RED MOUNTAIN UNDERGROUND GOLD PROJECT
VOLUME 2 | CHAPTER 5
CLOSURE AND RECLAMATION

Table of Contents

List of Tables

List of Figures

5 CLOSURE AND RECLAMATION

5.1 Introduction

IDM Mining Ltd. (IDM, the Proponent) proposed to develop and operate the Red Mountain Underground Gold Project (the Project), an underground gold mine in the Bitter Creek valley on a contiguous group of mineral tenures known collectively as the Red Mountain Property. The Project will extract high-grade gold and silver ore to be processed on site.

5.1.1 Project Setting

The Project is in northwest British Columbia (BC), approximately 15 kilometers (km) northeast of the town of Stewart (Figure 5.1-1). The Project falls within the Regional District of Kitimat-Stikine (RDKS). Project coordinates are approximately 55.896° to 56.054° north latitude and 129.665° to 129.802° west longitude.

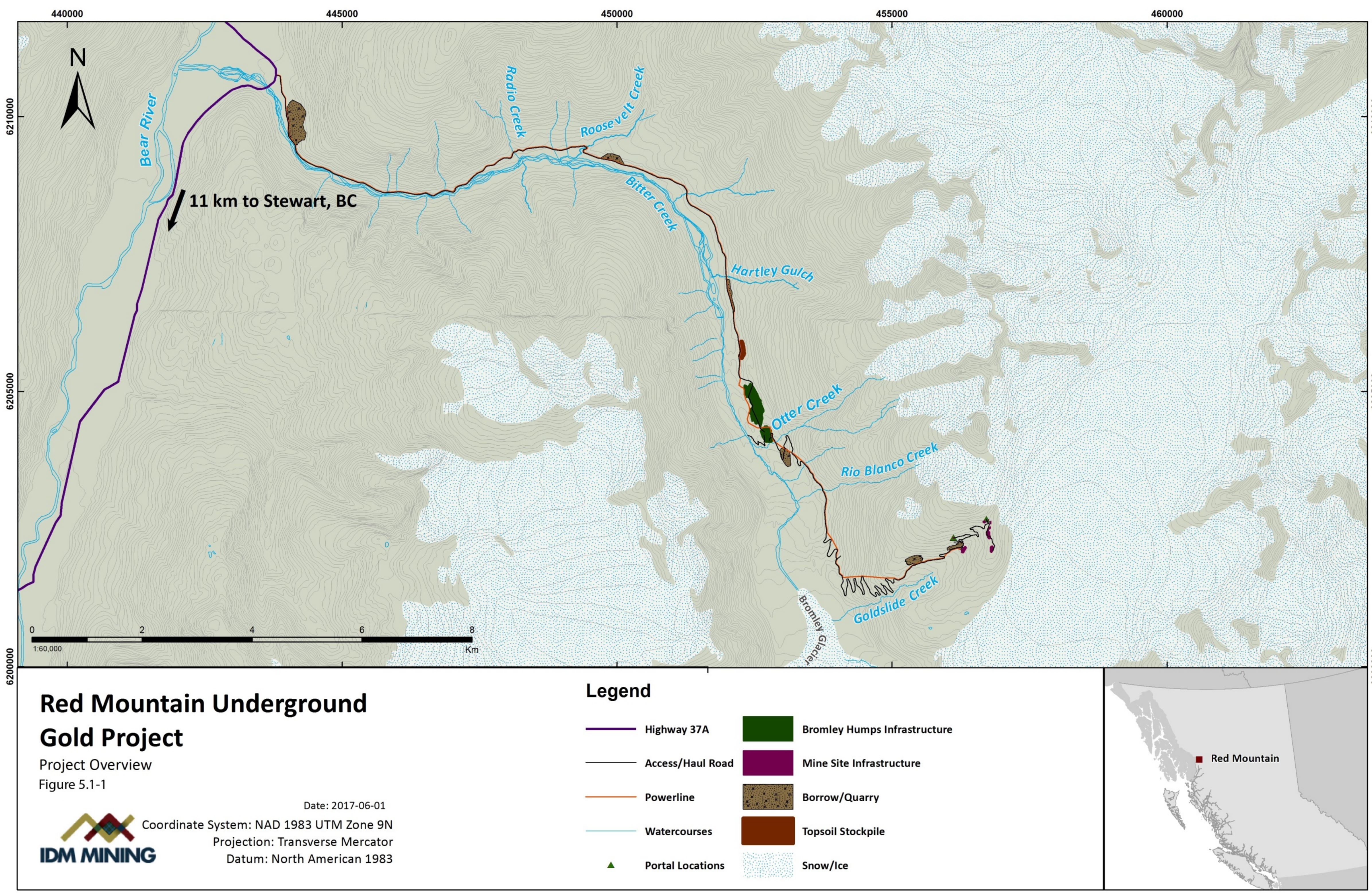
The Project area is characterized by rugged, steep terrain with weather conditions typical of the northern coastal mountains, including significant snow accumulation, typically of more than 2 metres (m) in the winter. An historic access road extends for approximately 13 km parallel to Bitter Creek, but terminates approximately 7 km from the proposed Mine Site.

The Project is within the Nass Area and the Nass Wildlife Area, as set out in the Nisga'a Final Agreement (NFA). Pursuant to the NFA, Nisga'a Nation, as represented by Nisga'a Lisims Government (NLG) has Treaty rights to the management and harvesting of fish, wildlife, and migratory birds within the Nass Wildlife Area and the larger Nass Area. The Project is also within the asserted traditional territory of Tsetsaut Skii km Lax Ha (TSKLH) and is within an area where Métis Nation BC (MNBC) claims Aboriginal rights.

5.1.2 Project History

Placer mining commenced in Bitter Creek at the base of Red Mountain at the turn of the century, but significant work on the current deposit began in 1988 when Wotan Resources Inc. staked claims in 1988 and optioned the property to Bond Gold Canada Inc. (Bond) in 1989. In that year, gold mineralization in the Marc and Brad zones were discovered by drilling. LAC Minerals Ltd. (LAC) acquired Bond in 1991. Surface drilling on the Marc, AV, and JW zones continued in 1991, 1992, 1993, and 1994. Underground exploration of the Marc zone was conducted in 1993 and 1994. In 1995, LAC was acquired by Barrick who subsequently optioned the property to Royal Oak Mines Ltd. in 1996. North American Minerals Inc. (NAMC) purchased the property from the receivership sale of Royal Oak in 2000. NAMC subsequently sold the property to Seabridge Gold Inc. (Seabridge) in 2002 who optioned the property to Banks Island Gold Ltd. (Banks). Banks terminated the option in 2013 and the property reverted to Seabridge. Seabridge subsequently optioned the property to IDM in 2014, and on May 26, 2017, IDM exercised its option and acquired the Project.

Figure 5.1-1: Project Overview



Advanced exploration and engineering activities are currently in progress at site on a seasonal basis. IDM operates a 40-person exploration camp to support surface and underground drilling, geophysical surveys, and operation of ventilation and dewatering of an exploration decline that was driven over 20 years ago. No roads currently access the site, but there are all-terrain vehicle trails utilized for transportation between the camp and the existing mine portal. Bulk goods and fuel are typically flown to site via helicopter.

5.1.3 Project Overview

The proposed Project consists of the underground mining and on-site processing of gold and silver. There will be three main Project components (Figure 5.1-2 and Figure 5.1-3):

- **Mine Site**: An underground mine consisting of an Upper Portal, a Ventilation Portal, a Lower Portal, quarries, and supporting facilities, located in the cirque (alpine) area between the Cambria Ice Field and the Bromley Glacier, at elevations ranging between 1,500 and 2,000 metres above sea level (masl);

- **Bromley Humps**: An area consisting of the Process Plant, Tailings Management Facility (TMF), and supporting infrastructure, which is in the Bitter Creek valley (elevations of 350 to 500 masl) and approximately 5 km down the valley from the Mine Site; and

- **Access/Haul Road**: The Access Road will extend 15 km from the provincial highway system (Highway 37A), followed by an additional 11 km Haul Road to the Mine Site.

Ore will be mined year-round using conventional underground mining methods, first from the Upper Portal for 1.5 years and then from the Lower Portal for the remainder of the Operation Phase. The main mining method is longhole stoping. Stopes will be mucked by remote controlled load-haul-dump machines (LHDs). Mineralized material will be transported by LHD to level remucks or directly to the muckpass. Muck will be loaded from the level remuck or muckpass into haul trucks and transported to a stockpile at the portal entrance. Front end loaders will load haul trucks that will transport the ore to the larger Run of Mine (ROM) Stockpile located next to the Process Plant at Bromley Humps.

The underground mine will be backfilled using unconsolidated waste rock in the secondary stopes and cemented rock backfill (CRF) in the primary stopes. All waste rock generated during the mining process, as well as the existing historical waste rock pile from the excavation of the existing decline, will eventually be used as backfill during operations, and additional talus material from a talus quarry near the Lower Portal will be quarried to make up the shortfall.

Ore will be processed using conventional Carbon in Leach (CIL) recovery processes at the Process Plant, and tailings will be discharged to an adjacent TMF. The TMF impoundment will be fully lined with a high-density polyethylene (HDPE) liner and capped with rock and vegetated soil layer designed to shed runoff.

The mine plan for the Project is an estimated 6-year Operation Phase based on currently delineated resources, with a total ore feed to the Process Plant of approximately 2 million tonnes. Continued exploration may extend the duration of operations.

