

29. Environmental Management and Monitoring Plans

29.1 INTRODUCTION TO ENVIRONMENTAL MANAGEMENT AND MONITORING PLANS

29.1.1 Context

The Application Information Requirements (AIR) for the Brucejack Gold Mine Project (the Project) refers to the need for Environmental Management Plans (EMPs) that are able to provide the proper measures and controls for mitigating the potential effects of the Project on both the biophysical and socio-economic environments. Chapter 28, Environmental Management System, describes the context within which EMPs are formulated, i.e., as a high-level supporting framework and policy point of departure.

This section describes the approach to the formulation of the EMPs for the Project, against the background of the over-arching environmental management objectives that Pretium Resources Inc. (Pretium) is committed to and as reflected in Chapter 28, Environmental Management System.

29.1.2 Principles of Environmental Management Planning

There are common elements to all EMPs and include the following:

- an environmental policy statement that provides statutory and corporate guidance throughout the project cycle;
- a clear indication of how the organization is structured and resourced to allow for the execution of the EMP;
- details of the measures specified for the management of particular environmental components or effects; and
- a system of recording performance and applying corrective action when necessary.

In the case of the Project, these principles have been interpreted in a purpose-designed manner and incorporated into a standardized planning approach and structure. The elements of the standardized EMPs for the Project are described individually in the next section.

29.1.3 Environmental Management Plans for the Brucejack Gold Mine Project

29.1.3.1 Structure

The EMPs compiled for the Project are structured according to the following elements.

Purpose

Under this heading, a general statement provides the purpose and scope of the management plan in minimizing the potential adverse residual effects of the Project on the particular component being addressed. General principles characteristic to the subject area are also described, if these are indeed relevant to the design of the particular plan.

Regulatory and Policy Framework

The relevant federal and provincial legislation, regulations, guidance documents, and best management practices that guide the development and implementation of the plan, are described.

Performance Objectives

A description is provided of the specific performance objectives aimed at achieving the purpose recorded above, together with any tangible outcomes of the monitoring activities described below.

Environmental Protection Measures

The environmental protection measures envisaged to reduce potentially adverse residual effects during relevant phases of the Project (i.e., Construction, Operation, Closure, and Post-closure) are described. These typically encompass various types of mitigation and are cross-referenced to other EMPs where the subject area is common to more than one EMP.

Monitoring Program

The monitoring program is described, including the parameters, frequency and means of implementation. This allows an evaluation against the performance objectives described earlier. Where applicable, monitoring programs are guided by regulatory requirements.

Work Planning and Schedule

A specified schedule of when the monitoring activities formulated in the previous section will occur is provided.

Follow-up Program (if Required)

Where there is uncertainty associated with a significance evaluation or mitigation technique for a particular environmental component or effect, a follow-up program may be required.

Reporting Requirements

Voluntary, compliance, and follow-up reporting requirements are described. Importantly, the responsible authority to whom a particular report is submitted is identified, as summarized in Table 29.22-1.

29.1.3.2 Responsibilities

Pretivm's Environmental Policy (Pretivm 2013e) provides a point of departure for defining the responsibilities for the successful execution of the Project's environmental management and monitoring plans. Pretivm will appoint an Environmental Manager who will be responsible for all matters related to environmental management of the Project. The Environmental Manager will provide line-function accountability to Pretivm's executive management and staff-function accountability to the Mine Manager, to whom compliance reports will be submitted. The Environmental Manager and his/her support personnel will work in collaboration with the Project's health and safety personnel, in the interests of integration and functional efficiency.

The Mine Manager will carry line-function accountability for the Project's environmental performance, with the support and advice of the Environmental Manager, which will include planning, oversight, monitoring and reporting. Environmental management tasks will typically comprise undertaking regular inspections, recording and reporting on inspection findings, initiating corrective actions for non-compliance, and maintaining an acceptable level of training and awareness among personnel.

The Project's Environmental Manager will be supported by Pretivm personnel assigned to defined tasks as required. In this way, a system of support and monitoring of environmental performance as carried out at the workplace can be provided. Contractors appointed to undertake aspects of the Project will also be required to meet prescribed environmental performance standards and to this end will be expected to provide personnel with defined environmental responsibilities.

29.1.3.3 *Subject Area Environmental Management Plans*

The subject area EMPs that are called for by the AIR for the Project are encompassed by the following list of stand-alone plans:

- Air Quality Management Plan;
- Aquatic Effects Monitoring Plan;
- Avalanche Management Plan;
- Ecosystem Management Plan;
- Emergency Response Plan;
- Hazardous Materials Management Plan;
- Heritage Management Plan;
- Invasive Plants Management Plan
- ML/ARD Management Plan;
- Noise Management Plan;
- Rare Plant Management Plan;
- Soil Management Plan;
- Spill Prevention and Response Plan;
- Tailings Management Plan;
- Waste Management Plan;
- Waste Rock Management Plan;
- Water Management Plan;
- Wetlands Monitoring Plan; and
- Wildlife Management and Monitoring Plan.

This suite of subject area EMPs is presented in Section 29.2 to Section 29.21.

The detailed permitting requirements that will follow the Application for an Environmental Assessment Certificate / Environmental Impact Statement (Application/EIS) submission and the issuing of an Environmental Assessment Certificate (if such a certificate is issued) will allow for properly specified EMPs, beginning with a Construction EMP before commencement of the Project is allowed. Obligations defined in the current high-level framework EMPs will be further developed into Standard Operating Procedures at that time.

29.2 AIR QUALITY MANAGEMENT PLAN

29.2.1 Purpose

The purpose of the Air Quality Management Plan is to outline:

- the legislation and standards relevant to air emissions associated with the Project;
- the legislative context for mitigating greenhouse gas (GHG) emissions in British Columbia (BC);

- o the main emission mitigation methods that Pretivm will implement; and
- o the continual assessment, monitoring, and reporting of emissions that will take place throughout the Project life.

29.2.2 Regulatory and Policy Framework

The federal government has set National Ambient Air Quality Objectives (NAAQOs) and Canada-wide Standards (CWSs) under the *Canadian Environmental Protection Act* (1999). CWSs are intended to be achievable targets that will reduce health and environmental risks within a specific timeframe, whereas NAAQOs identify benchmark levels of protection for people and the environment. The new Canadian Ambient Air Quality Standards (CAAQS) were adopted in 2013 and will be effective from 2015 and 2020, and will supersede the CWSs. In addition, BC has also developed air quality objectives for a number of contaminants.

The applicable standards relating to the Project include:

- o National Ambient Air Quality Objectives (NAAQOs; CCME 1999);
- o Canada-wide Standards (CWS; CCME 2000);
- o Canadian Ambient Air Quality Standards (CAAQS; CCME 2013c) and
- o BC Air Quality Objectives and Standards (BC MOE 2009).

Table 29.2-1 summarizes the federal and provincial ambient air quality criteria.

Table 29.2-1. Federal and Provincial Ambient Air Quality Criteria

Pollutant	Averaging Time	Concentrations (µg/m ³)					
		Canada			BC Objective		
		Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Level A	Level B	Level C
SO ₂	1-hour	450	900	-	450	900	900-1,300
	24-hour	150	300	800	160	260	260
	Annual	30	60	-	25	50	80
NO ₂	1-hour	-	400	1,000	-	-	-
	24-hour	-	200	300	-	-	-
	Annual	60	100	-	-	-	-
CO	1-hour	15,000	35,000	-	14,300	28,000	35,000
	8-hour	6,000	15,000	20,000	5,500	11,000	14,300
TSP	24-hour	-	120	400	150	200	260
	Annual	60	70	-	60	70	75
PM ₁₀	24-hour	-	-	-	-	50	-
PM _{2.5}	24-hour	30 ^a , 28 ^b (2015) and 27 ^b (2020)			25 ^c		
	Annual	10 ^b (2015) and 8.8 ^b (2020)			8 ^d		

Notes: (-) dash indicates not applicable

^a Annual 98th percentile value, averaged over three consecutive years. Canada-wide standard published by CCME.

^b CAAQS adopted in 2013 and will be in effect from 2015 and 2020.

^c Based on annual 98th percentile value.

^d BC objective of 8 µg/m³ and planning goal of 6 µg/m³ was established in 2009.

In addition to the objectives and standards for criteria air contaminants (CACs), BC also has an objective for dustfall levels. The *Pollution Control Objectives for the Mining, Smelting, and Related Industries of British Columbia* (BC MOE 1979) was developed with the goal of protecting the quality of BC's environment. The ambient air control objective for dustfall is defined to be between 1.7 mg/dm²/day to 2.9 mg/dm²/day, averaged over 30 days.

International agreements and North American national legislation with clear and enforceable GHG mitigation targets at the project level have yet to be determined. However, provincial and national development of such legislation is underway as described in the section below. Legislation, policy, and initiatives to address climate change adaptation are also being developed (CEA Agency 2003; IPCC 2007; BC MOE 2010b), but there is some regulatory uncertainty as to what legislation will apply during the Project life due to changes in political influences. In BC, carbon management and markets fall under both regulatory and voluntary domains, therefore organizations can implement carbon management strategies under several voluntary third-party programs that additionally promote best practices in the monitoring, reduction, and transparent reporting of GHG emission inventories.

The main pieces of legislation pertaining to carbon management for major projects in BC, including taxation and market mechanisms, are listed in Table 29.2-2.

Table 29.2-2. GHG Emission Legislation and Initiatives

Name	Year	Type	Level of Government	Description
Copenhagen Accord	2009	Agreement	International	Canada signed to a GHG ¹ emissions target of 17% reduction from 2005 levels by 2020; national regulations, under the Clean Air Regulatory Agenda (below), are shaped to meet this target.
<i>Canadian Environmental Protection Act</i>	1999	Act	National	Act respecting pollution prevention and the protection of the environment and human health to contribute to sustainable development that provides authority for the collection of GHG emission data nationally by Statistics Canada and Environment Canada.
Clean Air Regulatory Agenda	2006	Agenda	National	Established in 2006 and administered by Environment Canada, this agenda supports national efforts to reduce GHG and other air pollutant emissions. Transport sector emissions regulations fall under this agenda.
<i>Federal Sustainable Development Act</i>	2008	Act	National	Purpose is to provide legal framework for a Federal Sustainable Development Strategy which has Climate Change as its Goal 1, to make environmental decision-making more transparent and accountable.
Federal Sustainable Development Strategy	2008	Strategy	National	Goal 1 of the Federal Sustainable Development Strategy is climate change, to "reduce greenhouse gas emission levels to mitigate the severity and unavoidable impacts of climate change."
On-road Vehicle and Engine Emission Regulations	2002	Regulation	National	This and newer regulations under the authority of the <i>Canadian Environmental Protection Act</i> (1999) and Clean Air Regulatory Agenda regulate the reduction of vehicle emissions and establish emission standards.
BC Climate Action Plan	2007	Plan	Provincial	Action plan under which provincial acts regulating emissions are being created to achieve specific targets, such as 33% GHG reduction by 2020 compared to 2007 levels.

(continued)

Table 29.2-2. GHG Emission Legislation and Initiatives (completed)

Name	Year	Type	Level of Government	Description
BC Air Action Plan	2008	Plan	Provincial	Comprises 28 actions that promote clean transportation and clean industry, including emissions reductions.
Carbon Tax	2007	Tax	Provincial	Revenue-neutral tax to incentivize emissions reductions.
<i>Greenhouse Gas Reduction (Cap and Trade) Act</i>	2008	Act	Provincial	Legislation to authorize hard caps on GHG emissions. Reporting underway, but caps currently being negotiated.
<i>GHG Reduction (Vehicle Emissions Standards) Act</i>	2008	Act	Provincial	Will increase automobile fuel efficiency thereby reducing transport sector GHG emissions.
<i>Zero Net Deforestation Act</i>	2010	Act	Provincial	Sets reporting on net deforestation to start in 2012 and achieve net zero deforestation by 2015.
Greenhouse Gas Reporting Regulation	2010	Regulation	Provincial	Under the <i>GHG Reduction Act</i> , sets out GHG reporting requirements for facilities emitting 10,000 t/year CO ₂ e or more.
Part 6 - Clean Air Provisions under BC <i>Environmental Management Act</i> (2003a)	2004	Provision	Provincial	Provides general authority to make regulations on fuel emissions and motor vehicle/engine and burning emissions.

Under the Copenhagen Accord in 2009, Canada signed on to reduce its total GHG emissions by 17% from 2005 levels by 2020, mirroring United States of America (USA) targets. To meet this national GHG reduction target, Canada has also begun to implement regulations under the *Canadian Environmental Protection Act* (1999) and the Clean Air Regulatory Agenda for energy suppliers (starting with coal) and the transport sector (for heavy- and light-duty vehicle manufacturers). To demonstrate its reductions, Canada reports national GHG emissions annually to the United Nations Framework Convention on Climate Change (UNFCCC).

Canada has set progressively more aggressive fuel efficiency targets for manufacturers through national transport regulations—in line with those in the USA—which will help to provide transport sector GHG emissions reductions in future years, and consequently provide transport-related GHG reductions for the Project from upstream sources. For instance, on November 27, 2012, new regulations for automobiles and light trucks manufactured between 2017 and 2025 were announced by the federal government, which mandate improvements to engine fuel efficiency such that by 2025, vehicles in this category will consume 50% less fuel and emit 50% less GHG emissions than similar 2008 models (Environment Canada 2012a). These proposed regulations will build on the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (SOR/2010-201) for vehicles manufactured between 2011 and 2016, which mandates that 2016 models have about 25% lower GHG emissions compared to similar 2008 models. The proposed Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulation will mandate manufactured emission reductions for heavy-duty vehicles, commence in 2014, and also help to lower transport-related emissions of the Project compared to current estimates (SOR/2013-24). The Regulations apply to manufacturing and importing new on-road heavy-duty vehicles of the 2014 and later model years. The Regulations include provisions that establish compliance flexibilities, which include a system for generating, banking, and trading emission credits, including additional credits for hybrid vehicles and electric vehicles. Moreover, the Regulations will include further flexibilities to use a phased-in approach for model year 2014 through 2016 tractors and vocational vehicles.

BC also has several provincial climate change regulations in place, often aligning targets and mechanisms with those in California. Through the BC Climate Action Plan (Government of BC 2008), the province has set more stringent targets—33% GHG emissions reductions by 2020, and 80% by 2050, compared to 2007 levels—than the national targets described above. BC currently also has a carbon tax, although the general *GHG Reduction (Cap and Trade) Act* (2008a) is currently slated to become the major legislative arm to regulate emissions in BC. The *GHG Reduction (Cap and Trade) Act* also enabled BC to be the first Canadian province to join the regional (USA and Canada) Western Climate Initiative in 2007, but BC has not yet implemented regulations through the Western Climate Initiative and still has the option to opt out prior to its slated implementation in 2015.

The *GHG Reduction (Vehicle Emissions Standards) Act* (2008b) is also slated to roll out in BC in the next few years, putting initial caps on transport emissions; however, this Act is not currently in force. These vehicle standards will cut GHG emissions by 30% relative to 2008 vehicle models, which is a reduction of 600,000 tonnes (t) of GHG emissions annually by 2016.

Regarding land-use change, in support of the Climate Action Plan, BC has enacted the *Zero Net Deforestation Act* (2010), targeting net zero deforestation for BC by December 31, 2015, starting with government reporting on deforestation in 2012. The objectives of this act are to achieve net zero deforestation without “undermining economic development,” and to use information and incentives to encourage voluntary action by industry to avoid and reduce deforestation and increase afforestation levels (BC MFML 2010).

29.2.3 Performance Objectives

The main source of emissions of the Project will be from diesel exhaust. Diesel emissions include carbon monoxide, nitrogen oxides, sulphur dioxide, particulate matter, and GHGs. Emissions will also be produced by the incineration of inorganic and organic wastes. Other than the diesel exhaust emissions, blasting, grading of the road, bulldozing, and road traffic will contribute to fugitive dust emissions.

The Air Quality Management Plan will establish measures to mitigate emissions from Project activities to meet air quality legislative requirements and to reduce the Project effects to reasonable levels. The objective of the plan is thus to mitigate and monitor emissions from Project activities. The targets are meant to avoid, control, and mitigate air pollutants.

In an effort to mitigate emissions during the various phases of the Project, Pretium is currently implementing, or will be implementing, the measures described in the next section.

29.2.4 Environmental Protection Measures

The protection measures envisaged to ensure proper management of air quality at the Project are described in this section.

29.2.4.1 Equipment and Vehicles

Equipment and vehicles used for the Project will be maintained on a regular basis. Regular inspection will be conducted and all parts showing signs of excessive wear that indicates near-term failure will be promptly replaced. Poorly maintained engines can use up to 50% more fuel (D. Cope Enterprises 2004). Studies have shown that 1995 model-year and older vehicles produce smog-causing pollutants at a rate up to 19 times greater than a new vehicle (Summerhill 2013).

29.2.4.2 *Generators and Incinerators*

The generators will be used during the construction period before the transmission line is completed. After the transmission line is in operation, the generators will only be used as backup. On-site generators and incinerators will burn fossil fuel. When fuel is burned, air pollutants will be released in the form of exhaust gases. The Off-Road Compression-Ignition Engine Emission Regulation (SOR/2005-32) limits the amount of emissions produced. Incinerators will comply with Canada-wide standards for dioxins and furans (CCME 2009) and the Canada-wide standard for mercury emissions (CCME 2010).

29.2.4.3 *Fugitive Dust from Ore Processing*

Crushing can be a significant source of dust emissions in the mining process if not properly mitigated. Crushing of low- and high-moisture ore produces significantly different amounts of particulate matter. Primary crushing of ore will take place underground to control fugitive dust emissions to the environment. The primarily crushed ore will be transported to the mill through the conveyor decline where ore will be further processed. The differential air velocity needs to be considered in the design. When the drift velocity and the conveyed material are moving in opposition, a reduced drift velocity is required. Given the planned conveyor speed of 1.0 m/second and the designed maximum velocity of 5.5 m/second, the velocity in the conveyor decline should be less than 4.5 m/second.

Other than increasing the moisture content of the ore, installation of baghouses is the most common mitigation method. Fabric filters generally collect particles with sizes ranging from submicron to several hundred microns in diameter at efficiencies in excess of 99% (US EPA 2002). Several baghouses will be installed along the crushing circuit to reduce fugitive dust emissions.

29.2.4.4 *Unpaved Roads*

Mitigation control for unpaved roads, described in Chapter 13, Section 2 of AP-42 (US EPA 2006), include vehicle restriction, surface improvement, and surface treatment. In the Project design, watering of the road to reach at least 2% moisture ratio has been included. Watering increases the moisture content that conglomerates particles and reduces the likelihood of them becoming re-suspended. The control efficiency associated with a 2% moisture ratio is 75% (US EPA 2006). The roadway will also be properly graded, compacted, and maintained in order to reduce the silt content.

29.2.5 **Monitoring Program**

The Project-specific meteorology monitoring program began in October 2009 with the commissioning of the Brucejack Lake meteorological station, was expanded with the commissioning of the Scott Creek station in July 2010, and Wildfire Creek station in August 2011. These meteorological stations were operated as part of the meteorology baseline monitoring program for the Project. There are four Environment Canada stations in the region that provide data for comparison (Brucejack Lake, Unuk River Eskay Creek, Bob Quinn AGS, and Stewart Airport stations). Information collected from these stations is documented in the meteorological baseline report for the Project in [Appendix 7-B](#).

Monitoring of meteorological data will continue through the Project life—including temperature, relative humidity, precipitation and snow depth, solar radiation, and barometric pressure. The positioning of stations in the area of the Project will shift as per regulatory reporting requirements and air quality, hydrological, climate change, safety, and other data needs change over the life of the Project.

The Project-specific air quality monitoring program that began in 2012 consists of dustfall monitoring of particulates, anions, cations, and total metals, and a passive air sampling system (PASS) for nitrogen dioxide, sulphur dioxide, and ozone. Each station monitors over consecutive 30-day periods during the

summer and early fall. The locations of the stations during Construction and Operation are likely to be slightly different than the baseline locations due to shifting areas of activity on site as the Project progresses.

The dustfall monitoring stations will collect particulates small enough to pass through a 1 mm screen and large enough to settle by virtue of their weight. This will require containers of a standard size and shape, which are partially filled with deionised water and algaecide to prevent the growth of algae in the canisters. Each dustfall monitoring station will consist of two canisters each surrounded by a wind screen and mounted on a 2-m pole. One of the containers will be analyzed in the laboratory for particulates (total, soluble, and insoluble) and anions (sulphate, nitrate, chloride, and ammonia) and the other for total metals and various cations. The algaecide in the deionized water in the dustfall containers will ensure that algae do not interfere with dustfall measurements. The windscreens around the sample containers will improve the dustfall collection efficiency and bird spikes will be used to minimize contaminants from bird faeces.

