All Clear” from the Mine Manager prior to resuming duties. Report all incidents, injuries, potential injuries, including near misses, to your Supervisor.

9.2 ENVIRONMENTAL MANAGEMENT PLAN

9.2.1 PURPOSE AND SCOPE

The Environmental Management Plan describes the overall company objectives and management structure for implementation of the mine management plans. The plan will be developed to include the following elements:

- Environmental policy statement
- Environmental management roles and responsibilities
- Statutory requirements, including applicable local, provincial, or federal environmental standards and guidelines, permit requirements, regulations, and orders

- Environment standards and procedures, including applicable sector-specific standards, guidelines, best management practices, and codes of practice
- Environmental management approach (e.g., adaptive management, continuous improvement, precautionary approach)
- Mine organization structure
- Training programs

The Environmental Management Plan will be applicable during all phases of the RRIMM Project and will be a living document and updated as appropriate during the mine life.

9.2.2 Environmental Policy Statement

W.H.Y. Resources is committed to protecting the health and safety of its employees, contractors and the public, and to safeguarding the environment affected by its activities. We care about our employees, the environment, and communities in which we operate.

Key principles of W.H.Y. Resources' environmental policy are:

- Conduct all activities in compliance with applicable legislation, policy and programs thus providing for protection of the environment, employees, and the public.
- Integrate management of environmental, social, cultural, and economic issues into all company business and planning.
- Be a responsible environmental steward through taking the necessary precautions to minimize environmental effects of operations and developing controls to mitigate environmental risks.
- Ensure awareness among employees and contractors of this environmental policy, promote shared responsibility and accountability for environmental obligations, and provide support and training necessary to achieve these objectives.
- Communicate openly with government, employees, location communities, First Nations, and the public to sustain mutual understanding of environmental, social, cultural, and economic issues.

9.2.3 Environmental Management Roles and Responsibilities

It is imperative to have clear understanding of roles, responsibilities, and level of authority for all persons working at a mine. For the Project, it will be W.H.Y. Resource's responsibility to clearly define and communicate roles, responsibilities, and authorities for implementing environmental management on site.

As part of the process, all documentation relating to site environmental management will clearly state who is responsible for ensuring the requirements defined are achieved. W.H.Y Resources will appoint individuals to positions that will play key roles in environmental management of the Project. The following positions and their responsibilities have been compiled for the Project:

- Mine Manager: The Mine Manager will have the responsibility under the *Mines Act* to ensure that the Project operates in compliance with the Health, Safety and Reclamation Code for Mines in BC and in accordance with permits, as well as to provide the necessary resources to establish, implement, maintain, and improve the mine management plans. The manager will be responsible for overall operations including environmental management and for oversight of the environmental policies and mine management plans for the Project, including auditing, action planning and verification processes.

- Environmental Management Personnel: The key environmental management personnel accountable for the implementation and day-to-day operation of the environmental programs and plans will be comprised of the Environmental Technician and Environmental Monitor. These personnel will also be responsible for the development and execution of Standard Operating Procedures (SOPs) which will ensure safe, effective, and environmentally-sound work practice. They will also ensure environmental plans and SOPs are updated as requirement and are periodically audited for effectiveness. Environmental management personnel will be part of the Technical Department that ultimately reports to the Contract Manager.
  - Environmental Technician: will report to the Contract Manager and will be responsible for ensuring that the Project complies will all regulatory and permit requirements. The Environmental Technical will ensure there is the necessary resources to establish, implement, maintain, and improve the environmental programs and plans, as well as ensure that all government reporting, permit, and regulatory requirements are fulfilled.
  - Environmental Monitor: will report to the Environmental Technician and assist in ensuring that all government reporting, permit, and regulatory requirements are fulfilled. Duties will include site inspections, development of standard operating procedures, sample collection and data review and preparation of documents and reports for government distribution.

9.2.4 Regulatory Context and Resources

Provincial statutory requirements that are anticipated to be applicable during the construction of the Project:

- *Environmental Management Act* (2003)
- *Mines Act* (1996)
- Municipal Wastewater Regulation (2012)
- Hazardous Waste Regulation (1988)
- *Drinking Water Protection Act* (2001)
- *Water Sustainability Act* (2014)
- *Forest Act* (1996)
- *Land Act* (1996)
- *Forest and Range Practices Act* (2002)
- *Motor Vehicles Act* (1996)
- *Transportation Act* (2004)
- *Heritage Conservation Act* (1996)

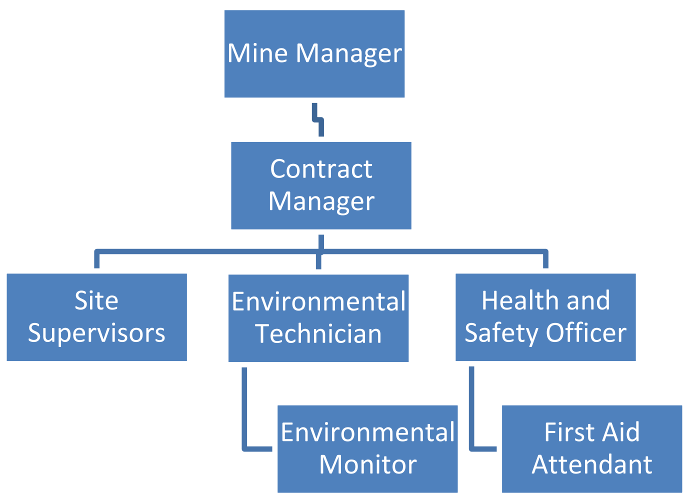
- *Wildfire Act* (2004)
- *Wildlife Act* (1996)

The federal legislation and regulations that are anticipated to be application during the construction of the Project are:

- *Explosives Act* (1985)
- *Fisheries Act* (1985)
- *Migratory Birds Convention Act* (1994)
- *Species at Risk Act* (2002)

Legislation and regulations affecting any aspect of construction and operations will be reviewed regularly. In additional, permits and licenses, emission and discharge limits, permit requirements and other legal matters will all be kept on file on site and maintained by the Environmental Technician.

9.2.5 MINE ORGANIZATION STRUCTURE



9.2.6 TRAINING PROGRAMS

All employees will be appropriately trained and qualified to carry out their duties under the scope of the environmental management programs, and W.H.Y. Resources will require that employees of its contractors are trained and qualified to carry out their duties under the scope of the environmental management programs. Any activities that can have a potential adverse effect on the environment will be identified and appropriate measures will be activated to ensure all persons associated with the Project are aware of any potential effects of their work activities, and their roles and responsibilities.

Training needs for employees will be identified and provided, and training records retained. Formal training will be undertaken on-site in regard to two aspects: general environmental, and job-specific training. These aspects will be incorporated into job orientation and structured around safe and environmentally sound job execution. Job orientation training will include, but not be limited to, environmental policy, environmental risks and potential environmental impacts of their work, and roles and responsibilities with respect to environmental management.

All new employees, contractors and consultants will be briefed on relevant environmental management plans and SOPs, and ongoing training will continue as plans are updated. Management plans and operating procedures will be continuously updated to ensure that training and awareness of policies and procedures are at an acceptable level, and to ensure that the procedures are still adequate.

9.3 CONSTRUCTION MANAGEMENT PLAN

9.3.1 PROJECT SCHEDULE

A detailed discussion of the mine development sequence and scheduling can be found in Section 3.2 of this Permit Application. The mine development sequence includes a three-month construction period, which includes construction of site access haul roads and pads, as well as salvaging and stockpiling topsoil from the project disturbed areas and mobilization of required project equipment. Site facilities constructed during the construction period include: a site security gate, parking area, maintenance pad, site offices, dry buildings, mobile crusher pad, and powder magazine. Site haul roads and pads constructed for offices, maintenance areas, and mobile crusher will be constructed as cut and fills with no planned externally quarried construction materials.

Production phase of the project includes two years of mining at a rate no greater than 200,000 tonnes per year of mineralized material which will be delivered to the crusher pad before being hauled off-site. A total of 100,000 tonnes of waste stripping will be mined over the two-year mine life and stockpiled in the waste rock storage facility until mine reclamation.

9.3.2 CONSTRUCTION COORDINATION AND MANAGEMENT

Environmental management during all phases of the Project will be coordinated by W.H.Y. Resources Environmental Technician who will work in conjunction with the Contract Manager and Environmental Monitor.

9.3.3 CONSTRUCTION WORKFORCE

A peak workforce ranging from 60 to 70 people is anticipated during the construction phase. Positions will include heavy equipment operators, mechanics, millwrights, electricians, control technicians, supervisory personnel, administrative personnel, service and maintenance specialists, labourers, and environmental compliance specialists.

Key operations personnel will be recruited early. Early recruitment will be required to hire qualified workers for mining and operations and to establish various training programs. Some of these programs will be designed to attract the residents of local communities to enable them to develop the skills needed to participate in mine development and subsequent operations.

9.4 SURFACE EROSION PREVENTION AND SEDIMENT CONTROL PLAN

9.4.1 PURPOSE AND SCOPE

The Surface Erosion Prevention and Sediment Control Plan is provided in Appendix 9-B (SRK 2018c). This section provides a summary of relevant details of the plan for ease of reference; however, review of complete details is recommended in Appendix 9-B.

This Surface Erosion Prevention and Sediment Control Plan describes strategies to minimize the risk of erosion and control sediment transport during the life of the RRIMM Project. These strategies include best management practices and are designed to accommodate varying site conditions while maintaining appropriate standards for protection of environmentally sensitive areas.

The potential for sediment release within the Project site, such as waste rock dumps and pit walls, is addressed in the Mine Site Water Management Plan (Section 9.6).

9.4.2 REGULATORY CONTEXT AND RESOURCES

All of the Project components have the potential to produce runoff with elevated concentrations of suspended sediment. The soil stockpile, mine access road, and parking lot areas are particularly susceptible to erosion but construction activities and material handling anywhere on site has the potential to mobilize sediment.

Suspended sediment in effluent must be properly controlled to protect downstream water quality. The BC Water Quality Guidelines for Protection of Aquatic Life (WQG PAL) includes the following guideline for total suspended solids (TSS) concentrations:

- Maximum change from background of 25 mg/L TSS at any one time for a duration of 24 hours in all waters during clear flows or in clear waters.
- Maximum change from background of 5 mg/L TSS at any one time for a duration of 30 days in all waters during clear flows or in clear waters.
- Maximum change from background of 10 mg/L TSS at any time when background is 25 to 100 mg/L TSS during high flows or in turbid waters.
- Maximum change from background of 10% when background is greater then 100 mg/L TSS at any time during high flows or in turbid waters.

The objective of the Surface Erosion Prevention and Sediment Control Plan is for the site to operate within the BC WQG PAL limits.

9.4.3 Erosion Prevention and Control Measures

9.4.3.1 General Practices and Measures

The following general practices for surface erosion prevention were considered when developing the plan:

- Limiting the area of land disturbance to the extent practicable.
- Reducing water velocity across the ground using surface roughening and recontouring.
- Constructing and operating all site facilities and infrastructure following approved plans and procedures.
- Maintaining and inspecting all site water management and sediment control infrastructure.
- Constructing appropriate erosion prevention and sediment control measures (see below) as needed.
- Monitoring of site and downstream water quality.

One or more standard measures for surface erosion prevention and/or sediment control may be implemented to meet BC WQG PAL limits for TSS, including:

- Filter fabrics or geotextile
- Riprap
- Silt fences
- Silt (turbidity) curtains
- Sediment traps
- In-channel rock energy dissipaters
- Settling ponds
- Gravel berms

9.4.3.2 Construction

A three-month construction period is required to mobilize equipment, establish site access, clear and prepare the crusher pad, stockpile area, topsoil and waste rock storage areas, the office area and parking lot. Topsoil excavated as part of the site preparation will be salvaged and placed in the topsoil stockpile.

During construction, surface erosion prevention and sediment control measures will include the following:

- Mine access and haulage roads: During road construction, erosion will be controlled using standard construction methods including silt fences, mulch, mats, geotextiles, etc. on an as-needed basis as determined by the RRIMM Project team. Dust suppression measures (i.e., road watering) will control dust from constructed roads.
- Pads: During pad construction, erosion will be controlled using standard construction methods (e.g., silt fences, mulch, mats, geotextiles, etc.) on an as-needed basis.
- Soil stockpile: Prior to construction, soil will be scavenged from footprint areas and will be placed in a stockpile. The soil stockpile will be seeded with a weed-free erosion control seed mix.

During construction, environmental monitoring personnel will inspect all erosion control measures daily or several times daily after significant runoff-producing rainfall event. Silt fences, sediment basins, ditches, culverts, and the sediment control ponds will be visually inspected for the following:

- Performance in accordance with design intent
- Sediment build-up or blockages
- Structural/physical integrity
- Anticipated wear and tear.

Sediment removal and proper disposal will be performed as required.

9.4.3.3 Operations

During operations, surface erosion prevention and sediment control measures will include the following:

- Mine access and haulage roads: Dust suppression measures (i.e., road watering) will control dust from constructed roads.
- Soil stockpile: soil stockpile will be reseeded as necessary with a weed-free erosion control seed mix.
- Open pit: refer to the Mine Site Water Management Plan (Section 9.6; Appendix 3-A and 3-E).
- Waste rock storage facility: refer to the Mine Site Water Management Plan (Section 9.6; Appendix 3-A and 3-E).
- Other facilities: erosion around other facilities will be monitored, and erosion prevention or control measures will be implemented on an as-needed basis.

9.4.3.4 Closure and Post-Closure

At the end of the two-year project, the RRIMM will be reclaimed and returned to its pre-mining land capability (wildlife habitat). Revegetation of disturbed land will be implemented progressively as well as at the end of Project life to prevent soil erosion and return the land to wildlife habitat. A weed-free native seed mix suitable for use in this region will be used. In addition, native tree and shrub seedings will be placed. Early successional stage species suitable for the region will be selected.

The environment manager will work with the RRIMM Project engineers and environmental team to monitor erosion and TSS in surface water, implement prevention and control measures as required, and monitor the effectiveness of the measures.

During reclamation, surface erosion prevention and sediment control measures will include the following:

- RRIMM access and haulage roads: The roads constructed to access the open pit, waste rock and soil stockpiles, and buildings will be decommissioned once no longer needed for reclamation. The side cast material will be pulled back to fill the cut bank and recontoured to blend into the surrounding landscape. Any culverts installed during road construction will be removed and natural drainage patterns restored.
- Open pit, waste rock storage facility, and soil stockpile: Once mining is complete, stockpiled waste rock will be back-hauled into the open pit. Soil from the soil stockpile will be placed on the surface of the

waste rock in the open pit as growth medium. The growth medium will be revegetated to prevent erosion.

- Other facilities: All equipment and buildings will be removed from the RRIMM site

9.4.4 Monitoring and Reporting

All surface erosion prevention and sediment control infrastructure will be visually inspected a minimum of once per week during the operating period (six months of the year) and after any significant weather events. These inspections will be reviewed along with monitoring results to identify any structures that need to be repaired or replaced to effectively retain sediment.

In conjunction with visual inspections and as-needed maintenance of surface erosion prevention and sediment control infrastructure, monitoring of downgradient water quality for TSS concentrations will be conducted regularly to confirm that TSS is staying below permit limits. The specific monitoring frequency and monitoring locations will be determined in the permit for the RRIMM Project but is anticipated to include a minimum of monthly monitoring and after any significant weather events. Monitoring results will be reported as required in the permit.

If monitoring indicates that the surface erosion prevention and sediment control infrastructure is not performing as intended and/or downstream water quality exceed objectives or permit limits for TSS, the Contract Manager will work with site personnel and contractors to identify specific response actions.

9.5 FUEL MANAGEMENT AND SPILL CONTROL PLAN

9.5.1 Purpose and Scope

W.H.Y Resources is committed to provide safe and healthy working conditions, and understands that health, safety, and environmental protection are vital elements of the proposed RRIMM Project. Environmental protection for fuel management requires implementation of proper procedures for transportation, handling, inspection, storage, transfer, reporting, and documentation for all fuel products throughout the two year mine life.

The Fuel Management and Spill Control Plan describes procedures for transportation, storage, and handling of fuel products, as well as preventative and response measures for spills. These products (mostly hydrocarbon and petroleum products) include diesel, gasoline, oils, and hydraulic fluids.

This plan is a living document and will be amended with input from the construction contractor to include additional details as to fuel storage and handling locations, employee training programs and certifications, work instructions, inspections, reporting, documentation, and details of continual improvement initiatives.

The intent of the Fuel Management and Spill Response Plan is to ensure activities involving fuels are undertaken in such a way that minimizes risk of an accidental release into the ground or water. The plan also outlines the course of action to be implemented in the event of an accidental spill.

Objectives of the plan are to:

- Provide effective, suitable direction and training to employees for fuel management (transporting, handling, and storing fuel and lubricating products) and spill contingencies (containment and/or cleanup of spilled material).
- Ensure fueling practices reduce risk and impacts to human safety and protect the environment from accidental release into the ground or water.
- Promote safe and effective recovery or disposal of spilled materials, including risk of fires and explosions.
- Comply with provincial and federal requirements pertaining to contingency planning and reporting.

Response to fuel spills and emergencies are also addressed under the Mine Emergency Response Plan (MERP) (Section 9.1; Appendix 9-A). Health and safety aspects of transporting, handling, and storing fuels are addressed in Health and Safety (Section 8.0).

9.5.2 Regulatory Context and Resources

Fuel activities (transportation, handling, and storage) shall be undertaken in accordance to the following statutes, industry standards, and codes of practice:

- BC *Environmental Management Act* (2003)
- Spill Reporting Regulation (BC Reg 187/17)
- Spill Cost Recovery Regulation (BC Reg 185/17)
- Contaminated Sites Regulation (BC Reg 375/96)
- Petroleum Storage and Distribution Facilities Storm Water Regulation (BC Reg 168/94)
- BC *Mines Act* (1996)
- Health, Safety, and Reclamation Code for Mines in British Columbia (BC Ministry of Energy and Mines 2022)
- Workplace Hazardous Materials Information System Regulation (WHIMIS; BC Reg 257/88)
- BC *Building Act* (2015)
- BC Fire Code Regulations (BC Reg 166/2013)
- BC *Workers Compensation Act* (1996)
- Occupational Health and Safety Regulation (BC Reg 296/97), Part 5 WHMIS
- BC *Transport of Dangerous Goods Act* (1996)
- Canadian *Environmental Protection Act* (1999)
- Environmental Emergency Regulations (SOR/2003-307)
- *Fisheries Act* (1985)

- Canadian *Transportation of Dangerous Goods Act* (1992)
- Transportation of Dangerous Goods Regulation (SOR/2001-286)
- Underwriters Laboratories of Canada and Canadian Standards Associations
- A Field Guide to Fuel Handling, Transportation and Storage (BC Ministry of Water, Land and Air Protection 2002)

9.5.3 Site Fuel Requirements

Diesel will be used by motor vehicles and mining equipment on site, as well as two back-up diesel generators to power the crusher and temporary office trailers. Limited quantities of gasoline will be used in maintenance facilities for smaller motorized equipment and machinery.

Fuel storage, up to maximum capacity for 25,000 L of diesel, will be located at the maintenance pad. Fuel will be delivered as needed from the town of Rossland and stored in an enviro-tank. An onsite fuel truck will supply fuel to the mine fleet in the pit, as well as any fixed equipment. Other surface mobile equipment will fuel-up at the storage tank. Fuel transfer is done by pumps.

The enviro-tank will be provided with standard instrumentation and controls to monitor and safely manage tank inventory. Fuel storage area and vehicles will be equipped with spill kits for emergency response. Each spill kit contains the appropriate type, size, quantity of equipment for the volume/type of fuel present in storage.

9.5.4 Fuel Management Procedures

9.5.4.1 Fuel Transport

Fuel will be delivered to site by third party supplier (locally from Rossland or Trail) with proper certification and training in fuel transport. Fuel suppliers will be required to provide documentation supporting their authority to transport fuel and present their own transportation procedures, spill contingency plan, and measures to minimize risk of accidental release of fuel. The third party supplier will be responsible for fuel during transport and required to complete necessary documentation relating to Transportation of Dangerous Goods Regulation, as well as required documents such as the material safety data sheet (MSDS) and manifest. Fuels shall be properly secured and labelled during transport. Commercial fuel transport drivers will be required to complete a site orientation prior to or upon arrival to site.

9.5.4.2 Fuel Dispensing and Storage Equipment

Fuel will be stored away from ignition sources and environmentally sensitive areas, with consideration of site drainage and surface flows and pathways to the nearest waterbody. The designated fuel storage area is one above ground diesel storage enviro-tank (25,000 L) located at the maintenance pad. This area will be well ventilated and designated as non-smoking. The area will be equipped with spill kit and anti-spill devises such as drip pans, interceptor drains, sensors, and one-way values. Diesel delivered to the storage tank will be by commercial purpose designed tanker trucks equipped with necessary instrumentation to ensure no spills, including using enclosed lines, hoses, and pumps.