Figure 5.1-2: Project Footprint – Bromley Humps

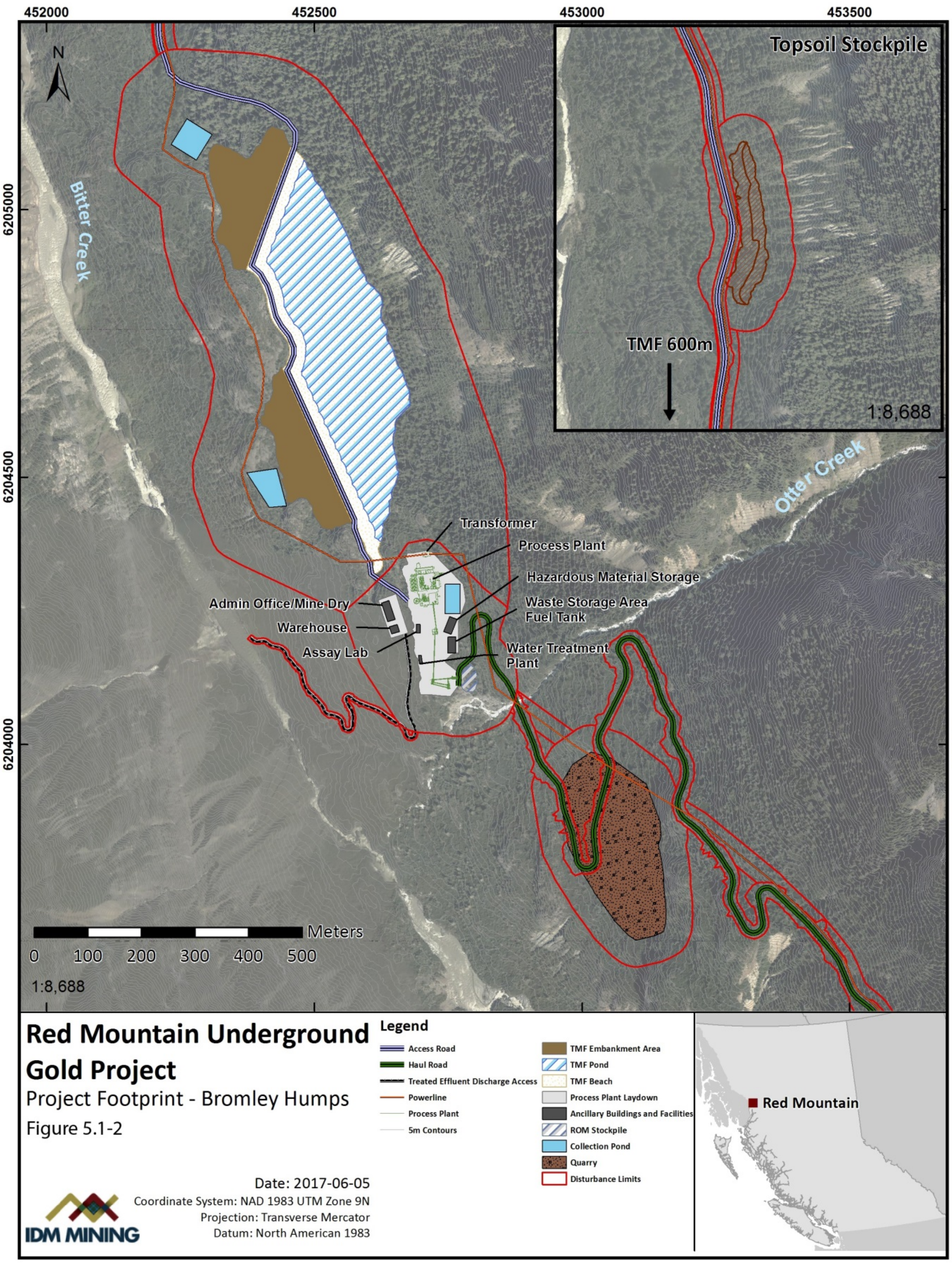
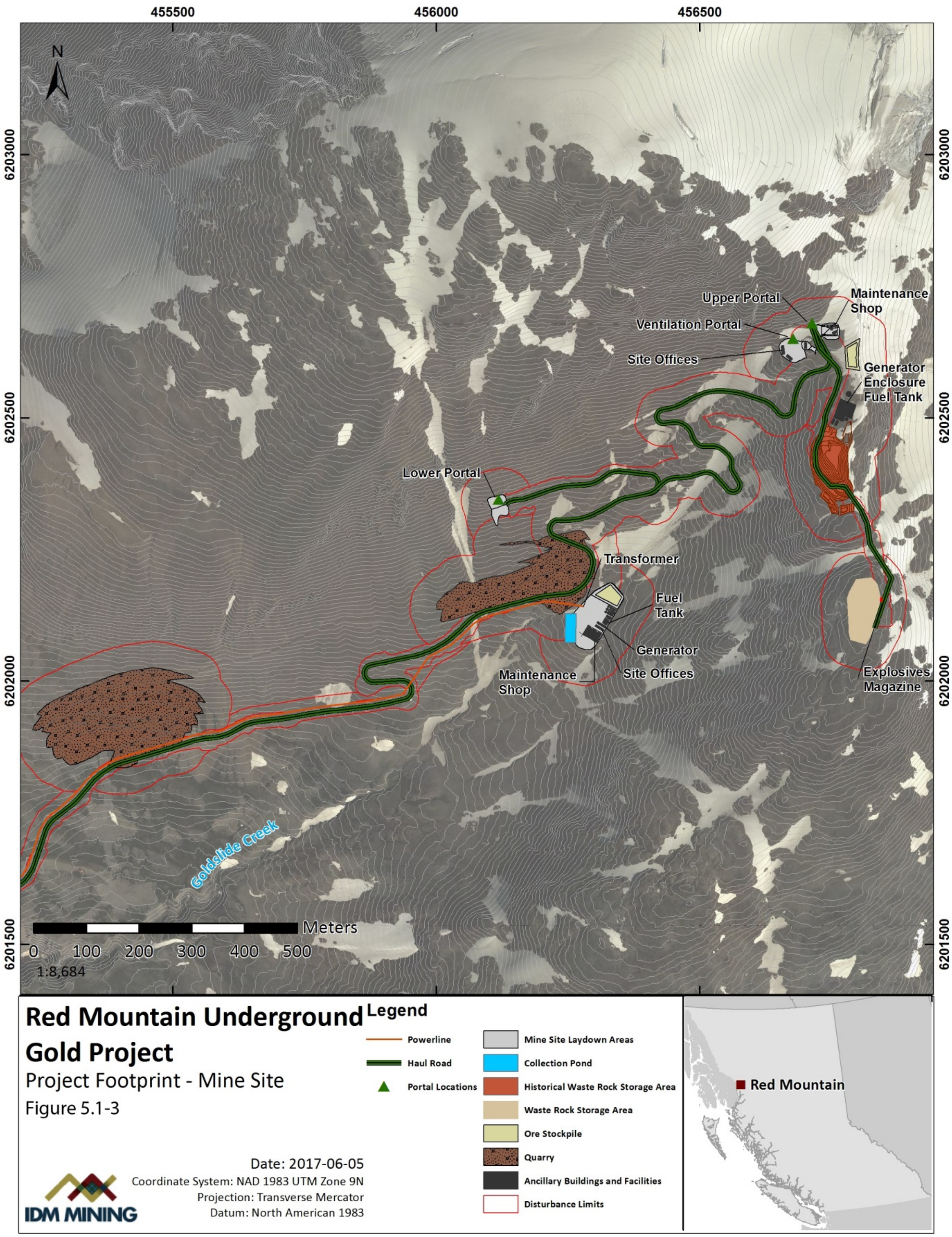


Figure 5.1-3: Project Footprint – Mine Site



5.1.4 Project Phases

The life of the Project is approximately 23 years, as follows:

- Construction Phase: 18 months;
- Operation Phase: 6 years (based on the current reserve base);
- Closure and Reclamation Phase: 5 years; and
- Post-Closure Phase: 10 years.

The duration of the Post-Closure Phase is contingent on achieving the closure objectives described in Section 5.3. The closure and reclamation schedule is described in further detail in Section 5.11.

5.1.5 Current Site Conditions

5.1.5.1 Physiography, Climate, and Hydrology

The Mine Site is situated at the toe of the Bromley Glacier, and the surrounding area is characterized by steep mountainous terrain with incised glaciated valleys. The region has undergone several stages of glaciation and local glaciers are currently in active retreat. Within the last century, the Bromley Glacier has retreated an average rate of 45 m per year with a total vertical thinning of approximately 300 m. Because of the glaciation, exposed rock outcrops are well rounded with steep sides above 1,600 masl.

The proposed underground mine is in the Red Mountain cirque, a short, westerly-trending hanging valley above Bitter Creek. The Mine Site is situated at approximately 1,500 to 2,000 masl. The TMF and Process Plant are located down the valley, at an elevation of approximately 350 to 500 masl. This area likely experiences more rainfall versus snowfall than the Mine Site. Orographically-induced precipitation is expected due to the topographic variation of the area.

The region has cold weather and warm summers, but no dry seasons. Climatic conditions at Red Mountain are dictated primarily by its altitude (i.e., 1,742 masl at the centre of the deposit) and proximity to the Pacific Ocean. Temperatures are moderated year-round by coastal influence; with more than four months with an average temperature of greater than 10°C, and an average temperature below 22°C in the hottest month. Precipitation is significant in all months, with October being the wettest. The area is characterized by significant snow accumulation in the winter (i.e., +2 m snow accumulation). Even at sea level, over one-third of the annual precipitation falls as snow. This proportion is greater at higher elevations, where snow may fall at almost any time of year (Volume 2, Chapter 1).

The baseline meteorology study for the Project (Volume 8, Appendix 12-A) includes data from a meteorological station (Redmount Station El. 1,498 masl) installed in July 2014 at the Mine Site. The specific installation location of this station was considered ideal for wind speed and direction but less desirable for precipitation, in particular measurements of snow depth, due to wind scour during the winter. Long-term records from regional climate stations supplement the data provided by the Redmount Station.

Based on correlations between site and regional datasets, the mean annual air temperature at 1,514 masl (considered representative for the Mine Site) was estimated as 0.8°C, with monthly variability ranging between 6.4°C in December and January and 6.9°C in August. The Environment Canada climate station at the Stewart Airport (7 masl), was considered to be the most representative for the Project for daily precipitation, with a mean annual precipitation of 1,847 millimetres per year (mm/year) (Appendix 12-A).

Watersheds in the Project area consist of the Bitter Creek catchment (defined by surface water catchments), which extends up to the Cambria Icefield. Bitter Creek is the main watercourse in the Project area. Bitter Creek originates from the Bromley Glacier and flows into the Bear River, which then flows into the Portland Canal near Stewart. Three other creeks are located close to the proposed Project infrastructure. They are as follows:

- Goldslide Creek, which drains the Red Mountain cirque, where the existing portal is located. The flow in Goldslide Creek is highest during freshet (typically in June) and is not influenced by glacial melt.
- Rio Blanco Creek, which drains the catchment where the Rio Blanco Snowfield is located into Bitter Creek downstream of the Goldslide/Bitter Creek confluence. The flow in Rio Blanco Creek is highest during freshet and flow appears to be glacially-influenced and dominated by snowmelt.
- Otter Creek, which drains into Bitter Creek, next to Bromley Humps, downstream of the Rio Blanco/Bitter Creek confluence. The flow in Otter Creek is highest during freshet and flow appears to be glacially-influenced and dominated by snowmelt.

5.1.5.2 Fish and Wildlife

5.1.5.2.1 Aquatic Environment

The aquatic environment most likely to be influenced by the proposed Project is the Bitter Creek drainage. Major mining-related infrastructure (e.g., temporary waste rock storage areas and TMF) and major activities will be restricted to the Otter Creek and Goldslide Creek drainages.

Goldslide Creek, a short, 2.4 km long, first-order watercourse, is one of the many tributaries of Bitter Creek and is located in the headwaters near the foot of Bromley Glacier. Otter Creek is located 3.3 km north, and is a 2.6 km long, second-order watercourse. Bitter Creek is a 17 km long, fourth order stream that flows west and drains into Bear River. Bear River is a large, 38 km long, fifth order, fish-bearing watercourse.