Dustfall monitoring will provide a 30-day average ground-level mass of deposited dust. These values will be compared to the relevant BC dustfall objectives stated in *The Pollution Control Objectives for the Mining, Smelting, and Related Industries of British Columbia* (BC MOE 1979). In addition, analysis of temporal trends will be undertaken to determine if there are any increasing trends in the measured concentrations with consideration to the time of year and meteorological conditions.

Results from the monitoring programs will be reviewed to determine if any trends are evident and if target criteria are being met. The need for any corrective actions to on-site emissions management or installation of additional control measures will be determined on a case-by-case basis.

The monitoring data will also be used to provide feedback to modify the dust management procedures incorporated at the site, if required. Measures described in the Air Quality Management Plan apply to all components for the life of the Project, unless otherwise indicated. This plan is designed to be adaptive, effective, and achievable in both the short- and long-term. Components of the Air Quality Management Plan may need to be revised over the life of the Project, based on regulatory changes and/or technological advances. Any modifications made to the overall Plan will be communicated to regulatory authorities where applicable.

29.2.6 Work Planning and Schedule

Monitoring of PASS and dustfall will be incorporated for the Project (Table 29.2-3). The method and procedure for the monitoring will be the same as monitoring during the pre-construction phase. The monitoring locations may shift depending on the distance to the operation locations and additional dustfall stations may be added in the future. Dustfall results will be compared to the *Pollution Control Objectives for the Mining, Smelting, and Related Industries of British Columbia* (BC MOE 1979) stipulation of 1.7 mg/dm²/day to 2.9 mg/dm²/day, averaged over 30 days. Results will be reported as described in Section 29.2.7 below.

Table 29.2-3. Monitoring Schedule

Monitoring	Phase		
	Baseline and Pre-Construction	Construction	Operation
PASS	Required.	Required.	Required.
Dustfall	Required.	Required.	Required.

29.2.7 Reporting Requirements

In support of Canada's GHG mitigation targets, since 2010, facilities emitting over 50,000 t of carbon dioxide equivalent (CO₂e¹) have been required to report emissions to Environment Canada for the *Greenhouse Gas Emissions Reporting Program* (Environment Canada 2010), under the jurisdiction of Section 46 of the *Canadian Environmental Protection Act* (1999). Data from the Reporting Program supplement those from the annual Report on Energy Supply-Demand in Canada compiled by Statistics Canada in national inventory reports (NIRs) to the UNFCCC (Environment Canada 2012b).

Since January 1, 2010, facilities in BC emitting over 10,000 t of CO₂e must report to the BC Ministry of Environment. Those emitting over 25,000 t CO₂e are required to have emissions verified by an independent and accredited third party under the BC Reporting Regulation (BC Reg. 272/2009) of the *Greenhouse Gas Reduction (Cap and Trade) Act* (2008a).

The above provincial and national reporting regulations only pertain to facility-level emissions, and so do not include land use change. If the Project facility-level GHG emissions surpass 50,000 t CO₂e/year, hence, triggering federal and provincial reporting requirements, Project GHG emissions will need to be assessed, verified, and reported. Project GHG emissions can be reported through the online one-window reporting system, which was introduced in 2010 to harmonize the needs of federal and provincial reporting, prevent duplication, and reduce the reporting burden on industry (BC MOE 2011).

Monitoring data will be stored and made available for review upon request. Air quality monitoring, including the occurrence of dust, will be carried out to establish the emissions associated with the site activities during operation monitoring, and summarized on a monthly basis with annual reporting. If adverse findings are evident from the monitoring a particular area or process, adaptive management policies will be implemented.

29.3 AQUATIC EFFECTS MONITORING PLAN

29.3.1 Purpose

The purpose of this plan is to describe the rationale, framework, strategy, and scope of the Aquatic Effects Monitoring Plan (AEMP) to be implemented during the Construction, Operation, Closure, and Post-closure phases of the proposed the Project. The AEMP will be established as a requirement of the permits and licences under which the proposed Project will operate (e.g., BC *Environmental Management Act* [EMA], MMR). The focus of this program will be to ensure regulatory compliance, monitor the effectiveness of mitigation measures, and to verify the predictions of the effects assessment. Spatially, the AEMP will focus on the mine site area and the discharge pathway along Brucejack Creek, downstream of Brucejack Lake.

This AEMP describes and presents the following components:

- applicable standards, guidelines, and regulations that will determine the monitoring components, study design, and sampling frequency;
- references to relevant proposed mitigation and management plans designed to protect and minimize potential effects on the aquatic environment from all Project activities in or near watercourses through all Project phases;

¹ The reporting threshold has decreased from 100,000 t of CO₂e in 2009.

- a conceptual outline of the program study design, including the incorporation of the Environment Effects Monitoring (EEM) program of the MMER (Environment Canada 2012b; SOR/2002-222); and
- the processes for reporting, including those under the MMER.

The AEMP targets the effluent discharge pathway along Brucejack Creek and the following Valued Components (VCs) as identified in the AIR (BC EAO 2014):

- surface water quality;
- surface water quantity; and
- aquatic resources (sediment quality, primary, and secondary producers).

Fish will not be considered as part of the AEMP as they have never been found in the Brucejack watershed or in Sulphurets Creek upstream of a 200-m cascade in Sulphurets Creek (Tripp 1987; Rescan 2010; BC MOE 2014). The cascade is an impassable upstream barrier for fish and is approximately 1.3 km upstream of the Unuk River confluence and approximately 21 km downstream of the Project. There are no Project activities predicted to affect fish and fish habitat (water quality, sediment quality and quantity, and aquatic resources) in lower Sulphurets Creek and the Unuk River downstream of the cascade (Sections 10.8, 13.6, 14.6).

29.3.2 Regulatory and Policy Framework

The AEMP will be designed to comply with existing regulations and follow the available guidelines and technical guidance documents provided by the government of British Columbia and the federal government. The main applicable regulations, guidelines, and guidance documents are outlined below.

29.3.2.1 *Applicable Regulations*

British Columbia Environmental Management Act

The AEMP will follow stipulations as per the Effluent Discharge Permit obtained for the Project under the BC EMA (2003a). The BC EMA provides the authorization framework to protect human health and the quality of water, land, and air in BC. Mines require authorization under the BC EMA to discharge mine-affected effluent to receiving waters, and are required to register effluent (or have it included in the mine effluent permit) from sewage treatment facilities. The BC EMA also specifies procedures for monitoring and analysis, and procedures or requirements respecting the handling, treatment, transportation, discharge, or storage of waste that the permit holder must fulfill.

Fisheries Act

The AEMP will follow stipulations under Section 36 of the federal *Fisheries Act* (1985c) per the MMER, which stipulate that mines are required to conduct environmental effects monitoring (EEM) if effluent discharge rates exceed 50 m³ per day and/or deleterious substances are discharged into any waterbody. Schedule 5 of the MMER outlines the requirements of EEM studies, including effluent and water quality monitoring (i.e., effluent characterization and toxicity testing) and biological monitoring studies (i.e., site characterization, fish populations, mercury levels in fish tissue, and benthic invertebrate communities). Biological surveys for fish population and health as well as fish usability are not included in the AEMP study design as waterbodies directly receiving tailings, waste rock, and along the proposed discharge pathway (i.e., Brucejack Lake and Brucejack Creek) are not fish bearing. The AEMP will follow all other relevant stipulations under Section 36 of the federal *Fisheries Act* as per the MMER.

Canadian Environmental Assessment Act, 2012

The AEMP will follow stipulations as per the *Canadian Environmental Assessment Act, 2012* (CEAA 2012; 2012). The CEAA 2012 requires that compliance monitoring and follow-up programs are implemented to verify predictions of the effects assessment, uncertainties identified in the assessment are addressed, proposed mitigation measures are working as intended, and to support the implementation of adaptive management measures to address previously unanticipated adverse environmental effects.

29.3.2.2 Guidelines

British Columbia and the Canadian Council of Ministers for the Environment (CCME) water and sediment quality guidelines for the protection of aquatic life (BC MOE 2014; CCME 2013a, 2013b) will be used to screen all water and sediment quality monitoring results. These guidelines are designed to be protective of all forms of aquatic life and all aspects of aquatic cycles, including the most sensitive species over the long term. Periphyton biomass will be screened against the BC water quality criteria for algae.

29.3.2.3 Guidance Documents

The following BC and federal guidance documents will be used to design the AEMP to ensure proper study design, sampling methods, analyses, and quality assurance and quality control measures:

- *British Columbia Field Sampling Manual* (Clark 2003);
- *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012b);
- *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012b);
- *Environmental Code of Practice for Metal Mines* (Environment Canada 2012a);
- *Policy for Metal Leaching and Acid Rock Drainage in British Columbia* (BC MEM and BC MELP 1998);
- *Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia* (Price and Errington 1998); and
- *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009).

29.3.3 Performance Objectives

The goal of the AEMP will be to eliminate or minimize potential adverse effects on the aquatic receiving environment, while systematically seeking to enhance positive effects. This goal will be achieved by meeting the following objectives:

1. Monitoring of the aquatic habitat along the proposed discharge flow pathway for potential Project effects with identified pathways (Sections 13.4.2, Identifying Potential Effects on Surface Water Quality; 14.4.3, Identifying Potential Effects on Aquatic Resources) of interaction between the Project and the aquatic environment.
2. Ensuring that aquatic monitoring occurs at the frequency and to the extent required by regulations such as the federal MMER/EEM program or by provincial discharge permits issued under the BC EMA.
3. Addressing requirements under the CEAA 2012 related to follow-up monitoring or information needs for risk adaptive management of Project effects on the aquatic environment by:
 - evaluating the accuracy of effects predictions from the effects assessment;

- assessing the effectiveness of mitigation measures; and
- identifying unforeseen Project effects and designing additional mitigation measures.

29.3.4 Environmental Protection Measures

Environmental protection measures describe the mitigation and management designs, structures, and processes applied by the Project to eliminate or minimize Project effects on the surrounding environment. Effects to the aquatic environment have the potential to occur through various pathways during the life of the Project, many of which overlap in terms of definition and scope. These effects include:

- discharges, including:
 - effluent release (water and sewage treatment plants);
 - discharge from Brucejack Lake (site of tailings and waste rock disposal);
- groundwater interactions and seepage;
- metal leaching and acid rock drainage (ML/ARD);
- erosion and sedimentation;
- spills of materials into the aquatic environment resulting from accidents or malfunctions;
- leaching of nitrogen residues generated from blasting; and
- atmospheric deposition.

The primary mitigation approach will be to minimize the number and magnitude of pathways (e.g., deposition of sediment by runoff) through which Project activities can adversely affect the aquatic environment during mine Construction, Operation, Closure, and Post-closure. The Project will employ design and alternatives analyses to minimize/avoid potential effects and will use relevant Best Management Practices (BMPs) to further mitigate or avoid residual effects on the aquatic environment. Details of mitigation and management strategies relevant to the AEMP are available in the following Application/EIS chapters:

- Chapter 7, Air Quality Predictive Study;
- Chapter 9, Hydrogeology Predictive Study;
- Chapter 10, Surface Water Hydrology Predictive Study;
- Chapter 11, Terrain and Soils Predictive Study;
- Chapter 13, Assessment of Potential Surface Water Quality Effects;
- Chapter 14, Assessment of Potential Aquatic Resources Effects;
- Chapter 15, Assessment of Potential Fish and Fish Habitat Effects; and
- Chapter 31, Accidents and Malfunctions.

Additional mitigation and management measures relevant to the AEMP are provided in the following environmental monitoring and management plans:

- Section 29.2, Air Quality Management Plan;
- Section 29.7, Hazardous Materials Management Plan;

- Section 29.10, ML/ARD Management Plan;
- Section 29.13, Soils Management Plan;
- Section 29.14, Spill Prevention and Response Plan;
- Section 29.15, Tailings Management Plan;
- Section 29.18, Waste Rock Management Plan;
- Section 29.19, Water Management Plan; and
- Section 29.20, Wetlands Monitoring Plan.

29.3.5 Aquatic Effects Monitoring Program

The purpose of the AEMP will be to evaluate if the Project is successfully avoiding and minimizing adverse effects to the aquatic environment. The AEMP will help determine if the stated performance and compliance objectives are being achieved, thus informing management if prescribed mitigation and management measures are meeting their objectives.

The AEMP will integrate the monitoring requirements of the BC EMA, the federal MMER and its EEM program, and CEAA 2012's follow-up monitoring program for efficiency and to ensure compliance. An initial AEMP will be developed in consultation with the Ministry of the Environment (BC MOE), Environment Canada, and First Nation groups, and will be treated as a 'living document' that will be re-evaluated based on annual findings and upgraded throughout the life of the Project. Spatially, the AEMP will focus on the mine site area and the discharge pathway along Brucejack Creek, downstream of Brucejack Lake. This area has no fish-bearing watercourses, and as such, fish populations will not be evaluated as part of the AEMP nor during the MMER reporting.

The following aquatic components will be considered in the AEMP:

- surface water quality;
- surface water quantity;
- sediment quality;
- primary producers (periphyton); and
- benthic invertebrates.

Features that will be included as part of the MMER/EEM program will include:

- effluent characterization;
- water quality monitoring;
- toxicity testing;
- biological monitoring (benthic invertebrates); and
- site characterization.

The AEMP will use baseline data previously collected in the area (see Rescan 2014a; Rescan 2014b) and at relevant reference sites and will compare these data to those collected when Project activities commence. Post-baseline sampling will begin early in the Construction phase and will continue throughout Operation, with the program being re-evaluated for the Closure and Post-closure phases. Specific MMER components (i.e., effluent toxicity and characterization) will only apply during periods

when discharge rates exceed 50 m³/day and/or the Project discharges deleterious substances as per Subsection 36(3) of the *Fisheries Act* (1985c). The monitoring schedule of each aquatic component will take into account the sampling frequencies and methodologies outlined in the MMER and the BC EMA as well as in the *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012b), the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012b), and the *British Columbia Field Sampling Manual* (Clark 2003). At a minimum, water quality will be collected quarterly at specified sites, with at least one month between samples as per MMER requirements. Biological and sediment quality samples will be collected annually in August as per the guidance documents above.

Sampling sites will be based on previous baseline sites and selected MMER and permit compliance sites and will be situated such that downstream gradient effects can be determined. Reference sites will be included in the sampling design and environmental effects analyses will take a ‘before-after-control-impact (BACI)’ approach according to *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012b). Specific environmental endpoints (e.g., water quality parameters concentrations, biological community abundance and diversity) will be subjected to BACI analyses, with relevant summary statistics calculated for each endpoint. All analyses will meet necessary statistical assumptions (adequate power, homogeneity of variances, etc.), and all data collection, compilation, analyses, and reporting will conform to proper quality assurance and quality control (QA/QC) requirements.

29.3.6 Work Planning, Scheduling, and Reporting

The planning and scheduling of the tasks required to undertake the monitoring address the key reporting requirements. Reporting of environmental monitoring data will be conducted in accordance with permits and approvals. Regulatory requirements are anticipated to entail formal annual reports, and disclosure of issues of non-conformance. Reporting on the results of the AEMP will be the responsibility of Pretium’s Environmental Manager for the Project, with delegation as appropriate to appropriate personnel. Consultants and contractors hired to implement aspects of the AEMP will be suitably qualified professionals.

Two types of reporting are required to fulfill regulatory requirements.

29.3.6.1 Annual Aquatic Effects Monitoring Program Report

An annual AEMP report will fulfill annual requirements under the BC EMA permit detailing the status of the aquatic environment, and any observed trends of the Project. This report will be produced each year throughout the Construction and Operation phases of the Project, as well as during Closure and Post-closure phases as determined at that time. The report will review the sampling frequencies, methodologies applied, and monitoring routines/schedules, and practices. The annual AEMP report will include the following:

- a description of Project activities during the monitoring interval;
- raw monitoring data obtained during the most recent reporting period;
- descriptions of the methods used for sample and data collection;
- a detailed evaluation of effects on the designated monitored parameters;
- results from the evaluation of effects, in text and figures;
- conclusions from the evaluation of effects;
- description of mitigation measures in place, and a discussion of their effectiveness; and

- identification of additional mitigation measures.

29.3.6.2 Reports under Metal Mining Effluent Regulation

MMER reporting will capture effluent quality and biological monitoring as specified in the relevant regulations per the EEM program. In particular, quarterly reporting of monitoring results will be required, after the initial monitoring study design is subjected to a six-month advanced submission period. The frequency of biological effects monitoring reporting may vary in response to trends that may emerge during the lifecycle of the Project. In general, reporting requirements include:

- Quarterly reporting of monitoring results for effluent/water quality and toxicity testing, within 45 days of the end of the quarter. The reporting of mass loadings will also be included in the reports. If no effluent is discharged during a quarter then the report will consist of a statement to that effect.
- Submission of a first study design for biological effects monitoring, at least six months in advance of beginning studies. After the first study design submission, subsequent study design submissions will include a summary of the results from previous biological monitoring studies.
- Ongoing interpretative reports for biological effects monitoring, either on a 36-month cycle or a 72-month cycle, depending on whether significant project effects are identified and how many reports have been previously submitted.

29.3.7 Follow-up Program

Follow-up monitoring programs are mandatory under the CEAA 2012 for those projects requiring a comprehensive study (large projects with the potential for environmental effects). The follow-up program is designed to verify the accuracy of the predictions of the environmental assessment and determine the effectiveness of mitigation measures designed to reduce environmental effects. As part of the Project, the follow-up monitoring program will be integrated into the AEMP design to meet the objectives of the CEAA 2012 and other federal (e.g., MMER) and provincial (e.g., BC EMA) compliance requirements. This program will be accomplished through annual environmental effects analyses and the issuance of an annual AEMP report that will identify potential Project effects and facilitate adaptive management by determining when additional mitigation, monitoring, or reporting is necessary.

29.4 AVALANCHE MANAGEMENT PLAN

29.4.1 Purpose

The purpose of this Avalanche Management Plan for the Project is to minimize avalanche risk to mine personnel and facilities, while limiting disruption to mining activities throughout all phases of the Project. It also provides guidelines for the safe travel and work within the avalanche areas of the Project.

Pretivm commissioned Alpine Solutions Avalanche Services to develop an avalanche management safety plan. The initial version, *Brucejack Project: Preliminary Avalanche Hazard Management Plan for Mine Construction and Operations* (Alpine Solutions 2013a) was completed in August 2013. This version was revised and updated based on experiences gained during exploratory activities and other applicable guidelines for travel and work within avalanche areas. The *Brucejack Project Avalanche Safety Plan* (BJ-042, Mountain Safety Division, Soucie Construction Ltd. 2013b) was produced in December 2013. This plan will serve as the primary document in meeting the need for such controls on site. This section is largely developed from the Avalanche Safety Plan BJ-042.

29.4.2 Regulatory and Policy Framework

While not guided directly by regulatory or policy frameworks *per se*, recognition is given to the following guidelines and resources:

- Canadian Avalanche Association (CAA). 2002. Guidelines for Snow Avalanche Risk Determination and Mapping in Canada. McClung, D.M., Stethem, P. A. Schaerer, and J.B. Jamieson (eds.), Canadian Avalanche Association, 23 pp.
- Canadian Avalanche Association (CAA). 2006. Observational Guidelines and Recording Standards for Weather, Snowpack, and Avalanches.
- Canadian Avalanche Association (CAA). 2009. Recommended Generic Table of Contents - Active Avalanche Safety Plans. Canadian Avalanche Association (CAA). 2013 to 2014. Rescue Resource Directory. Avalanche Contact information directory updated annually by the CAA.
- Health, Safety, and Reclamation Code for Mines in British Columbia. <http://www.empr.gov.bc.ca/Mining/HealthandSafety/Documents/HSRC2008.pdf>
- Pretium Resources Inc. (Pretivm) 2013h. Procedures and Guidelines Glacier and Travel in Spring/Summer. Mine Site Procedure BJ-031.
- Pretium Resources Inc. (Pretivm) 2013f. Glacier Travel Guidelines Brucejack Camp.
- Soucie Construction Ltd. 2012. Avalanche Control Blasting Procedures.

29.4.3 Performance Objectives

Detailed examination of topography and natural features from available mapping and imagery resulted in identification of avalanche paths and hazard areas. These were confirmed by a ground-truthing reconnaissance in the field. There is the potential for Project infrastructure or access roads to be potentially affected in 36 locations by avalanche paths or hazard areas, and that many of these locations may be affected on an annual basis. The primary performance objective is to reduce the risks posed by the avalanche paths or hazards by applying risk management actions (location of structures, road alignments, controlled explosives, etc.), combined with purpose-designed safety awareness and training for personnel.

29.4.4 Environmental Protection Measures

The following is a synopsis of Section 5 (Equipment, Infrastructure Requirements), Section 6 (Training), and Section 9 (Emergency Response) of the Alpine Solutions plan (Alpine Solutions 2013a).