Fuel dispensing and storage equipment shall meet all applicable BC regulations and BC Fire Code requirements. This includes, but is not limited to:

- Valves of the storage tank must be constructed of steel according to the Fire Code.
- Fuel hose length must not exceed 4.5 m, or 6 m where a retracting system is used.
- Hose nozzle valves must conform to CAN/ULC-S620-M *Hose Nozzle Valves for Flammable and Combustible Liquids* (Fire Code 4.5.5.2)
- When a hose nozzle valve with a hold-open device is used, a break-away coupling conforming to CAN/ULC-S644-M *Emergency Break-away Fittings for Flammable and Combustible Liquids* shall be provided.
- When dispensing flammable liquids into a container or storage tank made of metallic or electrically conductive material, ensure that static electrical charges are controlled by establishing an electrical connection between the tank or container and the truck box fill stem, or by providing other appropriate measures as applicable (Fire Code 4.1.8.2).

9.5.4.3 Fuel Handling

Fuel handling personnel shall receive training and must demonstrate an understanding of fuel handling procedures and work instructions.

Key components of fuel handling procedures include, but are not limited to:

- Only persons trained to safely handle fuels and aware of Workplace Hazardous Materials Information System (WHMIS) requirements shall implement procedures for handling fuel.
- Monitoring and reporting of any release (reportable or not) should they occur.
- Refueling to be conducted outdoors and occur at a refuelling point with drainage capture/collection installed. In the event refuelling occurs elsewhere, drip trays shall be used under vehicles and equipment.
- Refueling and maintenance activities shall not occur within 30 m of any watercourse or waterbody except where required due to equipment breakdown or approved activities near water.
- Tanks (including portable fuel containers) must not be filled beyond their safe filling level.
- An automatic shut-off nozzle must be used when using an integral hold-open device.
- Smoking is not permitted where dispensing is being carried out.
- Do not use any object or device to maintain the flow of fuel that is not an integral part of the hose nozzle valve assembly.
- Personnel will remain at the dispensing nozzle whenever pumping fuel from the storage tank.

9.5.5 Monitoring and Inspection

Monitoring fuel inventories, inspecting equipment, and documentation are key components of the Fuel Management and Spill Control Plan.

9.5.5.1 Fuel Inventory

Fuel products transported to and moved within the mine site and storage facilities shall be inventoried regularly. This includes reconciliation of total amounts received against amount ordered and measuring fuel volumes and use during distribution to any storage tank.

9.5.5.2 Preventative Maintenance

Fuel tanks and fueling equipment shall be kept in good operating condition. Monitoring, preventative maintenance activities, and procedures shall be undertaken to prevent inadvertent releases of product to the environment, including, but not limited to:

- Equipment and light vehicle operators shall conduct regular visuals to ensure equipment integrity, cleanliness, and the adequacy of spill prevention material.
- Fuel tanks shall be visually monitored for signs of leakage, which includes looking for signs of corrosion, staining on the ground, and cracks or breaks in hoses and other ancillary equipment during visual inspection.
- Signs on fuel tanks shall be present, visible, and legible.
- Piping shall be protected from traffic.
- Any secondary containment area shall be kept clear of debris, snow, ice, or standing water.
- Emergency pumps and spill emergency equipment shall be tested on a regular basis.

9.5.5.3 Inspections and Leak Detection

Any storage tank and piping system shall be monitored for leaks in accordance with minimum frequency requirements and tested when a leak is suspected.

9.5.6 REPORTING

Records of inspections, maintenance, tests, and operational procedures shall be kept on site. This includes summaries of reconciled bulk inventory, fuel use summaries, reconciliation of any storage tank, overfill alarm tests, pressure tests (if relevant), inspections and maintenance checks, any alteration to the system, reports of leaks and loses, and records of training.

Records of all leak tests will be retained and available for inspection as follows:

- Initial verification and commissioning tests shall be retained for the life of the system.
- In-service monitoring tests and leak investigation tests shall be retained for a minimum of two (2) years, but at least the latest and immediately prior tests shall be retained on file.

9.5.7 SPILL CONTINGENCY PLAN

This section outlines the spill contingency plan to prevent and minimize the risk of a spill, and the controls in place to respond to an emergency spill during the life of the Project. This section provides initial guidance on how to reasonably avoid, control, and mitigate spills, and outlines emergency response procedures to be implemented should an accidental spill occur. These steps are practical and include provision as to how to assess an incident safely and to implement an effective and safe response.

As this plan is conceptual, prior to construction, W.H.Y Resources and the selected construction contractor will review the plan, and if necessary, revise and/or include any additional details relating to spill preventative and emergency spill contingency measures.

9.5.7.1 Spill Prevention

First steps in control and prevention measures are to: a) identify and understand potential materials and spill mechanisms; and b) implement proper storage, handling, and transportation measures.

In addition to implementation of fuel transport, storage and handling procedures outlined in Section 9.5.4, the following initiatives contribute to effective prevention of spills:

- Site planning, including optimal site locations for storage of fuel, hazardous materials, and spill control and containment should be incorporated into the infrastructure.
- Facility design to incorporate best management practice for spill containment, such as:
  - Double-walled containment of fuel products.
  - Protective barriers around hazardous products where there is potential for impact from vehicles.
  - Bermed storage areas for hazardous material containers.
- Maintaining and implementation of inspection schedules and practices for all storage areas and tanks
- Regular and frequent maintenance of vehicles, roads, equipment, and storage facilities.
- Maintaining spill response kits strategically located to be available and applicable to any type of spill material.

9.5.7.2 Spill Response

Despite the preventative control and mitigation measures implemented, a spill contingency and response plan is needed in case a spill occurs. Immediate and safe response to spills is important to minimize adverse effects.

An emergency spill is a spill of materials that can adversely affect the environment, the health safety or welfare of people, property, and/or operational efficiency. Such a spill is large and/or serious enough to require a controlled and coordinated response.

An important component of spill response is to have spill kits readily available and nearby to contain, reduce, or remove a spill in a prompt manner. The site and vehicles will be equipped with spill kits. Kits vary in size and contents depending on the type and volume of spills possible and environmental sensitivities of the surrounding areas. Basic contents include oil absorbent pads and booms, absorbent socks, granular absorbent, and protective personal equipment. Site kits will be stored in weather-resistant containers and located in strategic, visible locations. Kits should be inspected regularly, and a list of suppliers of specialized spill response services and materials maintained and updated to provide support on short notice or when replacement materials are needed.

The following actions will be taken in the event of a spill in order of priority and response:

1. Immediately identify and control:
   - Immediate dangers to human life and/or health
   - Spill material and source, as well as the potential for additional related sources of spill
2. Once safe to do so:
   - Stop the flow or shut off the spill source
   - Notify Supervisor
   - Assess severity of the spill
   - Contain the spill
3. Notification of authorities, stakeholders, First Nations and communities, as appropriate, so that those groups may initiate response for their own interests or their assistance elicited.
4. Recover and cleanup, rehabilitate site to protect the environment.
5. Investigate the incident.
6. Notify appropriate stakeholders, government agencies, BC Provincial Emergency Program, and nearby communities and landowners, as required.
7. Immediately report the incident.

If the spill for some unforeseen reason cannot be handled by on-site trained personnel or spill response equipment on-site, a spill response contractor will be called to site. A plan for cleanup and remediation of hydrocarbon contaminated soils may be developed by the Mine Manager following Section 8 of the *Field Guide to Fuel Handling, Transportation and Storage* (BC Ministry of Water, Land and Air Protection 2002), or his/her designate, in coordination with external consultants, if and as required.

9.5.7.3 Spill Response Training

Educating and training employees and equipping them with relevant knowledge and tools increases the effectiveness of the contingency plan, as well as emphasizing employee responsibilities under the plan. All employees and contractors will undergo training to identify hazards and potential spill receptors and pathways. Additionally, specific staff would undergo further training in the role of a Spill Response Team. Members of the team would be available 24/7.

Employees and contractors would be educated on, and made aware of:

- Spill Contingency Plan

- Applicable regulations
- Environmental sensitivities
- Application of appropriate spill response mechanisms
- Procedures for initial spill response and reporting
- Site muster station locations

9.5.7.4 Spill Reporting

W.H.Y. Resources will immediately report spills in accordance with the Spill Reporting Regulation (Ministerial Order No. M 329) which includes immediately reporting to the Provincial Emergency Program by calling 1-800-633-3456. As per spill reporting guidance as published by the Ministry of Environment and Climate Change Strategy (November 2017), when reporting a spill, provide as much of the following as possible:

- Contact information for individual making the report, responsible person in relation to the spill, and owner of the substance spilled
- Data and time of spill
- Location of spill site
- Description of spill site and surrounding area
- Description of the source of spill
- Type and quantity of substance spilled
- Description of the circumstances, cause, and adverse effects of the spill
- Detailed of action taken
- Names of government, federal government, location government and First Nation government agencies at the spill site
- Names of other persons or government, federal government, location, or First Nation government advised about the spill

9.6 MINE SITE WATER MANAGEMENT PLAN

The Mine Site Water Management Plan is supported by the Sediment Pond Design Report (SRK September 2023a, Appendix 3-A) and Operations, Maintenance, and Surveillance Manual for Sedimentation Pond (SRK September 2023d, Appendix 3-E).

For details regarding water management infrastructure, operating and monitoring procedures, and contingency planning, please review the Sediment Pond Design Report (SRK September 2023a, Appendix 3-A) and Operations, Maintenance, and Surveillance Manual for Sedimentation Pond (SRK September 2023d, Appendix 3-E).

9.7 WASTE (REFUSE) MANAGEMENT PLAN

9.7.1 PURPOSE AND SCOPE

The Waste (Refuse) Management Plan describes waste management strategies to be followed during construction, operation, and closure of the RRIMM Project. This plan outlines the discharges through the various construction and operation phases of the Project for refuse and any additional sources of site contamination. The emissions inventory and associated air quality management measures is not included here; instead, specifically addressed in the Fugitive Dust Management Plan (Section 9.15; Appendix 9-E. Effluent management is also not included here; refer to the Safe Discharge Plan (Section 9.8). Additionally, review the Chemicals and Materials Storage and Handling Plan (Section 9.11) and Fuel Management and Spill Control Plan (Section 9.5) for hazardous materials or dangerous goods, and fuel management, respectively.

The objective of the Waste (Refuse) Management Plan is to protect human health and to minimize potential adverse effects to the environment from waste produced at the Project site during construction, operation, closure and reclamation, and post-closure phases of the Project. A material is defined as a waste once it cannot be used for its original purpose.

9.7.2 REGULATORY CONTEXT AND RESOURCES

The Project is subject to the regulatory requirements of federal and provincial legislation to governing waste management. This includes treatment and disposal, characterization, record keeping, and reporting.

Federal and provincial legislation guiding waste management are:

- Canada *Transportation Act* (Government of Canada 1996)
- Federal *Hazardous Products Act*, including the Controlled Products Regulations
- Federal Canadian *Environmental Protection Act*, including the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations, and the Interprovincial Movement of Hazardous Waste Regulations
- Canada Labour Code, including the Canada Occupational Health and Safety Regulations
- *Environmental Management Act* RSBC 2003, Chapter 53 (Sewage, Air, Refuse, and Special Waste Regulations), including the Hazardous Waste Regulation, the Spill Reporting Regulation, and the BC Contaminated Sites Regulation
- *Health Act*, RSBC 1996, Chapter 179
- *Drinking Water Protection Act*, S.B.C 2001, Chapter 9
- Health, Safety and Reclamation Code for Mines in BC, Mines Act RSBC 1996, Chapter 293, including the Workplace Hazardous Materials Information System Regulation (Mines)
- Provincial *Transportation of Dangerous Goods Act*, including regulations
- BC *Workers Compensation Act*, including the Occupational Health and Safety Regulation

- BC *Fire Services Act*, including the BC Fire Code Regulation.

9.7.3 Refuse Waste Generated

The following types of refuse may be produced from the Project:

- Domestic:
- Refuse/garbage (e.g., food scraps)
- Glass and aluminum cans
- Plastics
- Paper
- Industrial:
- Dry batteries
- Building materials
- Cement
- Scrap metal and wood
- Tires
- Light bulbs
- Glass

An inventory of types of hazardous waste anticipated is provided in Section 9.11.

A detailed inventory of the estimated types and quantities of waste that will be generated will be developed with the construction contractor prior to construction.

9.7.4 Refuse Management

Reduce, Reuse and Recycle

The key to waste management is to reduce consumption of materials, reuse materials where possible, and recycle wastes that cannot be avoided or reused. Some waste reduction measures include:

- Substituting materials with recyclable and reusable materials where possible to replace non-recyclable and non-reusable materials.
- Purchasing materials in bulk containers and minimal packaging where possible to avoid volume of containers and packages.
- Using non-disposal items and materials over disposable products.
- Repurpose scrap metal and wood.
- Reuse waste oils, glycols, and solvents for secondary jobs.

- Implement inventory and material ordering practices to maximize use of materials before product expiration.
- Train personnel on waste minimization and reuse.

Collection and Storage

Waste will be collected in designated waste collection areas, separated, and sorted into appropriate reuse and recycling sites. Solid waste (scrap steel, wood, etc.) will be collected in appropriate containers indicative of waste stream. Empty chemical totes, lubricant drums, etc. will be collected and compacted. Designated bins will be clearly marked, and workers will be adequately trained on what is prohibited and permitted. Separating all waste at the source and ensuring proper handling, storage, and disposal will mitigate attracting wildlife.

Disposal

All industrial waste will be back-hauled offsite for recycling or disposal in an appropriate manner. Waste transport offsite will be conducted in safe and appropriately equipped and labeled trucks and only to approved disposal and recycling facilities. All hazardous waste will be handled, stored, and transported in accordance with the Chemicals and Materials Storage and Handling Plan (Section 9.11) and the Transportation of Dangerous Goods regulations (RSBC. C. 203/85).

9.7.5 Roles, Responsibilities, and Training

All workers will undergo appropriate training on environmental and waste management, including the importance and practical implementation of refuse management (i.e., reduce, reuse, recycle, and disposal), waste management practices to minimize wildlife attraction, and how and where to recycle materials at the Project site. Each worker will be expected and responsible of disposing waste according to the waste management plan.

Specific workers employed to manage the waste collection facilities will be further trained in more detail and in accordance with the applicable regulations and guidelines. This includes training in the safe work and sorting procedures and proper procedures in the identification and action plan of any potential waste improperly sorted. Workers who are involved in the receiving, storing, or transportation of potentially hazardous materials will undergo WHMIS training and Transportation of Dangerous Goods training. Information about training for workers handling hazardous materials is provided in the Chemicals and Materials Storage and Handling Plan (Section 9.11).

9.7.6 Monitoring and Reporting

Monitoring of waste management procedures include the assessment and review of the implementation of refuse management practices. A comprehensive checklist will be developed for assessment at regular intervals and will include checking that measures were implemented for waste management, such as volume waste recycled, reused, and recovered, materials being used by their expiry dates, and the largest containers being used for ordering materials as practicable for the needs of the Project.

Certain components of the plan may need to be modified based on site experience or changes in legislation or best management practices. All aspects of the plan shall be audited or reviewed for effectiveness and to identify components needing correction, adjustment, or upgrading. Most importantly, review of this plan shall include any aspects affecting protection of the environment, property, and persons. Formal evaluations of this plan will be documented, with deficiencies noted and corresponding progress in addressing deficiencies tracked in writing. Responsibilities to address deficiencies and accountabilities will be assigned and deadlines for addressing required changes will be set.

9.8 SAFE DISCHARGE PLAN

9.8.1 PURPOSE AND SCOPE

The Safe Discharge Plan is provided in Appendix 9-C (SRK 2023g). This section provides a summary of relevant details of the plan for ease of reference; however, review of complete details is recommended in Appendix 9-C.

The Safe Discharge Plan for the RRIMM Project includes:

- An assessment of potential constituents of concern in discharge from the RRIMM site;
- Proposed limits for discharge rates and water quality that aim to be protective of the downstream aquatic environment; and
- A description of mitigation measures that will be implemented as part of the Project development and a summary of mitigation measures that can be implemented if required.

The estimate range of future discharge rates and water quality are based on results of the water quality model developed for the Project (SRK 2023g). The water quality model is a mass-conservative mass balance model that aims to produce conservative estimates for discharge water quality.

Analysis of potential effects or concerns associated with predicted discharges from site, discharge methods, proposed discharge limits, and discharge monitoring are detailed in Chapter 5.0 and 6.0, as well as summarized in Appendix 9-C; thus, are not repeated here. Below summarizes mitigation measures that will be implemented during initial construction, as well as mitigation measures that may be implemented, if required.

9.8.2 MITIGATION MEASURES

9.8.2.1 Summary

Water quality parameters of potential concern in effluent from the RRIMM site include ammonia, nitrite and TSS. The proposed Safe Discharge Plan for the Project was developed to address water quality risks associated with those parameters.

Mitigation measures for TSS include:

- Erosion and sediment control (refer section 9.4; Appendix 9-B)
- Sedimentation in settling pond (Appendix 3-A and 3-E)

- Coagulation and flocculation to the extent required (detailed below).

Mitigation of TSS is expected to reduce total aluminum and total beryllium below applicable guideline and discharge limits. Planned mitigation measures for ammonia and nitrite include:

- Addition of ferric chloride coagulant to achieve an effluent pH of no greater than 7.5 and an effluent chloride concentration greater than 10 mg/L.

Additional contingency measures for ammonia and nitrite are unlikely to be necessary but can be implemented if required. These include:

- Zeolite filtration for ammonia
- Ozone oxidation of nitrate.

These mitigation measures were deemed to be sufficient given the relatively clean mineralization, the small scale of the Project and the short operating life.

9.8.2.2 TSS Control

The proposed water quality mitigation measure is ferric chloride coagulation and flocculation of the influent water to the settling pond. This will facilitate removal of TSS and prevent ammonia and nitrite from exceeding the proposed effluent standards.

Coagulant and Flocculant Coagulant Dosing System

A coagulant and flocculant dosing system will be rented as a complete turnkey system from a reputable vendor. The system will include reagent dosing and mixing units as well as required pumping equipment. Turbid feed water from a collection sump upstream of the settling pond inlet would be pumped through the flocculant dosing system. The anticipated maximum flow rate is approximately 5,500 m^3/day or roughly 1,000 US gpm.

Ferric chloride coagulant reagent will be dosed to the turbid water upstream of the treatment system. This will allow the coagulant to mix fully with the feed water before flocculant is dosed. The addition of ferric chloride will cause the formation of ferric hydroxide solids, which will help coagulate TSS and organic molecules in the feed water. The addition of flocculant will cause coagulated ferric hydroxide solids and TSS to form larger particles, which will settle as sludge in the settling pond.

Overdosing safeguards of the system include:

- Feed flow interlock: dosing systems stop if feed flow stops.
- Periodic pH checks of water in the settling tank (coagulant dose check).
- Operator diligence: dose rates will always be set to match the feed flow rates.

It will not be necessary to remove sludge from the pond during the operating season due to the short duration. Rather, sludge consisting of sediment and iron hydroxide will be collected at the end of the season by a vac truck and hauled off site for disposal. If all runoff to the settling pond contains 50 mg/L TSS, and all of it is removed a total of 7 tonnes of sludge (dry weight) would accumulate in a season. This corresponds to a volume of 70 m^3, or about three truckloads, assuming a solids content of 10%.

Coagulant and Flocculant Products

Table 9.8-1 lists the coagulant and flocculant products that may be used with the dosing system. Ferric coagulant can either be dosed as a ferric chloride or ferric sulphate solution. Liquid flocculants would be made up to a concentration of approximately 0.5% and then dosed.

Table 9.8-1: Coagulant and Flocculant Products

Coagulants	
Ferric Chloride Solution (35 to 45%)	An iron-based coagulant, which eliminates negative surface charges on finely dispersed suspended sediment. Delivered in totes or drums as acidic solutions. Solution is dosed directly from the drum/tote.
Flocculants	
ClearFloc AE0555	An anionic flocculant polymer used to bind finely dispersed suspended sediment. LC50 values for trout are generally greater than 100 mg/L. Dose is not expected to exceed 5 mg/L.
ClearFloc AP3080	
ClearFloc AP0380	
ClearFloc NE0055	An non-ionic flocculant polymer used to bind finely dispersed suspended sediment. LC50 values for trout are generally greater than 100 mg/L. Dose is not expected to exceed 5 mg/L.
ClearFloc NP0065	

Material Safety Data Sheets for the products listed are included in Appendix 9-C. Reagents delivered to site will be stored in a secure area by the site office. Measures to prevent safety hazards or accidental spills of coagulants or flocculants include:

- Containment berms, spill trays or lined secondary containment will be in place where required.
- Spill kits will be located where the reagents are in active use.
- Access to the dosing systems is restricted to qualified and trained personnel.
- First aid kit and reservoir-style eye wash station at the dosing stations.