Bitter Creek is the primary watercourse supporting fisheries that may be affected by runoff from waste rock and tailings from the Project. However, historical and current information suggests the upper-most reaches of Bitter Creek are non-fish bearing; it is believed that the closest fish presence and habitat is approximately 6.5 km downstream from the Goldslide Creek/Bitter Creek confluence and 3.2 km downstream of Otter Creek, near Hartley Gulch. Field surveys specific to fish distribution, abundance, and diversity have confirmed historical information. Along proposed rights-of-way, fish and fish habitat may be affected through degradation of habitat by erosion, sedimentation, and clearing of riparian vegetation for road construction and use. As well, increased access to fish habitat may lead to increased fishing pressure on local fish stocks; however, the local area is not believed to be heavily used.

Although downstream changes to water and sediment quality are expected to be minimal, changes in the quality of these features downstream of the Project and potential implications to fish and fish habitat as well as lower trophic levels will be assessed. Linear features (e.g., powerline and access road rights-of-way) will also be evaluated in the assessment. Mitigation measures will be implemented to manage any potential effects on fish and fish habitat as required. See Volume 3, Chapter 18 (Fish and Fish Habitat Effects Assessment) for more information.

5.1.5.2.2 Wildlife, Avian Species, and Species at Risk

Wildlife species that are likely or known to occur within the Project area include large and mid-sized carnivores (grizzly and black bear, wolf, and wolverine), smaller furbearers (American marten, red squirrel, and hoary marmot), mountain goats, a variety of bird species (small passerines, raptors, ptarmigan, and grouse), and amphibians (western toad). It is of note that the diversity of species is expected to be much lower at higher elevations, and is expected to increase with decreasing elevation. See Volume 3, Chapter 16 (Wildlife and Wildlife Habitat Effects Assessment) for more information.

5.1.5.3 Mine Site Ecology

Ecologically, the Mine Site is relatively new, as the terrain has undergone recent deglaciation. The upper mountain and Mine Site rests within the Coastal Mountain Alpine (CMA) Tundra Zone which is characterized by long, cold winters and short, cool growing seasons dominated by dwarf shrubs, herbs, mosses, and lichens (SNC, 2017). The soil is described as nutrient poor, resulting in low net production and low ground cover.

The surficial geology of the Mine Site consists of bare bedrock on steep slopes and a thin veneer of colluvium on less steep slopes. The recent deglaciation in this region is responsible for the steepened slopes and sparse vegetation, which promote physical weathering patterns such as frost shatter and mass wasting, and a thin development of soil (Appendices 9-A and 9-B). Soils, if present, are classified as Regosolic and are poorly developed. See Volume 3, Chapter 15 (Vegetation and Ecosystems Effects Assessment) for more information.

5.1.5.4 Bromley Humps Ecology

Bromley Humps varies in elevation from 350 to 500 masl and is primarily within the Mountain Hemlock Biogeoclimatic zone. It is characterized by high snowfall and a short growing season (Appendices 9-A and 9-B). Bromley Humps is located below the treeline (treeline elevation is 900 masl) within a densely forested area. The forest consists of mountain hemlock, amabilis fir, and varying amounts of yellow cedar. Brunisolic and podzolic soils are more common at the elevation of Bromley Humps, especially on north- to northwestern aspects. There is an overall higher capacity for sustained vegetation growth within Bromley Humps as soil formations are available. See Volume 3, Chapter 15 (Vegetation and Ecosystems Effects Assessment) for more information.

5.1.5.5 Access Road Ecology

The Access Road follows Bitter Creek, from the intersection of Highway 37A at 115 masl to the proposed TMF at Bromley Humps at about 400 masl. Roosevelt Creek is a significant drainage occupying a hanging valley in the northeast portion of the watershed, while smaller watercourses frequently occur in deep gullies on the steep mountain slopes. The area is characterized by steep, wet slopes that contain frequent avalanche tracks. The north end of Bitter Creek valley contains coastal western hemlock (CWH) forests along the lower- and mid-slopes, including large areas of mid-slope mature and old forests. The mouth of Bitter Creek, as it drains into Bear River, is characterized by flat floodplain forests dominated by deciduous stands adjacent to the rivers and grading into mixed forests on higher, less active floodplains. Narrow fringes of floodplain forest extend up Bitter Creek, with most of the active creek floodplain area being highly scoured rock and gravel and occasional sparsely vegetated areas. Mountain Hemlock (MH) forests occupy a narrow, steep band above the CWH (around 700 masl) and replace the CWH at the valley bottom as elevation increases to the southeast of Roosevelt Creek. Parkland MH forests start around 900 masl and often contain old to very old forested stands before giving way to stunted Krummholz around 1,200 masl as the alpine zone begins.

As Bitter Creek climbs in elevation towards Bromley Glacier, lower slope forests begin to be replaced by early seral shrub communities where the soil development is limited and vegetation communities are in early stages of post-glaciation establishment. At the southern end of the valley, the MH transitions into sparse parkland communities with most the area dominated by recently de-glaciated morainal deposits along with colluvial slopes and barren alpine communities. Alpine communities are varied in the Bitter Creek watershed, where transitional areas above the parkland forests are often diverse and contain rich herb meadow slopes, subalpine fir (*Abies lasiocarpa*) Krummholz, and expanses of alpine heath intermixed with dwarf shrub tundra-like communities. Exposed higher elevations contain extensive sparsely vegetated communities and barren rock outcrops before giving way to glaciers and icefields.

Avalanche tracks are abundant in the watershed due to steep slopes and high snowfall. Avalanche communities are typically wet and rich and dominated by alder (*Alnus viridis* ssp. *crispa*) with lesser components of Devil's club (*Oplopanax horridus*) and various willows (*Salix* spp.). At upper elevations, the avalanche slopes contain lush herb meadows. The edge of avalanche tracks, as they pass through forested areas, often contain slide-maintained forested communities that are irregular, fragmented in extent, and contain a high percent of dead or damaged trees. See Volume 3, Chapter 15 (Vegetation and Ecosystems Effects Assessment) for more information.

5.1.6 Geochemical Characterization of Mine Materials

The geochemical characterization of mine materials at the proposed Project has been assessed to determine the metal leaching and acid rock drainage (ML/ARD) potential for waste rock, ore, talus, tailings, and construction rock. The assessment of the geochemical characterization of the Project has been completed based on acid-base accounting and laboratory-based kinetic data from a series of historical geochemical characterization programs and from an extensive site monitoring program spanning approximately 20 years (see Volume 7, Appendix 1-B). Operationally, waste rock and ore are classified as potentially acid rock generating (PAG).

The following sections present a summary of the geochemical characterization work completed to date, described in greater detail in Volume 7, Appendices 1-B, 1-K, and 1-L.

5.1.6.1 Waste Rock

Records indicate that the existing waste rock pile is PAG; however, compliance monitoring indicates that there is a substantial delay to the onset of acidic conditions in this material (Appendix 1-B). Approximately 90% of waste rock can be classified as PAG, with the remaining 10% classified as uncertain or non-PAG. The waste rock seepage from the Marc Zone waste rock pile has been monitored since 2003, and has resulted in a pH ranging from neutral to acidic (pH<6). Waste rock can be grouped into mudstone and volcanic rock, with mudstone waste rock having a lower buffering capacity.

Neutral seep water chemistry resulted in periodic elevated levels of cadmium, cobalt, nickel, and zinc. It was concluded that localized areas of acidic waste rock seepage may be evident, however the waste rock pile has an overall buffering capacity. The isolated areas of acidic conditions are thought to be responsible for the mobilization of cobalt and nickel. The presence of cadmium and zinc are inferred to be a result of sphalerite oxidation. Aluminum, copper, and iron levels correlate with lower pH conditions.

5.1.6.2 Ore

The ore geochemistry is very similar to the waste rock and is described as being analogous.

5.1.6.3 Tailings

A geochemical characterization program was undertaken on metallurgical tailings from the AV, JW, and Marc zones of the deposit (Volume 7, Appendix 1-K). Tailings samples from all zones are classified as PAG. Because tailings will be rapidly deposited in the TMF and the exposure time of the tailings to atmospheric conditions will be on the order of weeks, acid rock drainage (ARD) is not expected to develop during operations.

Elemental analysis indicates enrichment of silver, gold, arsenic, bismuth, cadmium, cobalt, copper, lead, sulphur, antimony, selenium, and zinc relative to ten times the crustal abundance for low- and high-calcium granite.

Humidity cell test work on the Marc zone tailings has been initiated. After 11 cycles, the leachate is neutral to alkaline and sulphate is starting to stabilize. Ongoing humidity cell test work will define the time frame to the onset of acidic conditions for the tailings and metal leaching, if present.

5.1.6.4 Talus Quarry

There is a deficit of backfill and, as such, talus in the vicinity of the Portals may be used as a potential backfill of the underground workings (Volume 7, Appendix 1-B). Approximately half of the talus samples tested were classified as PAG, with a third of the fine fraction being acidic (Appendix 1-B). The acidic conditions resulted in the leaching of cadmium, cobalt, copper, nickel, and zinc.

Specific local borrow sources, adjacent to the proposed road alignment, will provide the bulk of crushed rock and aggregate to build roads, laydown areas, provide concrete aggregate, and generally support construction. Only quarries with geochemically suitable materials will be utilized as sources of processed aggregate. Where feasible non-PAG waste rock will be used for construction material.

5.2 Applicable Legislation and Guidelines

5.2.1 Provincial Legislation

Provincial legislation governing mine closure in BC has been established to protect workers and the public through provisions for minimizing the health, safety, and environmental risks related to mining activities. Mine closure in BC is governed by the following legislation:

- *Mines Act* (1996);
- Health, Safety and Reclamation Code for Mines in British Columbia (BC MEM, 2008 and 2016) (the Code); and
- *Environmental Management Act* (EMA; 2003).

The *Mines Act* and the Code are administered by the BC Ministry of Energy and Mines (BC MEM).

The *Mines Act* and accompanying Code have been established to protect workers and the public through provisions for minimizing the health, safety, and environmental risks related to mining activities. Section 10 of the *Mines Act* and Part 10 of the Code require mining operations to carry out a program of environmental protection and reclamation to return areas disturbed by mining operations to pre-mining land use and capability. Applications for *Mines Act* permits must include detailed designs for all project components and phases of the Project life. Proposed mining projects require approval under the *Mines Act* as per Section 10 (10.1.2) of the Code (BC MEM, 2017).

The Code has recently been updated following a review of the Mount Polly dam failure and the implementation of seven recommendations from the Independent Expert Engineering Panel's investigation. The updates to the TMF portion of the Code include new design and operation criteria for TMFs, requiring water balance and water management plans for TMFs, and requiring mines with TMFs to establish Independent Tailings Review Boards.

The *Mines Act* permitting process, which for major mines is closely integrated with the EMA permitting process, includes geotechnical design and reclamation and closure plans. Applications are reviewed by either the relevant regional Mine Development Review Committee (MDRC) or project-specific Mine Review Committees (MRCs), led by the Major Mines Project Office (MMPO). EMA is administered by the British Columbia Ministry of Environment (BC MOE) and prescribes requirements for environmental assessment, monitoring, reporting, and mitigation measures for environmental protection. EMA regulates industrial, municipal, and hazardous waste discharges and pollution into the environment, while protecting public health and the environment. EMA enables the use of permits, regulations, and codes of practice to authorize discharges to the environment and subsequent enforcement options. Guidelines and objectives for water quality are developed under EMA.