The Avalanche Division Manager will oversee all Mountain Safety personnel and is responsible for the scheduling, training, and coordination of the Mountain Safety Technicians (MST) who are working at various locations. They will also ensure that all documentation is completed appropriately and in a timely fashion, and that work is carried out according to approved plans and best practices to ensure a safe work environment. They monitor all logistics, planning, operations, and administration of the various avalanche safety programs. All incidents and near misses will be reported to the Mine and Health and Safety managers. An Avalanche Division Manager has oversight of two or three MSTs each stationed at Bowser and Brucejack camps.

MSTs will be responsible for avalanche forecasting by collecting and disseminating snow and avalanche information and issuing a daily (or scheduled) avalanche hazard assessment. They will collect and assess weather and climate data, conduct routine snow stability tests, and complete hazard reduction

work as required. They will have a direct liaison responsibility with the Mine Manager to fulfill training requirements, safety assessments, hazard reduction, and closures.

29.4.4.1 *Weather Monitoring*

The primary meteorological station for local forecasting of avalanche hazard is at Brucejack Lake (1,360 m UTM E425,729 N6,259,022 Zone 9 NAD83). Each of the meteorological stations consists of a standard 10-m meteorological tower with instrumentation to measure the following parameters:

- wind speed and wind direction;
- air temperature;
- barometric pressure;
- relative humidity;
- snow depth;
- net radiation;
- solar radiation; and
- precipitation (as rainfall and total precipitation).

In particular, precipitation, wind, air temperature, and solar radiation are critical parameters in forecasting avalanches. This data is streamed in real time to the Brucejack Camp to facilitate daily forecasting of the avalanche hazard.

29.4.4.2 *Communication*

The importance of VHF radio communication and its optimum use for remote areas are described. Satellite phones are mentioned as an alternative.

29.4.4.3 *Explosives*

The use of explosives to reduce road or worksite closures during periods of high avalanche hazard is described and the importance of an avalanche explosive control plan is emphasized. Worker safety, transportation, and storage are referred to in particular. Regulations, protocols, and standards relevant to the use of explosives are also listed (Alpine Solutions 2013a).

29.4.4.4 *Signage*

The optimum placement and recommended content of signage is described, covering avalanche hazard areas, road hazard areas, and rescue equipment cache location.

29.4.4.5 *Equipment for Avalanche Safety*

The use and testing of personal transceivers and the content and placement of avalanche rescue packs are described.

29.4.4.6 *Training*

The importance of awareness and training in avalanche safety and response is emphasized and the content and duration of the training sessions are described.

29.4.4.7 *Emergency Response*

A systematic approach to dealing with avalanche rescues is described, essentially comprising three plans, namely for immediate action by directly involved personnel, for the site rescue leader, and for base personnel, respectively. Samples of each of these plans are provided.

29.4.5 **Monitoring Program**

29.4.5.1 *Mapping*

Alpine Solutions have prepared preliminary avalanche maps for the Project (Alpine Solutions 2013b). While these may be further refined, they will serve as an initial reference for monitoring of avalanche conditions.

29.4.5.2 *Operational Checklist*

Monitoring of the AMP will be facilitated by the annual application of a pre-season task checklist that covers issues such as training, call-out lists, equipment, and new worksites.

29.4.6 **Work Planning and Schedule**

With reference to the previous sections, the frequency of monitoring will range from daily during periods of high avalanche hazard, weekly or monthly for weather monitoring stations, and annually for pre-season preparations.

29.4.7 **Reporting Requirements**

Routine reporting according to the monitoring and operational schedules described above and in the Avalanche Safety Plan BJ-042 (2013b) will be undertaken in a systematic manner. Of importance in defining reporting requirements, however, is to allocate responsibilities and the Avalanche Safety Plan BJ-042 (2013b) has done so in respect of an Avalanche Divisional Manager (professional member of the CAA), dedicated Mountain Safety Technicians (also professional members of the CAA), primary care paramedics, and equipment operators.

29.5 **ECOSYSTEM MANAGEMENT PLAN**

29.5.1 **Purpose**

The purpose of this Ecosystem Management Plan is to avoid and minimize adverse effects to ecosystem functions resulting from the Construction, Operation, Closure, and Post-closure activities of the Project. This plan provides strategies and mitigation measures for the ongoing management of terrestrial and wetland ecosystems, and is based on the guiding principles outlined in the Cassiar Iskut-Stikine Land and Resource Management Plan (CIS LRMP; BC ILMB 2000) and the Nass South Sustainable Resource Management Plan (SRMP; BC MFLNRO 2012).

29.5.2 **Regulatory and Policy Framework**

The following legislation, guidelines, operational statements, and governing agencies are applicable or of relevance to the management of vegetation, soils, and ecosystems:

- *Forest and Range Practices Act*, (2002b), Forest Planning and Practices Regulation (BC Reg. 14/2004) Section 47-52. This act and regulation applies constraints to when, where, and how forest clearing is undertaken (for forest and range licensees) and applies protection to old forests (through establishment of old-growth management areas; OGMAs) and to riparian

ecosystems (through Division 3, Riparian Areas, of the Forest Planning and Practices Regulation). The riparian reserve and management zones are consistent with those previously established under the 1996 *BC Forest Practices Code of British Columbia Act*, (1996d; e.g., Riparian Management Area Guidebook);

- *Fisheries Act*, (1985c). This federal act protects fish and fish habitat across Canada; Subsection 35(1) states that, “No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat;”
- *Operational Statement: Maintenance of Riparian Vegetation in Existing Rights of Way* (DFO 2010). This statement, applicable to freshwater systems within BC and the Yukon Territory, applies only to existing rights-of-way at the location where they intersect and cross a waterbody. It outlines measures to protect fish and fish habitat when maintaining riparian vegetation to ensure compliance with the *Fisheries Act* (1985c);
- *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2006). This guidebook outlines pertinent legislation and development guidelines to protect environmentally valuable features and habitats;
- BC Conservation Data Centre (BC CDC). This provincial agency, part of the Environmental Protection and Sustainability Division in the BC Ministry of Environment, collects and disseminates information on the plants, animals, and ecosystems at risk in BC; and
- *Windthrow Handbook for British Columbia Forests* (Stathers, Rollerson, and Mitchell 1994). This handbook is designed to provide an introduction to the subject of windthrow and to provide options for assessing hazards and management.

29.5.3 Performance Objectives

The goal of the Ecosystem Management Plan is to prevent and minimize adverse effects to ecosystem functions. The Ecosystem Management Plan is designed to provide environmentally responsible, realistic, and operationally feasible guidance for ecosystem, soils, and vegetation management. The Ecosystem Management Plan focuses on ecosystem-based management, which includes consideration of successional processes, such as disturbance type (e.g., fire, insects, avalanches), dispersal mechanisms (e.g., wind, water, animals), site history (e.g., flooding, erosion, fire), site competition (e.g., light, moisture), and germination conditions (e.g., time of year, weather, elevation, riparian versus non-riparian). The broad performance objectives of the ecosystem management plan are to:

- minimize soil loss and degradation (i.e., compaction, erosion, admixing) by adhering to the Soils Management Plan (Section 29.13);
- avoid the introduction and spread of invasive plants through ecology-based management of Project activities during all phases, by adhering to the Invasive Plants Management Plan (Section 29.9);
- avoid and minimize detrimental effects to rare plants and lichens, including rare plant and lichen habitat, by adhering to the Rare Plant and Lichen Management Plan (Section 29.12);
- avoid and minimize detrimental effects to wetland functionality through ecology-based management of Project activities during all phases, as prompted by the outcomes of the Wetlands Monitoring Plan (Section 29.20);
- avoid and minimize loss of ecosystem functions related to the Project effects specifically due to clearing activities, dust deposition, fragmentation, edge effects, windthrow, and altered hydrology; and

- restore ecosystem integrity at sites altered by Project activities upon Closure or cessation of such activities.

29.5.4 Environmental Protection Measures

An ecosystem-based approach to vegetation and soil management is required to effectively avoid and minimize loss of ecosystem functions related to the potential Project-related effects. Ecosystems are complex interactions of abiotic (e.g., soil parent material, climate, snow duration, recent glacial history, natural disturbance) and biotic components (e.g., wildlife, nitrogen-fixing bacteria, mycorrhizae, disease, pollination, humans, competition) that result in unique species composition, structure, and functions. Minimizing effects to these ecological processes will reduce the likelihood of short- and long-term effects to ecosystem function and ecosystem integrity.

Project activities will affect ecosystem function and integrity. The following section outlines ways in which to reduce impacts to ecological processes that maintain ecosystems. The effects of the Project on ecosystem function and integrity will be minimized through the actions listed below:

- minimize all clearing dimensions during Construction activities including the transmission line site preparation and tower installation, as well as upgrades to the exploration access road;
- ensure clearing activities are coordinated with other management plans including, but not limited to, the Wetlands Monitoring Plan (Section 29.20), the Air Quality Management Plan (Section 29.2), the Soils Management Plan (Section 29.13), the Aquatic Effects Monitoring Plan (Section 29.3), the Wildlife Management and Monitoring Plan (Section 29.21), and the Water Management Plan (Section 29.19);
- minimize soil degradation (i.e., erosion) by adhering to the Soils Management Plan (Section 29.13). Specifically, soil will be salvaged during appropriate weather conditions, transported to stockpiles in a timely manner, and establish erosion control structures to minimize erosion;
- avoid removal of mature and old forests, which provide multiple ecological functions, such as diverse wildlife habitat within close proximity and carbon storage;
- manage forests according to FRPA silviculture requirements;
- minimize environmental impacts to alpine, parkland, riparian habitats, wetlands/wetland complexes, lake outlets, and floodplains of rivers. Only consider exceptions to this management after assessing and weighing all implications (BC ILMB 2000);
- manage riparian areas according to the legislated reserve and/or management zone setbacks and work practices established under the FRPA, unless specifically indicated otherwise;
- reduce impacts to terrestrial ecosystems that depend on hydrological connectivity and flow through management based upon understanding of hydrology and how it affects ecosystem function. For example, water diversion structures will be engineered so that flow energy is not unsuitably altered;
- ensure all vehicles and machinery restrict travel to designated road surfaces;
- avoid and/or reduce windthrow according to best management practices through retaining windfirm trees, feathering edges, topping/pruning of individual trees, and monitoring for windthrow along clearings and road edges;
- carry out dust suppression on roads to prevent fugitive dust from impacting ecosystems;
- re-establish vegetation cover during restoration;

- establish communication procedures between on-the-ground employees and environmental managers to facilitate timely reporting of any incident or concern during each phase of the Project. Construction personnel will be required to communicate any concerns including erosion and sediment production, windthrow, invasive plants, and unauthorized access to restricted areas; and
- provide appropriate education and training for employees and contractors outlining how to minimize effects on ecosystems, soils, and vegetation, and why it matters. This information will be prepared and made available to all employees on site in the form of fact sheets and/or handbooks.

29.5.5 Monitoring Program

The purpose of the monitoring program is to evaluate and document if the Ecosystem Management Plan is successfully avoiding and minimizing adverse effects to ecosystem functions resulting from interaction between the Project and the environment. Specifically, monitoring will help determine if the stated performance objectives are being achieved, thus informing management if prescribed actions are meeting objectives.

Monitoring will include consideration of successional processes, such as disturbance type (anthropogenic versus natural), site history (e.g., flooding, erosion, fire), site competition (for resources such as water, light, etc.), and germination conditions (e.g., time of year, weather, elevation, riparian versus non-riparian). Consideration of successional processes will help distinguish natural effects from Project-related effects.

Environmental personnel will be on site during Construction to ensure that the Ecosystem Management Plan is being implemented and that the targets and objectives are being met. If targets are being met but objectives are not, then adaptive management will be undertaken to evaluate the effectiveness of the targets.

Monitoring is intended to retain ecosystem integrity. Therefore, the on-site environmental monitor will consider assessing the following:

- clearing during Construction activities is minimized;
- measures employed to reduce impacts to terrestrial ecosystems and identification of successful initiatives and opportunities for improvement;
- success of re-vegetation efforts as recommended (i.e., appropriate timing and seed mix, percentage cover of live vegetation, presence of invasive plants, etc.);
- assessment of windthrow reduction, including number and species of windthrown trees, approximate area affected, as well as adaptation methods for the proposed clearing of subsequent areas if required; and
- success of silviculture methods in areas where the end target of reclamation is forested ecosystems.

29.5.6 Work Planning and Schedule

The Environmental Manager (or designated qualified staff) will disseminate the performance objectives and actions with all Project personnel that have the potential to directly or indirectly influence vegetation, soils, or ecosystems on site during the Construction, Operation, Closure, and Post-closure

activities. Communication of this information and sign-off by individuals will be recorded and tracked as a key performance indicator.

Employees participating in ecosystem management education and training initiatives will be identified by Pretium and will receive training, if required. All employees will be made aware of the general issues and concerns surrounding environmental management activities and monitoring plans.

Communication and implementation of the information provided in this document will help to maintain ecosystem integrity, thus minimizing adverse effects to ecosystem function.

29.5.7 Reporting Requirements

Annual *Mines Act* (1996i) reporting of the environmental monitoring will include a description of the following:

- records of inventory, treatment, monitoring, and restoration activities will be summarized into a report, with a copy of all data forms filled in for that year to be kept at the mine office for review should they be requested; this information will be used as a means of tracking progress and determining future management activities;
- quality assurance and quality control protocols will be employed to ensure data (e.g., data validation will be built into the database to ensure that required fields, such as site number or name, photo number, and UTM coordinates, are not left blank or duplicated, and valid sets are used to ensure standardization of data);
- an assessment of the effectiveness of the ecosystem management, restoration, and monitoring, as well as actions taken to improve the program if relevant, which will include a summary of the following (including photos where applicable): updates to ecosystem, soil or vegetation-specific standard operating procedures;
- planning and ecosystem management activities (including clearing, sediment and erosion control, etc.) that illustrate coordination with other management plans such as the Soils Management Plan (Section 29.13), the Aquatic Effects Monitoring Plan (Section 29.3), and the Wildlife Management and Monitoring Plan (Section 29.21);
- measures employed to reduce impacts to terrestrial ecosystems that depend on hydrological connectivity and flow (e.g., restoration of natural drainage following decommissioning of temporary access roads);
- evaluation of whether the environmental protection measures were carried out according to the planned management for the site as well as a their rationale;
- evaluation of the effectiveness of the environmental protection measure employed in achieving the stated objective(s);
- assessment of the communication procedures between site employees and environmental managers to facilitate timely reporting of any incident or concern during each phase of the Project and recommendations for improvement;
- assessment of the education and training for employees and contractors; and
- assessment of any emerging negative environmental trends possibly attributable to the Project as identified by the monitoring program, as well as a rationale to probable causes and strategies to address the negative trend.

Enhanced training in existing provincial and federal legislation, ecology, available data entry tools, and reporting programs related to ecosystem-based management and restoration will be provided, if required, to the responsible environmental personnel.

The Project's Environmental Manager will ultimately be responsible for the development, implementation, and monitoring of the Ecosystem Management Plan and be responsible for ensuring that the Performance Objectives are achieved and reported.

29.6 EMERGENCY RESPONSE PLAN

29.6.1 Purpose

The purpose of this preliminary Mine Emergency Response Plan (MERP) for the Project is to provide the initial framework for the Construction and Operation MERP. This MERP will be submitted as part of the Mines Act Permit application and will outline the response procedures and preventive measures for achieving effective management of emergency situations. The MERP is intended to ensure that unplanned or episodic events that may have potentially harmful consequences to workers, the environment, or mine property are responded to in a timely and efficient manner, thereby containing and mitigating such consequences. Note that the information contained in this plan is at a level of detail appropriate for the Application/EIS submission and that it will be further developed into a detailed plan for specific permitting prior to commencement of each phase of the Project.

An emergency is a situation that threatens the well-being of persons, the environment, or mine property, to the extent that a controlled and coordinated response is required. Note that this preliminary MERP does not include the management of accidental spills including those of hazardous materials. These are dealt with in the Spill Prevention and Response Plan (Section 29.14).

29.6.2 Regulatory and Policy Framework

Mine Emergency Response Plans are required for all mines in British Columbia, according to the Health, Safety and Reclamation Code for Mines in British Columbia (the Code; BC MEMPR 2008), which is empowered under the *Mines Act* (1996i).

The Code and related *Mines Act* (1996i) require, in summary, that:

- the Mine Manager develops and maintains such a plan and is responsible for ensuring that sufficient resources in the form of people, equipment, and facilities are available to respond to emergencies;
- the Mine Manager is responsible for providing training to all personnel involved in emergency operations;
- in situations where mine rescue personnel need to be deployed at a mine, the mine rescue teams come under the direction of the Mine Manager, unless otherwise directed by the Chief Inspector of Mines; and
- the Mine Manager carries the financial responsibility for all costs related to establishing, equipping, operating, and maintaining mine rescue teams, as prescribed by the Chief Inspector of Mines.

A synopsis of other legislative requirements applicable to emergency planning is provided as follows:

- *BC Environmental Management Act (2003a)* - Describes overall direction on how wastes and related emergency response situations are to be managed.
- *Contaminated Sites Regulation (BC Reg. 375/96)* - Prescribes standards for contaminated site remediation and management, including emergency response situations but excluding mine wastes.
- *Fisheries Act (1985c)* - Prohibits the release of a deleterious substance to fish habitat, including emergency response for unplanned releases.
- *Transportation of Dangerous Goods Act (1992)*; *Transportation of Dangerous Goods Regulations (SOR/2001-286)* - Provides specified transportation requirements for dangerous goods and includes a substance classification system. Note that Pretium has a plan titled *Emergency Response Assistance Plan for Transportation of Dangerous Goods (Mine Site Procedure BJ-037, August 28, 2013c)* already in place for their current exploration activities on the Brucejack site.
- *Canadian Environmental Protection Act (1999)*; *Environmental Emergency Regulations (SOR/2003-307)* - Stipulates the preparation of an Environmental Emergency Plan, contingent on the presence of listed substances (excluding explosives, *inter alia*) at quantity limits above certain thresholds.

29.6.3 Performance Objectives

The objectives of emergency response planning generally are to provide:

- guidance for personnel, such that they are able to respond efficiently to an emergency situation;
- a common set of practices and procedures that allow for the orderly governance of the various activities needed for responding to an emergency situation, and scheduled reviews of such practices and procedures;
- a means of appropriately engaging with authorities and communities in the event of an emergency, such that their interests may be protected or their assistance elicited;
- assistance to responsible personnel in implementing strategies for early containment and control of an emergency situation, with the ultimate intention of ensuring that the post-mitigation effects of an emergency, are not significant; and
- a common set of training protocols and material for all personnel that have emergency response performance commitments.

The premise of the plan is that emergency situations should be prevented, and responded to and contained very quickly if they do occur. Therefore, formulating procedures that address the complete array of possible emergencies will be a vital informant in the avoidance of such emergencies. The importance of appropriate training of personnel, together with the provision of purpose-designed equipment, is clear.

29.6.4 Emergency Preparedness Measures

The British Columbia Ministry of Energy and Mines (BC MEM) has published a guideline titled *Mine Emergency Response Plan: Guidelines for the Mining Industry (BC MEMNG 2012)*, that requires an Emergency Response Plan to include the following elements:

- Policy Directive;

- Mine Emergency Response Plan Coordinator and Planning Group;
- Emergency Identification, Prevention, and Protection;
- Emergency Notification Plan;
- Emergency Management Organization for Incident Command;
- Emergency Operations Centre;
- Duties and Responsibilities of Personnel;
- Mine Emergency Response Procedures;
- Action Plans;
- Mine Plan;
- Evacuation Plan and Map of Escape Routes;
- Check-in/Check-out Procedure for Emergency Operations;
- Mine Rescue Equipment Inventory;
- Mutual Aid Agreement;
- First Responders Consultation;
- Communication Services;
- System for the Dissemination of Information;
- Training Plan;
- Practice Session Plan;
- Plan for Review and Updating; and
- Costs.

The following sections describe how Pretivm will address these requirements in the Mine Emergency Response Plan (2013d) and the Underground Mine Emergency Response Plan (2013i) developed during the application and permitting process per the *Mines Act (1996i)* and will evolve as the Project progresses through the Construction, Operation, Closure, and Post-closure phases. Besides the guidelines referred to above, requirements of the Chief Inspector for Mines and the British Columbia Fire Code, *inter alia*, are also described below. These address mine rescue, firefighting, first aid, evacuation, snow avalanche, power failure, road closure, and water and tailings management failure.

29.6.4.1 Policy Directive

The MERP will include a clear policy outlining Pretivm's support of the plan, since their first priority is the health and safety of workers and the public. Other priorities are to protect the environment, avoid adverse social and economic effects, and preserve heritage. The Project MERP will be a key element in meeting that priority. While every effort will be made throughout the life of the Project to prevent emergencies, the MERP will ensure that the Brucejack Mine Site is resourced with appropriate equipment, procedures, and trained staff to respond quickly and effectively to every potential event throughout the life of the Project.