Operating Procedures

Coagulant and flocculant reagents will be dosed when turbidity of the water in the collection sump exceeds the effluent limits, or if pH or chloride concentrations must be adjusted to mitigate ammonia or nitrite concentrations. The systems will be operated according to the suppliers operating procedures and instructions. A table showing reagent feed rates for different feed flows will be posted by the reagent dosing pumps.

Operators will be trained in the proper use and maintenance of the system. The training will cover such topics as:

- Equipment safety hazards and review of MSDSs.
- The theory of coagulation and flocculation processes.
- Start-up and shut-down of the equipment.

- Adjusting and verifying reagent doses.
- Use of hand held turbidity and pH meters.
- Sampling and reporting.

pH of the tank water will be checked a minimum of four times in a 24-hour period or when process set-point changes are made. Water samples of the effluent from the system will be sampled daily for the first week of operations and weekly thereafter. Samples will be analyzed for total suspended solids (TSS), turbidity, pH, conductivity, anions, dissolved and total metals.

9.8.2.3 Ammonia Control

The source of ammonia, nitrate and nitrite is undetonated ANFO explosives. Therefore, strict adherence to proper blasting practices is the first and most important ammonia mitigation measure. However, some loss of ANFO is unavoidable. The proposed primary measure for controlling ammonia, nitrate and nitrite is assimilation of the nutrients by vegetation through land application. However, if ammonia concentrations are higher than the proposed effluent limits or if ammonia is causing failure of acute lethality, a zeolite filtration unit for removal of ammonia would be deployed.

Zeolite is a natural mineral that adsorbs ammonia from solution via an ion-exchange mechanism. The affinity of ammonia for the ion exchange sites in zeolites is well documented (Liu 1995). Zeolite-based ammonia treatment systems have been implemented commercially to a limited extent, including at the Lake Shore Gold Mine near Timmins, Ontario. However, zeolite ammonia treatment is typically not a feasible treatment method for ongoing operations due to the relatively high cost of the mineral (approximately US$8,000/tonne), which renders it uneconomic for a one-off use. Zeolite ion exchange sites can be regenerated by washing spent zeolite with acid, but post-processing of the acid and rise required to regenerate the system is difficult and costly. The treatment system installed at Lake Shore Gold relied on a zeolite regenerating circuit using nitric acid.

However, zeolite filtration is a suitable solution for the RRIMM Project due to the short operating window (two seasons of six months) and the relatively low ammonia load expected. Used in a single-pass configuration, zeolite can remove more than 90% of ammonium. Assuming a usable exchange capacity of 0.85 eq N/L, a conservative zeolite cost estimate is $50,000/month if all water must be treated by the zeolite filters. In addition, zeolite filtration can be implemented in low-cost, off-the-shelf conical bottom polymer tanks and the by-product is a non-toxic, natural mineral that can be land applied.

System specifications:

- Four 1,000-gal conical bottom tanks, up-flow configuration. A tank drawing is included in Attachment B (Appendix 9-C).
- Interconnecting pipe and fittings is 4” schedule 80 PVC.
- Capacity: 100 gpm (each tank). Average flow conditions would require two operating tanks.
- Zeolite bed: 1.9 m^3 (each tank).
- Spent zeolite is dropped into roll-off bins below.

- Fresh zeolite is loaded from super sacs using airlift.
- Total installed cost $100,000 to $150,000 with an estimated lead-time of 2 months.

A decision to implement ammonia mitigation would be based on a gradual increase in concentrations that trend toward a future exceedance, without exceeding discharge limits. Production at the RRIMM site can continue through the implementation period provided that the ammonia concentrations do not exceed applicable discharge standards.

9.8.2.4 Nitrite Control

Nitrite can be oxidized to nitrate using ozone gas. Ozone is commonly used as a disinfectant agent for drinking water treatment but is also used to facilitate removal of iron and manganese from groundwater.

In the unlikely event that nitrite concentrations in the sedimentation pond are higher than expected, ozone can be injected into the discharge-side of the pump for the land application system. This will allow the ozone to thoroughly mix with the discharge water and oxidize nitrite before the water reaches the big gun spray nozzles.

An ozone system for the RRIMM Project would consist of the following components:

- Oxygen supply in the form of oxygen gas cylinders.
- An ozone generator with a capacity of approximately 300 g/hr.
- A peristaltic pump for dosing to ozone to the discharge side of the land application pump.

The maximum estimated dose required to lower nitrite concentrations in the effluent is 1.0 mg/L ozone. At a maximum discharge capacity of 1000 US gpm a total dose of 227 g/hr is required.

Complete implementation of an ozone system for the RRIMM Project would take approximately two months. Standard lead time for an ozone generator is approximately four weeks. Lead time for a small peristaltic pump for delivering the ozone is two to three weeks. Electrical installation and construction of a small shelter to house the unit can be complete during the lead time.

A decision to implement nitrite mitigation would ideally be based on a gradual increase in nitrite concentrations that trend toward a future exceedance. Production at the RRIMM site can continue through the implementation period provided that the nitrite concentrations do not exceed applicable discharge standards.

9.8.2.5 Emergency Procedures

In the event contingency measures are ineffective, W.H.Y. Resources would immediately suspend mining operations until a satisfactory solution can be implemented. In the short-term, this would reduce, and in the long-term eliminate, sources of nitrogen nutrients.

9.9 ML/ARD CHARACTERIZATION AND MANAGEMENT PLAN

9.9.1 PURPOSE AND SCOPE

The Metal Leaching and Acid Rock Drainage Potential Assessment and Management Plan is provided in Appendix 9-D (SRK 2023h). This section provides a summary of relevant details of the plan for ease of reference; however, review of complete details is recommended in Appendix 9-D.

The Metal Leaching and Acid Rock Drainage Potential Assessment and Management Plan addresses the following:

- Characterization of ML/ARD potential of rock likely to be exposed by mining (including waste rock, pit wall rock, and ore stockpiles).
- Prediction of contact water chemistry (referred to as "geochemical source terms") for the waste rock storage facility (WRSF).
- Identification of management approaches to address ML/ARD potential, including an operational monitoring program with triggers for further management response.

Geochemical characteristics of wastes are an input into water quality effects assessment for the Project. Characterization activities have focused on the geochemical characterization of core from exploration drilling programs conducted in 2007, 2008, and 2011.

9.9.2 WASTE ROCK GEOCHEMICAL CHARACTERIZATION

9.9.2.1 Conceptual Geochemical Model

Sources of ML/ARD potential at the Record Ridge Project include waste rock, pit wall rock, and ore stockpiles. The ore will be processed offsite, so tailings are not a consideration for the Project. Borrow material for construction purposes is considered unlikely to be required in the current mine plan.

Waste rock and pit wall rock will be comprised of serpentinite, andesite, and monzosyenite. Ore will be largely serpentinite.

ARD potential in serpentinite is expected to be offset by the dissolution of carbonate and magnesium hydroxide (brucite), and to a lesser extent, some magnesium silicates such as forsterite and serpentine (Jambor *et al.* 2002). The mobility of nickel and cobalt released from silicate weathering is expected to be low given the dominantly alkaline pH conditions. Sulphate may be highly soluble where sulphide minerals are oxidizing because contact water will be magnesium-dominated (i.e., magnesium sulphate minerals such as hexahydrite, $MgSO_4{\cdot}6H_2O$, and epsomite, $MgSO_4{\cdot}7H_2O$, are more soluble than calcium sulphate minerals such as gypsum, $CaSO_4{\cdot}2H_2O$).

Andesite is expected to have variable ML/ARD potential, depending on its sulphur content and sulphide mineral composition.

ML/ARD potential in monzosyenite is expected to be low due to its low sulphide content and sufficient alkalinity from silicate weathering to offset the weak acidity from sulphide oxidation.

9.9.2.2 Program Overview

In August 2016, SRK reviewed the Project's exploration geochemistry database and selected 75 drill core composite samples for static geochemical characterization. The main objectives of the static characterization program were to:

- Obtain data on ARD potential using conventional methods for neutralization potential (NP) and acid potential (AP), and
- To determine if results from these methods correlate with routine determinations of calcium (a potential surrogate for NP) and sulphur (a potential surrogate for AP) performed during exploration for which thousands of results are available.

Testing was completed in November 2016. Based on this work, the exploration database was queried to define six drill core composites for kinetic testing.

Kinetic testing consisted of both laboratory-scale humidity cell tests (containing 1 kg of -1/4 inch rock) and onsite barrel tests (containing 150 to 250 kg of -1 inch rock). Each program has six parallel samples, one sample duplicate, and one method blank. The objectives of kinetic testing are to measure mineral reaction and element release rates to:

- Assist in establishing site-specific criteria for ARD potential classification.
- Measure element leaching rates as input to contact water chemistry predictions.

Humidity cell tests were started on March 31, 2017. The serpentinite and monzosyenite humidity cell tests met the test objectives and were closed on February 2, 2018 after 44 weeks of testing. The monzosyenite humidity cell test and its duplicate were continued and reached 47 weeks of testing as of February 23, 2018.

Barrel tests were started between April 3 and April 7, 2017. Leachate from the barrels was collected in May, June, and July 2017. Barrel leachate monitoring continued in 2018.

Static testing of the 75 selected drill core samples and comparison of these data with the exploration database has shown:

- Serpentinite is non-PAG due its low sulphide content (typically less than 0.13 wt.%) and off-setting carbonate content.
- Andesite has localized ARD potential with PAG intervals ranging in length from 1.3 to 8.0 m (average 3.0 m) identified in drill holes within the southwestern section of the investigation area, and typically intermixed with non-PAG andesite or untested serpentinite.
- On the basis of measured sulphide oxidation rates from laboratory, time to acid onset for PAG andesite intervals ranged from less than 1 to 97 years with an average of 35 years.
- Monzosyenite has negligible potential for ARD due its sulphide content typically less than 0.02 wt.%.
- Calcium is correlated with carbonate content in andesite and monzosyenite, but not serpentinite, and therefore is a proxy for neutralization potential for andesite and monzosyenite only.

- ML potential in serpentinite was identified for arsenic, boron, lead, silver, and zinc on the basis of enrichment relative to average ultrabasic rock.
- ML potential in andesite was identified for cadmium, lead, silver, and zinc on the basis of enrichment relative to average basalt.
- ML potential in monzosyenite was identified for cadmium, chromium, cobalt, and nickel on the basis of enrichment relative to average syenites.
- Enriched concentrations of cadmium, lead, silver, and zinc show some correlation with sulphur or elements known to occur in association with sulphides, whereas arsenic, chromium, cobalt, and nickel do not.

Kinetic testing of the six selected drill core composites has shown:

- pH for all humidity cells has remained alkaline (pH 8.6 to 10) after 44 weeks of testing.
- highest sulphate, antimony, barium, cobalt, and nickel release rates were associated with leachate from the serpentinite humidity cells.
- highest cadmium and copper release rates were associated with leachate from the andesite humidity cell.
- highest uranium release rate was associated with leachate from the monzosyenite humidity cell test.
- pH for all barrels has remained alkaline (pH 8.1 to 10.2) after one year of testing.
- Comparison of element concentrations between the humidity cell and barrel leachates indicates several trace elements including aluminium, barium, boron, iron, lead, manganese, thallium, and uranium are likely constrained by mineral solubility limits under field conditions.

9.9.3 Contact Water Chemistry Prediction

Contact water chemistry for the waste rock facility reflecting weathering processes was predicted using the average element release rates measured from laboratory-based humidity cell testing. Appendix 9-D contains a listing of the contact water chemistry predictions. The effect of leaching explosives residuals is described by the Water Quality Model report (SRK 2023e).

The approach used for these predictions was as follows:

- Element release rates were averaged to reflect the proportions of waste rock types expected to be present in the WRSF (97% serpentinite, 1% monzosyenite, and 2% andesite).
- The overall laboratory element release rates were multiplied by a series of field correction factors to account for differences in temperature, grain size, and contact effects.
- A contact flow of 6,600 m^3/year was calculated using a mean annual precipitation of 917 mm/year and WRSF footprint area of 12,000 m^2 with an assumed infiltration factor of 60%.
- Field corrected rates were multiplied by the amount of waste rock present (100,000 tonnes) and divided by the contact flow (6,600 m^3/year).

- Resulting concentrations were used in a geochemical equilibrium modelling to determine whether there were any secondary minerals that would control concentrations. Modelling was undertaken in PHREEQCI (Version 3.3.12.12704, released May 10, 2017) using the minteq.v4 thermodynamic database. Aluminium, alkalinity, barium, iron, magnesium, and phosphorus concentrations were limited to the solubility of gibbsite ($Al(OH)_3$), calcite ($CaCO_3$), magnesite ($MgCO_3$), barite ($BaSO_4$), ferrihydrite ($Fe(OH)_3$), and hydroxylapatite ($Ca_5(PO_4)_3OH$). Other secondary minerals common to WRSFs were undersaturated with respect to mineral solubility limits, including gypsum ($CaSO4{\cdot}2H_2O$) and fluorite (CaF_2).
- Equilibrated concentrations were compared to average element concentrations in leachate from the onsite barrels to assess whether any increase in concentrations was appropriate. Element concentrations in the individual barrel leachate samples were averaged to reflect the proportions of waste rock types expected to be present in the waste rock facility, as was done for the humidity cell tests. If the average barrel concentration exceeded the equilibrated concentration, the average barrel concentration was used instead of the equilibrated concentration as the source term. Source terms for alkalinity, barium, iron, magnesium, phosphorus, and sodium were adjusted to the average barrel concentration resulting in final source term concentrations for these elements less than the unequilibrated concentrations but more than the equilibrated concentrations predicted by the geochemical equilibrium model.
- Resulting concentrations were used as inputs to the site wide water and load balance (SRK 2023a).

9.9.4 WASTE ROCK MANAGEMENT AND MONITORING

The open pit will produce approximately 100,000 tonnes of waste rock across two years of operation. The geological block model presented by SRK (2013) and the geological drill core database indicates most waste rock will be serpentinite (97%) with some monzosyenite (1%) present along the eastern boundary of the quarry. Andesite (2%) occurs as thin dykes (average 1.8 m in thickness, range 0.6 to 3.5 m) within the central and western sections of the open pit.

Based on this rock composition, SRK anticipates negligible ML/ARD potential from the waste rock and pit walls. Any PAG andesite intervals (average 1.8 m in thickness) should readily mix with surrounding non-PAG rock given mining will take place using a 6 m bench height. However, given the occurrence of larger PAG/uncertain andesite intervals (average 3.0 m) to the south-west of the proposed open pit, SRK recommends operational monitoring of blast hole composites for benches containing andesite.

9.9.4.1 Geochemical Management Criterion

Andesite waste rock is to be classified based on ARD potential determined using the TIC/AP ratio. The following equations will be used to calculate TIC and AP:

- $TIC_{andesite}$ (kg $CaCO_3$/t) = $TIC_{measured}$(%) × 83.3
- $AP_{andesite}$ (kg $CaCO_3$/t) = Total $S_{measured}$(%) × 31.25

The geochemical criterion used to define PAG andesite rock is TIC/AP<3. Mineralogical analysis will be used to determine if the criterion can be lowered to 2.

No ARD management criterion has been established for serpentinite or monzosyenite waste rock as these rock types were assessed to have negligible ARD potential.

No metal leaching criterion have been established. Leaching of most elements produced from rock weathering will be controlled by maintaining a neutral to alkaline pH. The site wide water and load balance model has shown element concentrations produced from rock weathering, including uranium concentrations from the leaching of monzosyenite waste rock, are unlikely to exceed BC water quality guidelines for the protection of freshwater aquatic life under the currently proposed mine plan (SRK 2023e).

9.9.4.2 Blast Hole Sampling Frequency and Analysis

TIC and AP are to be determined on blast hole chip composites for benches containing andesite. Andesite-bearing benches will be identified by the site geologist prior to blasting. Only one composite is to be collected per bench per blast. The composite is to contain representative material from all rock types within the bench (i.e., sampling is not to be restricted to andesite chips).

TIC is to be determined using a hydrochloric acid leach until total carbon can be determined to be an appropriate proxy for carbonate. Total sulphur is to be determined by Leco combustion furnace. Composites may be stored at site and dispatched for analysis at a commercial laboratory on a monthly basis.

Each month, one andesite composite is to be selected for mineralogical analysis by XRD with mineral quantification by Rietveld Refinement to confirm carbonate mineral composition. This information will be reviewed by a technical ARD specialist after the first year of operation.

9.9.4.3 Monitoring and Reporting

Records of laboratory analysis are to be compiled into a monitoring spreadsheet and reviewed by site staff each month. Technical review of the operational monitoring data and need for the preparation of a separate PAG Rock Management Plan will be undertaken by a technical specialist if operational monitoring for any given month shows one or more andesite-bearing benches with a TIC/AP below 3.

The need for operational monitoring will be reviewed after the first year of operation but may be reviewed earlier pending the results of infill sampling and analysis using existing drill core.

9.10 TRAFFIC MANAGEMENT PLAN

9.10.1 Purpose and Scope

The purpose of the Traffic Management Plan, as required by Part 6.8.3 of the *Health, Safety and Reclamation Code for Mines in British Columbia*, is to ensure that all traffic movements on the Project site are within a specified corridor and conforms to a standard set of rules and guidelines with the intent of protecting the public, enhancing driver safety, and protecting the environment.

The objectives of the Traffic Management Plan, as described herein, present general processes and procedures to minimize risk of accidents and incidents to mine employees, contractors and the public resulting from traffic during mine construction, operation, and closure activities; and ensure compliance with all pertinent company policy and regulations. These policies, plans, and procedures will apply to all phases of the Project.

Further, the Traffic Management Plan (McElhanney 2023; Appendix 9-H) for Record Ridge Mine has been updated from the original version produced in November of 2018 as several key assumptions have changed. The previous version of this report was prepared based on an assumption of 1 million tons, a reduction in tonnage has resulted in a smaller vehicle fleet and fewer trips required. Objectives of the McElhanney Traffic Management Plan includes:

- Description of the general condition of area infrastructure including the Old Rossland- Cascade Highway, and Highway 22 between the Old Rossland-Cascade Highway/Hwy 22 intersection and Record Ridge mine site access.
- Description of how material will be transported from the mine site to Trimac Transportation in Trail, BC, including a description of the proposed route.
- A review of the suitability of the area infrastructure to accommodate the proposed use by WHY Resources.
- Description of any infrastructure improvements and/or safety enhancements required to support mine activities during the initial 2-year period.
- Estimation of the number of vehicles that will travel the route. This includes both transport vehicles, general deliveries, and staff transport vehicles.

The complete Traffic Management Plan (McElhanney 2023) is located in Appendix 9-H.

9.10.2 Regulatory Context and Resources

Any personnel operating mobile equipment or any other equipment in the mine will be directly responsible for its safe operation. Operators must comply with Company safety practices and operating procedures, Health, Safety and Reclamation Code for Mines in BC (2022), and provincial and federal laws and regulations related to traffic and highway/road use including the *Mines Act*, *Transportation Act*, and *Motor Vehicle Act*.

9.10.3 Vehicle Operation Rules

The following on-site vehicle operations rules are for all mining equipment, small vehicles, pickups and vans that will be used for project operations:

- Maximum speed limits of:
  - 50 km/hr in the mine (on haulage roads)
  - 15 km/hr around pit shops, buildings, mill, and plant areas.
- No parking within 6 meters of intersections or fire hydrant houses.
- Driving over trailing cables prohibited except where cable is protected.

- No parking behind any vehicles or equipment without being in sight of the operator.
- All trucks and heavy equipment operators must sound their horn before moving. One horn is sounded before starting the engine and again before moving forward. Before moving in reverse, the horn must be sounded twice. One continuous horn indicates an emergency stop. After sounding the horn, the operator must wait eight seconds before moving to allow the immediate area to be cleared
- There shall be no smoking or vehicles left running while fuelling.
- No more than three (3) persons permitted to ride in the front seat of a truck cab (riding on the deck or in the box of trucks or pickups is prohibited).
- Any person entering an active mining area in the pit must contact the Mine Supervisor, either personally or by radio before entering.
- Always do a walk-around check before using any vehicle and report any damage.
- Do not pass any operating equipment without first notifying the operator of your intentions (by radio or visually).
- All loose articles must be properly secured inside the cab of the equipment.
- Equipment log books must be filled in at the start and end of each shift: include such items as comments, conditions found, etc.
- Light vehicles entering the pit must be equipped with a buggy whip with a light and a flag attached as per Part 4.9.5 of the HSRC requirements. Those vehicles which are not equipped with buggy whips are to be escorted at all times when entering the pit area.
- Vehicles working in or about the mine must have the headlights on at all times. Headlights must be kept clean at all times.
- All maintenance vehicles that work in or around the mine site shall be equipped with a buggy whip.