The *Forest Practices Code of BC Act* governs the construction, operation, and deactivation of forestry roads. Details are provided in the associated Forest Road Engineering Guidebook (BC Ministry of Forests, 2002).

5.2.2 Federal Legislation

Federal legislation governing mine closure in Canada pertains to measures that are required to protect fish resources during closure activities. The *Fisheries Act* (1985) and the *Metal Mining Effluent Regulations* (MMER) (SOR/2002-222) enabled under the *Fisheries Act* provide requirements to prevent the introduction of deleterious substances into fish habitat. The MMER cease once a mine is deemed a "recognized closed mine" pursuant to section 32 of the *Fisheries Act*.

The Environmental Code of Practice for Metal Mines (Environment Canada, 2009), supported by the MMER (Minister of Justice, 2017) under the *Fisheries Act*, promotes recommended best practices to facilitate and encourage continual improvement in the environmental performance of mining facilities throughout the mine life cycle.

5.3 Closure Objectives

The overall objective for Closure and Reclamation is to produce a written strategy that will both comply with the necessary standards and will also be tailored specifically to providing a plan that will outline the reclamation strategy given the physiography of the Project. At a minimum, this approach will ensure that the Project area will be left in a condition that will limit any future liability to both the environment and people of BC.

Four broad closure objectives have been developed for this Project. They are as follows:

- Design the mine for closure;
- Achieve long-term physical stability;
- Achieve long-term chemical stability; and
- Consider future use and aesthetics.

Each of these is described below.

5.3.1 Objective 1: Design the Mine for Closure

This involves identifying the processes and forces that may act upon the mine components after mine closure and reclamation so that they can be factored into the design and operation of the Project. This includes adoption of the principles outlined as follows:

- Design and construct mine components in such a way that the reclamation objectives and closure criteria can be achieved;
- Determine mine reclamation costs as part of the closure planning process and provide adequate security to cover the cost of reclamation to ensure closure criteria can be met;
- Include reclamation planning in the development and operation of the mine. This planning will ensure that mine operating activities do not unnecessarily increase the amount of reclamation work or effectively compromise what might otherwise be promising reclamation activities;
- Incorporate progressive reclamation activities into operation of the mine; and
- Consult with federal, provincial, and regional regulators as well as with Nisga'a Lisims Government, local community members, and stakeholders to ensure that appropriate objectives, closure criteria, and activities are developed.

5.3.2 Objective 2: Achieve Physical Stability

Mine components that will remain after closure will be constructed or modified to be physically stable so as not to erode, subside, or move from its intended location under extreme natural events or disruptive forces to which it may be subjected after closure. The objective of physical stability is to reduce hazards to humans, wildlife, or the environment.

Achieving physical stability includes establishing the conditions post-closure that allow for natural revegetation, where local conditions support revegetation, so that the land returns to productive use by wildlife.

5.3.3 Objective 3: Achieve Chemical Stability

Mine design will ensure that all components, including wastes remaining after mine closure, will be chemically stable. Chemical constituents released from the mine components should not endanger the public, wildlife, or affect the environment. These constituents must not result in an inability to achieve the water quality objectives in the receiving environment and must not adversely affect long-term soil or air quality. If necessary, appropriate long-term management of potentially ARD/ML materials and any affected waters will be considered.

5.3.4 Objective 4: Consider Future Use and Aesthetics

The site will be compatible with the surrounding lands once reclamation activities have been completed. Consideration of future use and aesthetics involves the following elements:

- Naturally occurring biophysical conditions, including any physical hazards of the area (pre- and post-development);
- Characteristics of the surrounding landscape pre- and post-development;
- Level of ecological productivity and diversity prior to mine development and intended level of ecological productivity and diversity after closure;
- Local community values and culturally significant or unique attributes of the land; and
- Level and scale of environmental effect.

An important aspect of mine closure is the incorporation of community perspectives on closure. In the short term, community perspectives are expected to be gathered during the permitting phase through the public environmental review. Beyond the permitting phase, communities and workers will become more familiar with the Project through the Construction and Operation Phases, and will provide input into the Closure and Reclamation Phase through worker and community engagement as well as during formal closure planning reviews.

Table 5.3-1 presents closure objectives 2, 3, and 4 in relation to the reclamation standards in Part 10 of the Code along with how each of the reclamation standards will be met by the Project.

Table 5.3-1: Closure and Reclamation Objectives

Broad Closure Objectives	BC Reclamation Standard (Part 10 of the Code)	Project Implementation
Physical Stability	Ensure long-term physical stability to protect public safety and reduce erosion and downstream sedimentation.	
	Remaining structures, such as TMF, will be physically stable in the long-term, in accordance with Section 10.7.6 of the Code.	The TMF will be the only significant structure remaining at closure. It will be covered with a liner followed by a soil cover to shed water and will be designed to be physically stable in the long-term.
	All spillways will be designed by a professional engineer in accordance with the CDA Dam Safety Guidelines and installed prior to final abandonment of the TMF (Section 10.6.10).	The TMF will be drained at closure and become reclassified as a landform, not a dam. All spillways (including the final spillway on the TMF) will be designed by a professional engineer in accordance with CDA (2013) Dam Safety Guidelines.

Broad Closure Objectives	BC Reclamation Standard (Part 10 of the Code)	Project Implementation
	Monitoring [of physical stability] will be undertaken to demonstrate that reclamation and environmental protection objectives, including stability of structures, are being achieved (Section 10.7.21).	Inspections, such as dam safety surveys, crown pillar assessments, and mine hazard assessments will be completed during the Closure and Reclamation and Post-Closure Phases. Proposed closure and post-closure monitoring is described in Section 5.10.
Chemical Stability	Ensure long-term chemical stability to protect receiving waters and aquatic life.	
	Ensure long-term chemical stability of the tailings by achieving applicable water quality standards in the receiving environment (Section 10.7.20).	There will be a liner above and below the TMF. Effluent discharges will meet effluent discharge limits established by the Province and under the MMER. Downstream groundwater quality will be monitored into the Post-Closure Phase.
	Prediction will be completed on potential ML/ARD) materials (Section 10.1.16) to compile a material inventory of ML/ARD to be submitted to the chief inspector (10.5.7).	Ongoing geochemical testwork will be completed during operations, as described in the Material handling and ML/ARD Management Plan (see Chapter 29.15).
	ML/ARD material will be stored, segregated, and/or removed from the TMF to ensure chemical stability.	All waste rock will be treated as ML/ARD material. All surface storage will be temporary, with final disposal underground. Geochemical evaluations to date suggest that the onset to ML/ARD is several decades, as such there is limited risk of ML/ARD runoff associated with temporary surface storage.
Future Use & Aesthetics	Create a final landform compatible with the surrounding landscape and consistent with the agreed upon post-closure land use.	
	The endpoint for land capability at closure is either not less than the average that existed prior to mining (Section 10.7.5), or will be reclaimed to an end land use approved by the chief inspector (Section 10.7.4).	The land capability endpoints identified herein consider current ecological conditions as well as amenability to reclamation and potential post-closure land uses (Section 5.4).
	Lands (including the TMF) will be revegetated to a self-sustaining state using appropriate plant species (Section 10.7.7), and growth mediums used will satisfy land use, capability, and water quality objectives (Section 10.7.8).	The mine site is located within different ecozones, which means that revegetation and reclamation endpoints will vary with location.
	All machinery, equipment, and building superstructures will be removed, concrete foundations covered and revegetated, and scrap material disposed of in a manner acceptable to an inspector (Section 10.7.10).	All equipment and materials will be removed from site.

5.4 Reclamation Approaches

5.4.1 Soil Management Strategy

IDM has developed a variety of management plans that are relevant to the closure of the Mine Site. Specifically, the Terrain and Soil Management Plan (Chapter 29.23) and the Vegetation and Ecosystems Management Plan (Chapter 29.24) will be crucial documents to identify what is realistically achievable for soil salvage as well as revegetation at closure. Information from these management plans will be used to ensure that appropriate revegetation recommendations are made for reclamation to assist with the overall reclamation success.

Overburden removal will occur during the preparation of mining and construction activities. Topsoil will be stockpiled separately and used where possible in reclamation activities.

5.4.1.1 Soil Assessment

The Project is in a recently deglaciated environment that has highly variable soil development. The Bitter Creek watershed exhibits the typical characteristics of a valley that has undergone the effects of the Little Ice Age. Over 400 years of glacial advance and retreat has left much of the valley in a post and peri-glacial state, while mid-slopes are occupied by mature old growth forest and the associated well-developed Podzols and Brunisols. The Alpine areas around Roosevelt Creek also exhibit well developed Brunisols with enriched A-horizons. Areas of well-developed soil are indicative of areas not affected by the Little Ice Age. However, the clear majority of these areas are too steep for consideration for use as borrows or for salvage.

At high elevations (Mine Site), hillslopes tend to be composed of veneers of coarse colluvium or morainal material directly overtop of bedrock. Colluvium over bedrock is also common. In many areas, bedrock has been exposed through recent receding glaciers.

Table 5.4-1 presents the surficial material extent within the 960.7 hectare (ha) Project Footprint Study Area (PFSA). Areas that are likely to be associated with soil salvage and reclamation (within the PFSA) are dominated by colluvium, moraine, and fluvial deposits. Soils associated with these parent materials are almost exclusively Podzols, Brunisols, and Regosols. The soil order at any location is determined by the time since recession of the Bromley Glacier, climate (elevation), and disturbance (as well as certain in situ characteristics, such as texture and coarse fragment; however, these are generally of less importance for being determinant factors in young environments). As one moves up the valley, podzolic soils become absent, as they are a more “mature” soil, and Brunisols and Regosols become dominant. However, these soils are so young that they display little in surface tier development beyond some minor amounts of eluviation, illuviation, and oxidation. Organic matter enrichment can be noticeable in certain areas, such as solufluction lobes in the alpine and lower elevation alders stands, but most these sites are too steep for salvage considerations.

Table 5.4-1: Distribution of Surficial Material in the PFSA

Surficial Material (Map Code)	Area (ha)	Percent
Anthropogenic (A)	24.1	2.5
Bedrock (R)	96.5	10
Colluviated till (CG)	44	4.6
Colluvium (C)	361.2	37.6
Fluvial (F)	164.4	17.1
Glaciofluvial (FG)	41.4	4.2
Glaciolacustrine (LG)	6.9	0.7
Ice (I)	0	0
Moraine (M)	219.3	22.8
Not Classified (NC)	0	0
Organic (O)	0.5	0.1
Undifferentiated materials (U)	0	0
Water features – small (OW, PO, N)	2.3	0.2
Weathered bedrock (D)	0.2	0
Total	960.7	100

Detailed Soil Map Unit (SMU) types and soil salvage potential (SSP) ratings were developed for each SMU (Volume 8, Appendix 9-A: Ecosystems, Vegetation, Terrain, and Soils Baseline). A total of 22 SMUs were established in the PFSA, each having a significant interpretative difference from a soil management and reclamation perspective (Table 5.4-2). The SMU mapping provides a description of general characteristics and soil conditions (soil texture, drainage, soil nutrient, moisture regime, etc.) for each type of soil. Soil salvage potential mapping indicates areas that may or may not contain soils for reclamation activities. Soil mapping terminology are defined in the Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Forests and Range and BC Ministry of Environment, 2010) and the Canadian System of Soil Classification (Soil Classification Working Group, 1998).