The Mine Manager will be ultimately responsible for the MERP, and will appoint an Emergency Response Plan Coordinator and an Emergency Response Planning Committee. The Mine Manager will ensure that the

Project budget addresses the requirements of the MERP and related training. Pretium currently has a number of plans applicable to emergency situations:

- *Emergency Response Plan* (Mine Procedure BJ-025, April 14, 2013d);
- *Underground Mine Emergency Response Plan* (Mine Procedure BJ-041, September 8, 2013i); and
- *Ambulance Operation and Use Procedure* (Mine Procedure BJ-027, May 24, 2013a).
- *Emergency Response Assistance Plan for Transportation of Dangerous Goods* (Mine Site Procedure BJ-037, August 28, 2013c).
- *Brucejack Project Avalanche Safety Plan*, BJ-042. Prepared for Pretium Resources Inc. by Mountain Safety Division, Soucie Construction Ltd., December 8, 2013b.

29.6.4.2 *Emergency Response Plan Coordinator and Emergency Response Planning Committee*

The Project's health and safety personnel will act as or designate a person to act as the Emergency Response Plan Coordinator. The Emergency Response Plan Coordinator will be a key member of the Project Management Team and will have the full support of the operating company to successfully implement the MERP. The Emergency Response Plan Coordinator will engage the Emergency Response Planning Committee in the development of a comprehensive plan, and in the regular review of that plan to ensure optimal effectiveness.

29.6.4.3 *Emergency Identification, Prevention, and Protection*

The Emergency Response Plan Coordinator and the Emergency Response Planning Committee will examine possible scenarios for each area of the Project, together with the possible means of prevention and protection, and the action to be taken. The pre-planning exercise will be reviewed periodically as conditions change over time.

Initially, all areas and processes of the Project will be inspected to determine the risks associated with the work environment, including confined spaces, mine fires, explosions, rock-bursts, falls of ground, runs of muck, inrushes of water, pit wall failure, and avalanches. Each contractor working on the Project site will be required to develop plans that comply with the Code (BC MEMPR 2008) for the work that they are performing. The Emergency Response Planning Committee will also consider uncommon and unlikely events, such as earthquakes, bomb threats, and sabotage. A Risk Register will be developed and maintained for the Project.

The Emergency Response Planning Committee will also review mitigation designed to prevent emergency events from occurring and reduce the adverse effects of such events. The review will assess the effectiveness of the mitigation and consider alternatives where necessary.

The Emergency Response Planning Committee will confirm the appropriateness of training and procedures, safe working practices, housekeeping programs, and first aid training to help prevent a minor emergency from becoming a crisis or a disaster.

The Emergency Response Plan Coordinator will engage supervisors and workers in the identification of hazards and the development of prevention and protection measures.

29.6.4.4 *Duties and Responsibilities of Personnel*

The job titles of key emergency personnel with their corresponding duties and responsibilities will be listed in the MERP.

29.6.4.5 *Emergency Notification Plan*

The MERP will include a procedure to notify required personnel to support the efficient notification or call-out of key individuals in the event of an emergency.

29.6.4.6 *Emergency Operations Centre*

An Emergency Operations Centre (EOC) will be established to assist the Incident Command System Emergency Management Organization with support in the event of an incident. The location of the EOC will be carefully selected for ease of access and communication. The location and telephone numbers will be identified in the MERP and posted prominently throughout the Project.

29.6.4.7 *Mine Emergency Response Procedures*

The Emergency Response Procedures will address three levels of response in an emergency operation: containment, notification, and mobilization.

Containment Level

Containment is the initial step in the effort to control an emergency, and exists from the moment a problem is discovered until emergency response personnel are notified. The steps in the containment level include discovery and reporting of the problem, monitoring the situation, and early and immediate action. The goal at this level will be for on-site personnel to follow concise emergency response procedures immediately.

Notification Level

The notification level will start when management decides outside help is needed to handle a situation or additional notification is necessary. Action will be taken immediately to minimize hazards to all persons and to get assistance as efficiently as possible. If an emergency occurs, managers will notify their own workers of the hazards and, if required, get them to safety and notify key personnel in order to activate the Emergency Response Procedures. The procedures to be followed will be clear and concise to avoid confusion or delays.

All supervisors and persons named in a notification process will be trained in how to initiate the notification level. Normal operating procedures cease to apply during the notification level. The notification level procedures will be kept simple, and the Notification plan will contain only those names absolutely required.

Mobilization Level

The mobilization level will take effect when the EOC has been established and senior management has assumed direction of emergency operations. All key persons will report to the EOC upon arrival at the Project site or, as the site is remote, report via remote access. The Mine Manager or a designate will assume the role of Incident Commander on arrival.

29.6.4.8 *Action Plans*

Concise emergency operational procedures will be developed for each potential emergency, to ensure that supervisory and other personnel have an understanding of duties and responsibilities and are aware of the tasks needed to control an emergency situation.

Based on a thorough assessment of the levels of response required, action plans will be written and assigned to those responsible for the execution of Emergency Response Procedures.

Action plans will typically contain the following types of information and documents:

- copies of all documents for recording events;
- lists of emergency support groups with names of contacts and telephone numbers (e.g., police department, fire department, ambulance service, doctors and medical specialists, paramedics, hospitals, and transportation services such as airlines, air charters, and helicopters);
- list of mine rescue equipment available on site;
- list of BC MEM contacts;
- list of BC MEM Mine Rescue Cache equipment available;
- BC Provincial Emergency Program;
- list of other key provincial personnel contacts and BC government resource agencies;
- list of key Canadian federal, United States federal, and State of Alaska contacts (Brucejack Creek drains into Sulphurets Creek and the Unuk River, which flows into Alaska, USA);
- list of key community, First Nations, and Treaty Nations contacts;
- list of specialized equipment and where it can be obtained, e.g., lifting bags or hydraulic jacks; and
- lists of special consultants, technical advisors, and contractors, e.g., avalanche control contractors.

29.6.4.9 *Mine Plan*

The MERP will include a copy of the physical layout of the Project (mine plan as per Part 3.7.11 of the Code; BC MEMPR 2008) and maps covering all underground and surface operations, including the access roads, transfer station, aerodrome, and transmission line.

29.6.4.10 *Evacuation Plan and Map of Escape Routes*

A copy of the evacuation plan and escape routes will be included and will be consistent with the up-to-date mine plan as per Section 29.6.4.10 above.

29.6.4.11 *Check-in/Check-out Procedure for Emergency Operations*

A check-in/check-out procedure for emergency operations will be established.

29.6.4.12 *Mine Rescue Equipment Inventory*

A mine rescue equipment inventory list will be compiled annually and submitted to the BC MEM Emergency Preparedness Committee in Victoria via the Regional Inspector.

29.6.4.13 *Mutual Aid Agreement*

The Project will establish customized mutual aid agreements with other first responders operating in northwestern BC, including other mine rescue teams, if required by the MERP. Agreements will be in writing and will address capabilities for a response, back-up teams, travel time, and payment of costs incurred.

29.6.4.14 *First Responders Consultation*

To ensure that first responders are prepared to respond to a mine emergency, the Mine Manager will consult with identified agencies to provide a copy of the MERP and current Project plans, including an up-to-date map identifying appropriate and safe route(s) of travel to the Project. A review of any hazards that may affect first responders will also be provided.

29.6.4.15 *Communication Services*

The MERP will require the establishment of an emergency communication system to ensure:

- the flow of information, including all orders, reports, and assignments during the entire operation;
- timely assessment of changing conditions;
- timely transmission of reports used to monitor conditions and actions; and
- command officials have the ability to keep track of available personnel, resources, and services.

The Emergency Response Plan Coordinator will identify personnel who are knowledgeable in the operation and maintenance of communications technology, and will appoint a Communications Coordinator. Additional personnel will be assigned as backup support.

The Communications Coordinator will be responsible for:

- evaluating the existing communications system and assessing its capacity for handling calls during an emergency;
- determining and selecting the technical and logistical components of the emergency communications system;
- developing backup and alternative means of communication;
- establishing a policy governing the authorized use of telephone lines at peak periods of an emergency;
- identifying and selecting personnel to activate the communications system and to check to ensure it is operating;
- setting up a rotation schedule and confirming the assignment of personnel who will monitor and record all calls during each shift; and
- establishing a standardized system for recording calls, messages, and information.

29.6.4.16 *System for the Dissemination of Information*

The Project and Pretivm will have a formal plan in place in the event of a serious or fatal accident. The plan will follow established protocols for communicating to the public about incidents. Specifically, families will be informed as early as possible and prior to any media releases. The names of the people affected will not be released publicly until they have been rescued or recovered and authorization from their families has been received.

All outside calls will be directed through the person designated by Pretivm as responsible for public and media relations. A strategy will be developed for the release of information to the media.

29.6.4.17 *Training Plan*

The MERP will outline a training plan for all individuals named in the emergency procedures, to ensure key personnel will know how to react. All personnel will be able to state verbally what their duties are in an emergency.

29.6.4.18 *Practice Session Plan*

Management will test procedures and evaluate performance of personnel in practice drills on a regular basis to develop and build upon a reliable response system. Drills will cover all actions ranging from the moment of discovery to the marshalling and deployment of emergency response teams, and will consist of setting up the EOC, and establishing communications.

29.6.4.19 *Plan for Review and Updating*

As frequent revision of the plan is a key element in the program, the Mine Manager will ensure that the MERP is revised and updated at least annually.

29.6.4.20 *Costs*

The Mine Manager will ensure that adequate funds are provided in the annual Project budget for Mine Emergency Response Plan activities.

29.6.4.21 *Mine Rescue*

A Mine Rescue Emergency Response Plan will be developed and filed with the Chief Inspector for Mines. The Mine Manager will ensure that there is a fully trained mine rescue team. A mine rescue team will have a normal complement of six workers including a team captain, vice-captain, and coordinator. The team will have a qualified trainer and will practice for not less than eight hours in each three-month period of mine operations. A training logbook will be kept on site. Training will include mine rescue, as well as hazardous materials handling, firefighting, crisis management, and incident command training.

Where the number of people employed underground at one time is:

- fewer than 10, the Mine Manager will maintain on-site trained personnel and equipment necessary to provide a first response and assessment, and establish mutual aid agreements with outside groups capable of providing additional personnel and equipment;
- fewer than 20, there will be at least three persons trained in mine rescue;
- greater than 10 but fewer than 50, there will be one mine rescue team; or
- greater than 50, there will be two mine rescue teams.

During the Construction phase, an emergency response team will be assembled from the site personnel. It will be organized and led by the Health and Safety Manager. Personnel will receive training in:

- first aid;
- firefighting;
- rescue techniques; and
- hazardous material handling and clean up.

The team will be provided with the following emergency equipment, as a minimum:

- protective gear for firefighting and hazardous material handling;
- a fully equipped rescue vehicle;
- dedicated communications devices (hand-held and vehicle-mounted); and
- tools (e.g., axes, shovels, cutters, and saws).

These teams will form the core of the emergency response organization, responsible for rescue and firefighting duties in the event of an emergency.

29.6.4.22 *Firefighting*

Firefighting equipment will be provided and maintained at locations throughout the Project site where fire may endanger life or property. Firefighting personnel will be part of the mine rescue team.

The British Columbia Fire Code will dictate the level of firefighting equipment required. Water and foam systems for fire suppression are incorporated into the Project design. At least two hours of fire water will be available in an emergency. Water for firefighting, if required, will be drawn from the fresh/fire water storage tank supplied by the water treatment plant or from Brucejack Lake.

Fire hazard areas, such as fuelling stations, may be designated as areas where no means of producing heat or flame will be permitted. Such areas will be clearly marked with warning signs.

Upon discovering a fire, all employees will be expected to be aware of, and capable of, carrying out initial containment measures. These measures will include an attempt to control the fire with the nearest extinguisher, raising the alarm, and seeking assistance. A fire within any enclosed structure will trigger a building evacuation. Similarly, an underground fire will trigger evacuation of the underground areas.

A refuge station will be located between the two decline tunnels at the mine works, in a bay off a drift and will be separated from the drift by a concrete wall. Access to the station will be through an airlock system. Additional refuge will be provided by five 12-person mobile self-sufficient rescue chambers placed at appropriate locations throughout the mine.

The open stoping mine operation has been designed to permit escape in the event of a fire. The mine will have two access ramp portals, as well as the existing portal, and will be equipped with a static refuge station and five mobile rescue stations as mentioned above. For the production stoping blocks, an escape ladderway will be installed in each of the raises located next to main ramps. The entire underground operation will have dedicated water systems for firefighting.

If there is a forest fire near the Project site, management will initiate close monitoring of the fire and seek advice from the British Columbia Ministry of Forests, Lands and Natural Resource Operations. Key personnel will be put on standby pending an evacuation.

Extreme fire conditions may cause the access roads into the Project to be closed to traffic. This could result in the cessation of operations until such time as the roads are once again passable.

29.6.4.23 *First Aid*

Part 3.6.1 of the Health, Safety and Reclamation Code requires that the Mine Manager provide and maintain first aid supplies and services as required by the Workers Compensation Board (WorkSafeBC). During the Operation phase, a first aid station will be maintained and equipped at the ground-floor level of the Mill Building, with a paramedic in attendance. Emergency vehicles will be provided at the

first aid station. All site personnel will be informed of the first aid and medical arrangements and the protocol for activating the emergency procedure. Notices indicating contact details for first aid personnel (or appointed persons), the emergency contact number and/or radio frequency, and the location of first aid kits will be posted around the site.

Helicopter landing pads will be provided on the laydown area adjacent to Brucejack Lake and at the Knipple Transfer Area. A level area will also be available for helicopter landings near the air terminal building at the Bowser Aerodrome. Major trauma cases can thus be evacuated by helicopter or fixed-wing air ambulance. A specific procedure will be developed for summoning either a road ambulance or provincial air ambulance. When weather conditions prevent evacuation by aircraft, road transport will be required. In this case, procedures for ambulance travel are outlined in *Ambulance Operation and Use Procedure* (BJ-027; Pretivm 2013a).

An accident and injury procedure will be developed that details the actions and record keeping required for minor, serious, and major injuries.

29.6.4.24 Evacuation

Safe evacuation procedures for the Project will be developed and posted in conspicuous places. Each employee will be instructed in the evacuation procedures and will be familiar with the emergency escape routes from the Project. An emergency warning system will be implemented, and drills conducted at least every 12 months to ensure that all employees can recognize the evacuation warning. Reports of these tests will be kept and reviewed by Pretivm's mine management.

The Mine Manager will implement a system to account for all of the persons on the Project property. This system will facilitate the early determination of any missing persons in the event of an emergency. A written copy of this system will be available for inspection.

In a severe emergency (e.g., because of danger from an avalanche, major earthquake or forest fire), the entire Project property might need to be evacuated. A specific site evacuation plan will be developed that includes procedures for plant shutdown and other protection measures. Transportation requirements will be included in the plan.

29.6.4.25 Snow Avalanche

The Project will operate in a high snowfall area with steep terrain subject to snow avalanches. It will use a comprehensive avalanche management scheme, using controlled initiation of avalanches to limit their size and destructive capacity. Infrastructure facilities will be located outside of known avalanche-prone areas. Personnel working in avalanche-prone areas during periods of snow will obtain prior advice on current risks from an avalanche expert and will be equipped with and trained to use avalanche beacons.

The mine rescue team will be trained in avalanche rescue techniques. Avalanche rescue will not be attempted unless the site is considered to be safe from further danger by contracted avalanche experts. Pretivm currently has a plan in place titled *Avalanche Safety Plan* (BJ-042, Mountain Safety Division, Soucie Construction Ltd. 2013b).

29.6.4.26 Power Failure

The Project will be dependent upon electricity delivered by a transmission line from the provincial electricity grid. This will be by means of a new 55-km-long 138-kV transmission line on single steel

monopole towers that will be constructed from the Brucejack Mine Site to the Bowser River Valley and then southwesterly to connect with the provincial grid at the Long Lake Hydro Project near Stewart.

One of the four 500-kW, 600-V diesel generators installed for construction activities will be redeployed as a dedicated back-up power supply for the permanent camp. Thus, in the event that electricity is interrupted, the Project will have a standby diesel power plant of sufficient power to operate critical equipment such as pumps and tunnel fans and to operate the camp. A plan will be in place for the orderly shutdown of all non-essential machinery to reduce risks of injury or damage to equipment when the power is re-established.

Project management will maintain an inventory of transmission line conductors and accessories to facilitate timely repairs to the transmission lines owned by the Project in an emergency.

29.6.4.27 Road Closure

The Project will be serviced by the Brucejack Access Road that passes through rough terrain from Highway 37. It is expected that sections of the road may be blocked or otherwise impassable at times, due to floods or washouts, avalanches or landslides, severe weather (heavy snowfall), or forest fires.

The length of road on the south side of Brucejack Lake between the Knipple Glacier and the Brucejack Mine Site often has high avalanche risks. During times when it is unsafe, an alternate snow route over the Valley of the Kings is available. This bypass road traverses around to the south of the property, eventually meeting up at kilometre 71 of Knipple Glacier Road, thus possibly providing emergency access to the Project site. This road is only available in the winter and also provides access to the upper elevations of the site for avalanche control measures.

During the Construction phase of the mine, a road closure would disrupt the delivery of materials and supplies. Construction workers will be housed on site, so food and other supplies could reach critical levels in the event of a prolonged closure. Alternative means of transporting such goods, e.g., by helicopter, will be considered and put in place during the planning of the Construction activities.

The Operation phase of the mine requires that workers be transported to the site for two weeks on, two weeks off rotations. A road closure could result in a rotation of workers being stranded at the Project site. Potable water will be available and food will be delivered via the second road (if appropriate) or by helicopter. Most emergency conditions are not expected to last more than 24 hours at a time.

Medical emergencies may require helicopter support in the case of impassable roads.

29.6.4.28 Water or Tailings Management Failure

The risk of failure of the diversion channels, contact water pond, or tailings pipeline is very low, given that the designs have been carried out by qualified professionals and the structures will be constructed and maintained in accordance with their designs.

Inspections of the diversion channels and contact water pond will be conducted following extreme precipitation or runoff events. Any spills will be contained by the construction of berms or other means, and mitigated as deemed appropriate. Note that a separate Spill Prevention and Response Plan (Section 29.14) has been prepared for the Project, which also addresses water and tailings management failures.

29.6.5 Monitoring Program

Given the unpredictable nature of emergency events, pre-emptive monitoring is not possible outside of the inspections carried out as part of the maintenance of the Project in entirety. Reliance will thus be placed on the efficient and comprehensive maintenance of those Project components that pose the greatest risk of accidents or failure. These typically are facilities where fire or explosion may occur or areas prone to damage by extreme weather episodes such as floods.

In the event of an emergency incident, and once it has been brought under control, the Emergency Response Plan Coordinator will launch an investigation of the incident. Together with the Emergency Response Planning Committee, key members of Pretium's mine management, and relevant health and safety personnel (as appropriate), a joint incident investigation and root cause analysis will be undertaken. The findings of the investigation will serve to modify the MERP if the investigation shows that shortcomings pertained. Such modifications will be subject to the regular annual review of the plan, to ensure optimal effectiveness.

Periodic reviews by independent third parties will be undertaken.

29.6.6 Work Planning and Schedule

Work planning and scheduling for Mine Emergency Response Plan activities requires maintaining a high level of preparedness of both personnel and equipment.

A Mine Emergency Response Plan requires that personnel generally, but particularly those with specified responsibilities, are subjected to purpose-designed training. This would include emergency preparedness briefings for all newcomers to the Project site as part of their health and safety induction, one-off emergency response training sessions on a scheduled basis, and the training and practice sessions required for specified responsibilities such as mine rescue teams and firefighting teams.

In summary, MERP training will be scheduled according to a Practice Session Plan and Training Plan as described above, and such sessions will be provided to:

- all new personnel - on first entry onto the site (together with health and safety training);
- all personnel - an annual refresher course; and
- personnel with specified responsibilities - not less than eight hours in each three-month period of mine operations.

All the equipment provided for safety and emergency purposes will be maintained and serviced according to manufacturers' specifications and be in a state of instant readiness at all times.

29.6.7 Reporting Requirements

29.6.7.1 Reports

A report will be prepared for every emergency incident that occurs and on every incident that might have become an emergency if not for timely response. Reports will be forwarded to relevant government agencies as required by regulations and licences. All reports will be reviewed internally by the Emergency Response Planning Committee in order to identify necessary improvements in the emergency prevention and response procedures.

29.6.7.2 Reporting Responsibilities

Designated job titles and corresponding responsibilities of emergency personnel will be listed in the detailed plan for specific permitting prior to commencement. As identified in the *Emergency Response Plan* (BJ-025; 2013d), the following key personnel and a brief reference to their responsibilities are identified:

- Mine Manager;
- Operational supervisory personnel;
- health and safety personnel; and
- Emergency Response Coordinator.