9.10.4 Traffic Control Procedures

9.10.4.1 Vehicle Right-of-Way

For the purposes of on-site vehicle priorities, the following order will be adhered to:

1. Emergency vehicles - Ambulance, Rescue or Fire truck
2. Personnel Buses (All equipment and vehicles listed below must come to a complete stop when encountering buses)
3. Loaded Haul trucks
4. Explosive truck
5. Empty haul trucks
6. Heavy Equipment

7. All other vehicles.

Note: “Blind side” has the Right-of-Way.

Give special attention to working graders and other road maintenance equipment. Notify the operator when passing; wait for an acknowledgement.

Dumping and loading areas are to be driven in a clockwise direction. Cross-overs will be clearly marked.

9.10.4.2 Maximum Allowable Speeds for Haulage Units

Speed limits will be developed in conjunction with the mining contractor and will meet all safety and mining regulations and restrictions.

9.10.5 Other Control Procedures

- Maximum ramp design grades will be 10%.
- Berms along haul roads will be maintained at ¾ the height of the haulage truck tire diameter and on any dump berm the berm shall be maintained at ½ the diameter of the haulage tire.
- Parking will not be allowed on ramps.
- Portable light plants will be used on all active dump areas.
- Signs are posted regarding notification to Mine Foreman before entering Pit area.
- All mobile equipment will have mobile radios (monitor appropriate mine channel).
- All personnel are to obey all traffic signs.

9.10.6 Monitoring and Reporting

Reporting will be conducted as per permits, approvals, and authorizations relevant to use of site roads, and will be delivered to the Mine Manager and/or delegates. Certain components of the plan may need to be modified based on site experience or changes in legislation or best practices. An auditing program will be developed and implemented for applicable compliance checks and to identify components needing correction, adjustment, or upgrading. Results of the audits will be included in the reporting system, including a record of the dates the audits took place, what was checked/reviewed, corrective actions carried out, and personnel involved.

9.11 CHEMICALS AND MATERIALS STORAGE AND HANDLING PLAN

9.11.1 Purpose and Scope

The RRIMM Project will use, generate, and dispose of a number of hazardous materials and dangerous goods through various phases of the Project. The Chemicals and Materials Storage and Handling Plan (CMSHP) will provide a framework for the management, including transportation, storage, and handling, of potential chemicals and substances classified or deemed hazardous to human health and/or the environment at the mine site.

In Canada, hazardous materials and hazardous recyclable materials are defined as those with properties such as flammability, corrosiveness, or inherent toxicity (Canadian *Environmental Protection Act* 1999), while dangerous goods are a schedule designation under the *Transportation of Dangerous Goods Act* (1992) under Classes 2 to 6, and 8 to 9, that are no longer used for its original purpose and are intended for storage, treatment, recycling, or disposal. These materials are the scope of this management plan. Review the Health and Safety Plan (Section 8.0), and Fuel Management and Spill Control plan (Section 9.5), for explosive (Class 1) and fuels management, respectively.

A hazardous waste does not include materials that are household in origin, Class 7 materials, radioactive materials, an empty container, or material intended for disposal in a sewage system or landfilling. The Waste (Refuse) Management plan (Section 9.7) provides the framework for these waste streams in more detail.

The goal of the CMSHP is to protect human health, safety, and the environment, including aquatic and terrestrial species and their habitats, from adverse effects from harmful chemical and hazardous materials. The following performance objectives have been established to achieve this goal:

- A goal of zero reportable hazardous material incidents will be established and communicated to all workers, achieved through the implementation of an effective management strategy and environmental protection measures for the handling, transportation, and storage of hazardous materials.
- A WHMIS will be implemented prior to construction that will continue to the Post- Closure Phase.
- Safe and efficient inspection procedures will be implemented in all Project phases that confirm compliance and effectiveness.

9.11.2 Regulatory Context and Resources

Development and implementation of the CMSHP will be guided by provincial and federal acts and regulations. Additionally, W.H.Y. Resources will utilize the following provincial and federal acts and regulation and various best management practices applicable to chemical and hazardous materials storage and handling management:

- *Environmental Management Act* (2003)
- Hazardous Waste Regulation (BC Reg. 63/88)
- *Public Health Act* (2008)
- *Water Sustainability Act* (2014)
- *Mines Act* (1996)
- Canada *Transportation Act* (1996)
- Canadian *Environmental Protection Act* (1999)
- *Hazardous Products Act* (1985)

- Controlled Products Regulations (SOR/88-66)
- *Hazardous Materials Information Review Act* (1985)
- *Transportation of Dangerous Goods Act* (1992);
- Transportation of Dangerous Goods Regulations (SOR/2001-286)
- Ministry of Water, Land and Air Protection's publication A Field Guide to Fuel Handling, Transportation and Storage (BC MWLAP 2002)
- WHMIS (WorkSafeBC 2015).

Workplace Hazardous Materials Information System (WHMIS) requirements are enforced under the federal *Controlled Products Regulations*, the provincial *Occupational Health and Safety Regulation*, and the provincial *Workplace Hazardous Materials Information System Regulation* (Mines) identified above. The key elements of WHMIS are cautionary labelling of containers of controlled products, the provision of material safety data sheets, worker education, and site-specific training programs.

9.11.3 Potential Hazardous Substance Identification

Since there is no processing facility nor tailings production on site, there are limited chemical reagents required for the Project. Supplies and materials classified as potentially hazardous that will be required or generated during the Project life generally include used oil, used glycol, and hazardous vehicle and equipment parts such as fuel tanks, gear boxes or hydraulic oil. The typical types of hazardous materials anticipated by Project phase, along with their use, are provided in Table 9.11-1.

the Project will put into place operational policies and procedures (i.e., SOPs), which meet or exceed the requirements of the applicable legislation and authorizations. These SOPs will be developed during permitting and prior to the Construction phase of the Project. MSDS will be required for each hazardous material type prior to their delivery to the Project site.

Table 9.11-1: Potential Hazardous Materials Used or Generate by Project Phase

Product	Used or Generated	Project Phase
Used petroleum products or new fuel/lubricants/oils/greases Refer to Section 9.5	Regular use and maintenance of Project vehicles and machinery will require periodic replacement of products such as fuel, lubricants, oils, and greases.	• Construction • Operation
Oil and fuel filters, hydraulic fluid	Regular preventive maintenance of Project vehicles and machinery will require periodic replacement of hydraulic fluid, oil, and fuel filters in the on-site maintenance facility.	• Construction • Operation
Used sorbents and rags	Used sorbents and rags may be generated from regular maintenance and occasional spill response activities.	• Construction • Operation
Empty petroleum hydrocarbon containers and drums	Empty petroleum hydrocarbon containers and drums will be stored and returned for recycling and disposal. Empty containers will also be used for the containment of spent or used product, such as oil, glycol, and hydraulic fluid.	• Construction • Operation

Product	Used or Generated	Project Phase
Flocculant and coagulant	Flocculant and ferric chloride coagulation is proposed as part of the water quality mitigation measures for controlling TSS, ammonia and nitrite in the sedimentation pond.	• Construction • Operation
Laboratory chemicals and reagents	Laboratory chemicals and reagents will be stored onsite for use mainly during the Operation Phase, with minor amounts used for environmental sample preservatives during the Construction, Closure and Reclamation.	• Construction • Operation • Closure and Reclamation
Paints and Solvents	Paints and solvents such as cleaning agents (degreasers), oil-based paints, and paint thinner and industrial glues will be used and stored at the on-site maintenance facility.	• Construction • Operation
Fluorescent light bulbs	Used florescent light tubes are expected to be generated by the Project.	• Construction • Operation
Electronics and electrical waste	Electrical devices will be used at the Project site, some of which may be hazardous which will require proper handling, recycling, and disposal.	• Construction • Operation • Closure and Reclamation
Batteries	Various types of batteries will be used on-site and stored at the on-site maintenance facility.	• Construction • Operation • Closure and Reclamation
Biomedical	Biomedical waste will be generated from human health care and personal health requirements on site, such as First Aid rooms.	• Construction • Operation • Closure and Reclamation

9.11.4 CLASSIFICATION AND LABELING

Using both WHMIS and Transportation of Dangerous Goods (TDG) legislative requirements all hazardous materials will be classified and labeled accordingly. Under WHMIS, there are six (6) major classes of hazardous materials (designated ‘a’ through ‘f’), with some of the classes further broken down into divisions and sub-divisions. The eight (8) WHMIS symbols are illustrated in Table 9.11-2.

Table 9.11-2: Classes and Subclasses of WHMIS

Symbol	Class and Name
	Class A - Compressed Gas
	Class B – Flammable and Combustible Material
	Class C – Oxidizing Material
	Class D-1: Materials Causing Immediate and Serious Toxic Effects
	Class D-2: Materials Causing Other Toxic Effects
	Class D-3: Biohazardous Infectious Materials
	Class E – Corrosive Materials
	Class F – Dangerously Reactive Materials

Under Transportation of Dangerous Goods, there are nine (9) classes of hazardous materials (designated 1 through 9), with some of the classes further broken down into divisions and sub-divisions. The nine (9) classes include the following:

1. Explosives
2. Gases
3. Flammable and Combustible Liquids
4. Flammable Solids
5. Oxidizing Substances
6. Poisonous (Toxic) and Infectious Substances
7. Radioactive Materials
8. Corrosive Materials
9. Miscellaneous Products or Substances.

One or more symbols will be attached to the material's storage container or transport vehicle to provide a quick means of communicating all the possible hazards associated with the material. Hazardous material storage containers will have proper WHMIS-compliant supplier labels when required.

9.11.5 Roles, Responsibilities and Training

The Mine Manager or his/her delegate will be responsible for the implementation and monitoring of the CMSHP. All employees, contractors, and contractor employees are responsible for complying with the intent of this plan.

WHY Resources is committed to train those employees and contractors (workers) associated with transportation, storage, and use of dangerous goods and hazardous materials. All new workers will be provided basic training of the general issues and concerns surrounding the management of hazardous materials as part of their routine health and safety orientation and training. Additional specific training will be provided for workers in hazardous materials management. Basic and specific training will provide information on how to safely assess an incident, to implement the prescribed response, and to safely complete a follow-up, including any corrective action. Proper communication and reporting will be part of the training as well. Mandatory refresher training will also be implemented at reasonably schedule intervals. Written procedures will be revised as improvements are identified and tested.

9.11.6 Environmental Protection Measures

9.11.6.1 Chemical and Hazardous Materials Planning

An updated inventory will list all chemicals on site and will include MSDS and WHMIS information on the products to ensure that Project personnel have all the necessary information for their safe transportation, storage, use, and disposal.

Before any chemical is brought to the site, the supplier or contractor will supply a MSDS for the product. Commercial, consumer products, such as those purchased at a hardware store, will be exempt.

Minimizing the risk of safety infractions and environmental adverse effects from accidental releases of hazardous materials will include the following practices:

- Knowing which hazardous materials are on site via an inventory control system.
- Understanding the adverse human health and environmental effects associated with the storage and handling of hazardous materials.
- Assigning roles and responsibility for managing hazardous materials.
- Implementation of reasonable controls and procedures to minimize escape of hazardous materials under all circumstances of all Project phases.
- Minimizing the use and generation of hazardous materials.
- Ensuring safe storage facilities are available to appropriately contain the materials.
- Monitoring and reporting any and all discharges and ensuring accurate record keeping.

The following will be implemented as reasonable avoidance, control, and mitigation actions in the management of hazardous materials:

- Manufacturers of hazardous products used for the Project will provide safe packaging and appropriate labelling.
- Chemical storage areas would be designated as non-smoking areas and located away from food storage areas.
- Storage areas would be appropriately climate-controlled, i.e., dry and well-ventilated.
- Containers holding hazardous materials will remain sealed until required use to prevent accidental leakage or spillage.
- Incompatible chemicals will be stored separately to prevent chemical reactions and cross-contamination.
- All workers handling dangerous goods will be trained and provided with personal protective equipment and required to wear it as appropriate.
- All bulk chemical storage sites will be constructed with concrete or lined floors and walls capable of containing appropriate volume and as stipulated by appropriate legislation or permits.

The Fuel Management and Spill Control Plan (Section 9.5) provides additional information on response in the event of a hazardous material spill. A communication system will be implemented to facilitate rapid notification of any observed spills, and workers will have basic spill response training appropriate to their positions, with trained emergency response team members specifically trained to contain and recover spills. Storage areas and transfer stations will have spill kits appropriate for the materials being handled. Spill kits will be stationed at appropriate locations at the Project site and equipped with appropriate equipment.

9.11.6.2 Transportation

Transport of hazardous material from and to site and disposal will be contracted personnel who will have adequate training and certification for the transportation, handling, and disposal of hazardous materials. The transport of hazardous materials will require the following approach:

- Designated materials will have MSDSs available.
- Fire extinguishers and fire prevention materials transported will be used as appropriate.
- Containers will be:
  - Appropriately sized for the material being shipped
  - Properly secured
  - Properly marked, labelled, and placarded
- Workers responsible for working with hydrocarbons will receive training in proper operating procedures and emergency response.

9.11.6.3 Handling and Use

All hazardous materials will be handled and used in accordance with information found within their respective material safety data sheet (MSDS). Found within each MSDS is a comprehensive and concise source of health and safety information for workers and emergency personnel.

9.11.6.4 Storage

All hazardous materials will be safely secured and clearly labeled. An accurate inventory of hazardous materials on the Project site will be implemented, maintained, and audited. Copies of MSDSs will be kept in an easily accessible location at every site where related hazardous materials are stored, in addition to the first aid office for reference in an emergency.

9.11.6.5 Disposal

Disposal of surplus or hazardous waste materials is detailed in the Waste (Refuse) Management plan (Section 9.7). Surplus materials will be collected, packaged, labeled, and shipped to appropriate off-site disposal facilities. MSDS information and input from suppliers will be referenced to guide the disposal process. Disposal activities will be inspected by a designated person, and inspection reports will be directed to the Mine Manager.

9.11.7 Monitoring and Reporting

The storage and use of chemicals and hazardous materials will be inspected regularly for leaks, non-compliance of policies, plans, and procedures. Inspections will cover on-site facilities, such as pipelines, tanks, connections, valves, gauges and meters, and sumps.

Proper documentation of inspections will be conducted, including inventories, manifests, and logbooks, and tracked and audited. The frequency of scheduled inspections will depend on the relevant policies, plans, and procedures.

All chemical and hazardous materials transported to the site, used and/or stored at the site, and transported away from the site as waste will be tracked, quantified, and recorded through a manifest system. Selected components of the recordkeeping and reporting system will include:

- Documentation of all employee training.
- Periodic analysis of all chemical and material streams (dependent upon volume and risk) to ensure compliance.
- Documentation of on-site and off-site disposal by tracking chemical and material type, volume, method of disposal, and location.
- Documentation of onsite and off-site spills.

Certain components of the CMSHP may need to be modified based on site experience or changes in legislation or best practices. All aspects of the plan shall be audited or reviewed for effectiveness and to identify components needing correction, adjustment, or upgrading. Formal evaluations of this plan will be documented, with deficiencies noted and corresponding progress in addressing deficiencies tracked in writing. Responsibilities to address deficiencies and accountabilities will be assigned.

9.12 VEGETATION MANAGEMENT PLAN

9.12.1 PURPOSE AND SCOPE

The objectives of the Vegetation Management Plan are to ensure that disturbance is limited to permitted boundaries and that effects of disturbance are mitigated in a timely manner. This plan provides details on proposed activities and measures to:

- Conduct vegetation clearing and maintenance brushing in a manner that minimizes disturbance to vegetation and wildlife.
- Prevent, manage, and mitigate the loss or damage to plants and ecological communities of concern.
- Prevent the establishment of invasive plants.

Vegetation monitoring and management related to closure and reclamation, such as monitoring trace metal uptake in vegetation and success of revegetation practices is not included here and instead provided in reclamation and closure Chapter 4.0. This plan is designed to operate in conjunction with other environmental management plans including the Wildlife Management and Monitoring Plan (Section 9.13), Surface Erosion Prevention and Sediment Control Plan (Section 9.4), and Mine Site Water Management Plan (Section 9.6).

9.12.2 Regulatory Context and Resources

9.12.2.1 Legislation and Regulation

Plant and ecological species of management concern include at-risk plant species (vascular, non-vascular, and lichen) that are provincially red- or blue-listed, as defined by BC Conservation Data Centre (CDC), federally listed by the SARA, or the COSEWIC. Plant species and ecological communities at risk may also be designated as Identified Wildlife provincially under the *Forest and Range Practices Act* (2002). There are no federal or provincial regulations specific to clearing and brushing; however, several acts and regulations apply to components of the clearing and brushing process (Table 9.12-1).

Invasive plants in the context of the RRIMM Project are plants that are not native to BC or the ecosystems found within the project footprint, and which tend to be adaptable, aggressive, and have a high reproductive capacity. Because they are not native to the area, natural pests or diseases that would normally keep their populations in check are not present; this increases the ability of invasive plants to become established and spread to the extent that they dominate natural areas and alter biological communities (MOFR 2010). Invasive plants often provide low to no value for local wildlife and their displacement of native plant species that are important to wildlife negatively affects habitat values. For clarification, the term “invasive plants” also refers to the general term “weeds”, whereas “noxious weeds” refers specifically to invasive plants that fall under the BC *Weed Control Act* (1996) and which must be controlled by land occupiers. British Columbia has several Acts and regulations dealing with invasive plants and their management. Invasive plant legislation relevant to the Project includes the *Weed Control Act* (1996) and the *Forest and Range Practices Act* (2002).

Table 9.12-1: Regulatory Summary

Species and Ecological Communities of Concern	Acts and Regulation
Species at Risk Act (SARA 2002)	SARA legislation aims to protect species at risk from becoming extinct or lost from the wild. It covers all wildlife species, including vegetation, listed as being at risk nationally (and their critical habitats; SRPR 2012).
Forest and Range Practices Act (2002)	The Identified Wildlife Management Strategy is a component of the Forest and Range Practices Act of BC. Its goals are to minimize the effects of forest and range practices on Identified Wildlife (MFLNRO 2004). The strategy designates species at risk as identified wildlife by the Deputy Minister of Environment, if the species requires special management to address the effects of forest and range activities. The terms "wildlife" and "species at risk" have been defined in the Act so that endangered or threatened plants and plant communities may be designated as Identified Wildlife (MFLNRO 2004).
Water Sustainability Act (2014)	A Section 11 authorization under the *Water Sustainability Act* is required for any changes in or about a stream, which includes some wetland types, namely, swamp, marsh, and fen.
Vegetation Clearing and Brushing	**Acts and Regulation**
Species at Risk Act (SARA)	SARA legislation aims to protect species at risk from becoming extinct or lost from the wild. It covers all wildlife species, including vegetation, listed as being at risk nationally (and their critical habitats; SRPR 2012).
Pest Control Products Act (2002)	The Pest Control Products Act regulates the development, approval, and use of herbicide products in Canada
Wildfire Act (2004)	The Wildfire Act regulates fire use, prevention, control and rehabilitation (BC MFLNRO 2005).
Invasive Plants	**Acts and Regulation**
Weed Control Act	The Weed Control Act is administered by the BC Ministry of Agriculture and Lands (MOA 2011). The Act aims to control the spread of designated noxious weeds on all provincial Crown and private land in British Columbia. Under the Weed Control Act, there is an obligation and duty for the land occupier to control designated noxious weeds. The Weed Control Act allows for the appointment of inspectors to enforce control measures on species that have been designated as noxious weeds. The purpose of the Act is to protect agricultural lands against the spread of noxious weeds which may out-compete crops and reduce yields. Currently, the Act lists 39 species that are classified as provincial noxious weeds for all regions of British Columbia; and 27 species that are classified as regional noxious weeds within the boundaries of British Columbia regional districts.
Forest and Range Practices Act	The Forest and Range Practices Act (FRPA) is administrated by the BC Ministry of Forest, Lands and Natural Resource Operations and Rural Development. The FRPA describes the responsibility for preventing the introduction and spread of invasive plants due to a forest or range practice. Anyone undertaking range or forest management practices must carry out measures that are specified in operational plans and authorized by the minister, and which will prevent the introduction or spread of prescribed invasive plant species (MOFR 2010). The FRPA Invasive Plants Regulation (IPR; B.C. Reg 18/2004) currently lists 42 species of invasive plants province wide.