Table 5.4-2: Area Extent of Each SMU in the PFSA

SMU	Area (ha)	Percent
1a	85.3	8.9
1b	24.3	2.5
1c	11.1	1.2
4	33.4	3.5

SMU	Area (ha)	Percent
4a	44.0	4.6
4b	13.0	1.4
4c	0.5	0.0
5	25.5	2.7
5a	29.5	3.1
6	122.5	12.8
6a	12.0	1.3
6b	73.2	7.6
6c	81.0	8.4
6d	60.1	6.3
6e	1.5	0.2
7a	20.8	2.2
7b	4.6	0.5
7c	0.2	0.0
7d	77.4	8.1
8	7.4	0.8
8a	71.6	7.4
8b	71.2	7.4
8c	9.9	1.0
A	21.1	2.2
I	16.9	1.8
RI	0.4	0.0
RO	42.4	4.4
Total	960.7	100.0

The six most common SMUs have the following characteristics.

- **SMU 6** (122.5 ha, 12.8% area; shallow till, colluvium, saprolite, often 30 to 50 cm to rock);
- **SMU 1a** (85.3 ha, 8.9% area, coarse till/colluvium blankets greater than 1 m, "average" mesic sites);
- **SMU 6c** (81.0 ha, 8.4% area, lower/toe slope position colluvium);

- **SMU 7d** (77.4 ha, 8.1% area, alpine-sub-alpine tundra with heather, sparse lichen/grass);
- **SMU 8a** (71.6 ha, 7.4% area, large inactive fluvial terraces); and
- **SMU 8b** (71.2 ha, 7.4% area, large active flowing creeks in the valley bottom, e.g., Bitter Creek).

Approximately 200 ha of the 960.7 ha PFSA will be utilized or lost because of the Project. This estimate considers roads, quarries, temporary stockpiles, borrow areas etc.

5.4.1.2 Trace Metal Uptake in Soils and Vegetation

The metals analyses determine current metal levels around proposed infrastructure as well as control sites outside of the expected zone of influence of project environmental effects. The interpretation of baseline data included comparing analytical results to the industrial guidelines provided for 19 metals by the Canadian Council of Ministers of the Environment (CCME 2007). Additional parameters, including pH, carbon, texture, $CaCO_3$ equivalence, and cation exchange capacity, were analyzed to provide information on potentially significant characteristics relative to reclamation suitability and soil management

This data is used to determine the base case of soil metals and the resulting potential for metals to be translocated into vegetation tissue.

Twenty-one samples were collected in 2016 from the 0 to 15 centimetre (cm) layer of soils considered to have some salvage value based upon visual assessment and topographical position. The results of the soil metal analysis indicate eight metals exceed the concentration criteria levels set for the most stringent land use, Agricultural Land Use (CCME), at least once:

- Arsenic (all 21 samples, maximum exceedance of 10×);
- Chromium (4 of 21 samples, maximum exceedance of 1.2×);
- Copper (14 of 21 samples, maximum exceedance of 3×);
- Molybdenum (10 of 21 samples, maximum exceedance of 7×);
- Nickel (4 of 21 samples, maximum exceedance of 1.1×);
- Selenium (17 of 21 samples, maximum exceedance 5×);
- Uranium (1 sample, maximum exceedance of slightly above 1×); and
- Zinc (1 sample, maximum exceedance of 1.2×).

Using the less stringent Industrial Land Use criteria (CCME), the list of metals of concern is decreased from eight to three, as follows:

- Arsenic (all samples, maximum exceedance of 10×) – same criteria as per Agricultural Use;
- Copper (4 of 21 samples, maximum exceedance of 2.1×); and
- Selenium (7 of 21 samples, maximum exceedance 1.6×).

Nine samples exhibit exceedance of industrial criteria for two or more metal species (seven are acidic soils, two are alkaline soils). Arsenic and selenium exceedance occurred across all soil reaction classes (acidic and alkaline). Copper exceedance of Industrial limits was only observed in the acidic soils.

Implications of the high baseline metals include possible avoidance of salvaging operations of high metal-containing soils identified above and to minimize, where possible, introducing elevated metal-containing soils to relatively pristine areas of the PFSA with normal levels of soil metals believed safe for the environment.

Elevated soil metal species appear generally similar to those noted for local geologic materials (waste rock, ore, and talus) as determined for static testing as part of ML/ARD investigations (Appendix 1-B). The key preliminary static testing findings, where metal enrichment is described as species that are found in concentrations that exceed ten times their average crustal abundance, include:

- Elevated element concentrations of As and Cu are found across all 13 rock, ore and waste rock units, as described by SRK (Hillside Porphyry 'HIp' and fragmented 'xHIp'; Mudstone interbedded 'MSI', Tuffs, bedded volcanoclastic 'TfB', Tuffs, fragmented volcanoclastic 'xTF', Contact breccias 'xTF-TfB', Fault Zone 'FZ', unknown/composite lithology 'N/A'and Talus 'N/A'); and

- Elevated Se concentrations are common to 8 of the 13 rock units (i.e., not in xHIp-ore/waste rock, MSI, xTF-TfB, FZ).

Other soil metals species of concern at more stringent criteria:

- Elevated soil Mo was often associated with elevated soil Cu, but unlike Cu, is more than 10× crustal concentrations in only 3 of the rock units (xTF ore/waste, and Talus);

- Elevated soil Cr and Ni are often found together and at relatively low levels; they are similarly companions in some rock units (5 of 13 units), though Cr is more common (9 of 13 rock units);

- Soil uranium concentration was found to be at criteria levels in only one soil sample (RW38) and similarly rare in rock units ('xTF waste rock only);

- Soil zinc concentration was found to be slightly elevated in only one soil sample (O12) and relatively common across rock units (10 of 13); and

- Silver was indicated to be high in all rock units but below the most stringent critical soil concentrations in all soil samples.

The results of soil metal analysis provide an indication of the metal species of concern for the Project. There were no samples from deep, un-weathered (non-bedrock) soil parent materials evaluated as part of the soil metal or ML/ARD programs. These materials may or may not be absent from the site where deep excavations or where other direct Project disturbances are anticipated. Thick overburden, if present, will be described in local geotechnical investigation programs.

5.4.1.3 Soil Salvage

During the construction of the TMF, Process Plant and other development areas (e.g., construction of pads, roads, pipelines), suitable soils and overburden will be salvaged and stockpiled for later reclamation activities. Soils and overburden suitable for salvage are materials that have the potential for establishing vegetation. Soils may be organics rich or are fine textured. Fine textured soils, if encountered, will be salvaged to provide a growth media during reclamation. Topsoil, if thick enough, will be salvaged separately to produce a local source of organically enriched materials. However, given the terrain and the minimal depth or soil and overburden this task will be difficult.

5.4.1.4 Soil Stockpiling

Soil salvaged during construction of the Project areas (namely the TMF and Process Plant) will be stockpiled (likely windrowed) at a location that will not be disturbed during the mine life. The salvaged soil will include the vegetation that was previously occupying the soil. The vegetation and soil will provide organic matter to the salvaged soil as well as a native seed bank which will promote growth once broadcasted during reclamation. Geosynthetic covers may be utilized on the soil stockpiles should erosion occur.

It is anticipated that recoverable soil will not be available for stockpiling at elevations above Bromley Humps.

5.4.2 Revegetation Strategy

A revegetation strategy has been developed in tandem with the Project's Vegetation and Ecosystems Management Plan (Chapter 29.24). The strategy considers the different climatic and soil conditions that are present between the Project area (Mine Site, Bromley Humps, and Access Road).

Reclamation is designed to facilitate passive vegetation establishment, whereby establishing a growth media that promotes the succession of a natural ecosystem establishments. The revegetation strategy is critical in the reclamation of the Project.

5.4.2.1 Mine Site

The Mine Site cirque is located at high elevation in an area that has been recently disturbed by glaciers, landslides, and avalanches. There is little soil development and vegetation is consequently sparse. As such, active revegetation will not be undertaken at this location.

At other, similar, high altitude locations that were not recently covered by glaciers, well established forests are noted to be present. Therefore, reclamation efforts will focus on ensuring that the Project-affected areas will be as capable in the long-term of reaching the same endpoints as adjacent areas not affected by the Project. This includes ensuring that materials placed over the Project footprint during reclamation are roughly equivalent to the local undisturbed soils such that these areas have an equivalent ecological trajectory.

5.4.2.2 Bromley Humps

As described in Section 5.1.1, the area surrounding Bromley Humps contains various soil covers as well as extents with little to no soil cover over bedrock. The soils that are present are low in nutrients, requiring special considerations for both stockpiling and for use in reclamation.

The seeds of native species will be collected when stripping vegetation during initial construction. The native seeds will be preserved for use during reclamation efforts. At closure, broadcast seeing of native species will be undertaken. Green alder and willow, also common to the area, can be used in revegetation to supplement the use of native species.

Due to the low nutrient content of the soils in this area, grasses will not be used to protect topsoil piles or as a nursery crop in initial revegetation efforts at closure, as the grasses will quickly deplete the available nutrients in the low nutrient soils present.

A monitoring plan for vegetation will be created and implemented to assess trace element uptake in soils and vegetation, which has implications for potential amplification within the food chain.

5.4.2.3 Access Road

The Access Road will be permanently deactivated in accordance with the Forest Practices Code of BC and the Forest Road Engineering Guidebook (BC Ministry of Forests, 2002). As such, the roadbed will not be scarified and revegetated.

There will be two quarries and two borrow areas located along the Access Road. These aggregate sources will be revegetated, applying the same strategies described for Bromley Humps. Namely:

- Collection of native seeds during initial stripping;
- Stockpiling topsoil for reclamation;
- Covering topsoil stockpiles with a geomembrane rather than a grass cover to present available nutrients; and
- Using stockpiled soil, native seeds and alder and willow to revegetate the sites.

Areas within the quarries and borrow areas with exposed rock will not be covered with soil and revegetated.

5.5 Continual Updates

Closure and Reclamation objectives will be revised or updated during the Operation Phase on a five-year frequency as per the Code (BC MEM, 2016b). Updates will include the following:

- Areas that have been successfully reclaimed;
- Areas that will need to be reclaimed over the following five-year period;
- Details regarding the soil and vegetation used for reclamation activities; and
- Updates to closure costs will be provided to reflect any change to the mine plan or adverse conditions encountered during the Operation Phase.

The following additional following reclamation reporting requirements are required under the Code:

- An Annual Reclamation Report will need to be issued by March 31 every year after the onset of Project construction;
- A Closure Management Manual is required prior to the end of the mine operations; and
- A Closure Management Manual Update is required every five years after closure and every subsequent 5-year period.