29.7 HAZARDOUS MATERIALS MANAGEMENT PLAN

29.7.1 Purpose

The purpose of the Hazardous Materials Management Plan for the Project is to protect employees and the public from possible deleterious effects on their health and safety from the release of harmful substances into the environment. Similarly, components of the biophysical environment such as water, air, and vegetation, as well as the fish and wildlife that depend on them must also be protected from possible deleterious effects on ecosystem function.

The information contained in this plan is at a level of detail appropriate for the Application/EIS and will be further developed during permitting. In Canada, hazardous materials and hazardous recyclable materials are defined as those with properties such as flammability, corrosiveness, or inherent toxicity (*Environmental Protection Act* 1999), while dangerous goods are a schedule designation under the *Transportation of Dangerous Goods Act* (1992). While both definitions overlap in the types of substances, hazardous materials are a broad and general definition, dangerous goods is specifically defined as belonging to one of nine categories (schedules) of materials with the term used during the transport of these materials. Note that the management of hazardous materials and dangerous goods including explosives are included in this plan. The management and disposal of sewage sludge is included in the Waste Management Plan (Section 29.17).

29.7.2 Regulatory and Policy Framework

The Hazardous Materials Management Plan for the Project will adopt as a minimum standard compliance with the following federal and provincial legislation regarding hazardous, dangerous, or controlled substances:

- *BC Environmental Management Act* (2003a) and its regulations;
- *Health Act* (1996e);
- *Fisheries Act* (1985c);
- *Water Act* (1996j);
- *Mines Act* (1996i);
- Petroleum Storage and Distribution Facilities Storm Water Regulation (BC Reg 168/94);
- Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008);
- *Environment and Land Use Act* (1996b);
- *Canada Transportation Act* (1996a);

- *Canadian Environmental Protection Act (1999)*;
- *Nuclear Safety and Control Act (1997)*;
- *Hazardous Products Act (1985d)*;
- *Hazardous Materials Information Review Act (1985e)*;
- Controlled Products Regulations (SOR/88-66); and
- *Transportation of Dangerous Goods Act (1992)*.

Regarding explosives, Natural Resources Canada (NRCAN) is responsible for regulating their use, under Part 7(1)(a) of the *Explosives Act (1985b)*. Significant revisions were made to the Explosives regulation in 2013. For a Magazine Licence or Storage in a Licensed Magazine (Part 6), the application for the licence requires information on the type and volume of explosive to be used, how it will be handled, the safety measures envisaged to reduce potential incidents, and a monitoring and reporting program. Other regulatory considerations relevant to the design, construction, and ultimate operation of an explosives facility and use of explosives on the Project site include the following:

- Explosives Regulations (SOR/2013-211); Ammonium Nitrate Storage Facilities Regulations (CRC, c 1145);
- Transportation of Dangerous Goods Regulations (SOR/2001-286); and
- NRCAN's (2010) Guidelines for Bulk Explosives Facilities.

As per the requirements of the *Explosives Act (1985b)*, an Explosives Handling Plan will be completed by the explosives contractor. Additionally, the 2013 regulations require a Security Plan, Fire Safety Plan, and Key Control Plan.

The Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008) also regulates the transportation, use, care, and handling of explosives. An Explosives Storage and Use Permit from the Ministry of Energy and Mines is required before a magazine is located, erected, built, put into service, or modified, or before carrying out any maintenance work including the installation of lighting or heating. The explosives facilities at the Project, as well as all employees and contractors handling, transporting, and using explosives, will comply with all regulatory requirements throughout the Construction, Operation, and Closure phases of the Project.

29.7.3 Performance Objectives

This Hazardous Materials Management Plan is designed to meet two primary performance objectives, as follows:

- To have a Workplace Hazardous Materials Information System (WHMIS) in place prior to commencement of construction of the Project. WHMIS is a requirement of the *Hazardous Products Act (1985d)* and the *Hazardous Materials Information Review Act (1985e)*. In June 2015, Pretium will adopt the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). GHS is a globally recognized system that defines and classifies the hazards of chemical products, and communicates health and safety information on labels and Material Safety Data Sheets (MSDSs). By June 2015, it is expected that Health Canada will complete alignment of GHS with the current WHMIS-related laws. The GHS system will have the same set of rules for classifying hazards, and the same format and content for labels and safety data sheets (SDS replacing WHMIS and/or MSDS) as those adopted and used around the world.

- To maintain an effective inspection procedure that confirms the effectiveness of the equipment intended to transport and store products and ensures compliance with established systems throughout the life of the Project.

As far as explosives management is concerned, the following performance objectives will be met:

- There will be no unintended property damage, or injury to persons.
- There will be no significant environmental effect related to the transportation, on-site manufacturing, storage, and use of explosives.

29.7.4 Environmental Protection Measures

Hazardous materials will be required on the Project site throughout the life of the mine, except the Post-closure phase which only has materials associated with monitoring. During Post-closure, there will be no storage of materials on site. Material Safety Data Sheets (MSDSs) will be required for each of these products prior to their delivery to the Project site. Most of the products will be consumed on site, but some (e.g., hydraulic fluid and batteries) will require disposal after use. This management plan addresses the regulatory arrangements for transportation of these products to and from the Project site, and their proper and safe storage, and use. The Waste Management Plan (Section 29.17) will address the disposal of the hazardous material. Table 29.7-1 lists typical dangerous goods and hazardous materials that may be found on the Project site.

29.7.4.1 Dangerous Goods and Hazardous Materials

Transport

The transport of dangerous goods will necessitate the following:

- MSDS will accompany all goods and materials;
- non-compatible materials will be transported in separate shipments;
- fire extinguishers and fire prevention materials will be adequate and appropriate for the material being transported;
- containers will be appropriate for the material being shipped;
- containers will be properly secured;
- containers and trucks will be properly marked, labelled, and placarded;
- manifests will be maintained in accordance with federal and provincial regulations;
- spill response materials will be adequate and appropriate for the materials being transported; and
- drivers will be adequately trained and equipped for spill first response, containment, and communication.

Actions to Avoid, Control, and Mitigate

An inventory of hazardous materials is a key element of this management plan. The 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.

Table 29.7-1. Typical Dangerous Goods and Hazardous Materials on Site by Project Phase

Product	Phase			
	Construction	Operation	Closure	Post-closure
Diesel fuel	Used throughout; stored at the Brucejack Mine Site in 205-L barrels, double-wall tanks, or fabric bladders with secondary containment	Used throughout; stored at the main fuel storage facility at the Brucejack Mine Site, as well as the Knipple Transfer Area and underground maintenance shops, in either double-wall tanks or within secondary containment	Used in decreasing amounts as components are decommissioned; stored at the main fuel storage facility at the Brucejack Mine Site, as well as the Knipple Transfer Area in either double-wall tanks or with secondary containment	Use in small quantities within vehicles associated with monitoring, no on-site storage
Gasoline	Used throughout; stored at the Brucejack Mine Site in 205-L barrels with secondary containment	Used throughout; stored at the main fuel storage facility at the Brucejack Mine Site, as well as the Knipple Transfer Area and underground maintenance shops, in either double-wall tanks or with secondary containment	Used in decreasing amounts as components are decommissioned; stored at the main fuel storage facility at the Brucejack Mine Site, as well as the Knipple Transfer Area and underground maintenance shops, in either double-wall tanks or with secondary containment	Use in small quantities within vehicles associated with monitoring, no on-site storage
Lubricating oil	Used throughout; stored at the Brucejack Mine Site in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment	Used in decreasing amounts as components are decommissioned; stored at maintenance shops in bulk tanks with secondary containment	Use in small quantities within vehicles associated with monitoring, no on-site storage
Lubricants, greases	Used throughout; stored at the Brucejack Mine Site in tubes, pails, and drums with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment	Used in decreasing amounts as components are decommissioned; stored at maintenance shops in bulk tanks with secondary containment	Use in small quantities within vehicles associated with monitoring, no on-site storage
Ethylene glycol	Used throughout; stored at the Brucejack Mine Site in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment	Used in decreasing amounts as components are decommissioned; stored at maintenance shops in 205-L barrels with secondary containment	Not required
Hydraulic fluid	Used throughout; stored at the Brucejack Mine Site in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment	Used in decreasing amounts as components are decommissioned; stored at maintenance shops in 205-L barrels with secondary containment	Not required
Batteries	Used throughout; stored at the Brucejack Mine Site and maintenance shops on pallets with secondary containment	Used throughout; stored at the Brucejack Mine Site and maintenance shops on pallets with secondary containment	Used in decreasing amounts as components are decommissioned; stored at maintenance shops on pallets with secondary containment	Use within vehicles or equipment associated with monitoring no on-site storage
Solvents	Used and stored at the maintenance shops; stored in 205-L barrels with secondary containment	Used and stored at the maintenance shops; stored in 205-L barrels with secondary containment	Used in decreasing amounts as components are decommissioned; stored at maintenance shops in 205-L barrels with secondary containment	Not required

(continued)

Table 29.7-1. Typical Dangerous Goods and Hazardous Materials on Site by Project Phase (completed)

Product	Phase			
	Construction	Operation	Closure	Post-closure
Lime	Used at temporary and permanent Water Treatment Plant (WTP); stored in large bulk bags at each plant and otherwise in bulk	Used at WTP; stored in large bulk bags at each plant and otherwise in bulk	Used in decreasing amounts as WTP is decommissioned; stored in large bulk bags at each plant and otherwise in bulk	Not required
Flocculent	Used at temporary and permanent WTP; stored in 25-kg bags at each plant and otherwise in bulk	Used at WTP and process plant; stored in bulk	Used in decreasing amounts as WTP is decommissioned; stored in bulk	Not required
Surfactant	Not required	Used at process plant; stored in bulk	Not required	Not required
Propane	Used at camps and other temporary and permanent facilities for space heating; stored in portable and permanent tanks/cylinders	Used at camps for kitchens and other facilities for space heating; stored in portable and permanent tanks/cylinders	Used in decreasing amounts for camps and other facilities for space heating; stored in portable and permanent tanks/cylinders	Not required
Domestic cleaning products	Stored and used primarily at camps and kitchens for cleaning	Used primarily at camps and kitchens for cleaning	Used primarily at camps and kitchens for cleaning	Not required
Laboratory chemicals	Preservatives for environmental samples; stored in 1-L to 5-L containers	Preservatives for environmental samples, reagents for laboratory analyses; stored in 1-L to 5-L containers	Preservatives for environmental samples; stored in 1-L to 5-L containers	Used as preservatives for environmental samples; no on-site storage
Process Plant reagents	Not required	Will include lime, potassium amyl xanthate (PAX), methyl isobutyl carbinol (MIBC), antiscalant and flux (possibly borax, Na ₂ B ₄ O ₇ ; sodium nitrate, NaNO ₃ ; silica, SiO ₂ ; and fluorspar, CaF ₂). Dry reagents will be stored in bulk bags up to 1 tonne in size, liquids in tanks	Not required	Not required
H ₂ SO ₄	Used in water treatment lab assay; stored in framed totes at the WTP	Used in water treatment lab assay; stored in framed totes at the WTP	Used in water treatment lab assay; stored in framed totes at the WTP	Not required
Water treatment sludge (treatment by-product)	Stored temporarily in an engineered cell or covered structure prior to hauling for appropriate offsite disposal	To paste backfill plant or stored temporarily in an engineered cell or covered structure	Stored temporarily in an engineered cell or covered structure	Not required

Minimizing the risk of safety infractions and/or environmental damage from accidental releases of hazardous materials will include the following practices:

- knowing which hazardous materials are on site through the maintenance of an inventory system;
- allocating clear responsibility for managing hazardous materials;
- understanding the actual or potential hazards and environmental impacts associated with the storage and handling of these materials;
- minimizing the use and/or generation of hazardous materials;
- constructing storage facilities that safely contain the materials in all foreseeable circumstances;
- implementation of physical controls and procedures to ensure that no materials escape during routine operation as well as in upset conditions. An example would be the containment of the fuel storage area with an impervious membrane under gravel to collect any spillage;
- having an emergency response plan in place to ensure immediate action to minimize the environmental effects should accidental or unplanned releases occur;
- monitoring all discharges and reporting unplanned discharges should they occur; and
- accurate record keeping and appropriate reporting of events and accidents.

Materials will be stored in appropriate containers within suitably contained areas. All the process reagents will be prepared in a separate reagent preparation and storage facility in a containment area. The reagent storage tanks will be equipped with level indicators and instrumentation to prevent spills from occurring during operation. Appropriate ventilation and fire and safety protection will be provided.

The following will be implemented as avoidance, control, and mitigation actions in the management of dangerous goods and hazardous materials:

- manufacturers to provide safe packaging and labelling for packaged materials, as a condition of purchase agreements;
- storage areas to be appropriately climate-controlled, dry, and well-ventilated;
- containers holding the materials to remain sealed until required to prevent accidental leakage and/or spillage;
- incompatible chemicals to be stored separately in order to prevent deleterious chemical reactions and cross-contamination;
- chemical storage areas to be designated as non-smoking areas and located away from food storage areas;
- all personnel handling dangerous goods to be trained and provided with appropriate personal protective equipment; and
- all bulk chemical storage sites to be constructed with concrete or lined floors and walls capable of containing 110% of the volume of the largest vessel in the area or as stipulated by appropriate legislation or permits.

The Spill Prevention and Response Plan (Section 29.14) provides additional information on response plans in the event of any spills of hazardous materials. A Project-wide communication system will

ensure rapid notification of any observed spills. In addition to all staff having basic spill response training appropriate to their positions, the site will have a trained emergency response team with resources to contain and recover spills so as to reduce their size and thus reduce any related potential adverse environmental impact. Storage areas and transfer stations will have spill kits appropriate for the products being handled. On-site equipment will include a comprehensive spill recovery kit (containing items such as absorbent pads and booms, skimmers, and dike materials) that will be ready to be loaded on a truck for rapid deployment to any spill scene. This kit will be easily transferable to enable delivery by helicopter if required.

Actions to Avoid, Control, and Mitigate during Construction

Management of dangerous goods and hazardous materials will require strict management during the Construction phase, because Construction activities will be dispersed and conducted by numerous third-party contractors. Contracts will include defined processes for the management of these products, including:

- maintenance of an accurate and detailed inventory of dangerous goods and hazardous materials on the Project site, to be shared on an ongoing basis with Pretivm or the prime contractor;
- provision by the supplier or contractor of a MSDS before any chemical is brought on site (for full-scale use or for trial use). These sheets will be kept in an easily accessible location at every site where related dangerous goods or hazardous materials are stored, and a copy will also be retained in a central file at the primary on-site construction office and first aid building for reference in an emergency. The MSDS provides information primarily aimed at worker health and safety, with some secondary information provided related to environmental impacts and remedial action in the event of spillage; and
- commitments to train those employees associated with transportation, storage, and use of dangerous goods and hazardous materials.

During the latter stages of Construction, the prime contractor will develop policies and procedures for the commencement of Operation, since the transition to Operation will be gradual in many areas.

Actions to Avoid, Control, and Mitigate during Operation

During Operation, Pretivm will apply the refined policy developed during Construction. The Hazardous Materials Management Plan will thus continue to be anchored by an inventory of all dangerous goods and hazardous materials on the Project site, along with appropriate WHMIS and MSDS information.

MSDSs will be kept in an easily accessible location at each site where the relevant dangerous goods and hazardous materials are stored, as well as with the Environment Manager. All facilities and activities will be inspected regularly, with inspection reports being directed to the Mine Manager. New employees will be trained, and existing employees will receive refresher training. Written procedures will be revised as improvements are identified and tested.

Actions to Avoid, Control, and Mitigate during Closure

Risks due to dangerous goods and hazardous materials transportation, storage, and use will decline during the Closure phase, other than for disposal of surplus materials. Disposal of surplus materials will be guided by the Waste Management Plan (Section 29.17). Surplus materials will be collected, packaged, labelled, and shipped to appropriate off-site disposal facilities. MSDS information and input from suppliers will be referenced to guide the disposal process. MSDSs will be kept in an easily accessible location at each site where the relevant dangerous goods and hazardous materials are

stored, as well as with the Environment Manager. Disposal activities will be inspected by a designated person, and inspection reports will be directed to the Mine Manager.

Actions to Avoid, Control, or Mitigate during Post-closure

The requirement for dangerous goods and hazardous materials at the Project site will be reduced during Post-closure. Diesel fuel and gasoline will continue to be required by vehicles used in monitoring. All other dangerous goods and hazardous materials are those associated with monitoring with no on-site storage. Procedures established during Operation will be modified to appropriately address the management of products for the lower level of activity during Post-closure. Monitoring and inspection will continue on a scheduled basis.

Management of Hazardous Material Types

Radioactive Equipment Handling and Disposal

Radioactive sources are used in the mining and mineral processing industry for tasks such as process monitoring (e.g., density gauges), exploration (e.g., down-hole logging), monitoring (e.g., neutron moisture gauges), geo-technical assessment (e.g., Troxler soil compaction meters), and research (e.g., tracer studies).

All aspects of the purchase, handling, use, storage, and disposal of nuclear equipment are regulated in Canada under the *Nuclear Safety and Control Act* (1997) and its associated regulations. Pretivm and its contractors will comply with all applicable regulations, including requirements for licensing.

The presence of radioactive materials at industrial facilities requires proper management, including management of the potential human health hazard (both occupational and public), as radioactive contamination may not be detected in conventional occupational, environmental, or process stream monitoring. Periodic checks of radioactive sources will be undertaken to ensure there has been no significant loss of integrity of the source container that could result in leakage or contamination. All radioactive materials will be appropriately labelled, and the labels will always be visible.

Radioactive sources no longer being used will be stored in appropriate containers in a secure building on the Project site. Whenever possible, purchase agreements will be established with suppliers to repossess the units being taken out of service. Where this is not possible, other acceptable disposal agreements will be arranged.

Petroleum Products

The materials with the highest risk potential for a spill or accidental release are petroleum products, due to their frequency of use. Hydrocarbon transportation, storage, and use will be outlined in the Spill Prevention and Response Plan. This policy will highlight the need for proper containers for each application; secondary containment for all liquid hydrocarbons; clear procedures for safe transfer between containers and from containers to equipment; constraints on refuelling in sensitive areas, such as riparian areas; the use of drip pans for stationary equipment; and the requirement for spill containment and response plans and equipment. Regular inspections of facilities and activities by designated staff will reinforce compliance with the policy. Inspections will be recorded and reported to Pretivm. All relevant staff will receive training on the policy before being permitted to transport, store, or use hydrocarbons.

Diesel fuel pipelines will be equipped with leak detection systems and automatic shut-off valves. Safety provisions will use conventional, proven technologies that will be consistent with regulations governing petroleum product pipelines.

Fuel handling, transportation, and storage facilities and activities will be consistent with the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008) and the Ministry of Water, Land and Air Protection's (BC MWLAP's; 2002) publication *A Field Guide to Fuel Handling, Transportation and Storage*. All fuel storage vessels will include secondary containment, and all transfer stations will have appropriate lining complete with oil/water separators during operation. Tanks and sumps will have high-level alarms. All transfers from tanker trucks to tanks at the fuel storage facilities will be done using enclosed lines, hoses, and pumps. All storage and transfer locations will also be equipped with appropriate spill kits. An inspection schedule will be developed for each fuel storage site, taking into account the volume of fuel stored at each site and the respective risks related to that storage. Inspections will include tanks, pipelines, connections, valves, gauges and meters, sumps and separators, and inventory records. Inspections will be recorded and filed with the Mine Manager.

Fuel transfer procedures will include management practices to ensure no overtopping of tanks or spillage. All spills or accidents will be reported immediately. Employees and contractors responsible for transporting or storing hydrocarbons or fuelling vehicles will receive training in proper operating procedures and emergency response. Hydrocarbon spills will be collected, and contaminated soils and overburden materials will be bioremediated on site as the first preference. Off-site bioremediation will be considered, contingent on the severity of contamination.

Oils, lubricants, degreasers, solvents, and other petroleum-based products will be delivered to the Brucejack Mine Site in drums by truck. These will be unloaded using a fork lift and then be stored in a secure area. The lubricants will be dispensed using hose reels and barrel pumps in the maintenance shop areas.

Note that the Knipple Transfer Area will serve as a staging area for materials for transportation over the glacier to and from the Brucejack Mine Site, primarily by means of purpose-designed tracked vehicles.

Reagents

The reagents used in the process plant housed in the mill building will include:

- lime;
- potassium amyl xanthate (PAX);
- methyl isobutyl carbinol (MIBC);
- flocculants, antiscalant and flux (possibly borax ($\text{Na}_2\text{B}_4\text{O}_7$));
- sodium nitrate (NaNO_3);
- silica (SiO_2); and
- fluorspar (CaF_2).

All the reagents will be prepared in a separate reagent preparation and storage facility with containment. The reagent storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during operation. Reagents will be clearly labelled, and MSDSs will be readily available. An inventory will be maintained showing deliveries and consumption. All relevant staff will be trained regarding risks related to each reagent and the measures required for the safe handling, use, storage, and disposal of these, including emergency and spill cleanup procedures. Appropriate ventilation and fire and safety protection, including personal protection equipment, will be provided at the facility.