9.12.2.2 Guidelines and Resources

The BC Mitigation Policy and Procedures (MOE 2014a, 2014b) provide information and expectations on application of a hierarchical approach to avoiding, mitigating, and restoring affected areas from projects. Other applicable information regarding species and ecological communities at risk can be found in BC CDC (2023a). Information on vegetation management for clearing and brushing activities are available in the guidance document, BC Hydro—Integrated Vegetation Management Plan (BC Hydro 2010).

9.12.3 Roles, Responsibilities and Training

The Mine Manager or their delegate will be responsible for assigning the following tasks to the environmental monitor, mine staff, and/or qualified contractors to ensure that designated environmental procedures and protocols are implemented with regards to:

- management of clearing and brushing activities, including ensuring that:
  - all applicable permits are acquired prior to any clearing, brushing, or burning activities (if required), and
  - clearing boundaries are adhered to.
- management of species and ecological communities at risk.
- early identification and effective management of invasive plants.

Environmental monitors and other qualified professionals supporting on site environmental monitoring will be equipped with both a species at risk guide and an ecosystem at risk guide for the purpose of identification in the field.

Educating staff, consultants and contractors on the prevention and reporting of invasive plants in the RRIMM Project area is an important step in early identification and prevention of spreading invasive plants. Invasive plant management training will be included in site orientation/safety training and may be presented via slides, signage, or a pamphlet.

9.12.4 Clearing and Brushing Management

9.12.4.1 Approach

Best management practices for clearing and brushing will be followed to minimize the effects on vegetation and wildlife components in the Project area. In particular, this section emphasizes the importance of minimizing the cleared area, retaining, and minimizing damage of the low shrub, herb, and moss layers, and rapid revegetation of disturbed areas where applicable.

A clearing schedule will be developed showing avoidance periods (e.g., bird nesting period) and measures to follow when avoidance is not feasible. Known species and ecological communities of concern will be clearly marked prior to the commencement of site clearing (Section 9.14.5). Opportunities to avoid clearing in the Surface Footprint, by even a small area, in the red-listed community, will be considered in the field during clearing activities.

Vegetation management along mine site roads will be maintained to the standards set in the BC Hydro (2010) guidance document through mowing, brushing, and maintaining clearing widths that are at least the minimum width necessary to accommodate the infrastructure, in keeping with the safety of industrial users, topography, drainage and stability, and operational requirements (MFLNRO 2004).

9.12.4.2 Clearing and Brushing Activities

RRIMM Project construction and operations require land disturbance, including vegetation clearing and, in some areas, only removal of tree and shrub layers. Brushing may also be required during the operation phase for maintenance and safe operation of mine site roads or other aspects of the mine.

Best management practices for minimizing adverse effects to vegetation resources during Project construction and operation activities include:

- Maintain a low shrub or herb layer in areas where trees or tall woody species need to be removed but ground disturbance is not required.
- Install necessary sediment control and water management features prior to site clearing.
- Maintain clearing activities within footprint clearing limits and delineate and clearly mark boundaries of land to be cleared.
- Mark boundaries of sensitive terrestrial features such as wetlands, riparian areas, ecological communities at risk, or plant species at risk (if identified) prior to removal of vegetation. Minimize clearing and brushing to the extent practicable in sensitive areas (i.e., riparian zones and edges of ecological communities at risk).
- Disturbance/clearing of watercourses and water bodies will be limited to only that which is necessary and permitted.
- Hand-cut brush, where practicable, within riparian areas to minimize disturbance of soil surface by machinery and to minimize introduction of woody debris to watercourses. Avoid brush placement within riparian zones or ecological communities at risk.
- Fell timber within the clearing boundary and not directed into sensitive features such as wetlands, ecological communities at risk, riparian areas, or watercourses.
- Minimize soil exposure during all phases of construction and operations to limit potential for soil erosion, including staging clearing activities, and minimize soil compaction where unnecessary.

Timber will be cut as authorized under the Occupant Licence to Cut issued by BC Ministry of Forests (MOF). Merchantable timber will be salvaged and removed from the site where economically feasible. Woody debris (including stumps, roots, limbs, and rotting logs) that is generated during clearing and grubbing operations, and suitable for reclamation, shall be stockpiled for erosion control purposes and/or subsequent use in reclamation. Non-merchantable timber and woody debris may be rolled back or piled along the margin of linear features (roads, conveyor) for access control or for use during reclamation.

An inventory of salvaged and stockpiled woody debris, including the locations, origins, and quantities of material will be documented and reported in the Annual Reclamation Report, as required by *Mines Act* permit requirements.

Chipping or burning of woody debris suitable for use in reclamation will be avoided unless not practicable. In such cases, burning activities will follow regulations described in the Open Burning Smoke Control Regulation (BC. Reg. 145/93) under the *Environmental Management Act* (EMA; 2003). For example, areas falling into category B burning must adhere to the following:

- Smoke release period no longer than 96 hours.
- After 96 hours, continued smoke release from greater than 5 percent of the debris initially ignited requires measures to prevent further burning.
- After 96 hours, debris still burning may be re-piled and used to ignite new piles of debris and this will be considered the initiation of a new burning period.

Best management practices for burning include, but are not limited to, ensuring burning only occurs on bare mineral soils (burning not to occur on organic soils) and ensuring adequate equipment and staff are on site to meet regulatory limits (BC MOE 2010). If conditions of the Open Burning Smoke Control Regulation are met, no further permit is required unless stipulated by more stringent local/municipal regulations.

9.12.5 Management of Species and Ecological Communities of Concern

9.12.5.1 Species and Ecological Communities at Risk

Plant Species at Risk

Non-vascular and vascular plant species at risk listed by the BC CDC that have the potential to occur in the Project area are listed in Table 9.12-2 and Table 9.12-3, respectively. One plant species, mountain holly fern, that is provincially red-listed and is federally listed by SARA and COSEWIC, was identified in the LSA.

These are located within 26 m from the northwest portion of the Surface Footprint and consist of multiple individual plants and will not be physically disturbed.

Best management practices for avoiding and minimizing adverse effects to vegetation resources during Project construction and operation activities include:

- Implement the avoid, minimize, and restore on site principles of the BC Mitigation hierarchy (MOE 2014a and 2014b).
- Clearly flag in the field and on construction maps a “no work zone”, 50 m from the closest individual plant located to the Surface Footprint with visible signage. However, the plants that are within less than 50 m of proposed infrastructure will be flagged at the furthest point possible from each location during construction as a protective boundary.
- Train workers employees and contractors), particularly the construction crew, on:
    - How to identify the species (e.g., can create laminated cards of the species to provide to the crews)
    - The importance of avoiding this provincially and federally listed species

  - The reporting protocol if a new plant location is identified or if damage to a plant occurs (i.e., notify the Environmental Manager who will consult with a Qualified Professional on best next steps).
- Implement adaptive management whereby monitoring of the known locations of the plants within the LSA occurs and if a plant is damaged or if a plant occurs in an area of Project construction area not yet identified, then W.H.Y Resources will consult with the Qualified Professional to determine the best next steps.

Ecological Communities at Risk

A search of known occurrences of red- and blue-listed ecological communities identified the occurrence of the red-listed graminoid grassland unit, Idaho fescue - bluebunch wheatgrass - silky lupine – junegrass, in the Surface Footprint and LSA. This known mapped area overlapped the Project ecosystem mapping for graminoid grassland. The grasslands in the RSA will, therefore, be assumed to be this ecological community.

A search for ecological communities at risk in the BC CDC database for potential communities in the RSA revealed seven additional at-risk ecological communities with potential to occur in the RSA (Table 9.12-4). Of the seven, three were noted to occur within the study area based on Terrestrial Ecosystem Mapping (TEM) classification:

- Douglas-fir/tall Oregon-grape/parsley fern (red-listed) ecological community was not identified within the Surface Footprint or LSA. However, it has the potential to be present within subzones ICHdw1 and ICHxw in the 102 site series, which occur in the RSA. As well, the rock outcrop and rock talus site series within these subzones were also identified as encompassing the Douglas-fir/tall Oregon-grape/parsley fern ecological community as pockets of the 102 site series may be present within these rock classes.
- Subalpine fir/white-flowered rhododendron/sitka valerian (blue-listed) was identified in the LSA and occurs in the Biogeoclimatic Ecosystem Classification (BEC) subzone Engelmann Spruce Subalpine Fir Moist Hot (ESSFmh) within riparian ecosystems (110 and 111 site series) but is not within the Surface Footprint.
- Western redcedar - western hemlock/common horsetail (blue-listed) ecological community was not identified within the Surface Footprint or LSA but has potential to be present in subzone ICHmw5 within the 111 and 112 site series, which occurs in the RSA.

No wetlands or old forest occur within the LSA.

Table 9.12-2: Non-Vascular Plant and Lichen Species at Risk with the Potential to Occur in the Project Area

Scientific Name	Common Name	Life Form	BC List Status[1]	Federal (SARA and COSEWIC) List Status
Bryum calobryoides	No common name	Moss	Red	N/A
Philonotis yezoana	No common name	Moss	Blue	N/A

Scientific Name	Common Name	Life Form	BC List Status[1]	Federal (SARA and COSEWIC) List Status
Pohlia elongata	No common name	Moss	Blue	N/A
Arctoparmelia subcentrifuga	abrading ring	Lichen	Blue	N/A
Cladonia cyanipes	blue-footed pixie	Lichen	Blue	N/A
Dermatocarpon intestiniforme	quilted stippleback	Lichen	Blue	N/A
Scytinium californicum	midlife vinyl	Lichen	Blue	N/A

[1] BC List status: Red = Candidate species for attaining extirpated, endangered, or threatened status within BC; Blue = Species considered to be of special concern within BC.

Table 9.12-3: Vascular Plant Species at Risk with Potential to Occur in the Project Area

Scientific Name	Common Name	BC List Status[1]	Federal (SARA and COSEWIC) List Status
Astragalus microcystis	least bladdery milk-vetch	Blue	
Botrychium montanum	mountain moonwort	Blue	
Carex pedunculata	peduncled sedge	Blue	
Castilleja cusickii	Cusick's paintbrush	Blue	
Castilleja tenuis	hairy paintbrush	Red	
Clarkia rhomboidea	common clarkia	Blue	
Claytonia cordifolia	heart-leaved springbeauty	Blue	
Crataegus okanaganensis var. okanaganensis	Okanagan hawthorn	Blue	
Elymus curvatus	beardless wildrye	Blue	
Erysimum capitatum var. purshii	Pursh's wallflower	Blue	
Glycyrrhiza lepidota	wild licorice	Blue	
Hesperochiron pumilus	dwarf hesperochiron	Red	Endangered
Isoetes minima	Columbia quillwort	Red	Endangered
Lindernia dubia var. dubia	yellowseed false pimpernel	Blue	
Muhlenbergia andina	foxtail muhly	Blue	
Olsynium douglasii var. inflatum	satinflower	Red	
Pinus albicaulis	whitebark pine	Blue	Endangered
Polystichum scopulinum[2]	mountain holly fern[2]	Red	Threatened
Pyrola aphylla	leafless wintergreen	Blue	

Scientific Name	Common Name	BC List Status[1]	Federal (SARA and COSEWIC) List Status
Scrophularia lanceolata	lance-leaved figwort	Blue	
Senecio hydrophiloides	sweet-marsh butterweed	Blue	
Senecio hydrophilus	alkali-marsh butterweed	Red	
Sisyrinchium idahoense var. occidentale	Idaho blue-eyed grass	Red	
Solidago gigantea var. shinnersii	smooth goldenrod	Blue	
Thalictrum dasycarpum	purple meadowrue	Blue	
Utricularia ochroleuca	ochroleucous bladderwort	Blue	
Viola sororia	woolly blue violet	Blue	

[1] BC List status: Red = Candidate species for attaining extirpated, endangered, or threatened status within BC; Blue = Species considered to be of special concern within BC.

[2] Mountain holly fern was confirmed at locations with the LSA.

Table 9.12-4: Ecological Communities at Risk with the Potential to Occur in the Project Area

Scientific Name	Common Name	Biogeoclimatic Zone/Subzone/variant[1]	Provincial Status[2]	BC List Status[3]	Occurrence (Yes/No)		
					Surface Footprint	LSA	RSA
Abies lasiocarpa/Rhododendron albiflorum/Valeriana sitchensis	subalpine fir/white-flowered rhododendron/Sitka valerian	ESSFdc1/04;ESSFdc2/07 ESSFmh/110/111	S3 (2004)	Blue	No	Yes	Yes
Abies lasiocarpa/Vaccinium membranaceum/Xerophyllum tenax	subalpine fir/black huckleberry/bear-grass	ESSFwc1/00;ESSFwc4/00	S3 (2004)	Blue	No	No	No
Betula nana/Carex aquatilis	scrub birch/water sedge	ESSF/Wf02; ICH/Wf02	S3 (2010)	Blue	No	No	No
Eriophorum angustifolium - Carex limosa	narrow-leaved cotton-grass - shore sedge	ESSF/Wf13; ICH/Wf13	S3 (2004)	Blue	No	No	No
Festuca idahoensis - Pseudoroegneria spicata - Lupinus sericeus - Koeleria macrantha	Idaho fescue - bluebunch wheatgrass - silky lupine - junegrass	ICHxw/Gg11, ESSFwc1, ESSFdc1, ICHmw2	S1S2 (2021)	Red	Yes	Yes	Yes
Pseudotsuga menziesii/Mahonia aquifolium/Cryptogramma acrostichoides	Douglas-fir/tall Oregon-grape/parsley fern	ICHdw1/02	S2 (2004)	Red	No	No	Yes
Thuja plicata - Tsuga heterophylla/Equisetum arvense	western redcedar - western hemlock/common horsetail	ICHmw1/07; ICHmw2/07 ICHmw5/111/112	S3 (2004)	Blue	No	No	Yes
Trichophorum cespitosum/Campylium stellatum	tufted clubrush/golden star-moss	ESSF/Wf11; ICH/Wf11	S2S3 (2004)	Blue	No	No	No

1 This is not an exhaustive list of biogeoclimatic zones that this ecological community can occur in.

2 Provincial Conservation Status: 1 = critically imperiled; 2 = imperiled; 3 = special concern; 4 = apparently secure; 5 = demonstrably widespread, abundant, and secure.

[2] BC List status: Red = Candidate species for attaining extirpated, endangered, or threatened status within BC; Blue = Species considered to be of special concern within BC

9.12.5.2 Avoidance

The best means of protecting species and ecological communities of concern is to leave them undisturbed and maintain the natural hydrology necessary to function naturally. Where a species or ecological community at risk or wetland is identified in the areas designated for clearing and construction, practicable effort shall be made to avoid disturbance to the individual plant, population, or ecological community if possible. A “no-work” buffer will be clearly marked in the field, and on maps, around the plant population or ecological community at risk to ensure minimal disturbance during Project development. Opportunities to avoid clearing in the Surface Footprint, by even a small area, in the red-listed community, will be considered in the field during clearing activities.

A buffered area will be clearly marked with flagging as a no-access zone for the known mountain holly fern locations and in the red-listed ecological community that occurs in the LSA, where practicable. A site assessment of the area may be conducted to assess potential effects on the ecosystem by mine construction and operations and to identify any feasible adjustments where practicable. The goal will be to avoid disrupting the vegetation community as well as protecting the abiotic factors supporting the ecosystem such as ground and surface water flow and nutrient cycling. When avoidance and protection is not possible, measures will be implemented to minimize potential effects.

9.12.5.3 Mitigation for Minimizing Effects

Mitigation measures will be implemented to minimize the effects to species or ecological communities of management concern, which may include, but not be limited to:

- Protecting a portion of the population, plant community or ecosystem when it is not practicable to protect the entire unit.
- Maintaining hydrological connections across the landscape whenever practicable.
- Installing sediment fences around construction and operation sites that are upslope of ecological communities of management ecosystems.
- Minimizing the clearing of ecological communities of management concern to a minimum by removing only trees when practicable and leaving shrubby and herbaceous vegetation.

Maintaining hydrological connections on the landscape is critical to maintaining healthy ecosystem function. Implementation of the Surface Erosion and Sediment Control Plan (section 9.4) and the Mine Site Water Management Plan (section 9.6) will also prevent transport of material into at-risk ecological communities of the Project area. Additionally, adherence to the Fugitive Dust Management Plan (section 9.15) and Noise Abatement Plan (section 9.16) during the construction and operations phase of the Project also plays a vital role in ensuring the continued health and vigor of ecological communities of concern by preventing excessive dust accumulation on plants.

9.12.5.4 Monitoring

Species and ecological communities of management concern that are known or identified during construction and/or operation of the Project within or near the periphery of the mine footprint, will be monitored. These inspections will document effectiveness of any mitigation measures (such as avoidance or protection measures), population numbers of red- or blue-listed species (if/where they exist, including mountain holly fern known locations), and presence and extent of invasive species at these sites. Results of any inspections and monitoring will be summarized and submitted with the Annual Reclamation Report, that is submitted as per *Mines Act* permit requirements.

9.12.6 Invasive Plant Management

The following best management practices will be implemented during the construction and operations phases of the Project for preventing invasive plant establishment on the Project site:

1. Where feasible, minimize soil exposure during all phases of construction and operations in order to limit the availability of exposed, unvegetated ground to invasive plant seed deposition.

2. Retain native vegetation in and around disturbance sites as much as possible.

3. For short term storage of non-infested soils and fill materials where vegetation cover establishment is not feasible, stockpiles of non-infested soils and fill material will be maintained in an invasive plant-free condition by:
    - Preventing seed contamination using physical barriers such as tarps, plastic sheeting, or erosion control blankets.
    - Frequent monitoring and timely eradication of new invasive plants prior to seed production.

4. If surface soils or fill materials contaminated with invasive plants are excavated, this material must be stockpiled separately:
    - They cannot be mixed with invasive plant free soils.
    - Soils contaminated with invasive plants must undergo herbicide or manual control treatments prior to re-use.
    - Where treatment is not practical, this material should be properly disposed of (landfill disposal or burial on-site).

5. Establish a vegetation cover as soon as possible after ground disturbance as follows:
    - Revegetate exposed soils promptly after ground is disturbed due to construction or operations, for erosion protection and invasive plant prevention.
    - Where warranted, revegetate areas that are inactive for some time and that are capable of supporting vegetation with interim native grass/legume/forb seed mixtures to prevent invasive plant establishment. Revegetate active mine site road edges with seed mixes that do not contain legumes.
    - Specify high quality seedlots in all commercial seed mixes used at the site. Low grade seedlots may contain a portion of invasive plant seed in the seedlot:
        - Seed grading must reflect that the seed mix is invasive-plant free.
        - Seed analysis certificates will be requested from the supplier for the seed lots that are to be used in order to determine the presence of any invasive plants.

- Commercially sourced candidate species for revegetation will be reviewed to ensure that they are not considered invasive to the region.

9.12.7 Reporting

The Mine Manager will maintain overall responsibility for documentation and reporting on the components of the Vegetation Management Plan. Reporting on the Vegetation Management Plan will be included in the Annual Reclamation Report, as per Mines Act permit requirements.

9.13 WILDLIFE MANAGEMENT PLAN

9.13.1 Purpose and Scope

The objective of the Wildlife Management Plan is to minimize impacts on wildlife in the Record Ridge Industrial Mineral Mine (RRIMM) Project area, with particular reference to focal species of interest and species at risk. This plan provides details on proposed activities and measure, including:

- General wildlife mitigation measures for avoiding and minimizing effects on wildlife habitat, reducing wildlife mortality risk, and preventing wildlife attraction to site and work activities.
- Breeding bird nest survey mitigation and monitoring protocols.
- Wildlife observation and incident monitoring.

This plan is designed to operate in conjunction with other Environmental Management Plans (EMPs) including the Vegetation Management Plan (Section 9.12), Surface Erosion Prevention and Sediment Control Plan (Section 9.4), and Waste (Refuse) Management Plan (Section 9.7).

The Wildlife Management Plan is a living document to be revised as new information relevant to the protection of wildlife in the Project area becomes available and as necessary to incorporate updates or changes throughout the life of the mine. Adaptive management measures will be employed to manage for any unanticipated effects of the Project. Key stakeholders, First Nations, and government agencies will be involved as necessary in developing effective strategies and additional mitigation (if needed).

9.13.2 Regulatory Context and Resources

9.13.2.1 Legislation and Regulation

Wildlife species of concern include at-risk species that are provincially red- or blue-listed, as defined by BC Conservation Data Centre (CDC), federally listed by the Species at Risk Act (SARA), or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). There are federal and provincial regulations specific to wildlife and wildlife habitat (Table 9.13-1).