5.6 Permanent Closure and Reclamation

5.6.1 Decision to Close

Permanent mine closure will occur when either all mineable and economic mineral reserves have been exhausted or if other external forces over a sustained period result in the Project no longer being a viable economic operation.

An important consideration of permanent closure is the effect of mine closure on employees, contractors, suppliers, and the public. It is IDM's aim to plan for closure so that adequate notice (if possible, on the order of a year or more) can be given to employees and the public.

Permanent closure measures to be implemented for specific project components are described below.

5.6.2 Underground Mine Workings

The underground mine will include three mine openings:

- Ventilation Portal (1,870 masl);
- Upper Portal (existing portal) (1,861 masl); and
- Lower Portal (1,720 masl).

Mining will be conducted through two access portals (the Upper and Lower Portals) at the upper elevations of Red Mountain. The underground workings will be accessed through the Upper Portal for the first year and a half of operations and through the Lower Portal for the remainder of operations. Ore will be brought to surface using scoop trams and temporarily stockpiled adjacent to the operating portal before being transported to a ROM Stockpile next to the Process Plant.

Groundwater inflows to the mine will vary throughout a given year, with an estimated average groundwater inflow rate of 40 cubic metres per day (m^3/d), up to 110 m^3/d. Mine water will be managed through the Upper Portal until the Lower Portal has been developed, after which mine water will be pumped out of the Lower Portal.

As part of mining, the underground will be backfilled using unconsolidated waste rock in the secondary stopes and CRF in the primary stopes. Backfilling operations will consume all waste rock brought to surface as well as an existing historical waste rock pile and proposed quarried talus material.

The following final closure measures will be implemented at the completion of mining:

- Mobile equipment and hazardous materials (fuels, oils, and lubricants) will be removed from the underground; and

- Each of the three portals will be sealed with a hydrostatic plug.

Baseline water levels within the mine workings have been measured at a maximum of 1,875 masl in the summer months (Volume 8, Appendix 10-A), which is higher than the elevation of each of the portals. It will take an estimated 20 to 40 years for groundwater levels to reach near baseline levels in the underground workings (Appendix 10-A).

Water quality modelling (Volume 8, Appendix 14-B) indicates some metal leaching will occur, and under worst-case assumptions, post-closure groundwater quality will exceed the Authorized Limits of a Deleterious Substance for zinc presented in Schedule 4 of the MMER (Minister of Justice, 2017). The mine water is expected to be alkaline from both the CRF in the primary stopes and lime that will have been mixed with the talus quarry rock also used as backfill (Appendix 14-B).

The hydrostatic plugs will:

- Restrict the discharge of mine water from the underground workings;
- Prevent the infiltration of surface water into the underground workings;

- Allow the mine to passively flood to minimize development of ARD/ML; and
- Prevent unauthorized access.

Given groundwater elevations will reach seasonal maximums of at least 1,875 m, the head applied to the hydrostatic plug on the Lower Portal will be at least 145 m. The heads experienced by each plug in the upper portals will be much lower (5 m to 15 m).

A conceptual design for the hydrostatic plugs to be used to seal the portals is presented in Volume 7, Appendix 1-I (Feasibility Study Design Drawings). The plugs will be designed with consideration of the Canadian Dam Safety guidelines (Canadian Dam Association, 2013). The conceptual design involves concrete plugs that are keyed into the underground portal floors and secured to the tunnels with epoxy dowels. Grouting lines will be employed after plug installation to seal voids.

Post-closure monitoring of the plugs will be accomplished through the installation of instrumentation equipped with telemetry, for remote monitoring, as well as annual inspections by a qualified geotechnical engineer. An Emergency Preparedness and Response Plan (EPRP) will be developed that outlines contingency measures to be implemented should the hydrostatic plugs not perform as expected. During the next phase of design, a maintenance and rehabilitation schedule will be developed that considers maintenance and/or replacement of the plug over the long-term.

IDM considered the following alternatives to installing hydrostatic plugs in each of the portals:

- Not flooding the underground workings at closure;

- Installing a hydrostatic plug in the Lower Portal only; and

- Repositioning all portal locations at elevations above the maximum baseline groundwater elevation of 1,875 masl.

Flooding the underground workings at closure is the most viable option, as mine water exceeding MMER discharge limits would be discharged from the Lower Portal and report to Goldslide Creek. If flooding was not promoted, the underground would remain exposed to oxygen over the long-term, possibly inducing acid mine drainage and further metal leaching once the alkaline CRF has been exhausted.

Installing a hydrostatic plug in only the Lower Portal would result in seasonal discharges of mine water from both the Ventilation Portal (1,870 masl) and the Upper Portal (1,861 masl).

Flooding of the underground workings without the installation of a hydrostatic plug would require re-positioning the portals to a higher elevation than maximum groundwater elevation (1,875 masl). However, the Upper Portal (1,861 masl) already exists, and therefore even if mining was accomplished by re-positioning any new portals above the baseline groundwater elevation, mine water would discharge seasonally from the existing Upper Portal. This option was considered but deemed to significantly affect the economics of the Project thus it was negated early in design.

5.6.3 Tailings Management Facility

Closure and reclamation of the TMF will involve:

- Containing and isolating the tailings so that:
  - Runoff is chemically inert and suitable for discharge to local receiving waters; and
  - Seepage is reduced to negligible quantities.
- Converting the TMF into a landform that is physically stable in the long term and that is compatible with the land capability of the surrounding area.

Closure and rehabilitation activities will be undertaken consistent with the reclamation standards in Part 10 of the Code (BC MEM, 2016b).

The Project is located in a wet climate in which annual precipitation exceeds the annual evaporation. The TMF supernatant water will need to be removed after the Process Plant is decommissioned and prior to implementing closure measures.

The following reclamation activities will be completed during TMF closure:

- Prior to closure, tailings will be selectively deposited around the TMF to establish a final tailings beach that will facilitate surface water management and reclamation;
- Tailings supernatant will be removed and treated in the water treatment plant to meet effluent discharge limits prior to discharge to the environment;
- Tailings and reclaim delivery systems and all pipelines, structures, and equipment not required beyond mine closure will be dismantled and removed;
- A permanent spillway will be constructed by excavating a channel within the west side of the TMF between the North and South Embankments;
- A geomembrane liner will be installed over the TMF surface;
- A combined rock and soil cover will be placed over the liner that will shed runoff to the permanent spillway;
- Seepage collection pump-back systems will continue to operate and seepage treated until it is suitable for direct discharge, after which the seepage collection systems will be dismantled;
- All access roads, ponds, ditches, and borrow areas associated with the TMF that are not required beyond mine closure will be removed and the areas re-graded; and
- Disturbed areas will be revegetated consistent with the optimal strategy.

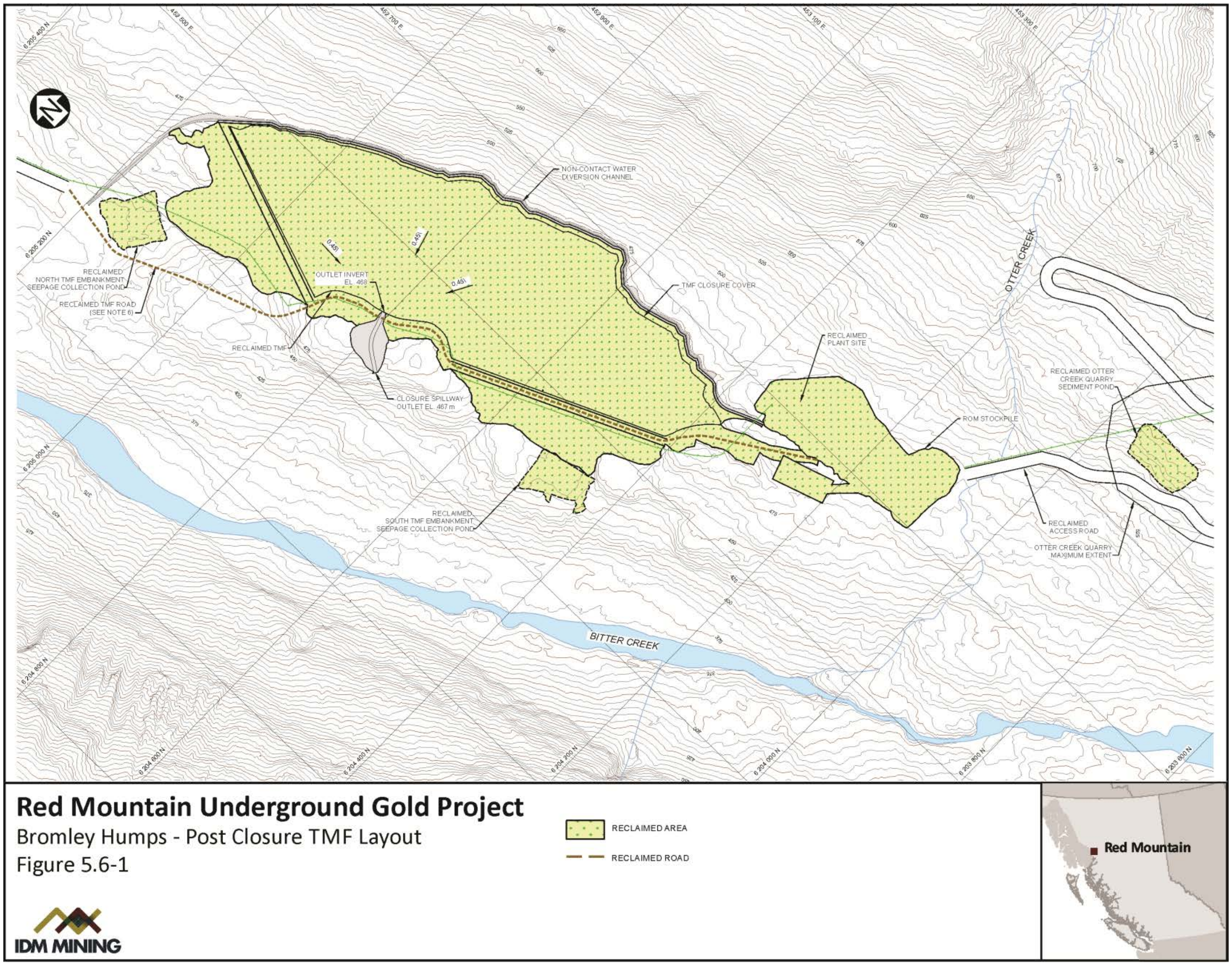
Figure 5.6-1 shows the post-closure layout of the TMF.

Embankment slopes will be constructed at 2H:1V, which are expected to be stable and therefore not requiring modification at closure other than surface preparation with topsoil and revegetation.

Reclamation of the TMF will be completed two years following the end of mining. The exception is the seepage collection system, which will operate for several additional years until seepage has diminished to negligible quantities and/or is suitable for direct discharge to the environment.

The groundwater monitoring wells and all other geotechnical instrumentation will be retained as long-term dam safety monitoring devices. Post-closure requirements will also include annual inspection of the former TMF and ongoing evaluation of water quality, flow rates, and instrumentation records to confirm design assumptions for closure.