The liquid reagents will be added in their undiluted form to various process circuits via individual metering pumps.

Dry reagents will be packaged in large bulk bags that may weigh in the order of a tonne. They will be trucked to the Knipple Transfer Area in conventional transport trucks, transferred to purpose-designed tracked vehicles, and transported over the glacier to the Brucejack Mine Site for unloading at the reagent storage and make-up area.

The bags will then be emptied into mix tanks for subsequent pumping and distribution to the appropriate area in the process plant. All the solid type reagents will be mixed with fresh water to solution strength in the respective mixing tank and then stored in separate holding tanks before being added to various addition points by metering pumps.

Lime will be received by tanker truck and unloaded pneumatically. Lime requires handling and safety precautions due to its serious health hazard because of its caustic nature, risk of burns, and potential to cause irreversible injuries to the eyes. Lime is not generally regulated as a hazardous chemical during transport. Small spills may be cleaned up dry and returned to the process stream. Larger spills may require neutralization with a weak acid.

Flocculent will be dissolved, diluted to correct strength, and then added to various thickener feed wells by metering pumps.

29.7.4.2 Explosives

Given the current stage in the permitting process for the Project, this explosives component of the Hazardous Materials Management Plan is considered preliminary. Additional components in the final Hazardous Materials Management Plan will include:

- detailed plans of the individual explosives facilities on the site with specific locations of various explosive materials and products, and typical quantities within the facilities;
- locations and description of various services and connections to the explosives facilities, such as water, fuel, communications, etc.; and
- linkages to the Emergency Response Plan (Section 29.6) and Spill Prevention and Response Plan (Section 29.14) that will provide specific information concerning compatibility groups, emergency plans for various classes of explosive materials, criteria for initiation of emergency and evacuation plans, resources, detailed contact lists, reviews, and testing plans, etc.

Design Criteria

To ensure worker and public safety, design criteria for all manufacturing and storage facilities for explosives at the Project site will conform with the requirements of the *Explosives Act* (1985b), Ammonium Nitrate Storage Facilities Regulations (CRC, c 1145), Transportation of Dangerous Goods Regulations (SOR/2001-286), Guidelines for Bulk Explosives Facilities (NRCAN 2010), and the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008).

Safety Considerations

Pretium will be responsible for the safe management of explosives on the Project site or provide oversight should a third party be contracted to conduct operations using explosives. The Spill Prevention and Response Plan (Section 29.14) and the Emergency Response Plan (Section 29.6) will be

developed further as part of permitting and will include details on procedures for dealing with incidents involving explosives.

Construction Measures

During the Construction phase the existing exploration explosives magazines will continue to be used for the development of the underground works. Contractors completing the earthworks for pad construction for the mill building, water treatment building, camp facilities, and related excavations will supply and acquire permits for temporary explosives magazines. Similarly, contractors undertaking any required blasting for access road upgrades will supply and permit temporary explosives magazines.

Explosives required during Construction will be ammonium nitrate-based products such as the Senatel™ range of emulsion explosives. Packaged stick explosives are also likely to be used where emulsion is not appropriate. Ignition systems will include detonating cords, boosters, detonators, and connectors. Explosives will be stored in licensed magazines located in accordance with the *Explosives Act* (1985b) and criteria established by the NRCan Explosives Regulatory Division.

The explosives storage magazines will:

- be in the charge of an authorized person who will carry out weekly inspections of the magazine;
- be locked at all times, except when explosives are being moved, and only authorized person(s) will be in possession of the key;
- have an up-to-date inventory of contents in a special logbook, kept in the magazine, where all entries will be signed by the authorized person in charge;
- be kept clean, dry, and free from grit at all times;
- be kept free of broken explosives packages or spilled explosives and, when necessary, the shelves and floors will be treated with a suitable neutralizing agent to remove all traces of explosive substances;
- have their contents arranged in a tidy and organized manner, including any explosives returned from a workplace;
- not contain any exposed iron or steel except in fixtures; and
- have stock rotated to ensure that the oldest stock for each type and size of explosive will be used first.

Explosives and detonators will not be stored or transported together. Smoking will be prohibited while handling, transporting, or using explosives. Only persons with a valid or provisional blasting certificate will be permitted to conduct blasting operations. All transportation of explosives and detonators will be consistent with the Transportation of Dangerous Goods Regulations (SOR/2001-286).

Operational Measures

The same ammonium nitrate-based products, such as the Senatel™ range of emulsion explosives, will be used during the Operation phase to break rock for underground mining activities. Their transportation, storage, and use will be consistent with the requirements of the federal *Explosives Act* (1985b), *Transportation of Dangerous Goods Act* (1992) and the provincial Health, Safety and Reclamation Code for Mines in British Columbia.

At the Brucejack Mine Site, explosives consumption at full production is estimated to be 2.7 t/day of bulk emulsion. Two emulsion bays will each contain two 6,000-L storage tanks and a storage area. The

entrance to the bays will be controlled with a rollup door and a man door. Two emulsion pumps will be used to transfer from the full tank to the empty one in the bay. Consumption will average three tanks per week.

The underground cap and powder magazine will provide storage for caps and powder on wooden shelves. A concrete wall with a steel door will separate this bay from the rest of the mine works.

Packaged explosives will be used for blasting underground where emulsion is not appropriate. Two pre-fabricated shipping container-type structures will be used for packaged explosives storage on the surface and will be locked at all times to prevent unauthorized access. The magazines will be sited and constructed to meet both federal and provincial regulatory requirements and Pretium will need to seek a variance from the current permit for exploratory work. Access to the explosives storage will be by road and the facility will be controlled by a locked gate.

A pre-fabricated shipping container-type structure on the surface will house the detonator magazine storage and will be locked at all times to prevent unauthorized access. Access to the detonator magazine storage will be by road, and the facility will be controlled by a locked gate. Neither the surface explosives nor detonator magazines will be located in avalanche hazard areas.

Closure Measures

Very limited volumes of explosives will be required during the Closure phase of the Project for such activities as breaking up concrete foundations or for limited slope re-contouring. Management of explosives will continue to be the same as during the Operation phase. When explosives are no longer required, the explosives storage areas will be deactivated, the sites ripped and capped with available overburden and topsoil, and seeded. The related access roads will be deactivated when they are no longer required for maintenance of the sites.

Post-closure Measures

Explosives use is not foreseen during Post-closure.

29.7.5 Monitoring Program

Storage facilities for dangerous goods and hazardous materials will be inspected regularly for leaks or non-compliance with policies, plans, and procedures. Inspections will include tanks, pipelines, connections, valves, gauges and meters, sumps and separators, and inventory records. Inspections will be recorded in a systematic manner and such records will be filed with the Mine Manager.

With reference to the management of explosives, manifests for delivered explosives components and products will be reviewed by the contractor to ensure that all explosives and related materials are accounted for. Similarly, magazine inventories and logbooks will be maintained and any deficiencies reported to the Mine Manager or appointed designates immediately. Blast noise levels will also be monitored as described in the Noise Management Plan (Section 29.11).

In the event of upset conditions related to hazardous materials, dangerous goods, or explosives, the Emergency Response Plan Coordinator will launch an investigation of the incident. Together with the Emergency Response Planning Committee, key members of the Project Management Team, and relevant health and safety personnel (as appropriate), a joint incident investigation and root cause analysis will be undertaken. The findings of the investigation will serve to modify the Hazardous Materials Management Plan if the investigation shows that shortcomings pertained. Such modifications will be subject to the regular annual review of the plan, to ensure optimal effectiveness.

29.7.6 Work Planning and Schedule

The Environmental Manager will disseminate the performance objectives and protection measures related to hazardous materials management to all Project personnel that have a direct or indirect influence on such management during the Construction, Operation, Closure, and Post-closure activities. Communication of the performance objectives and their acceptance as performance indicators by responsible individuals will be recorded. Performance against the indicators will then be tracked and reported on annually.

Personnel requiring specific training in the management of hazardous materials will be identified by Pretivm and will receive such training prior to assuming any related responsibility, or within a reasonable time if their current level of training allows it to be delayed. All employees will be made aware of the general issues and concerns surrounding the management of hazardous materials as part of their routine health and safety induction and training.

29.7.7 Reporting Requirements

29.7.7.1 Reports

Routine recording according to a schedule of monitoring inspections will be undertaken in a structured manner such that the storage and use of hazardous materials can be accurately tracked. Inspections will cover on-site facilities such as tanks, pipelines, connections, valves, gauges and meters, sumps and separators, as well as related documentation such as inventories, manifests, and logbooks. The frequency of scheduled inspections will be dictated by the relevant policies, plans, and procedures.

The Hazardous Materials Management Plan will be subjected to an annual review to ensure optimal effectiveness.

Emergency or spill incidents will be reported per the requirements of the Emergency Response Plan (Section 29.6) and Spill Prevention and Response Plan (Section 29.14).

29.7.7.2 Reporting Responsibilities

The Project's Environmental Manager will ultimately be responsible for monitoring and reporting on the management of hazardous materials, dangerous goods, and explosives. Pretivm will be responsible for ensuring that the performance objectives and protection measures are achieved.

29.8 HERITAGE MANAGEMENT PLAN

29.8.1 Purpose

The purpose of the Heritage Management Plan (the Plan) is to mitigate potential effects and detail the protection for heritage resources that have been identified within or adjacent to the Project footprint, as well as heritage resources that may be encountered during the course of the Construction, Operation, Closure, and Post-closure phases of the Project. The Plan has been prepared as part of the Project's Environmental Assessment Application and follows the AIR Guidelines (BC EAO 2014) set out in collaboration with the BC Environmental Assessment Office and the Working Group for the Project. The Plan will be reviewed and updated on an as-needed basis as the Project proceeds through detailed design and the Construction, Operation, Closure, and Post-closure phases.

29.8.2 Regulatory and Policy Framework

The BC *Environmental Assessment Act* (2002a) considers effects of development projects on heritage resources. Similarly, the CEAA 2012 considers indirect effects of any change that a development project may cause in the environment on any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance. As such, heritage resources are VCs (described further in Section 22.4), including protected archaeological, protected heritage, and protected paleontological resources. Legislation pertaining to the Environmental Assessment Application, as well as policies, standards, and guidelines pertaining to the protection of heritage resources are presented in this section and are summarized in Table 22.2-1.

In BC, the primary legislation protecting archaeological resources (both recorded and unrecorded) is the *Heritage Conservation Act* (1996f), which protects all sites predating 1846 CE on Crown and private land. Sites such as burials and Aboriginal rock art sites are protected regardless of age. The Archaeology Branch of the Ministry of Forests, Lands and Natural Resource Operations (Archaeology Branch) is the provincial ministry responsible for the administration of the *Heritage Conservation Act* (1996f), issuing permits for heritage inspection and site alterations, and maintaining a database of known archaeological sites. Burials and gravesites are also protected in British Columbia by the *Cremation, Interment, and Funeral Services Act* (2004).

29.8.3 Performance Objectives

Archaeological sites in BC are afforded protection by the legislation mentioned above, which includes previously known and as-yet unrecorded sites. Consequently, developments such as the project in question that involve excavating, moving, or disturbing soils may affect undiscovered archaeological sites. Certain types of sites, such as Culturally Modified Trees (CMT), can also be affected by logging or the clearing of vegetation. For the Project, it is anticipated that earth movement (blasting, cutting and filling, road building, landscaping) and vegetation clearing related to road and transmission line construction, will be the principle types of disturbance. As such, unknown archaeological sites that may be present within or adjacent to the proposed Project developments could be adversely affected.

For all archaeological sites, whether known or as-yet unrecorded, which are within or adjacent to the Project footprint, avoidance during Construction, Operation, and Closure is the preferred management and protection measure. This can be achieved by adaptive Project redesign or by considering Project alternatives. Where Project redesign or use of Project alternatives are not possible for archaeological sites that are discovered during Construction, Operation, or Closure phases, the management and mitigation strategies outlined in Section 29.8.4 will be followed.

Project personnel will thus be trained to use the Heritage Chance Find Procedure and the protocols and steps outlined in the procedure will be followed should heritage resources be encountered during Project activities. This procedure is discussed further in Section 29.8.5.

29.8.4 Environmental Protection Measures

This section includes an inventory of known protected heritage resources within the Project's Regional Study Area (RSA) as well as those sites located within the Local Study Area (LSA). The RSA includes an area from Highway 37 to Sulphurets Creek, and takes in portions of the Bowser River, Sulphurets Creek, and Treaty Creek watersheds; this area was based on the permitted area for the *Heritage Conservation Act* Heritage Inspection Permit 2013-0174. The LSA includes a 1-km buffer on either side of the proposed Project footprint that takes in the access road from Highway 37 to the current Brucejack exploration camp, proposed Project infrastructure related to the development of the Brucejack deposit, and a transmission line route that would provide power from the Long Lake Hydroelectric Project being built near the Premier Mine north of Stewart, BC.

Section 29.8.4.1 provides general guidance pertaining to the management and mitigation for archaeological sites in relation to the Project. These general strategies are applied in a more site-specific manner in Sections 29.8.4.2 and 29.8.4.3 and chance finds that may be discovered due to Project footprint revisions are discussed in Section 29.8.4.4.

The Project footprint considered in this Plan as well as the RSA and LSA are illustrated in Figure 29.8-1. Due to the sensitive nature of archaeological sites, locational information is not provided in this document but will be illustrated on construction maps. Sites that are within the RSA but are more than 1,000 m from the Project footprint are outlined for reference in Section 29.8.4.2 but are not considered further in this plan. Should Project footprint components be revised during the course of Construction or Operation, the site inventory and construction maps showing the locations of these sites will be consulted to determine if any known archaeological sites may be in conflict.

29.8.4.1 General Heritage Management and Mitigation Strategies

Project activities associated with the movement, excavation, or disturbance of soil, such as clearing and grading roads, building foundations and footings, earthworks, excavations, and blasting, have the potential to cause direct effects to protected heritage sites within the LSA, if present. In addition, protected heritage sites can be impacted by increased human presence in the area, as sites in this region often contain cultural materials present on the surface. Therefore, several levels of direct and indirect impacts have been considered. Where a site is located within:

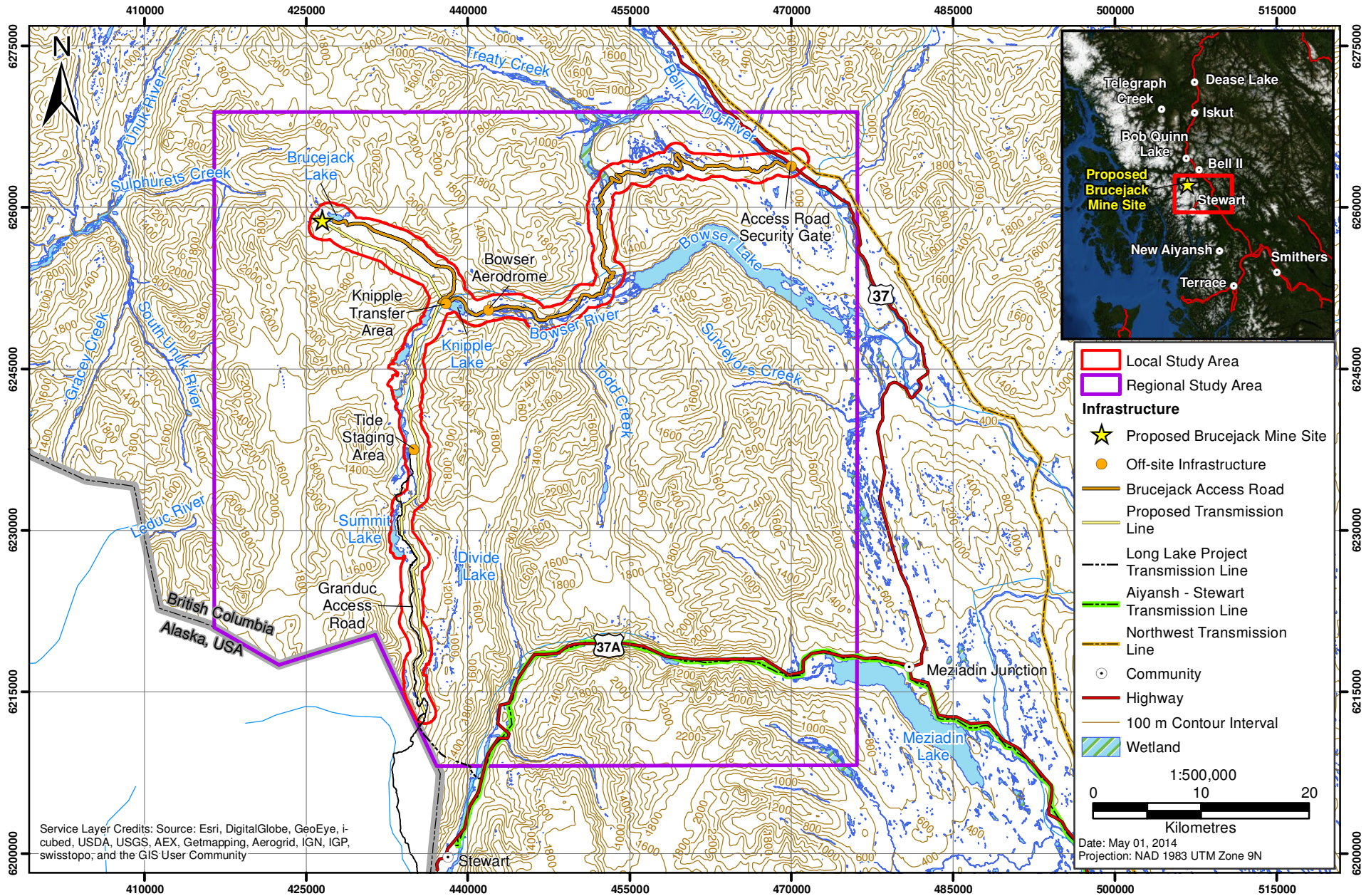
- **0 to 50 m** of ground-altering activities, direct impacts by construction with a high potential for adverse impacts are anticipated;
- **50 to 500 m** from Project components, indirect impacts through increased human presence during Construction, Operation, and Closure, with a low to moderate potential for adverse impacts are anticipated;
- **500 to 1,000 m** from Project components, no impacts by the Project are anticipated and therefore are not considered.

Where sites fall within **0 to 50 m** of proposed ground-altering activities, the risk of direct impacts from construction activities is high. Typically, site avoidance through Project design is the recommended management option, with the areas marked as “No Work Zones” on development maps. An environmental staff member will be present during construction activities near such sites and/or site boundaries will be flagged or fenced to limit any indirect impacts. Caution will be exercised during construction activities near the site. If avoidance is not possible, mitigation will be conducted prior to Project activities. Mitigation measures will be determined in consultation with the British Columbia Archaeological Branch. Mitigation may involve monitoring, detailed mapping, photography, and/or systematic data recovery through surface collection and/or controlled excavations of evaluative units if subsurface deposits are present. See Section 29.8.7.1 for additional reporting details.

Where sites fall within **50 to 500 m** from Project components, the risk of indirect impacts through increased human presence during Construction, Operation, and Closure is considered to be moderate. These areas will be marked as “No Work Zones” on development maps. An environmental staff member will be present during construction activities near such sites and site boundaries will be flagged or fenced to limit any indirect impacts. Caution will be exercised during construction activities near the site. Sites may be inspected on a case-by-case basis to determine if impacts have occurred. If direct impacts at these sites are anticipated during construction and/or have occurred, mitigation measures will be required (see above). Reporting pertaining to archaeological monitoring activities is described further in Section 29.8.7.2.

Figure 29.8-1

Regional and Local Study Areas for Heritage Resources in the Brucejack Gold Mine Project



Sites that fall within **500 to 1,000 m** from Project components are at low risk of direct and/or indirect impacts from construction and/or human presence, unless the Project footprint is revised during Construction and/or Operation. Therefore, sites beyond 500 m of proposed infrastructure are not discussed further in this plan.

Note that these stipulations are generic and would only be activated if heritage resources were uncovered or discovered during Project activities in the area. Specific management and mitigations measures for known heritage resources are described in Section 29.8.4.2 and 29.8.4.3.

29.8.4.2 Protected Heritage Sites within the RSA

There are ten heritage sites within the Project’s RSA which are documented in the Archaeology Branch’s Archaeological Site Inventory database. These sites, their general locations, and their protection status are summarized in Table 29.8-1. Four of these sites fall within the LSA and are discussed further in Section 29.8.4.3.