Table 9.13-1: Summary of Legislation for Wildlife

Acts and Regulation	Description
BC *Wildlife Act* (1996)	The *Wildlife Act* defines wildlife as all native (and some non-native) amphibians, birds, mammals, and reptiles that live in BC (BC MFLNRO 2017). The Act provides for the protection, conservation, and management of wildlife populations and wildlife habitats within BC. Under Section 34 of the Act, it is an offence to possess, take, injure, molest, or destroy a bird, its egg(s), or a nest that is occupied by a bird or its egg(s). The nests of select species are protected year-round. Wildlife species can be legally designated as endangered, threatened, or special concern under the Act, which enables penalties for killing or harming wildlife, or the establishment of Critical Wildlife Habitats in Wildlife Management Areas.
Species at Risk Act (SARA 2002)	SARA legislation aims to protect species at risk from becoming extinct or lost from the wild. It covers all wildlife species, including vegetation, listed as being at risk nationally (and their critical habitats; SRPR 2012).
Forest and Range Practices Act (FRPA; 2002)	The FRPA outlines standards and requirements for how forest and range practices and natural resource activities should be conducted on Crown land in BC in a manner that ensures protection of natural resources, including wildlife. Mechanisms under the FRPA include Ungulate Winter Ranges (UWRs) and Wildlife Habitat Areas (WHAs). An UWR is an area of habitat that is critical to meeting an ungulate species' winter habitat requirements; whereas a WHA is an area of habitat that is critical to meeting the habitat requirements of an Identified Wildlife species (BC MOE 2017). Identified Wildlife includes species legally designated as endangered, threatened, or special concern under the Wildlife Act and species considered important to a region of BC. The RRIMM Project does not overlap with any UWR or WHAs.
Species at Risk Act (SARA; 2002)	SARA provides for the legal protection of plant and wildlife species to conserve their biological diversity and prevent extirpation or extinction. Under SARA, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) identifies and assesses plant and wildlife species considered at risk, which may then qualify for legal protection and recovery under SARA. Once listed under SARA, species plans are legal requirements to secure the necessary actions for species recovery and management.
Migratory Birds Convention Act (MBCA; 1994)	MBCA protects and conserves migratory birds (as individuals and populations), their eggs, and their nests in Canada through the implementation of the Migratory Birds Regulations and the Migratory Birds Sanctuary Regulations. Deposit of harmful substances to birds in areas or waters frequently visited by migratory birds is prohibited.

9.13.2.2 Guidelines and Resources

Relevant best management practices and guidance related to wildlife and wildlife habitat include, but are not limited to, the following:

- The BC Mitigation Policy and Procedures (MOE 2014a, 2014b) provide information and expectations on application of a hierarchical approach to avoiding, mitigating, and restoring areas from projects.

- Identified Wildlife Management Strategy – Accounts and Measures for Managing Identified Wildlife (BC MWLAP 2004a): summaries the status, life history, distribution, and habitat requirements of Identified Wildlife. Also outlines specific guidelines for habitat conservation and management.
- Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia (BC MOE 2014c): Guideline provides province-wide direction for maintaining environmentally valuable resources during urban and rural land development in BC. Environmentally valuable resources include species, features, or locations that enhance the biodiversity of an area; may include common or rare species or habitats.
- Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia. Ministry of the Environment (MOE 2013): purpose of this guideline is to help maintain raptor populations and their habitats during urban and rural land development in BC. The document is a companion document to Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia (BC MOE 2014c).
- Guidelines for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia (BC MOE 2014d (BC MOE 2014c)): Guideline aim is to help maintain amphibian and reptile populations and their habitats during urban and rural land development in BC. The document is a companion document to Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia.
- Best Management Practices for Amphibian and Reptile Salvages in British Columbia (BC MFLNRO 2016): provides guidance on how to plan and implement amphibian and reptile salvages while minimizing adverse effects to the translocated and recipient amphibian and/or reptile populations.
- Best Management Practices for Bats in British Columbia (BC MOE 2016): Provides information on the potential effects of different natural resource development activities on bats and their habitats and guidance on how to minimize these potential effects.
- Kootenay Region Reduced Risk Instream Work Windows and Measures (BC MWLAP 2005).
- Standards and Best Practices for Instream Works (BC MWLAP 2004b).

9.13.3 Roles, Responsibilities and Training

The Mine Manager or his/her delegate will be responsible for ensuring that wildlife management is undertaken in a professional manner consistent with environmental laws, approvals, permits and plans. The Mine Manager may assign tasks to the environmental monitor, mine staff, and/or qualified contractors to ensure that designated environmental procedures and protocols are implemented with regards to:

- Mitigation measures for wildlife habitat, mortality risk and wildlife attraction.
- Wildlife education awareness training during site orientation and ongoing through regular health and safety meetings.
- Wildlife observation and incident monitoring, investigation, and reporting.

Educating staff, consultants, and contractors on wildlife awareness and the importance of protecting wildlife and wildlife habitat is an important step in not only minimizing potential effects on wildlife but also preventing human wildlife interactions and ensuring a safe work environment. The Wildlife Management Plan guidance policies and mitigation measures will be internally communicated to site employees and contractors through site orientation, regular health and safety meetings, and by posting signs, posters, notices in areas frequented by staff.

9.13.4 Reporting

On an annual basis, results of the Wildlife Management Plan will be compiled and summarized, including a summary of wildlife mitigation measures undertaken, results of monitoring, and if warranted, consideration of new or alternate management strategies or initiatives. This information will be provided within the Annual Reclamation Report as stipulated by Mines Act permit conditions.

9.13.5 General Wildlife Policies

General policies for wildlife protection are designed to reduce human-wildlife incidents and minimize the potential effect of the project on wildlife and wildlife habitat. The general policies for wildlife protection are as follows:

- Hunting and Fishing Prohibited on site: No hunting or fishing by Project employees, contractors, and consultants will be permitted on site. Personnel are prohibited from possessing firearms while on site. The only exceptions are registered weapons that are kept on site and under the control of authorized staff for problem wildlife situations or emergencies.
- No Wildlife Feeding or Littering: feeding or intentional attraction of wildlife will be prohibited on site.
- No Wildlife Harassment: harassment or approaching wildlife will be prohibited on site, including chasing wildlife with a motorized vehicle. Harassment can cause wildlife to leave a preferred breeding, resting, or feeding area, or birds to abandon their nest.
- No Deliberate Interference or Destruction of Wildlife Dwelling: deliberate interference or destruction of nests, eggs, burrows, dens, or any other wildlife “dwelling” will be prohibited at site. Specifically, disturbance of bird nests and eggs contravenes Section 34 of the BC Wildlife Act.
- No Pets: pets will be prohibited from site. Harassment of wildlife by pets contravenes Section 78 of the BC Wildlife Act. Pet-wildlife interactions may endanger humans by increasing the likelihood of negative human-wildlife interactions. On approval of the Mine Manager, service dogs would be an exception to this prohibition.
- Problem Wildlife: site workers or contractors (unless designated) will not attempt to deal with a problem wildlife issue. The Mine Manager must be notified of any problem wildlife issues, such as property damage, garbage feedings, unusual behaviour, and aggressive or injured wildlife. Incidents of problem wildlife will be reported to the appropriate authorities.

9.13.6 General Wildlife Mitigation Measures

This section provides basic concepts and scope of general wildlife mitigation measures to minimize, avoid, or mitigate potential effects of the RRIMM Project on wildlife and wildlife habitat. The following three types of mitigation measures are described:

- Habitat and sensory mitigation measures
- Mortality risk mitigation measures
- Wildlife attraction mitigation measures

9.13.6.1 Habitat and Sensory Mitigation Measures

Wildlife habitat features (e.g., wetlands, snags, mineral licks, and dens) and sensitive areas (e.g., old forests, rare ecosystems, etc.) are used by wildlife as areas of refuge, foraging, and reproduction. Loss of these important areas and features can cause wildlife to move to less productive areas. The following measures are intended to minimize potential direct (habitat loss, nest destruction) or indirect (habitat avoidance due to sensory disturbance, disruption of daily movements) project- related effects on wildlife habitat. Two types of habitat mitigation measures are outlined: avoidance measures and minimizing measures.

Avoidance measures designed to avoid impacts on wildlife habitat include:

- Mapping of sensitive wildlife habitats prior to construction to delineate boundaries of certain habitat features that are important for wildlife species.
- Site pre-construction and/or pre-clearing survey to verify sensitive wildlife habitat mapping. Identified sensitive wildlife habitats will be evaluated on a case-by-case basis to determine what type of mitigation (e.g., setback distance or mitigation protocol), if any, is needed.
- Communicate sensitive wildlife habitat locations and any specific mitigation protocols to construction crews prior to any work in or around such areas.
- Avoid work activity within identified sensitive wildlife habitats outside the immediate footprint through delineation with flagging, signage, fencing and/or other measures.
- Avoid vegetation clearing in sensitive wildlife habitats during important high risk timing windows for wildlife. If clearing or construction activities must proceed within high risk timing windows, pre-clearing surveys and mitigation protocols will be followed as outlined in Section 9.13.7 (Breeding Bird Nest Mitigation).
- Avoid piling soil, overburden or other materials removed during ground clearing and preparation in or near identified sensitive wildlife habitats.
- Keep all fueling stations and mobile fueling equipment away (at least 30 m or more) from identified sensitive wildlife habitats and watercourses unless adequate secondary containment of fuel sources is provided.

Measures to minimize potential Project effects on wildlife habitat include:

- Clearly flag and restrict clearing to those areas designated and required for construction and operations.
- Retain vegetation along the footprint boundary unless removal is required for construction and safe operations.

- Do not place clearing debris and brush across known or potential wildlife travel routes, such as wildlife trails and riparian areas.
- Reduce and avoid noise impacts related to source noise (e.g., vehicles, construction equipment, workers, blasting, and project facility components) as per the Noise Abatement Plan (section 9.16).
- Use of appropriate seed mixes along mine site road verges (see the Vegetation Management Plan section 9.12). Inappropriate seed mixes (e.g., ones that include legumes) can attract ungulates and bears to roadsides, which can create a traffic safety hazard and increase the likelihood of problem wildlife situations.
- Maintain wildlife trees (i.e., snags) as much as possible, particularly in riparian areas. If a snag is considered a hazard, consider topping the tree at 5 m or higher to retain some wildlife value. Where trees cannot be topped, some felled trees can be left lying in the area as coarse woody debris where appropriate.

9.13.6.2 Mortality Risk Mitigation Measures

The key mortality risk concerns associated with the RRIMM Project are direct mortality from attracting wildlife to site (see Section 3.4), site clearing (see Section 6 and Section 9), and increased risk of wildlife-vehicle collisions.

Measures to reduce the incidence of wildlife-vehicle collisions and near hits along mine site roads include:

- Traffic signs and adherence to speed limits on mine site roads.
- Give wildlife the right-of-way along all mine site roads and yield to wildlife observed at road crossings.
- Radio controlled mine site roads. Communicate locations of observed wildlife to warn other drivers about areas where there could be a collision hazard and reducing potential wildlife-vehicle collisions.
- Report and document any wildlife-vehicle collision or near-miss along mine site roads that results in animal death or injury (see Section 9.13.8 Wildlife Observation and Incident Reporting). Such information can assist in identifying hazardous areas that may require warning signs or changes in posted speed limits.
- Remove wildlife carcasses from mine site roads and dispose of carcasses away from active work areas.

9.13.6.3 Wildlife Attraction Mitigation Measures

Wildlife attractants draw wildlife to a site and can lead to habituation to human activities. This can pose a risk to human and wildlife safety. Project-related activities that result in food waste (e.g., cooking, cleaning) increase the probability of attracting wildlife. These activities are implicated in the creation of problem wildlife, especially with respect to bears. Waste of any kind can attract wildlife species such as ravens, which act as a cue to other wildlife species. Other wildlife attractants include road salt, empty chemical containers, wildlife carcasses from road kill and hunting, and roadside vegetation.

The general mitigation measures and monitoring components outlined in this section aim to minimize wildlife concerns associated with food wastes and garbage. Effective waste management is essential for reducing and eliminating habituation of wildlife. Habituation of wildlife often results in animals becoming a chronic problem at the site and poses a threat to both human and wildlife health and safety.

Measure to reduce attraction of wildlife to site include:

- A no littering policy enforced on site (section 3).
- Food wastes stored in wildlife-proof containers (outside) or indoor with no exterior passive access (see Waste (Refuse) Management Plan).
- Proper storage, clean-up and disposal of wastes associated with mechanical maintenance, repairs, and spills (Mine Emergency Response Plan and Fuel Management and Spill Response Plan).
- Preventing the build-up of attractant waste.
- Proper and timely removal of domestic wastes (includes food waste).
- Employee and contractor waste awareness and management training during orientation.
- If seeding of roadside areas is proposed, use of seed mixes (i.e., no legumes) that minimize the attraction of ungulates and bears (see Reclamation and Closure Chapter 4.0).
- Report and remove wildlife carcasses found along mine site roadsides (see Section 9.13.6.2 Mortality Risk Mitigation Measures).

9.13.7 Breeding Bird Nest Mitigation

9.13.7.1 Overview

Birds and their nesting sites are protected under federal laws and guidelines in Canada. The federal *Migratory Birds Convention Act* prohibits the disturbance of breeding habitat of migratory birds with the exceptions of raptors, pelicans, cormorants, kingfishers, and game birds. Avian species at risk are protected under the federal *Species at Risk Act*. Provincially, most birds, including raptors are protected in BC under Section 34 of the *Wildlife Act*. Under this Section, a person commits an offence if, except as provided by regulation, he/she possesses, takes, injures, molests, or destroys a bird or its egg, or a nest that is occupied by a bird or its egg.

Due to the above restrictions on disturbance to breeding habitat of birds, nest searches will be conducted for breeding birds prior to any land clearing that occurs within the active breeding period. Details of breeding bird nest searches are provided below, along with protocols to follow when nests are encountered in mine site areas during operational activity.

9.13.7.2 Pre-Clearing Nest Searches

Pre-clearing bird nest survey protocols are to be implemented during any vegetation clearing proposed to be undertaken during the critical bird breeding period. For the purposes of the Kootenay Region, the critical bird breeding period is considered to be from March 15 to July 31 with some species outliers that nest earlier (e.g., owls) and some that nest into August.

All surveyors must have sufficient experience to be able to identify local bird species and have experience in determining active or non-active bird nests. If a nest is detected and active, a 30 m buffer zone shall be marked with flagging to reduce the amount of disturbance around the nest and will remain in place until the nestlings have fledged. If an active raptor nest is found, Table 9.13-2 recommends minimum buffers for nesting raptors.

Table 9.13-2: Recommended Minimum Buffers for Nesting Raptors

Ability to co-exist*	Undeveloped	Breeding season “quiet” buffer (additional)
“High” and “moderate-high”	200 m	100 m
“Moderate”	500 m	100 m
“Low-moderate” and “low”	500 m	As advised by QEP or Professional Biologist**

***“Ability to Co-exist”** refers to the species’ tolerance to activity near the nest site. This may differ from the tolerance rating shown in Table 3 (MOE 2013) which also includes disturbances near feeding and winter habitats. Species listed below are those known to nest in proximity to rural or urban habitats in BC. Should nests of other species be found where they may conflict with potential development activities, the advice of a Professional Biologist should be sought before proceeding with activities that may disturb the nest site (BC MOE 2013).

i. Species with “high” tolerance: Osprey, Red-tailed Hawk, Great Horned Owl, and Barred Owl
ii. Species with “moderate–high” tolerance: Bald Eagle, Cooper’s Hawk, Swainson’s Hawk, American Kestrel, Merlin, Barn Owl, and Northern Saw-whet Owl
iii. Species with “moderate” tolerance: Turkey Vulture, Sharp-shinned Hawk, Peregrine Falcon, Northern Harrier, Flammulated Owl, Western Screech-Owl, Short-eared Owl, Long-eared Owl, and Northern Pygmy Owl
iv. Species with “low–moderate” tolerance: Burrowing Owl, Red-legged Hawk, and Prairie Falcon
v. Species with “low” tolerance: Golden Eagle, Northern Goshawk, and Spotted Owl

‘**Breeding season quiet buffer**’ is an additional buffer distance that should be used where land contouring, construction, or any unusual or sudden loud activities (e.g., tree felling, chain saws, concrete cutters, large trucks, whistles, fireworks, or banging devices) is to take place during the active breeding season (MOE 2013).

9.13.7.3 Protocol For Active Nest Encounters

If during the operations phase a nest is discovered in the active mine site area, it will be determined whether the nest is active or not. If active, the work around the nest should be minimized (if possible). The nest must not be disturbed. If it is determined that the nest is not active, the nest may be removed. Observations of nests, nesting birds, and nesting activity (i.e., nest construction, perching, and incubation) around the mine site should be recorded and entered into an on-site database.

9.13.7.4 Monitoring and Reporting

Pre-clearing breeding bird nest searches will occur during vegetation clearing proposed to be undertaken during the critical bird breeding period; reporting will include:

- Daily communication of pre-clearing nest search results to construction crew supervisor or as directed by Mine Manager.
- Weekly summary data report of pre-clearing nest search results to Mine Manager or designate.
- Annual reporting of results from nest searches undertaken during the breeding period (if any) within the Annual Reclamation Report.

Monitoring and reporting for breeding bird nest activity at site during operations shall include:

- Reporting of identified nest locations (if any) and results of monitoring of active nests (e.g., bird species, length of nest occupation and nest outcome [success, failure, or unknown fate]) in the Annual Reclamation Report.

9.13.8 Wildlife Observations and Incident Reporting

9.13.8.1 Overview

Reporting of wildlife observations, incidents, and mortalities at the RRIMM Project site can help identify hazardous conditions to both wildlife and humans, as well as provide information on wildlife habitat use and behavior patterns in relation to the Project. The following sections outline reporting protocols for wildlife observations, wildlife mortalities, and wildlife incidents.

9.13.8.2 Protocol for Reporting

Wildlife Observations

A 'wildlife observation' is an observation of any wildlife species considered natural and not influenced by mine site activities. Reportable observations can include ungulates (bighorn sheep, woodland caribou, moose, mountain goat, mule deer, elk, and white-tailed deer), furbearers (badger, bobcat, lynx, wolverine, beaver, black bear, grizzly bear, marten, mink, muskrat, cougar, coyote, ermine, fisher, wolf, red fox), birds and their nests, bats, amphibians, and reptiles.

Regionally significant species include grizzly bear, great blue heron, western screech owl, western toad, western painted turtle, western skink, badger and a number of bat species. Wildlife observation reporting will include the following components and protocols:

- Encourage personnel and contractors to report sightings of wildlife species (particularly of regional significance) on and around the site to environmental monitor(s) or designate.
- Record observation on a Wildlife Observation Form, including information on observation location, date, time of day, species, the number of animals and the animal behavior.
- Update and maintain wildlife observation database on-site.

Wildlife Mortalities

Natural and human-cause wildlife mortality will be monitored at the site in order to maximize wildlife and human safety. Wildlife mortalities of large mammals, species at risk, regionally important wildlife, and any mortalities of a grouping of the same species identified on the site will be recorded and descriptions reviewed to determine if mine activities contributed to a mortality event. Documenting wildlife mortalities can also facilitate the incorporation of adaptive management approaches and development of mitigation measures. Wildlife mortality reporting will include the following components and protocols:

- Encourage personnel and contractors to report sightings of wildlife mortality on and around the site to environmental monitor(s) or designate.

- Inspect reported wildlife mortality by environmental monitor(s) or designate to determine probable cause of death.
- Record detailed wildlife mortality data and enter data into a database, information to include:
  - Photograph and record obvious injuries, position of animal, anything unusual
  - Record time, date, location, estimate time of death, any sightings of other wildlife in area.
- Dispose of carcasses located near mine activities by moving it away from any work areas and leave carcasses that do not pose a threat to wildlife or human safety.
- Report mortality event to Conservation Officer Service and Wildlife Committee members as directed by regulation or permit stipulations.

WILDLIFE INCIDENTS

A ‘wildlife incident’ is an observation where there is an interaction between wildlife and human activity that may compromise the safety of the animal and/or humans. Not all wildlife incidents result in death or injury to wildlife, and therefore all interactions of wildlife with mine-site activities should be reported regardless of the outcome to the animal. Wildlife incident should also include any action where deterrent measures are deemed necessary. For example, a wildlife incident can include observations of ravens at a garbage disposal area, ducks in the settling pond, vehicle near- miss with an animal, or deterrence of bear from the open pit site.