Figure 5.6-1: Post-Closure TMF Layout



5.6.4 Waste Rock and Ore Stockpile Pads

After two years of mining, all waste rock stockpiled on the surface will have been used to produce CRF used to backfill the underground during mining. Therefore, there will be no waste rock storage areas to reclaim at final closure. Additionally, the temporary ore stockpiles outside of the Upper and Lower Portals, and the ROM Stockpile adjacent to the Process Plant will have been consumed.

In the event of unexpected final closure, any remaining waste rock and ore not processed will be placed underground.

Stockpile pads will be sampled at final closure, and, if the applicable soil quality criteria are exceeded, the pad material will be placed underground or covered. Stockpile areas will be re graded for long term physical stability.

5.6.5 Buildings and Equipment

The objectives in this document will be refined in the future to include an inventory of buildings and equipment expected to be on site at the end of the Operation Phase.

Temporary buildings may be dismantled for use elsewhere. Otherwise buildings will be demolished and the waste materials will be placed in the underground. Concrete foundations and slabs will be demolished to grade and covered with approximately 0.3 m of overburden. At all other development areas, the ground will be ripped to reduce compaction and enhance water infiltration and the areas re-graded to establish natural drainage. Final restoration will involve the application or soil covers and revegetation as prescribed in Section 5.4.

Stationary and mobile equipment with marketable value will be removed for salvage or resale. Any equipment that cannot be salvaged or sold will be decontaminated and recycled or sent off-site for disposal within a licensed landfill.

After removal of the Process Plant building, equipment, and foundations, a soil sampling program will be conducted to determine the presence of contaminants.

5.6.6 Roads

All Project roads will be permanently deactivated at the end of closure in accordance with the *Forest Practices Code of BC Act* and the associated Forest Road Engineering Guidebook (BC Ministry of Forests, 2002). The objectives and expectations of permanent deactivation are:

- Roads will no longer be used by the Project (all subsequent access to site will be by air);
- Roads will be placed in a self-maintaining state that will indefinitely protect adjacent receptors at risk; and
- The roads will not require any further inspections nor maintenance.

Bridges and culverts will be removed and natural drainage patterns will be restored. High-risk areas that are susceptible to erosion will be stabilized with rockfill or vegetation. Otherwise little will be done to the roadbed.

5.6.7 Aggregate Sources

Most aggregate source locations will have been progressively reclaimed prior to mine closure. The exceptions include the talus quarry at the Mine Site (used to backfill the underground mine) and the borrow area near Roosevelt Creek, which will be used for TMF embankment raises until the final raise in Year 5.

The following reclamation measures will be undertaken at rock quarries and borrow areas:

- Removal of the portable crusher and other equipment for salvage and/or resale;
- Inspection of quarry walls and borrow areas slopes by a qualified geotechnical engineer with adjustments made to ensure long term physical stability;
- Re-grading of any remaining aggregate stockpiles;
- Spreading of any salvaged topsoil; and
- Revegetation in accordance with the applicable reclamation approach described in Section 5.4.

5.6.8 Pipelines and Powerlines

Several pipelines will be used at site to convey:

- Tailings from the Process Plant to the TMF;
- Reclaim water from the TMF to the Process Plant;
- Potable water to administrative buildings;
- Make-up water and gland seal water to the Process Plant;
- Effluent discharge from the water treatment facility; and
- Seepage pumpback from the TMF seepage collection ponds.

Pipelines will first be drained. Then, buried pipelines will be capped and cut-off to a minimum of 1 m below ground level. Above ground pipelines will be removed for salvage, recycle, resale, or final disposal underground. Disturbed corridors will be regraded, covered with locally available topsoil, and revegetated.

Powerlines will deliver electricity across the site. Powerlines will be entirely removed or cut off at grade and removed and will be salvaged or placed underground.

5.6.9 Water Management Systems

Water management systems consist of:

- Ponds;
- Pipelines (addressed in Section 5.6.8); and
- Ditching.

Operation Phase ponds requiring decommissioning will include:

- North and South TMF Embankment Seepage Collection Ponds;
- Portal Collection Pond;
- Talus Quarry Sediment Ponds (2); and
- Quarry Sediment Ponds (4) at:
  - Otter Creek Quarry;
  - Roosevelt Borrow;
  - Hartley Gulch Borrow; and
  - Highway 37A Quarry.

The TMF Embankment Seepage Collection Ponds will continue to operate through closure and will be among the last components to be reclaimed. These and the other ponds will be decanted, liners (if any) removed and landfilled, and the berms re-graded and revegetated, if appropriate, in accordance with Section 5.4.

Site drainage ditches will also exist at various locations. This includes ditching around the Process Plant and ROM Stockpile that divert runoff to the TMF and a diversion ditch to redirect non-contact water around the TMF. Ditching will also exist at each of the quarries to direct runoff to the sediment ponds. Natural drainage will be restored at most locations. Drainage and diversion ditches at the TMF will be left in place as catchment water will continue to be discharged to Bitter Creek.

5.6.10 Chemicals and Explosives

Fuel tanks will be returned to the supplier or emptied and salvaged for resale. Any remaining fuel tanks will be emptied, steam cleaned, the rinseate collected and treated, and the tanks cut up for steel salvage or disposal in a licensed landfill.

Hazardous materials such as explosives, hydrocarbons, and hazardous chemicals will be inventoried and disposed of off-site prior to the mine closure. These materials will be sent back to the supplier or will be disposed of off-site by a licensed contractor.

5.6.11 Contaminated Site Investigation and Remediation

Areas that could be affected by contaminants, such as diesel, will be assessed during closure as part of an Environmental Site Assessment (ESA) undertaken in accordance with the BC Contaminated Sites Regulation. Any contaminated soils will be removed and disposed offsite by a licensed contractor. Confirmation testing will be completed at any remediated areas prior to restoring the areas.

5.6.12 Waste Management Sites

Mine operations will result in the production of solid waste in the form of plastics, wood, shipping and packing materials, and paper products. These waste products will be divided into recyclable materials and non-recyclable waste throughout the mine life. At closure, all remaining waste products will be transported to an approved local domestic waste facility.

Select insert bulky waste (pipelines, buildings) may be placed underground.

5.7 Temporary Mine Closure

Temporary closure occurs when mining ceases with the intent of resuming activities in the near future. The duration of temporary closure may last weeks or could extend to years. A temporary closure may be planned or unplanned and can arise from a variety of factors, including:

- Depressed precious metals prices;
- Major mechanical failure; or
- Environmental factors, such as an unintentional discharge to the environment.

A core team of site personnel will oversee care and maintenance activities. The objective is to maintain the site in a safe and physically and chemically stable condition so that mining can be re-started with limited reworking.

The following measures will be implemented during a temporary mine closure:

1. **Underground Mine**: All mine openings that are potentially dangerous will be protected against inadvertent access. This will consist of a temporary lockable closure, which will limit entry from inadvertent access. Pumping of groundwater (if necessary) and the collection of contact water will continue to be managed during temporary closure.

2. **Tailings Management Facility:** Since there is a surplus of precipitation at the site, it will be necessary to continue to operate water management facilities, including the TMF. When processing has ceased, water will accumulate in the TMF. Therefore, it may be necessary to treat and discharge effluent from the TMF during a protracted period of temporary closure.

3. **Waste Rock and Ore Stockpiles**: Regular stockpile inspections will be conducted to verify continued physically stability. Water management associated with the stockpiles (i.e., sediment ponds) will continue to function as during operations.

4. **Buildings and Equipment**: Buildings and equipment will be locked to prevent unwanted entry. Equipment will be placed in a state of zero energy consumption. Fluid levels and general condition of the equipment will be noted and routinely inspected for leaks or potential hazards.

5. **Access**: Roads will be maintained to enter the site during temporary closure.

6. **Aggregate Sources**: Any remaining quarries and borrow areas, not already reclaimed, will be monitored for geochemical and sediment and erosion control issues.

Environmental performance monitoring will continue during temporary closure.

5.8 Progressive Reclamation

Progressive reclamation measures will be implemented to the extent practical with the following objectives:

- Minimize physical safety concerns;
- Reduce environmental effects, such as erosion and sedimentation;
- Reduce environmental liabilities and the corresponding financial assurance requirements; and
- Provide learning that can be applied to final closure.

The following opportunities to undertake progressive reclamation have been identified based on the current mine plan:

- Decommission buildings and infrastructure associated with construction (temporary buildings, construction laydown areas);
- Stabilize roadways and overburden/topsoil stockpiles;
- Following the final embankment raise at the TMF in Year 5, the embankments can be stabilized and revegetated;
- In the final year of mining, tailings will be selectively deposited to establish final tailings beaches;
- Pads and sediment ponds associated with temporary waste rock and ore stockpiles at the Upper Portal can be reclaimed after mining at the Upper Portal is completed; and
- Quarries and borrow areas and associated sediment ponds can be reclaimed once no longer expected to be used.

Additionally, closure research programs and technical studies will be conducted through the Operation Phase of the Project.

5.9 Expected Conditions Post-Closure

The post-closure Project landscape is expected to be comparable to existing conditions with the addition of a permanent post-TMF landform, deactivated roads, and contoured development areas (revegetated, where feasible). The objective is to reestablish a landscape that will be physically and chemically stable in the long-term. Runoff from former facilities is expected to meet permitted water quality objectives.

Expected post-closure conditions are described below for major Project components.

5.9.1 Access Road

The Access Road will be permanently deactivated in accordance with BC Ministry of Forestry (2002) guidelines. Watercourse crossings will be removed and natural drainage conditions restored. The roadbed will remain a permanent indication of the former road.

5.9.2 Bromley Humps

Bromley Humps will consist of the TMF landform, final closure spillway, and the diversion ditch. All other infrastructure will have been removed. Similar to baseline conditions, where sufficient soil can support it, revegetation with alder and other native plants will have a re-established vegetation cover.

5.9.3 Mine Portals

Post-closure, the three sealed portals will be visible as well as evidence of prior disturbance due to infrastructure, stockpiles, and quarries. The signs of prior disturbance in this area will be less apparent given that the alpine area has been recently disturbed by glaciers, landslides, and avalanches. Final restoration efforts will have established a good ecological trajectory such that the land will naturally re-establish itself given enough time.

5.10 Monitoring

5.10.1 Overview

Monitoring is required under Section 10.7.30 of the Code to demonstrate that closure and reclamation objectives are successful. Post-closure monitoring helps to ensure that land use, productivity, water quality, and stability of the structures are achieved beyond the Closure and Reclamation Phase. Specific monitoring requirements will be confirmed as part of active permit conditions. Additionally, MMER and any water quality objectives detailed in permits will remain applicable until the Project is deemed a "recognized closed mine." The monitoring results will be summarized and provided in an annual reclamation report.

The Post-Closure Monitoring Program will consist of the following:

- Ensuring physical stability of mine hazards;
- Confirming chemical stability; and
- Biological monitoring.

Monitoring per permit conditions will be implemented throughout the Operation Phase and throughout the staged Closure and Reclamation Phase. The post-closure monitoring will be conducted for a period of approximately 10 years to ensure that the area remains both chemically and physically stable and that closure objectives have been achieved.