Table 29.8-1. Protected Heritage Sites within the RSA

Site	Antiquity	Site Type	General Location	Overall Site Significance Evaluation	Distance to Closest Project Component	Protection Status & Legislation
HbTm-1	Pre-contact	Prehistoric Lithic Scatter	Summit Lake	Low	346 m	Protected by the HCA
HbTm-2	Recent Historic	Aircraft Wreckage (associated with a movie production)	Summit Lake	Low	533 m	Legacy Site - Not protected by the HCA
HcTj-1	Post-contact	Human remains (grave), cabin	Bowser Lake	High	8,927 m	Protected by the HCA
HcTk-1	Post-contact	Culturally Modified Trees	Bowser Lake	Low	15 m	Protected by the HCA
HcTn-1	Pre-contact	Prehistoric Lithic Scatter	Brucejack Lake	Moderate	675 m	Legacy Site - Not protected by the HCA
HcTo-1	Pre-contact	Prehistoric lithic scatter	Sulphurets Creek	Moderate	9,939 m	Protected by the HCA
HdTj-1	n/a	Treaty Creek Site (<i>Nisga’a Final Agreement</i>)	Treaty Creek	High	4,659 m	Protected by the HCA
HdTn-1	Pre-contact	Prehistoric Lithic scatter	Mitchell Creek	Low	8,368 m	Protected by the HCA
HdTn-2	Pre-contact	Prehistoric Lithic scatter	Mitchell Creek	Low	8,432 m	Protected by the HCA
HdTo-7	Pre-contact	Prehistoric Lithic scatter	Sulphurets Creek	Moderate	10,377 m	Protected by the HCA

29.8.4.3 Protected Heritage Sites within the LSA and Site Specific Effects, Management, and Mitigation

There are four heritage sites documented in the BC Archaeology Branch’s Archaeological Site Inventory database that are located within the Project’s LSA, within 1,000 m of the Project footprint: HbTm-1, HbTm-2, HcTk-1, and HcTn-1. Two of these sites, HbTm-2 and HcTn-1, have been designated as Legacy Sites by the Archaeology Branch and are no longer protected by the *Heritage Conservation Act* (1996f); they will not be discussed further.

HbTm-1 is a heritage site protected by the *Heritage Conservation Act* (1996f), which falls within 50 to 500 m of the Project footprint. The site is approximately 346 m west of the Brucejack Transmission Line, on the western side of the Granduc Access Road near Summit Lake. The site is at low risk of indirect impacts from increased human presence during construction activities. The site area will be marked as a “No Work Zone” on development maps. The site may be inspected to determine if impacts have occurred following construction. If direct impacts occur during construction or are anticipated prior to construction, mitigation measures will be implemented (see Section 29.8.4.1).

HcTk-1 is a heritage site protected by the *Heritage Conservation Act* (1996f), which falls within 0 to 50 m of the Project footprint. The site is approximately 15 m south of the Brucejack Access Road, located west of the northwestern corner of Bowser Lake and east of Scott Creek. The site is at risk of direct impacts from use and maintenance of the Brucejack Access Road. Continued avoidance of the site is recommended and the site area will be marked as a “No Work Zone” on maintenance maps/documents and the trees marked as such. If avoidance is not possible and/or if the trees become a safety hazard, mitigation of the site should be conducted. Mitigation measures will be determined in consultation with the British Columbia Archaeological Branch (see Section 29.8.4.1).

29.8.4.4 Revisions to Project Footprint during Construction, Operation, and Closure

Any sites discovered as a result of revisions to the Project footprint during Construction, Operation, and Closure within 1,000 m of Project impacts will be subject to the same level of management and mitigation afforded to protected sites outlined in this plan. Should they be found, such sites will be inspected by an Archaeologist and documented under a *Heritage Conservation Act* Heritage Inspection Permit, issued by the Archaeology Branch. Reporting pertaining to chance find sites is described further in Sections 29.8.5.3 and 29.8.7.2.

29.8.5 Monitoring Program

Site monitoring and/or site flagging during Construction, Operation, and Closure is identified in Section 29.8.4 of this Plan for protected heritage sites that are located within 50 to 500 m of any Project infrastructure (Figure 29.8-1). This section describes how and when site monitoring and site flagging will take place at the site previously identified (HbTm-1), as well as the use of the Project’s Heritage Chance Find Procedure for new site discoveries.

29.8.5.1 Site Monitoring and Flagging

Construction occurring near protected heritage sites that are within 50 to 500 m of the Project footprint may have such sites flagged or temporarily fenced prior to construction to serve as a visible barrier. However, the one known site is adjacent to Granduc road and accessible to the public; flagging or fencing may attract unwanted public attention to the site. Development maps will clearly indicate the location of archaeological site boundaries in relation to the Project footprint components. An environmental staff member will watch for archaeological site impacts or situations where construction activities will occur less than 50 m from a site. Should impacts be anticipated or found to occur less than 50 m from a site, the Project Archaeologist will be contacted to determine if mitigation measures, which may include systematic data recovery, are required.

Construction Monitoring

Protected heritage sites that are within 50 to 500 m of the Project footprint, and may be impacted by ongoing Project activities, will have the environmental personnel check on these sites on an annual basis to determine that they remain intact and unaffected by the Project. Should impacts be observed at archaeological sites, the Project Archaeologist and the Archaeology Branch will be contacted and

notified of the impacts. Post-impact mitigation plans will be developed in consultation with the Archaeology Branch on a case-by-case basis.

Boundary Flagging/Fencing

Where construction activities will take place in close proximity to protected heritage sites, between 50 to 500 m, a physical barrier may be established around a site, the boundaries flagged or fenced. Typically, site boundary flagging involves the use of rebar or wooden stakes with snow fencing or other visible barriers, running around the outside of the site boundary. Similarly, brightly coloured stakes installed at intervals around the boundaries of the site can be used if snow fencing or other visible barriers are impractical or constitute a barrier for wildlife. In either case, fencing will be visible above the anticipated snowline, particularly where sites are located adjacent to areas where construction will be undertaken when snow is still present.

It is best practice to have site boundaries marked for flagging/fencing by the environmental personnel or an Archaeologist in order to limit impacts to the site and to avoid any sensitive areas that may be present. Flagging/fencing of archaeological site boundaries will take place prior to construction during snow-free conditions, where possible, and when the ground is not frozen. Archaeological sites in the region typically contain surface and subsurface scatters of artifacts; therefore installation of flagging/fencing is best conducted when the surface of the site is visible to prevent any unnecessary damage. Installation of flagging/fencing when the ground is not frozen is recommended for ease of installation where rebar or wooden stakes will be used.

Once a site has been flagged/fenced, it will be visited during and after construction activities to determine if impacts have occurred. Environmental personnel will also check on and maintain these flagged/fenced boundaries if future construction or other development activities are planned nearby in the future.

29.8.5.2 Field Notes, Photographs, Logistics, and Management

The environmental personnel will document, by means of photographs and field notes, the type of construction and disturbance occurring near a site, weather conditions, personnel present, and other pertinent details. It is imperative that detailed field notes are recorded during monitoring activities. This information will be summarized in a Heritage Site Monitoring Report to be provided to the Project Archaeologist for inclusion in the permit report to the Archaeology Branch.

Field Notes

The following information will be recorded in the field during site monitoring and/or flagging/fencing activities for sites known to occur within 50 to 500 m from construction activities, or any new site discovered during Construction, Operation, or Closure activities:

- Borden number (i.e., HbTm-1) of the site being monitored;
- photographs in cardinal directions (N, E, S, W) of the site and photographs illustrating any construction or other activities being conducted nearby;
- all photograph numbers, direction of image, and a description of each image must be recorded in the field notes;
- date and time the monitoring was undertaken and completed at the site;
- nature of construction or other activities being undertaken;
- distance from the site to construction or other activities being conducted;

- GPS location and estimated unit error;
- personnel involved in construction activities and the name(s) of the environmental personnel;
- general observations of the condition of the site;
- if fencing/flagging is installed at the site, a detailed list of materials used and general methods employed will be documented; and
- weather conditions at the site at the time of monitoring.

It is imperative that photographs showing detail are taken and that detailed field notes are recorded during site monitoring.

29.8.5.3 *Heritage Chance Find Procedure*

Pretivm will arrange for site orientation and training of all employees and on-site personnel/contractors with regards to compliance with the *Heritage Conservation Act* (1996f) and the use of the Project's Heritage Chance Find Procedure (ERM Rescan 2014b). Training and site orientation will be provided for all new employees during their induction. This training will focus on not disturbing known heritage sites (including protected archaeological, historic, and paleontological sites), the procedure in place for responding to newly identified sites, as outlined in the Project's Heritage Chance Find Procedure, and how to report these sites or observed site impacts. Copies of the Project's Chance Find Procedure will be kept on-site for reference and on file by Pretivm. In general, if personnel suspect archaeological, historic, or paleontological materials or human remains have been discovered they will:

- Stop all work in the area to reduce/minimize impacts to the site.
- Leave the material in place and protect and/or mark the area around the site; do not disturb or collect any heritage material or human remains.
- Report the discovery to their supervisor. The supervisor will inform the Environmental Manager and Mine Manager. The Mine Manager and Project Archaeologist will inform the Archaeology Branch and local Aboriginal organizations of the discovery.

29.8.6 **Work Planning and Schedule**

As outlined in Section 29.8.4, mitigation, monitoring, and management of protected heritage resources in the Project will be largely scheduled in relation to planned construction activities that will occur in proximity to sites.

Project activities that will take place within 0 to 50 m of protected heritage sites will require mitigation to take place prior to Project activities. Such mitigation would be conducted under a *Heritage Conservation Act* Heritage Inspection Permit and may involve detailed mapping, photography, and systematic data recovery. Reporting the results of mitigation would meet the submission date outlined in the permit application. Approval for work to proceed in the area will be given by the Archaeology Branch to allow for impacts within the site boundaries. See Section 29.8.7.1 for additional reporting details.

Project activities that will take place within 50 to 500 m of protected heritage sites may be subject to either site boundary fencing/flagging or monitoring. If site fencing/flagging is used, it will need to be installed during snow-free conditions when the ground is not frozen when possible, prior to construction activities. Site monitoring will be conducted during construction activities that are taking

place in close proximity to archaeological sites. In addition, site monitoring/inspection will also be conducted following construction activities to determine that no impacts to the site occurred.

The Project's Heritage Chance Find Procedure will be used on an as-needed basis during the course of Construction, Operation, and Closure. Should heritage materials be encountered, the procedure will be followed. See Section 29.8.5.3 for additional information.

29.8.7 Reporting Requirements

29.8.7.1 Mitigation Reporting

For protected heritage sites that are within 0 to 50 m of Project impacts, mitigation will be conducted prior to construction (see Section 29.8.4). BC Site Inventory Forms must be updated detailing the mitigation measures and submitted to the Archaeology Branch for inclusion in the Archaeology Branch's Archaeological Site Inventory database. Reporting detailing the results of mitigation measures will be included in a *Heritage Conservation Act* Heritage Inspection Permit, issued to the Project Archaeologist by the Archaeology Branch. The permit application will specify the delivery date of the report to the Archaeology Branch as well as Aboriginal groups who will require a copy of the report for reference, and the repository that will curate any collected artifacts and all associated field notes, artifact catalogues, and reporting.

Reporting relating to mitigation will be completed and will meet the submission date outlined in the permit application. Approval to proceed in the area of the site is given by the Archaeology Branch, to allow for work to be conducted within the site boundaries. A report will be submitted to the Archaeology Branch, outlining the work carried out within the site boundaries.

29.8.7.2 Monitoring Reporting

Pretivm, in collaboration with the Project Archaeologist, will coordinate monitoring and site inspection and the documentation of chance finds. Pretivm will maintain documentation regarding monitoring and any heritage sites that may be discovered during the course of Construction and Operation, and will report any impact to heritage sites to the Project Archaeologist who will report as appropriate to the Archaeology Branch (see Section 29.8.5).

Monitoring activities, outlined in Section 29.8.5, will be summarized in an Archaeological Site Monitoring Report to be provided to the Project Archaeologist who will report as appropriate to the Archaeology Branch.

29.9 INVASIVE PLANTS MANAGEMENT PLAN

29.9.1 Purpose

The purpose of the Invasive Plant Management Plan is to maintain ecosystem functions in order to avoid the introduction and spread of invasive plants resulting from the Construction, Operation, Closure, and Post-closure activities of the Project. This plan provides strategies and mitigation measures for the ongoing management of invasive plants at the Project site and is based on the guiding principles outlined by:

- Northwest Invasive Plant Council (Northwest Invasive Plant Council 2012);
- Invasive Species Council (Invasive Species Council of British Columbia 2008-2013);

- *Pest Management Plan (PMP) for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia* (BC MOFR 2010b); and
- *Invasive Alien Plant Program: Reference Guide* (BC MOFR 2010a).

29.9.2 Regulatory and Policy Framework

The following legislation, guidelines, management plans, and governing agencies are applicable or of relevance to the provincial management of invasive plant species:

- *Forest and Range Practices Act* (2002b). This act specifies that activities should not encourage the establishment or spread of invasive plants.
- *Weed Control Act* (1996k). Administered by the Ministry of Agriculture, this act imposes a duty on all land occupiers to control designated noxious plants; they may not be introduced or spread to unaffected areas.
- *Seeds Act* (1985h). Regulates the grading of seed sold, imported, and exported in Canada, requiring that seed in Canada is free of prohibited noxious weeds and ensuring standards of purity.
- *Species at Risk Act* (SARA; 2002c). Specifies that invasive plant species that threaten rare wildlife species' habitat must be controlled.
- *BC Integrated Pest Management Act* (2003b). This act regulates the use of herbicides to control weeds (invasive plants).
- *Cassiar Iskut-Stikine Land and Resource Management Plan* (LRMP; BC ILMB 2000). Recommends measures be undertaken in the short- and long-term to control existing alien plants and to monitor and prevent the introduction of other alien species, as presented in the *Weed Control Plan* for the LRMP area.
- *Ministry of Forests and Range (2010): PMP for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia* (BC MOFR 2010b). This plan, prepared in association with the Ministries of Environment, Agriculture and Lands, and Transportation and Infrastructure, "...provides the ability to meet obligations for invasive plant management as outlined in the *Weed Control Act* (1996k) and the *Forest and Range Practices Act* (2002b) and facilitates the Government's partnerships in invasive plant management as outlined in the invasive plant management strategies developed by the Northwest Invasive Plant Council, NWIPC, and the Northeast Invasive Plant Committee, NEIPC. It is developed in accordance with the *Integrated Pest Management Act* (2003b) and accompanying regulations."
- *Ministry of Forests and Range (2010): The Invasive Alien Plant Program: Reference Guide* (BC MOFR 2010a). A resource manual for all agencies and partners involved in invasive plant management in British Columbia.
- *Invasive Species Council of British Columbia* (ISCBC). This registered charity has a primary goal of educating the public and professionals about invasive species and their risk to ecosystems and economies. Relevant outreach materials include a variety of brochures, pamphlets, and booklets, including the T.I.P.S. series.
- *Northwest Invasive Plant Council* (NWIPC). This group, comprising of agencies, organizations, and individuals, identifies plant species of regional significance or concern. Planning and strategy documents available through the council included the NWIPC 2013 Plan and Profile, and the *Invasive Plant Strategy for BC*.

29.9.3 Performance Objectives

The Invasive Plant Management Plan is designed to provide environmentally responsible, realistic, and operationally feasible guidance for ecosystem, soils, and vegetation management related to invasive plants.

The performance objective of the invasive plant management plan is to prevent invasive plant establishment through maintenance of ecosystem integrity, such that the composition, structure, function and resilience are retained.

This will be done through:

- avoiding the introduction and spread of invasive plant during all phases;
- removing invasive plants that are present at site or become introduced; and
- restoring ecosystem integrity at sites altered by Project activities.

29.9.4 Environmental Protection Measures

General Measures

An ecosystem-based approach to vegetation and soil management is required to effectively prevent the introduction and spread of invasive plants related to the Project. Ecosystems are complex interactions of abiotic (i.e., snow duration, recent glacial history, natural disturbance, etc.) and biotic components (i.e., nutrient-fixing mycorrhizae, disease, pollination, competition, etc.) that result in unique species composition, structure, and functions. Minimizing effects to these ecological processes and ultimately ecosystem integrity will reduce the likelihood of invasive plant establishment and spread. Impacts to ecosystem integrity will be minimized through the following actions:

- Minimization of all clearing dimensions during construction activities (including upgrades to the existing exploration access road) as invasive species thrive in recently disturbed areas where there is little shade and competition from other plant species.
- Minimization of soil degradation i.e., erosion, by adhering to the Terrain and Soils Management and Monitoring Plan (ERM Rescan 2013). Specifically, soil will be salvaged during appropriate weather conditions, transported to stockpiles within appropriate time frames of salvage, and controlled for surface erosion.
- Vehicle inspections for target invasive plants at designated Project checkpoints. Project vehicles (i.e., bulldozers, mine trucks excavators, etc.) transported from other areas will be thoroughly inspected, target species will be removed (if present), and vehicles will be properly washed, if the inspection indicates washing is required, at an appropriate location where the removal of dirt or plants can be effectively achieved without harm to natural ecosystems.
- Detection and eradication of invasive plants, through the implementation of an effective early detection system, inventory, control, and monitoring program (detailed in the following sections). Treatment options include mechanical, chemical, biological or a combination of these methods using an ecology-based approach, commonly referred to as integrated pest management. The ecological cause (e.g., disturbance, favourable light conditions, and compacted soil) and likely succession of the invasive plant population will be used to help select an ecologically appropriate treatment option(s).
- Follow-up monitoring of controlled sites will occur to evaluate efficacy of treatment and requirements for follow-up treatment.

- Appropriate education and training for employees and contractors, including those responsible for moving equipment to the site, will be provided in a series of fact sheets or small handbook outlining what invasive plants are, why they matter, and how to avoid introduction and spread of invasive plants during regular operations. This information will be prepared and made available to all employees on site. Invasive species references currently available for use include, but are not limited to the following:
 - *Best Practices for Managing Invasive Plants Along Roadsides: A Pocket Guide for British Columbia's Maintenance Contractors* (Invasive Species Council of British Columbia 2008-2013);
 - Invasive Species Council of BC website (T.I.P.S. brochures); identification of key plant species, with pictures and brief habitat and management information (Invasive Species Council of British Columbia 2008-2013);
 - *Forest and Range Practices Act (FRPA; 2002b): Invasive Plants Identification Field Guide* (Province of BC 2008); developed to help identify the FRPA-listed invasive plants throughout BC; also provides basic habitat and impact information;
 - *Field Guide to Noxious Weeds and Other Selected Invasive Plants of British Columbia* (Cranston, Ralph, and Wikeem 2002); and
 - *Guide to Weeds in British Columbia* (BC Ministry of Agriculture, Food and Fisheries 2002);
- Enhanced training in existing provincial legislation, ecology, available data entry tools, and reporting programs related to invasive plant management will be provided, if required, to the Project's Environmental Manager.

The following section outlines specific measures to address invasive plant populations in the event that they occur.

Treatment and Control

In the event invasive plants are identified on site, the NWIPC or an appropriate authority will be consulted to determine if control or monitoring is required. If control is required, appropriate treatment options and timing will be addressed. The appropriate treatment for invasive plants depends on the species involved, site conditions, and the size of infestation. Invasive plant species vary in their aggressiveness and ability to dominate a site, so some are inherently easier to eradicate than others. Larger infestations are also more difficult to control than smaller ones. The NWIPC ranks species and site conditions, and provides a guide for determining if, when, and how to control different invasive plants in northwest BC (NWIPC 2012). Pretium will work with the NWIPC (and/or the Invasive Plant Council, depending on availability) to determine a species and site-specific best treatment option for the invasive plant population.

Potential treatment options include mechanical, biological, and chemical methods. Mechanical control adopts physical means of removal, such as pulling by hand. Biological control uses living organisms, such as insects, to control pest populations of invasive plants, and chemical control uses herbicides to reduce and eradicate plant populations.

If herbicide use is deemed a recommended treatment, the *Handbook for Pesticide Applicators and Dispensers* (BC MOE 2005) provides detailed methodology for treatment activities and includes measures (including designation of pesticide-free and no-treatment zones) to protect waterbodies and riparian areas. To the extent possible, approved herbicides will be applied using spot-control methods rather than broad spraying techniques to minimize adverse effects to the surrounding environment.

Further details regarding control methods, including legislation and site-specific use of herbicides (from storage and transport to application and disposal), is available within the *PMP for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia* (BC MOFR 2010b).

29.9.5 Monitoring Program

The aim of the Monitoring Program is to evaluate and document if the Invasive Plant Management Plan is successfully preventing the introduction and spread of invasive plants resulting from the Construction, Operation, Closure, and Post-closure activities of the Project.

General Mine Site

In general, monitoring will be on an observational basis with different parts of the mine covered each year, with the entire mine covered over two years. A trained observer should walk high-risk areas based on an "intuitive" sampling method focused on areas of greater risk of harbouring invasive species. These include: disturbed areas, bare soils, areas with transported fresh soils, and areas with high traffic, such as parking lots, walkways, muster areas, recreational areas, etc.