The purpose of managing wildlife incidents is to reduce the potential for wildlife-related safety concerns for personnel and contractors, and to minimize potential effects of mine activities on wildlife. The Mine Manager or delegated trained personnel will evaluate human-wildlife conflicts to determine whether an animal should be considered a problem animal and the appropriate course of action to take. A policy of using successive levels of deterrents will be applied at the site, starting with avoidance (removing crews from the area), visual monitoring, truck deterrence (include horn), bear bangers, and rubber bullets. Dispatching an animal is only done as a last resort when all other deterrents have failed. If an animal is killed in defense of life or property, the BC Conservation Officer Service must be notified and consulted regarding proper disposal of the dead animal.

Wildlife incident reporting will include the following components and protocols:

- Report wildlife incidents to Mine Manager or site designate.
- Immediately respond and follow-up on wildlife incidents where appropriate.
- Record details of incident in a Wildlife Incident Report Form and enter into on-site database, type of information collected can include:
  - Location (GPS coordinates), incident type (vehicle, site specific, or unknown), date, time of day, wildlife species, number of animals and a description of the incident.
  - Description of management response or adjustment in mitigation measures; for example, a high number of incidents may precipitate a re-evaluation of the effectiveness and enforcement of

existing problem wildlife prevention measures and precipitate the adoption of new adaptive management strategies until the issue is considered resolved.

- Report any problem wildlife incidents to regulatory bodies.

DATA COMPILATION AND REPORTING

Wildlife observations, mortalities and incidents will be recorded on appropriate forms and entered into an on-site spreadsheet. Staff will regularly review information for patterns or potential concerns (e.g., non-compliance with wildlife attractants from improper waste storage).

Observations of focal wildlife species and a description of all wildlife mortalities and incidents will be included in the Annual Reclamation Report, along with a description of management response and deterrents used (if any).

9.14 ARCHAEOLOGICAL MANAGEMENT AND IMPACT MITIGATION PLAN

9.14.1 PURPOSE AND SCOPE

W.H.Y. Resources has prepared this Archaeological Management and Impact Mitigation Plan in order to mitigate against the disturbance of potential unidentified archaeological, paleontological, heritage, or cultural resources encountered during the construction, operation, and closure and reclamation phases of the RRIMM Project.

The purpose of the Archaeological Management and Impact Mitigation Plan is to protect heritage resources associated with the Project and establish control measures to mitigate potential effects on potential unidentified archaeological sites within or adjacent to the Project footprint. The plan outlines a procedure to discover any previously unidentified archaeological, paleontological, heritage, or cultural resource and ensure sites area preserved, recorded, and protected while minimizing disruption to Project activities in the area.

The Archaeological Management and Impact Mitigation Plan is a living document and will be reviewed and updated as required based on need and findings of ongoing monitoring and evaluations. W.H.Y. Resources is committed to applying adaptive management principles across all management plans.

9.14.2 REGULATORY CONTEXT AND RESOURCES

The provincial *Heritage Conservation Act* (1996) prohibits the destruction, excavation, or alteration of archaeological, historical, and/or paleontological sites predating 1846 in BC without a permit. Burials, ship wrecks, plane wrecks, First Nation rock art sites, and sites which have been designated by the provincial government are protected regardless of age

The Archaeology Branch of the Ministry of Forests, Lands and Natural Resource Operations and Rural Development (FLNRORD; Archaeology Branch) is the provincial ministry responsible for the administration of the *Heritage Conservation Act* (1996), issuing permits for heritage inspection and site alterations, and maintaining a database of known archaeological sites. All newly discovered archaeological or historical resources must be reported to the Archaeology Branch. Burials and gravesites are also protected in BC by the *Cremation, Interment, and Funeral Services Act* (2004).

Relevant guidelines include:

- British Columbia Archaeological Impact Assessment Guidelines (BC MFLNRO): provides guidance on conducting Archaeological Impact Assessments in BC.
- Fossil Management Framework (Province of BC): provides guidance related to fossil management in BC.
- British Columbia Archaeological Inventory Guidelines (BC Ministry of Small Business, Tourism and Culture 2000).

9.14.3 ARCHAEOLOGICAL RESOURCES

9.14.3.1 Site Assessment

An archeological overview assessment (AOA) was completed to identify any archeological concerns associated with the Project (Ursus Heritage Consulting 2016). No archaeological, paleontological, heritage, or cultural resources have been identified in the Project area and no registered archaeological sites have been recorded within the Project area. The AOA identified two areas with moderate potential to contain archaeological sites:

- AOP 1 is located in the northern half of the mine site, consisting of the uppermost southeastern flanks of the unnamed summit at the south end of Record Ridge.
- AOP 2 is located within the stockpile and crusher area, encompassing the margins of Sophia Creek and one of its unnamed tributaries.

Additionally, it is likely that the historic route and designated heritage trail Dewdney Trail is located in proximity to the Project area (Figure 2 *in* Appendix 3-16; Management Plan 1996); however, precise location or map of this section of the historic trail is not available or registered.

9.14.3.2 Archaeological Materials

There are several archaeological materials and features that may indicate the presence of an archaeological site. Components of archaeological sites that may be encountered include:

- Artifacts: objects created or modified by humans, and may be made of stone, bone, antler, or wood.
- Cultural deposits: include buried ground-surfaces that show evidence of being heavily-used in the past, such as house-floors, occupation areas and activity areas. These types of cultural deposits can be identified by a linear subsurface concentration of one or more of the following; charcoal, fire-reddened soil, rich layers of organic material and/or fire-altered rock
- Wet site deposits: typically associated within peat or water saturated silt areas which preserve organic artifacts that typically degrade in non-wet sites. Such artifacts include basketry, string and rope, wooden tools, weapons, sporting equipment, and cordage.

- Burials: any physical human remains, rectangular depressions, whole or fragmented cedar box remnants or rock cairns may be an indication of a burial site. Cremations may be represented by dense concentrations of charcoal, ash, fire cracked rock.
- Culturally modified trees: tree that has been altered by aboriginal people as part of their traditional use of the forest. This includes, but not limited to, trees with sections of bark removed by either cutting and/or stripping; Aboriginally logged trees that has been tested, planked, felled, cut, or otherwise modified by Aboriginal people as part of the traditional procurement of logs, posts, planks, and other pieces of wood; and other modified trees from pitch/sap collection, messages, aborglyphs, and arborgraphs.
- Trails: Aboriginal transportation routes for travel, trade and access of hunting, fishing, trapping, and gathering areas. Rock cairns, blazed trees and other markers may help define trails.
- Cultural depressions: surface archaeological feature; typically cache pits and roasting pits; usually found on well-drained ground, are round or rectangular in shape and have a well-drained rim surrounding their perimeter.
- Rock art: pictographs (drawings or design painted on rock) and petroglyphs (drawings or designs pecked or carved into rock).

9.14.4 Training

This Archaeological Management and Impact Mitigation Plan shall be a component of site orientation during construction and operations and reviewed with all personnel and contractors working onsite as part of their initial site training. Specifically, all persons involved in construction activities shall be made aware that:

- Heritage resources are protected by law on provincial land.
- Any archaeological materials or human remains encountered during construction must be reported immediately to the site supervisor.
- STOP WORK procedure must be immediately implemented should any artefacts or remains be encountered.

Site supervisor (or designate) will be familiar with the Chance Find Procedure (as per Section 9.14.5.2) and trained in preliminary identification of potential archaeological materials.

9.14.5 Implementation

9.14.5.1 Preliminary Field Reconnaissance

Prior to construction, a Preliminary Field Reconnaissance will be conducted in the identified areas of archaeological potential and the portion of the Project area in proximity to the Dewdney Trail. Archaeological potential for the remainder of the Project area is considered to be low and no further archaeological investigation is warranted prior to construction.

9.14.5.2 Chance Find Procedure

Chance Find Procedure provides a clear protocol should an archaeological, paleontological, heritage, or cultural resource be discovered during the construction, operation, or closure and reclamation phases of the Project. Chance Find Procedure is applicable to:

- Construction, operations, and management personnel
- Environmental team members
- All visitors and individuals in the Project area.

In the event a previously unidentified archaeological, paleontological, heritage, or cultural resource is encountered, crews shall abide by the following procedure:

1. All activities in the immediate vicinity of the resource will immediately cease. The resource will not be disturbed. The area will be delineated with flagging tape and an appropriate buffer will be applied in order to secure the area to prevent damage or loss.
2. Site Supervisor (or equivalent) will document the resource's location on an Archaeological or Cultural Heritage Site Card. The Archaeological or Cultural Heritage Site Card will include the following information:
    - Date of encounter
    - Observer (name of person completing the Archaeological or Cultural Heritage Site Card)
    - Site location (with GPS or enough detail to relocate the site)
    - Type of site (archaeological, paleontological, heritage, or cultural resource)
    - Any disturbance to the site (by equipment, etc.)
    - Photographs.
3. Completed Archaeological or Cultural Heritage Site Card will be submitted to the Mine Manager.
4. Site Supervisor will immediately contact the W.H.Y. Resources' executive representative responsible for environment, health, and safety (for example, Vice President of Safety, and Environment).
5. Appropriate W.H.Y. Resources' executive representative will, in a timely manner, notify:
    - Archaeology Branch of BC MFLNRORD
    - A qualified archaeologist.
6. If photographs are available, they will be provided.
7. If human remains are located, procedures will follow the Archaeology Branch Policy Statement "Found Human Remains" (September 1999). The appropriate WHY executive representative will also contact the Royal Canadian Mounted Police (RCMP). The Archaeology Branch of BC MFLNRORD and RCMP will determine whether the remains are archaeological.

8. The qualified archaeologist will determine if a visit to the site is required. If a field visit is determined to be necessary, the archaeologist(s) will undertake the inspection process in accordance with all Project Health and Safety protocols under the direction of the Mine Manager.

9. If the significance of the resource is determined to be significant enough to warrant further action, the qualified archaeologist will work in consultation with the Archaeology Branch of BC MFLNRORD to determine the appropriate course of action or mitigation plan for the site or artifact.

10. The appropriate WHY executive representative and Mine Manager will implement the appropriate course of action or mitigation plan. Should it be necessary to excavate, move, or alter the resource, permitting will be obtained in accordance with sections 12, 13, and 14 of the Heritage Conservation Act.

11. When the site is assessed and mitigated to the satisfaction of the Archaeology Branch of BC MFLNRORD and the site has been cleared, Project activities may recommence.

9.14.6 Monitoring and Reporting

W.H.Y. Resources, in collaboration with a Qualified Archaeologist, will coordinate monitoring and site inspection and the document of chance finds as required by the mitigation plan or *Heritage Conservation Act* permit. W.H.Y. Resources will maintain documentation regarding monitoring and any heritage sites that may be discovered during the Project activities throughout the construction, operation, and closure and reclamation phases. A report will be submitted as appropriate to the Archaeology Branch of BC FLNRORD, which may include the following items:

- Summary of activities at or near any archaeological site
- Any non-compliance activities and subsequent work stoppages, mitigative actions, and/or rectifying measures
- Unexpected archaeological concerns and potential mitigation strategies
- Incident reports describing significant archaeological issues.

9.14.7 Roles and Responsibilities

Chance find procedure roles and responsibilities are detailed above. W.H.Y. Resources will engage at least one individual to be responsible for identifying previously undiscovered archaeological, paleontological, heritage, or cultural resources that may be encountered. W.H.Y. Resources will ensure that the individual(s) responsible is provided with adequate training to identify resources.

The appropriate W.H.Y. Resources executive representative will contact parties listed in Table 9.14-1 in the event of the discovery of previously unidentified archaeological, paleontological, heritage, or cultural resource is encountered.

Table 9.14-1: Chance Find Procedure Contacts

Name	Contact Information
Archaeology Branch of FLNRORD	Phone: 250-953-3334 Fax: 250-953-3340 Email: ARCWEBFEEDBACK@gov.bc.ca Archaeology Branch Ministry of Forests PO Box 9816 Stn Prov Govt Victoria BC, V8W 9W3
Police – RCMP (Trail)	250-364-2566

9.15 FUGITIVE DUST MANAGEMENT PLAN

9.15.1 PURPOSE AND SCOPE

The Fugitive Dust Management Plan is provided in Appendix 9-E (SRK 2023f). This section provides a summary of the relevant aspects of the plan, with a recommended reference to review the complete details in Appendix 9-E and the Emissions Inventory Report in Appendix 2-A (SRK 2018a).

The Fugitive Dust Management Plan (FDMP) for the RRIMM Project details mitigation and management measures planned to limit the emission of fugitive dust and other airborne pollutants from all areas of the operation including the mining, crushing, loading, and hauling. Fugitive dust emissions from hauling ore along the unpaved haul road and from materials handling are estimated to be the primary fugitive dust management concern. Strategies for minimizing emissions and fugitive dust that could be considered detrimental to the surrounding region are driven by the application of best management practices (BMPs), designed to accommodate varying site conditions while maintaining appropriate standards for protection of environmentally sensitive areas.

9.15.2 FACILITY COMPONENT OVERVIEW

Infrastructure for the proposed RRIMM Project is located on mineral tenures controlled by W.H.Y. Resources. The RRIMM Project infrastructure and facilities include the following:

- Open pit
- Waste rock storage area
- Sediment pond, collection, and diversion ditches
- Topsoil stockpile
- Ore stockpile
- Crusher
- Portable Generators
- Electrical Transmission Lines
- Office and parking lot

- Haul roads

Figure 2 of the FDMP (Appendix 9-E) shows a map of the proposed infrastructure and facilities. Potential fugitive dust emission sources are indicated along with proposed dust monitoring locations. Potential sources of fugitive dust are discussed in Section 4.1 of the FDMP (Appendix 9-E) and the proposed fugitive dust monitoring program is detailed in Section 5.2 of the FDMP (Appendix 9-E).

9.15.3 Fugitive Dust Control Measures

RRIMM Project design criteria implemented to manage emissions and the potential for generation of dust will align with BMPs. Table 3 of the FDMP (Appendix 9-E) shows the site-specific mitigation measures prescribed (based on BMPs) to address identified fugitive dust sources and activities.

9.15.4 Monitoring and Maintenance

Given the collective duration of months (nine) in which activities will occur at the mine and the relatively low volume of materials being extracted, it is anticipated that emissions can be effectively managed by proactively implementing the mitigations outlined in Section 4.2 of the FDMP (Appendix 9-E).

Visual inspections shall occur at a minimum of twice daily at each monitoring location for a 15-minute observation period. If statistical comparisons of emission rates indicate no significant improvement in dust emission management, additional dust mitigation measures will be implemented according to the Trigger Action Response Plan detailed in Section 5.3 of the FDMP (Appendix 9-E).

Visual inspections will be performed at the following three locations: at the open pit, at the crusher loading area, and in the parking/offices area where the haul road can be well seen. A map of these monitoring locations is shown in Figure 2 of the FDMP (Appendix 9-E). These locations are selected since the majority of dust emissions comes from vehicle road dust (high risk source) and materials processing activities (moderate to high risk sources), as discussed in Section 3.3 of the FDMP (Appendix 9-E).

9.15.5 Reporting

Operational monitoring results will be reported as required by the *Mines Act* Permit and *Environmental Management Act* Permit.

The complete Fugitive Dust Management Plan (SRK 2023f) can be found in Appendix 9-E.

9.16 NOISE ABATEMENT PLAN

9.16.1 Purpose and Scope

The Noise Abatement Plan is provided in Appendix 9-F (SRK 2023i). This section provides a summary of the relevant aspects of the plan, with a recommended reference to review the complete details in Appendix 9-F.

The Noise Abatement Plan details mitigation and management measures for noise-related adverse effects from mining activities. The plan defines mitigation measures to control noise effects from the mine and identify noise criteria that would trigger further potential contingency and adaptive measures, if exceeded.

The Noise Abatement Plan focuses on limiting the area of effects from project noise sources to best adhere to the guidance from the Environmental Code of Practice for Metal Mines (Environment Canada 2009), applying to construction and operations phases of the mine.

Strategies for minimizing the generation of noise that could be considered detrimental to the surrounding region are driven by the application of best management practices, designed to accommodate varying site conditions while maintaining appropriate standards for the protection of environmentally sensitive areas.

9.16.2 Regulatory Context and Resources

Guidelines considered in the development of Noise Abatement Plan are contained in Table 9.16-1.

Table 9.16-1: Noise Performance Consideration

Guideline	Description	Relevance
BC Oil and Gas Commission noise control Best Practice Guideline (BCOGC 2012)	Nighttime Permissible Sound Level (PSL) range from 40 dBA to 51 dBA, receptor dependant. Daytime PSL range from 50 dBA to 61 dBA	Residential receptors
Health Canada (2010)	Change in percent highly annoyance (%HA) less than 6.5%	Residential and social receptors (e.g., daycares, schools, places of worship)
World Health Organization (WHO) Night Noise Guidelines for Europe (2009)	42 dBA (outside) during the nighttime period	Residential receptors

9.16.3 Noise Abatement Measures

The following sections detail the design criteria and dust control and emission mitigation measures applicable to construction, operations and closure.

9.16.3.1 Design Criteria

Project design criteria implemented to abate noise emissions will align with the following concepts:

- Where possible, heavy equipment such as the crusher, compressor, generators, pumps, and motors will either be shielded or located within an enclosure.
- Haul roads will be designed to limit haul distances onsite.
- Use of appropriately sized trucks to limit total number of trips when hauling material.
- Mobile equipment will be equipped with manufacturer recommended exhaust mufflers and be maintained at appropriate intervals.

9.16.3.2 Noise Mitigation Measures

Building on the design criteria abatement measures listed above, measures added during construction, operation and closure will include the following:

- Keep all operating equipment building doors and windows closed.
- Limitation of the use of vehicle horns, or associated noises other than for safety purposes.
- Operate vehicles and equipment per the recommended operational parameters.
- Keep vehicles within site speed limits.
- Select best achievable technologies, where practicable.
- Maintain all operating equipment per the manufacturer's recommendation, or at appropriate intervals.
- Blasting, and other potentially noise intensive tasks will occur exclusively during the daytime period when the Daytime PSL is greater. Develop specific blasting times during the daytime period in conjunction with the mine contractor.

MONITORING AND REPORTING

A noise abatement monitoring program will be undertaken at receptors to measure noise levels during different Project phases and verify if levels fall within, or exceed performance criteria, as outlined in Table 9.16-1. If monitoring indicates exceedance of performance criteria during the Project phases, the General Manager will work with site personnel and contractors to identify specific response actions. Operational monitoring results will be reported as required in the permit. In the event of upset conditions or non-compliance, reporting procedures would be followed as outlined in the permit.

9.17 ASBESTOS AND FIBROUS MINERALS MANAGEMENT PLAN

9.17.1 PURPOSE AND SCOPE

This section provides a summary of relevant details regarding W.H.Y. Resources assessment of potential for asbestos and fibrous minerals, as well as an overview of the RRIMM Project geology and minerology of asbestos and fibrous minerals in the deposit.

An Asbestos Management and Exposure Control Plan was developed to meet the conditions of W.H.Y Resources' Mineral and Coal Exploration Activities and Reclamation Permit Number MX-5-460. This plan is attached as Appendix 9-G. The purpose of the plan is to detail adequate engineering controls to avoid inhalation of fibrous minerals and manage potential exposure to meet the requirements of the latest revision of "Safe Work Practices for Handling Asbestos" published by Work Safe BC in 2017 and outline an airborne asbestos exposure monitoring program for the workers.

The plan includes:

- Identification of activities and locations where the potential for airborne asbestos exposure exists
- An inventory of potentially asbestiform bearing materials

- An exposure risk assessment
- Asbestos management procedures
- Exposure monitoring and control management
- Storage, transport, and disposal of materials that could potentially contain asbestos.t

Prior to the initiation of the construction of the proposed RRIMM Project, the plan will be amended to ensure that it provides:

1. A comprehensive risk assessment of worker exposure to airborne asbestos fibers, including the potential for asbestos to be disturbed through any mining activity (exploration, construction, operation, and reclamation) and become airborne.
2. A risk-based exposure control plan which describes the controls and work procedures to effectively mitigate the asbestos exposure hazard.