The following sections describe the anticipated monitoring requirements.

5.10.2 Physical Stability of Mine Hazards

This will include monitoring of the TMF, mine openings reviews, as well as any Project landforms (such as the drained TMF). The following plans will detail monitoring to be included during operations and at closure:

- Erosion and Sediment Control Plan (including available site-specific control measures);
- Tailings Management Plan;
- Terrain and Soil Management Plan; and
- Materials Handling and ML/ARD Management Plan.

The TMF will be monitored both visually and through instrumentation data. The data will be used to monitor and assess embankment performance and to identify any conditions different to those assumed during design and analysis. Amendments to the ongoing designs and/or remediation work can be implemented to respond to the altered conditions, should the need arise. During the Closure and Reclamation Phase, monitoring will include an annual inspection of the TMF and an ongoing evaluation of water quality, flow rates, and instrumentation records to confirm design assumptions for closure.

At the Mine Site, the performance of the hydrostatic concrete plugs (i.e., within the lower portal) will be monitored to ensure that design specifications are met and groundwater discharge to the surface is prevented.

5.10.3 Chemical Stability

Chemical stability monitoring for mine effluent discharges and seepages (i.e., seepage collection from the TMF), local surface waters, groundwater near to the TMF, stockpiles, and mine portals are detailed in the Chapter 29 management and monitoring plans. Monitoring under these plans will continue into the Closure and Reclamation and Post-Closure Phases until consistent monitoring demonstrates that the site will be chemically stable in the long-term. This includes final environmental effects monitoring studies in accordance with water quality objectives needed to obtain status as a recognized closed mine from Environment Canada.

Section 32 of the MMER (2002) details the requirements for becoming a “Recognized Closed Mine” as follows (paraphrased):

> *“An owner or operator who intends to close a mine shall provide written notice of that intention to the authorization officer and shall maintain the mine’s rate of production at less than 10% of its design rated capacity for a continuous period of three years starting on the day that the written notice is received by the authorization officer. A biological monitoring study during the three-year period referred to in paragraph (b) in accordance with*

> *Division 3 of Part 2 of Schedule 5 must also be completed. If the owner or operator has complied with all the requirements set out described above, the mine becomes a recognized closed mine after the expiry of the three-year period. The owner or operator shall notify the authorization officer in writing at least 60 days before reopening the recognized closed mine. The owner or operator referred to in this section shall keep at any place in Canada all records, books of account or other documents required by these Regulations for a period of not less than five years beginning on the day they are made, and shall notify the authorization officer in writing of their location."*

Environmental monitoring outlined above will reference the MMER (Schedule 4) until the mine obtains status as a "Recognized Closed Mine".

5.10.4 Biological Monitoring

Biological monitoring will track the success of vegetated covers for growth, quality, and long-term biological stability. Terrestrial and aquatic species will be assessed for post-closure function. The following plans will outline biological monitoring activities:

- Aquatic Effects Management and Response Plan;
- Wildlife Management and Monitoring Plan; and
- Vegetation and Ecosystems Management Plan.

5.10.5 Reclamation Research Studies

Aspects of Project closure requiring further study to refine ongoing objectives include:

- An assessment of the implications of elevated metals, such as arsenic in local soils, to inform the use of these materials for final reclamation;

- Approaches to best preserving or enhancing the low nutrient content of soils from Bromley Humps to be used in final reclamation;

- Verifying the quality of mine water from the underground over time with respect to the need to seal all three mine portals to eliminate the discharge of mine water post-closure;

- Conducting revegetation trials at aggregate sources along the Access Road (among the first Project components to be reclaimed) using native seeds, alder, and willow plantings; and

- An assessment of the stability of the crown pillar prior to final closure.

The results of these studies will be incorporated into future updates to Project closure documents.

5.11 Schedule

Mine closure will be scheduled to encompass:

- A five-year Closure and Reclamation Phase consisting of:
  - A period in which all infrastructure not required for post-closure monitoring will be decommissioned and the site prepared in accordance with proposed closure endpoints;
  - A period in which seepage will be collected from the TMF and treated until closure endpoints have been achieved; and
- A 10-year Post-Closure Phase in which scheduled monitoring will be conducted to ensure that the closure objectives of physical and chemical stability have been met.

During the first year of the Closure and Reclamation Phase, immediately at the cessation of production, the mine, equipment, and infrastructure will be decommissioned. Mine backfill and reclamation of mine rock storage facilities will have been mostly completed during the Operation Phase, however the final grading and reclamation will be complete at closure. Final reclamation of the TMF will be completed two years after cessation of mining. The Post-Closure Phase will consist mostly of site monitoring until the site is returned to a stable condition with no significant effect on the environment.

Post-closure monitoring will be conducted for a period of approximately 10 years to ensure the area remains both chemically and physically stable. However, post-closure monitoring will carry on until closure objectives have been achieved.

5.12 Closure Cost Estimate

Preliminary closure and reclamation costs have been developed based on information provided in the Project Feasibility Study (IDM 2017). The cost estimates (2017 C$) are based on a third-party contractor performing all works. More detailed costing will be developed as part of *Mines Act* permitting. The cost estimates will be regularly reviewed and updated throughout the life of the Project as required by the Code.

5.12.1 Decommissioning Costs

Closure cost estimates are provided for demolition and decommissioning activities as well as for closure-related infrastructure, such as the TMF closure spillway and bulkhead installation in the mine declines. Cost offsetting for equipment salvage value has not been incorporated in the estimates, except for the water treatment plants where the salvage value is expected to offset the decommissioning and removal costs.

The closure cost estimate for decommissioning considers the following infrastructure and activities:

- Removal of buildings from the portal area and demolition of the CRF plant and conveyors;
- Demolition and removal of the Process Plant, crushers, and ancillary buildings;
- Removal of fresh water pipelines, powerline, tailings discharge pipeline, and TMF reclaim water pipelines;
- Installation of portal plugs (3);
- Investigation of hydrocarbon-contaminated areas; and
- Removal/disposal of solid waste.

The closure cost estimate for decommissioning is $5.1 million.

Cost estimates have been developed for reclaiming all areas disturbed by the Project. The cost estimates represent total costs and do not factor in progressive reclamation that will partially offset liability at closure. Reclamation activities include removal of operational diversions and installation of closure diversions (e.g. TMF spillway channel), hauling and spreading of overburden soil, revegetation, and maintenance.

The reclamation cost estimate includes:

- Installation of the TMF closure spillway;
- Allowing for the dewatering/consolidation of tailings, hauling cover material, installing an HDPE liner, and revegetating the TMF dam and pond area;
- Re-grading and revegetating diversion ditches up-gradient of the TMF;
- Re-grading and revegetation of access corridor and footprints of all portal area infrastructure; and
- Re-grading and revegetation all borrow areas.

The reclamation cost estimate is $6.2 million.

5.12.2 Water Treatment Costs

Treatment of supernatant water from the TMF is expected to occur in the first year of active closure only. Treatment will be carried out using the same plants used during operations. Costs have been estimated using closure TMF discharge estimates and assuming that the plant will operate over a six-month period. The cost estimate includes reagents, shipping, power, maintenance, and labour. Water treatment costs are estimated to be $0.3 million.

5.12.3 Monitoring Costs

Monitoring costs have been estimated for reclamation, surface and groundwater, and geotechnical monitoring for dam safety review. The costs are based on assumptions for the number of monitoring sites, the frequency and length of monitoring, and average 2017 rates for sample collection and analytical and reporting cost. More frequent sampling will occur during the Closure and Reclamation Phase and less frequent sampling for a further five years in the Post-Closure Phase. The monitoring cost estimate is $0.3 million.

5.12.4 Indirect Costs

Indirect costs include project management and engineering estimated as 4% of the decommissioning/demolition and reclamation costs over the Closure and Reclamation Phase. These costs are estimated at $0.5 million.

5.12.5 Total Cost

The total estimated mine closure and reclamation cost is approximately $12.4 million.

5.13 References

BC Contaminated Sites Regulations (B.C. Reg. 375/96). O.C. 1480/96.

Canadian Environmental Protection Act, 1999 (S.C. 1999, c. 33).

Canadian Environmental Assessment Act, 2012 (S.C. 2012, c. 19, s. 52).

Environmental Assessment Act. SBC 2002, c. 43.

Environmental Management Act. SBC 2003, c. 53.

Explosives Act (R.S.C., 1985, c. E-17).

Forest Practices Code of BC Act (RSBC 1996, c.159).

Fisheries Act (R.S.C., 1985, c. F-14).

Heritage Conservation Act. RSBC 1996, c. 187.

Land Act. RSBC, 1996, c. 245.

Mines Act. RSBC, 1996, c. 293.

Metal Mining Effluent Regulations, SOR/2002-222.

Mines Act. RSBC, 1996, c. 293.

B.C. Ministry of Forests. 2002. *Forest Road Engineering Guidebook*. For. Prac. Br., B.C. Min. For., Victoria, B.C. Forest Practices Code of British Columbia Guidebook. Available at: http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/guidetoc.htm.

BC Ministry of Forests and Range and BC Ministry of Environment, 2010. Field Manual for Describing Terrestrial Ecosystems, 2nd edition. Land Management Handbook 25. Copyright: 2010 Province of British Columbia.

Canadian Dam Association, 2013. *Dam Safety Guidelines, 2007 (Revised 2013).*

Canadian Dam Association, 2014. *Technical Bulletin – Application of Dam Safety Guidelines to Mining Dams.*

Environment Canada. 2012. *Metal Mining Technical Guidance for Environmental Effects Monitoring*. https://www.ec.gc.ca/esee-eem/AEC7C481-D66F-4B9B-BA08-A5DC960CDE5E/COM-1434---Tec-Guide-for-Metal-Mining-Env-Effects-Monitoring_En_02[1].pdf.

Government of British Columbia. 2002. *Environmental Assessment Act*. SBC 2002. Chapter 43. Assented to May 30, 2002. http://www.bclaws.ca/Recon/document/ID/freeside/10_371_2002.

Government of British Columbia, Ministry of Energy, Mines, and Petroleum Resources, Mining and Minerals Division. 2008. *Health, Safety, and Reclamation Code for Mines in British Columbia*.

Government of British Columbia, Ministry of Energy, Mines, and Petroleum Resources, Mining and Minerals Division (BC MEM), 2016a. *Health, Safety, and Reclamation Code for Mines in British Columbia - Revisions to Part 10 Effective as of July 20, 2016*.

Government of British Columbia, Ministry of Energy and Mines, 2016b. *Guidance Document - Health, Safety and Reclamation Code for Mines in British Columbia, Version 1.0*. Updated July 2016.

Minister of Justice, 2017. Metal Mining Effluent Regulations. SOR/2002-222. Current to May 11, 2017 Last amended on June 22, 2016. Available at: http://laws-lois.justice.gc.ca.

Soil Classification Working Group, 1998. The Canadian System of Soil Classification, 3rd Ed. ISBN 0-660-17404-9. Copyright: National Research Council of Canada.