9.17.2 Regulatory Context and Resources

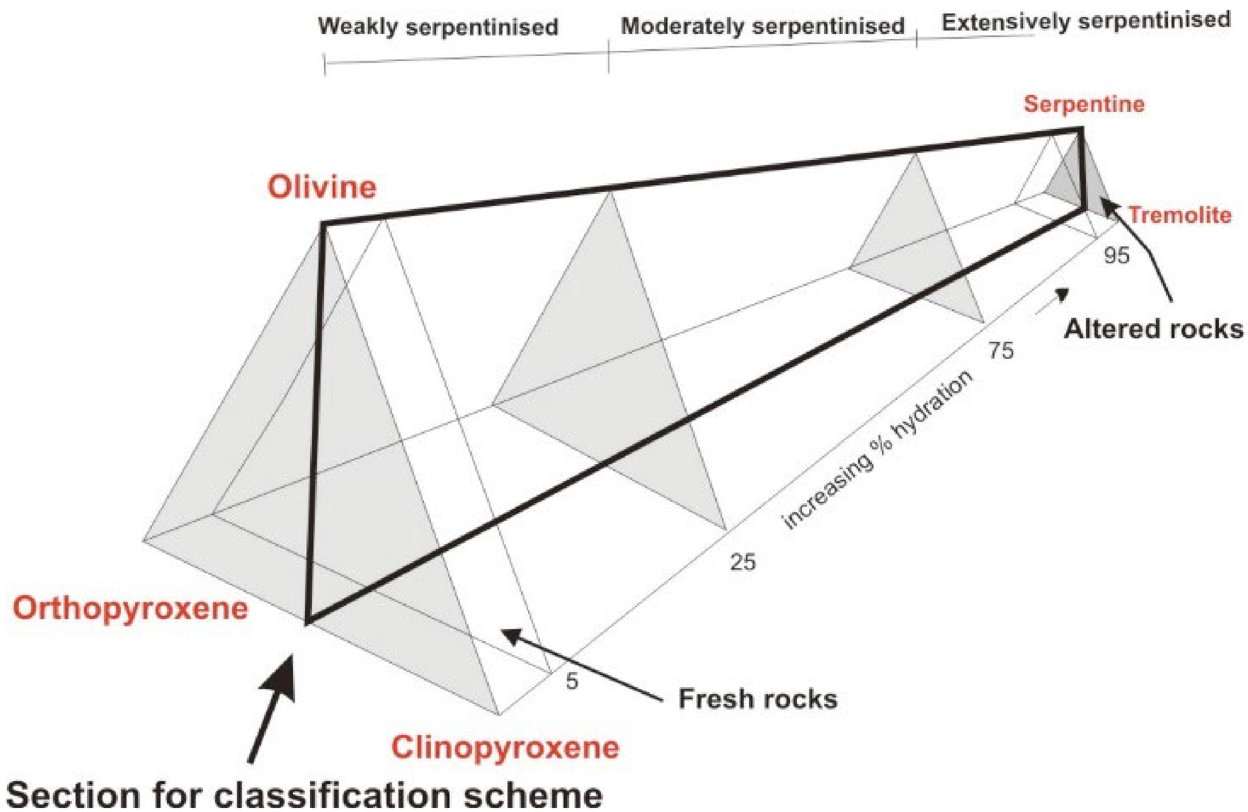
The regulatory framework applicable to asbestos management for this project falls within the provincial jurisdiction of British Columbia and includes provincial codes, permits and regulatory guide documents. The regulatory requirements are provided in the following documents:

- Health, Safety and Reclamation Code for Mines in British Columbia (Ministry of Energy and Mines 2022)
- Safe Work Practices for Handling Asbestos (WorkSafe BC 2017)

9.17.3 Geology and Mineralogy of Asbestos and Fibrous Minerals

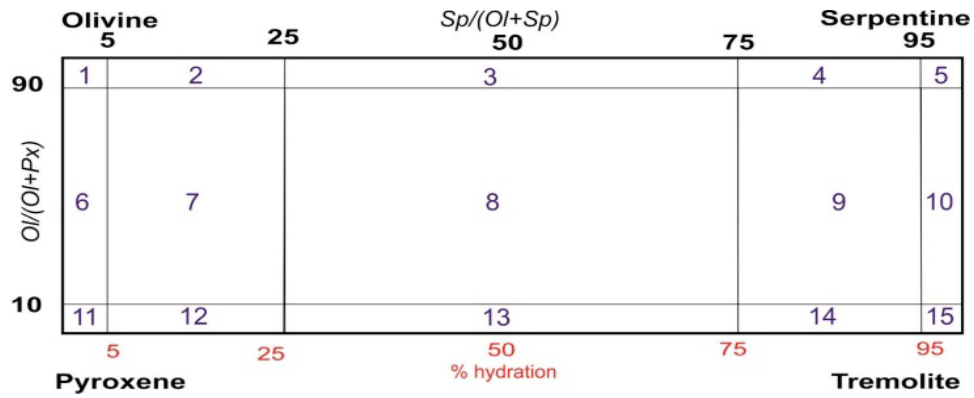
9.17.3.1 Ultramafic Rocks

The RRIMM Project is mainly underlain by the ultramafic rocks known as the “Rossland ultramafic body” (Open File 1990-27) or “Record Ridge ultramafic body”, which is rhombic in shape with an area of about 6.2 square kilometers (British Geological Survey Bulletin 108 Chapter 5). Record Ridge Ultramafic rocks are plutonic, derived from the Earth's mantle, probably ophiolitic and part of the oceanic Slide Mountain Terrane. It is probably an on-land fragment of an ancient oceanic lithosphere evolved in an ancient arc–forearc–backarc setting of subduction zones. An example of plate tectonics and the geodynamic evolution of this region. However, according to Michael T. Styles of the British Geological Survey, (I. Kennedy, Personal Communications) the study and classification of the wide range of compositions of ultramafic rocks have largely concentrated on the simple olivine-rich or serpentine rich end-members while the vast majority of ultramafic rock compositions were untested. We need to understand that many ultramafic rocks consist of intimate mixtures of olivine, pyroxene and serpentine continuum as shown below (Figure 9.17-1 to Figure 9.17-4).



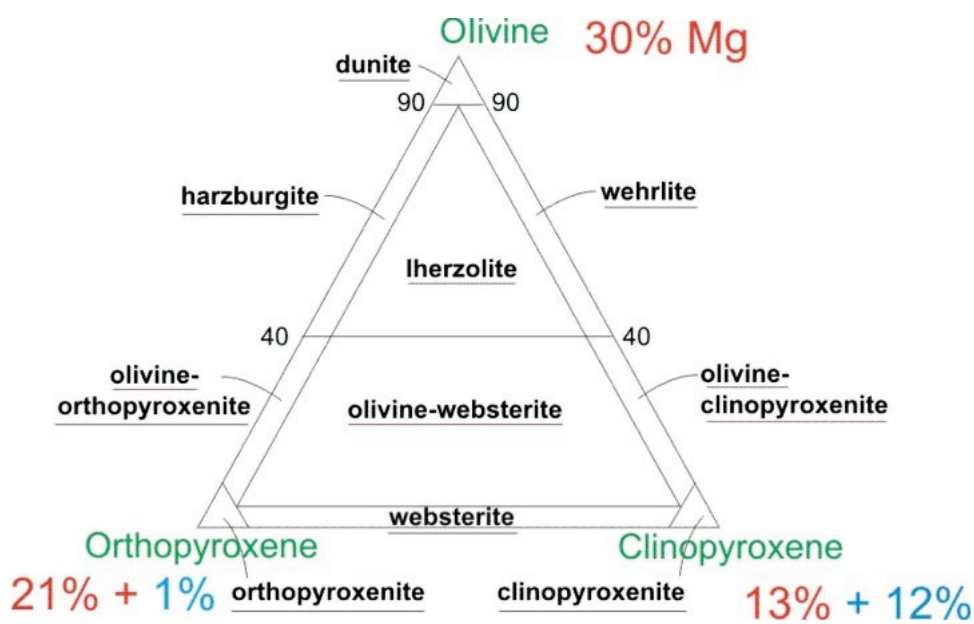
Source: Greenhouse Gas Sci Technol. 4:440–451 (2014)

Figure 9.17-1: Range of Mineralogical Compositions of Naturally Occurring Ultramafic Rocks, Showing the Plane Through the Apex used for Classification



Source: Greenhouse Gas Sci Technol. 4:440–451 (2014)

Figure 9.17-2: A Classification Diagram for Ultramafic Rocks Based on the Proportions of Constituent Minerals.



Source: B.C Bulletin 108 - Figure 5.5. Classification and nomenclature of ultramafic rocks in the olivine-orthopyroxene-clinopyroxene prism (after Streckeisen, 1975)

Figure 9.17-3: Classification of Fresh, Anhydrous Ultramafics

Mg content of the rocks at each apex is shown in red and the Ca content in blue (weight% element).

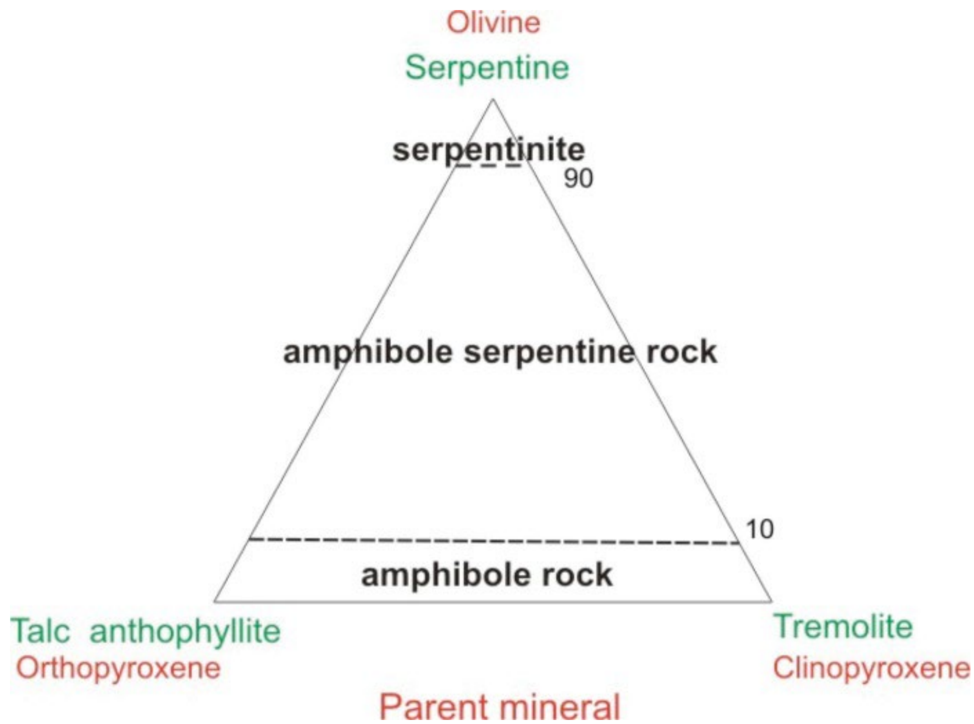


Figure 9.17-4: Classification of Hydrated Ultramafics

Actual minerals present are shown in green and the parent anhydrous minerals in red.

It is clear from Figure 9.17-1 to Figure 9.17-4 that as the degree of hydration increases in the ultramafic rocks phase from one end of the continuum being Olivine-rich to the other end being, Serpentine-rich.

The geology of the Record Ridge Ultramafic is described in Chapter 2.3.2 with a mineralogy comprising predominantly dunite, with subordinate wehrlite and/or lherzolite. They have well-preserved primary cumulate textures typical of both Alaskan- and Alpine-type ultramafics. Ultramafic (or ultrabasic) rocks are dark-coloured, heavy, and rich in iron and magnesium minerals and relatively low in silica.

The mapped rock assemblage as shown in Figure 2.3-1, repeated below for ease of reference (Figure 9.17-5), shows the Record Ridge ultramafic as being more towards the Olivine end of the continuum and thus a mineralogically decreased instance of forming asbestos and/or asbesiform minerals. There is obviously differing degrees of serpentinization within the Record Ridge ultramafic and it will be important to understand the impact on Magnesium mineral type, magnesium content, and metallurgy as the degree of serpentinization changes within the deposit.

9.17.3.2 Serpentine and Asbestos

Both serpentine and chrysotile asbestos are magnesium silicates, but serpentine is a massive rock, while chrysotile has water in the molecule due to the metamorphism of serpentine, which added water and converted it to a fibrous form. Therefore, serpentine and chrysotile asbestos have different chemical formulas. Serpentine is a light to dark green metamorphic rock derived from ultramafic igneous rocks due to heat and pressure. It is a relatively soft rock with a resinous texture. Chrysotile is a hydrous magnesium silicate. Chrysotile is a fibrous alteration of serpentine that forms as cross-fibre veinlets within fractures in the serpentine rocks.

The degree of serpentinization determines the overall type of the asbestiform mineral. There are groups of six fibrous minerals that occur naturally in metamorphic deposits located around the world. Of the hydrous magnesium silicate variety, the six types include: tremolite asbestos, actinolite asbestos, anthophyllite asbestos, chrysotile asbestos, amosite asbestos and crocidolite asbestos.

These six groups can be further broken down into specific types of ‘asbestos’:

- serpentine asbestos group contains only one type of asbestos, chrysotile (White asbestos).
- amphibole asbestos group consists of the remaining 5 types of asbestos: amosite (Brown or Gray asbestos), crocidolite (Blue asbestos), anthophyllite, tremolite, and actinolite.

It is important to note that while chrysotile asbestos is only found in serpentine, not all serpentine is asbestos bearing.

W.H.Y. Resources’ petrographic examination to date indicates we have a variety of lithologies within the olivine-orthopyroxene-clinopyroxene prism. None of the samples examined to date have reported finding asbestos.

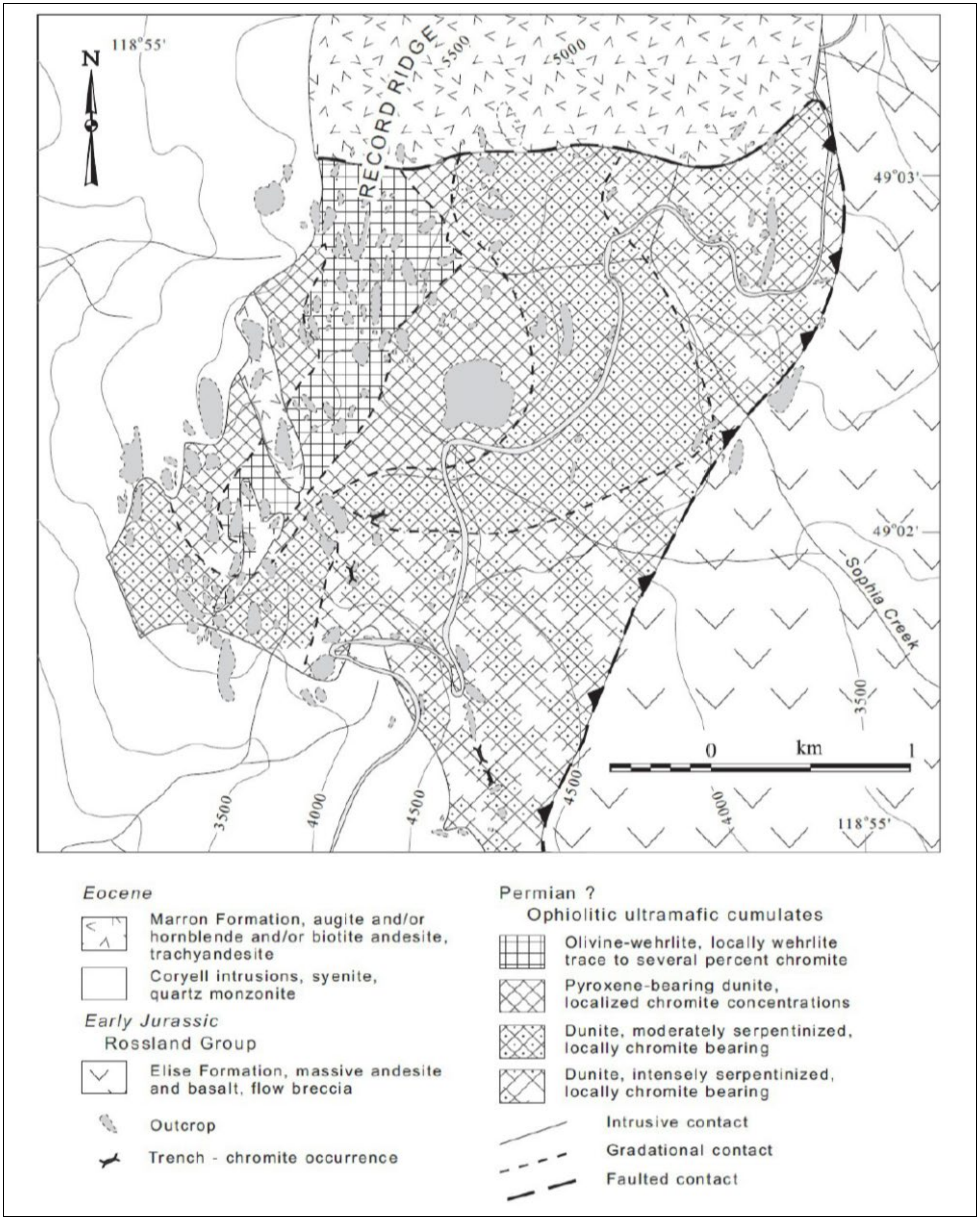


Figure 9.17-5: Geological Map of the Record Ridge Ultramafic Exposed on Record Ridge

9.17.3.3 Characterization

Given the possibility that fibrous asbestiform minerals could be present within the deposit an independent consulting firm, RJ Lee Group, specializing in the identification of asbestiform minerals was commissioned to complete a full assessment of the deposit.

RJ Lee's extensive investigation of the existing drill core compiled from all previous drilling on the property was completed in order to determine what asbestiform minerals where present within the deposit and if present, what minerals were present and what was their frequency of occurrence throughout the deposit. Approximately 1,500 m of core of the 15,221 m drilled to date was examined. The core targeted for examination initially focused on all intervals previously identified during the initial logging of the core as containing asbestiform minerals (1,274.41 m over 6 holes, with a potential total meterage or 20.74 m). In addition, core chosen for examination represented all lithological units present as well as intersections representative of the major structures within the deposit given that this type of mineralization is secondary in nature and most often formed in fault zones. The onsite examinations included visual identification as well as examination through a Polarized Light Microscope. It confirmed that the initial logging of the 1,274.41 m incorrectly identified white to grey mineralogy as asbestiform minerals.

The investigation resulted with the identification of 15 occurrences of Chrysotile and 7 occurrences of an amphibole asbestiform minerals, suspected to be tremolite or Anthophyllite. All occurrences were in the centimeter to millimeter size range associated with veinlet structures and collectively amounted to approximately 6 cm of total asbestiform mineralization. The total asbestiform mineralization amounted to approximately 0.004 % of the total core examined with greater than 50% of this mineralization occurring as Chrysotile. No asbestiform minerals were observed in the groundmass of the serpentinite. Using the estimated thickness of the veins and the total meterage of core examined, it is estimated that the deposit contains approximately 0.0001% asbestos. The full RJ Lee report is found in Appendix 9-G(i) (RJ Lee Group June 2018).

9.17.4 Asbestos and Fibrous Minerals Management and Exposure Control

Subsequent to the RJ Lee report, W.H.Y. Resources commissioned March Consulting Associates Inc., a certified Industrial Hygienist. March developed an asbestos Management and Exposure Control Plan to meet the conditions of W.H.Y Resources' Mineral and Coal Exploration Activities and Reclamation Permit Number MX-5-460. This plan is attached as Appendix 9-G(ii).

The plan:

- Details adequate engineering controls to avoid inhalation of fibrous minerals and manage potential exposure to meet the requirements of the latest revision of "Safe Work Practices for Handling Asbestos" published by Work Safe BC in 2017.
- Outlines an airborne asbestos exposure monitoring program for the workers.

The plan was implemented during a 2018 diamond drilling program and followed NIOSH 7400 sampling and analytical method, as specified by the Province of British Columbia. In addition, an analysis using a Transmission Electron Microscopy that differentiates between asbestos and other fibres was also completed on the samples. The results of the analysis completed in accordance with the plan were consistent with the RJ Lee characterization program completed, indicating a very low presence of fibrous and/or asbestiform minerals. The preliminary conclusion following the receipt of all analytical results indicate that during normal operations of the proposed RRIMM project, the possibility of exposure to airborne asbestos exceeding the exposure limit of 0.1 fibre/mL of air is insignificant.

Chrysotile was identified in the core shack sump sludge sample, however the final analytical results indicated there was no worker exposure to asbestos with all analysis reporting <0.01 fibres/mL of asbestos, indicating the implementation of the Plan was successful. The final analytical results are attached in Appendix 9-G(iii) (ALS Certification of Analysis November 2018).

As mentioned above, prior to the initiation of the construction of the proposed RRIMM Project, the plan will be amended to ensure that it provides: 1) a comprehensive risk assessment of worker exposure to airborne asbestos fibers, including the potential for asbestos to be disturbed through any mining activity (exploration, construction, operation, and reclamation) and become airborne; and 2) a risk-based exposure control plan which describes the controls and work procedures to effectively mitigate the asbestos exposure hazard.

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