While the general Mine Site will be evaluated with a general survey for invasive species. Specific areas will require more systematic sampling. These are listed below.

Cleared Sites

Ideally, clear sites are to be re-vegetated:

1. with seeds (and/or plants) suitable for the local area and ecosystems; and
2. during the appropriate growing season and conditions to ensure maximum survival rate and to avoid establishment of invasive plants.

Monitoring of cleared sites will be conducted every second year (biennial). If follow-up treatments are required more frequent monitoring may ensue to evaluate treatment results. This information will be collected using a monitoring/reporting form designed specifically for the Project. This will facilitate on-site "learning by doing".

Roads

Biennial monitoring will occur along the Brucejack Access Road and at the Brucejack Mine Site to determine the presence/absence of invasive plants. The timing of the surveys will be determined by the Environmental Manager (or designated qualified personnel) based on plant phenology (e.g., timing of biological activities such as flowering, propagation, and seed dispersion).

If invasive plants are observed, information will be collected to help determine appropriate future actions. Recorded information includes: ecosystem type, species present, soil texture, species density and distribution, proximity to water, structure, elevation, slope, and any other characteristics that may contribute to the way in which the site is managed.

Monitoring Forms

Monitoring will be documented using one of the Invasive Alien Plant Program (IAPP) forms, available through the Ministry of Forest, Lands and Natural Resources (BCMFLNRO 2013) to ensure that the data is collected in accordance with the required data fields for the provincial IAPP database resource.

29.9.6 Work Planning and Schedule

The Environmental Manager (or designated qualified staff) will disseminate the performance objectives and actions with all Project personnel that have the potential to directly or indirectly influence vegetation, soils, or ecosystems on site during the Construction, Operation, Closure, and Post-closure activities. Communication of this information and sign-off by individuals will be recorded, and tracked as a key performance indicator.

Employees participating in invasive plant education and training initiatives will be identified by Pretivm and will receive training within the first year of employment. All employees will be made aware of the general issues and concerns surrounding invasive plants. Fact sheets describing various invasive plant species of concern will be made available to all Pretivm employees working at the Project site.

Monitoring will occur biennially (between June and September) during Construction, Operation, and Closure. Monitoring frequency during Operation will be reviewed after the first scheduled monitoring cycle. Additional monitoring schedules will be determined for the Post-closure depending on the amount of ground disturbance activities.

If herbicide treatment is required, it will be applied before the flowering stage (early spring) when plants are most susceptible (BC MOE 2005). A minimum of two weeks between treatments will be observed (BC MFLNRO 2013). Treatments applied after flowering (autumn) will involve the removal and disposal of seed heads to an appropriate waste disposal location.

29.9.7 Reporting Requirements

Annual reporting of the environmental monitoring inspection reports will include a description of the following:

- Records of inventory, treatment, monitoring, and restoration activities will be summarized into the *Mines Act* annual reclamation reporting requirements. A photographic record of invasive species surveyed locations as well as a copy of all data forms filled in for that year will be included in the report. Collectively, this information will be used as a means of tracking progress and determining future management activities.
- Quality assurance and quality control protocols employed to ensure data accuracy (e.g., all invasive plant species names were entered correctly according to the most current accepted names for any one taxon); all GPS UTM coordinates were entered correctly (checked against the field plot card); and no blanks or duplicates in any pertinent database fields (e.g., site number or name, photo number, or UTM coordinates).
- Assessment of the effectiveness of the inventory, treatment, and monitoring methodologies and actions taken to improve the program if relevant.
- Identification of any emerging negative environmental trends likely attributable to the Project.
- Proposed revisions to the Invasive Plant Management Plan to address emerging negative trends, or to adjust monitoring programs, if required.

To further develop the provincial invasive species database, occurrences will be entered into the “Report-a-Weed” Program, a provincial online mapping and reporting tool associated with the IAPP Application within the same year as the surveys. Once the data (report) are entered, they are automatically compared to known locations of the reported species in the IAPP Application, and are then sent directly to a provincial Invasive Plant Specialist for the region.

The Project's Environmental Manager will ultimately be responsible for the development, implementation, and monitoring of the Invasive Plant Management Plan and its reporting.

29.10 ML/ARD MANAGEMENT

29.10.1 Introduction

The proposed ML/ARD Management Plan for the Project involves the prediction, monitoring, prevention and mitigation of ML/ARD and applies to the Construction, Operation, Closure, and Post-closure phases of the Project. The main objective of the plan is to prevent or mitigate potentially adverse effects from ML/ARD that may be generated from materials produced or exposed by the Project and that could affect surface water quality and/or groundwater quality.

The ML/ARD Management Plan covers various disturbed materials and mine wastes exposed and produced during construction and operations of the underground mine, including:

- waste rock, ore and underground exposures;
- Tailings and paste backfill;
- Surface materials including excavated material (e.g., bedrock) and materials used for cut and fill at:
 - the Brucejack Mine Site (including the plant foundation, and roads);
 - the proposed Bowser Aerodrome;
 - the Brucejack Access Road;
 - the proposed non-potentially acid-generating (non-PAG) quarry site; and
- Sludge from the water treatment plant (WTP).

The ML/ARD Management Plan is organized as follows:

- Section 29.10.2 - ML/ARD-related monitoring methods and a description of criteria used to determine those materials that will require ML/ARD management.
- Sections 29.10.3 through 29.10.6 - ML/ARD management measures specific to the mine wastes and surface exposures listed above. Materials handling, results of baseline ML/ARD predictions, proposed monitoring, and proposed ML/ARD prevention and mitigation measures are discussed for each material, together with a monitoring program to evaluate the effectiveness of the proposed measures.
- Section 29.10.7 - Post-closure monitoring program to evaluate the long-term performance of the proposed ML/ARD management strategies at the Project.
- Section 29.10.8 - ML/ARD prevention/management strategies to address temporary or early closure scenarios.

29.10.2 Monitoring Methods

ML/ARD-related monitoring will be implemented for mine wastes (i.e., waste rock, tailings, sludge, paste, surface materials) and site contact waters (i.e., tailings effluent, WTP influent, underground sumps, quarry runoff). Monitoring during Construction and Operation will enable the validation of ML/ARD predictions developed for the ML/ARD Baseline Report (BGC 2014a) and, depending on monitoring results, allow for the refinement of waste or contact water handling procedures (where appropriate). Monitoring plans for solid wastes and contact waters are discussed in Sections 29.10.2.1

and 29.10.2.2, respectively, and are summarized in Tables 29.10-1 and 29.10-2. Chemical analyses of sample materials and associated management criteria are outlined in Sections 29.10.2.3 and 29.10.2.4, respectively.

29.10.2.1 Surface Material and Mine Waste Sampling

Surface materials and mine wastes that have been identified as PAG in the Project's ML/ARD Baseline Report (BGC 2014a) will require ML/ARD management. The solid waste monitoring program (developed below) followed the guidelines in Chapter 8 of MEND Report 1.20.1 (Price 2009). Sampling of solid materials includes testing for ABA parameters, soluble elemental release and total metal abundances (by aqua-regia digest).

Waste Rock

The majority (85%) of waste rock geologic units generated at the Project are predominantly composed of PAG material (BGC 2014a). Therefore, all waste rock from the underground is treated as PAG material in the ML/ARD Management Plan and does not require a material segregation plan. Waste rock sampling frequencies will include one composite sample for every 75,000 tonnes of waste rock (Price 2009), for the purpose of continually monitoring the ML/ARD characteristics of excavated waste rock during the Construction and Operation phases.

The Brucejack Mine Plan specifies the amount of waste rock extracted from the underground mine during Construction and Operation, and characterizes this material based on seven units defined in the geological model (BGC 2014a; Chapter 5, Project Description). Samples will be taken from each geological model unit (by referencing the Mine Plan) with material taken from blast hole cuttings (at the frequency discussed above; i.e., one sample for every 75,000 tonnes of waste rock), as opposed to muck piles.

Tailings

Tailings material has been identified as non-PAG (BGC 2014a). Tailings will be both deposited subaqueously to the bottom of Brucejack Lake and backfilled in the underground (as part of paste) during mine operations. Tailings discharged from the flotation cells will be sampled at two locations: the paste backfill plant (i.e., paste backfill destined for underground) and the mixing tank (i.e., tailings slurry destined for Brucejack Lake). For the purpose of capturing possible spatial differences in tailings composition, tailings samples will constitute material originating from the Valley of Kings (VOK) and the West Zone ore zones. Therefore, tailings will be sampled 2 times per year, for a total of 24 samples from the West Zone and 24 from the VOK during the Operation phase.

Water Treatment Plant Solids

Solids or sludge will be produced in the treatment of WTP-influent waters and co-disposed with tailings to Brucejack Lake during Operation. Sludge is observed to be PAG material (neutralization potential ration [NPR] = 1.5) with modest AP and moderate to low neutralization potential (NP) values. Sludge solids are typically comprised of two types of material; a detrital component (sediments generated as part of underground mining and activities) and secondary precipitates (reflective of the WTP treatment process[es]).

Sludge characterization information for the existing Brucejack exploration WTP pertains to the former component. Characterization and monitoring of sludges (bearing both components) will be conducted during Construction and Operation, (as soon as required volumes are available) as efforts to generate pilot-scale sludge materials are onerous and impractical and there is a perceived low risk associated with sludge deposition in Brucejack Lake.

Table 29.10-1. Summary of Monitoring/Sampling Programs associated with Surface Material and Mine Waste

Material	Characterization	Monitoring	Sampling / Frequency	Other	Motivation
Underground excavated waste rock	Predominantly PAG	Non-segregated; placement in Brucejack Lake or remain underground in stopes with paste backfill.	One composite sample per 75,000 tonnes.	Samples to be taken from blast hole cuttings. Samples include material from all material types.	Continually characterize and validate ML/ARD characteristics.
Tailings	Non-PAG	To be placed in the underground with paste backfill or to Brucejack Lake (Operation only).	Solid samples to be collected from paste backfill flotation cells and mixing tank (for lake deposition). Sampled twice per year, at each location.	Ensure samples are taken from VOK and West Zone ore zones.	Spatial and temporal characterization of tailings material and processing methods.
WTP solids	Sludge detrital content is PAG	Solids will be co-disposed with tailings material (0.3: 100; w/w) in Brucejack Lake during Operation.	Large samples volumes will be collected at the start of Construction and Operation. Additional samples to be taken at Operation (at minimum) twice-yearly.	Samples submitted for geochemical analyses and large volume samples (i.e., at Operation and Construction) will include subaqueous column tests.	Characterize the detrital and secondary precipitate component of sludge materials, and any changes to treatment processes between WTPs.
Paste	Non-PAG	Paste = tailings and paste cements, and is used in primary and secondary stopes.	Sampled two to four times per year.	Samples include materials destined to primary and secondary stopes.	Continually validate ML/ARD characterization as non-PAG material.
Quarry	Non-PAG	On-site geologist to monitor quarry excavation. Additional sampling will be initiated in scenarios of changes to quarry lithology where PAG characteristics are of concern.	In scenarios of lithology changes, three samples per blast hole will be taken to assess if there is an associated ML/ARD characteristic change.		Quarry is the non-PAG source for foundation materials and fill. ML/ARD characteristics will be continually monitored and/or validated.
Mine site areas/roads	Predominantly PAG	Non-segregation; subaqueous lake deposition	No sampling is required.		

Test work to be conducted on these sludge volumes will fully characterize sludge (i.e., detrital and secondary precipitate) compositions and inform on potential compositional changes as a result of differences to the treatment process and/or WTP-influent chemistries. Changes to sludge compositions during Construction will be monitored by aqueous sampling of contact water ponds and Brucejack Lake. Sludge produced during Operation will be monitored by sampling these materials (at minimum) twice-yearly. Monitoring schedules for WTP solids are discussed in Section 29.10.6.

Paste

Paste will be backfilled into primary and secondary stopes in the underground during Operation. Paste material used in primary stopes will provide structural support to surrounding areas, and will consist of cement binder and tailings. Backfilled secondary stopes do not require the same structural properties as primary stopes, and therefore the paste used in these stopes will have a lower cement content. Paste material is shown to be non-PAG due to the high neutralization capacity offered by the low sulphur and high NP of the tailings, in combination with the high NP associated with the cement binders (BGC 2014a). Paste samples will be sampled 2 to 4 times per year and include samples destined for both primary and secondary stopes.

Surface Materials

Results from site characterization programs identify the quarry site as the main non-PAG material source at the Brucejack Mine Site (BGC 2014a). Given its use as a borrow source for construction and the limited accessibility at the time of earlier field programs, sampling will be continued during quarry excavation. The on-site geologist will monitor the excavation and, if lithological variations are observed and PAG characteristics are of concern, additional sampling will be undertaken to ensure the quarry material remains non-PAG. Additional sampling will consist of three composite samples per blast hole during excavation to determine if change in lithology is coincident with a change of ML/ARD characteristics.

Plant and road area materials at the Brucejack Mine Site are characterized as predominantly PAG and, during Construction, these materials will be monitored in a similar manner to waste rock from the underground (i.e., non-segregated). In regards to sampling, no additional samples will be collected unless additional roads and/or infrastructure (with excavation) are added to the existing site layout.

29.10.2.2 Mine-related Contact Water

This section describes the monitoring of mine-related contact water areas. Five main areas for water quality monitoring have been identified: tailings effluent, WTP influent, underground sumps and/or seeps, contact water pond, and quarry runoff. Aqueous samples will be analyzed for general parameters, anions, nutrient parameters, and total/dissolved metal concentrations. A summary of monitoring/sampling programs associated with mine-related contact water can be found in Table 29.10-2.

Tailings Effluent

Tailings effluent represents the supernatant portion of the tailings slurry. Supernatant samples will be collected on a quarterly basis to monitor changes in the aqueous portion of the tailings discharge. The timing of tailings effluent sampling will be comparable to, and compliment, tailings solid sampling.

Table 29.10-2. Summary of Monitoring/Sampling Programs Associated with Mine-related Contact Water

Contact Water	Sampling and Frequency	Other	Motivation
Tailings effluent	Supernatant samples to be collected on a quarterly basis	Sites and timing will complement tailings solids sampling (described above).	Characterize supernatant tailings chemistry.
WTP effluent	Raw influent will be monitored; hourly (to continuously) for pH/turbidity; weekly for water quality parameters (i.e., total/dissolved metals, nutrients)	WTP influent = water from the underground, contact water pond, and process plant.	Evaluates short and long term changes in influent composition.
Underground waters and sumps/seeps	Sampling of bulk underground waters will be done quarterly and on an opportunistic basis for sumps/seeps.	Sample frequencies will increase if ARD development is observed.	Sampling of underground waters assist with monitoring new waste rock exposures and the NP contribution of paste backfill to bulk WTP influents.
Contact water pond	Monthly sampling in Construction and opportunistic sampling frequency in Operation. Operation sampling will be on an opportunistic basis.		Monthly sampling (during Construction) will enable the geochemical characterization of potential chemical instabilities that may be associated with subaqueous disposal of sludges. Operation-phase sampling will validate plant-site runoff source terms and enable the identification of areas with unacceptable water chemistries or seasonally-driven changes to leachates.
Quarry	If seepage from the quarry site is observed, sampling should occur (at minimum) twice yearly.		Although the quarry is characterized as non-PAG material, any runoff should be monitored for neutral rock drainage-related issues. Specifically, certain elements show higher mobility at neutral-pH conditions (e.g., Mo, Se, As).

Water Treatment Plant Influent

Influent to the Operation WTP reflects a combination of waters from the underground mine, site contact-water pond, and the process plant. As part of standard operating procedures for the WTP, influents will be monitoring hourly or continuously for pH and turbidity and weekly for standard water quality parameters to maximize plant optimization (Veolia, pers. comm.). This sampling schedule will provide a robust means to evaluate short- and long-term changes in influent composition, for the purpose of capturing possible changes to its chemical composition

Underground Sumps and Seeps

The testing of the underground sumps and/or seeps on an opportunistic basis will serve to validate predictions with respect to underground source terms and help identify underground regions or zones governing WTP influent chemistries. Monitoring of sump water chemistry will also help support assessment of the effectiveness of paste backfill at delaying acidic conditions and providing additional neutralization potential (as cement binders) to bulk underground mine waters. As well, these samples will help identify potential ARD conditions associated with exposed waste rock surfaces. Sampling of the bulk underground discharge will be done quarterly, and specific sumps or seeps will be done on an opportunistic basis. If results from sump monitoring indicate zone(s) of potential ARD development, it may be necessary to increase the frequency of monitoring and implement mitigation measures if required. Examples of potential mitigation measures include selective paste backfilling or application

of shotcrete to areas with acidic runoff for the purpose of providing additional neutralization and/or minimize conductance through these zones.

Contact Water Pond and/or Perimeter Ditches

During Construction, the contact water pond will provide storage for WTP sludge and will require monthly testing to observe changes in sludge compositions and its impact to contact waters. During Operation, the testing of the contact water pond, and other related surface water diversions (where applicable), will be conducted on an opportunistic basis for the purpose of validating predictions related to plant-site runoff source terms. As well, sample results will enable identification of areas with unacceptable water qualities or seasonal-driven changes to these chemistries.

Quarry Runoff

ML/ARD assessment of materials from the proposed non-PAG quarry site shows a high neutralization potential, low sulphide content and high NPR values. However, materials that are not likely to produce ARD conditions may still pose a risk as some metals are shown to be more mobile in neutral pH conditions (e.g., Mo, As, Se). Therefore, any observed runoff or seepage from the quarry site will be sampled (at minimum) twice-yearly to ensure those elements with higher mobility at circumneutral pH conditions are adequately monitored.

29.10.2.3 Chemical Analyses

As described above, waste rock (minus quarry material) and sludge at the Project are treated as PAG materials, while paste, tailings and quarry rock are identified as non-PAG materials. Ongoing chemical analyses of these materials during Construction and Operation will be used to validate the assumptions associated with the ML/ARD predictions developed for the ML/ARD Baseline Report (BGC 2014a). Given the absence of any form of segregation in the mine plan, all analyses can be performed off-site.

The planned chemical analyses, described in detail in the ML/ARD Baseline Report (BGC 2014a), for waste rock, tailings solids, sludge, paste, and quarry material are:

- Acid-Base Accounting (paste pH, total inorganic carbon (TIC), Total-S, Sulphide-S, Sulphate-S, and Sobek-NP);
- total elemental content (using aqua-regia); and,
- shake flask extractions (SFEs).

Subaqueous columns will also be constructed to characterize the behavior of sludge under a water cover as described in greater detail in Section 29.10.6.5.

The chemical composition of aqueous samples pertaining to the supernatant of the tailings slurry, WTP influent, underground sump/seep waters, contact water pond, and quarry runoff will be analyzed for pH, TSS/turbidity, major cations and anions, nutrients, dissolved and total metals.

29.10.2.4 Management Criteria

The NPR is used to define which solid materials (e.g., mine waste and surface materials) excavated for Project development or mining are PAG ($NPR \leq 2$) or non-PAG ($NPR > 2$). Those materials that are characterized as PAG material will require ML/ARD management as discussed in Sections 29.10.3 to 29.10.6.

29.10.3 Waste Rock, Ore and Underground Exposures

29.10.3.1 Waste Rock Management

Waste rock from the Brucejack Gold Mine Project will be generated from two sources: (1) surface-related Construction activities at the Brucejack Mine Site (0.6 Mt); and (2) mining activities during Construction and Operation (4.4 Mt; Section 29.18, Waste Rock Management Plan). Waste rock produced by Construction phase activities at the Brucejack Mine Site will be placed in Brucejack Lake. However, waste rock generated from the underground development will be disposed of in Brucejack Lake or will remain underground, where it may be co-disposed (though not mixed) with paste backfill in secondary stopes.

Specifically, waste rock generated by underground development during the two-year Construction phase will be disposed in Brucejack Lake only. The amount of lake-disposal waste rock decreases significantly into Operation, with the most waste rock remaining underground between years 3 and 22 of Operation. During periods when direct haul of waste rock for disposal to Brucejack Lake is not possible, waste rock will be temporarily stored on the pre-production ore/waste rock transfer storage surface area (Figure 29.10-1). Additional details are provided in Section 29.18, Waste Rock Management Plan.

Similar to the temporary waste rock stockpile, the ore produced during the Construction phase will be temporarily stored in the transfer storage surface area known as the Upper Laydown Area (Figure 29.10-1).

29.10.3.2 ML/ARD Assessment

Paste pH values are circumneutral to alkaline and closely related to the presence of carbonates. Sulphide is the main sulphur species (greater than 90%) while sulphate-S and insoluble-S make up only a relatively small proportion of the total-S content. Carbonates (primarily calcite) are the main contributors to the NP of Brucejack waste rock (BGC 2014a).

Approximately 85% of the total generated waste rock at the Project contains 77 to 85% PAG material. Considering the high percentage of PAG material, all waste rock is treated as PAG in the ML/ARD Management Plan. Similarly, all ore materials are classified as PAG.

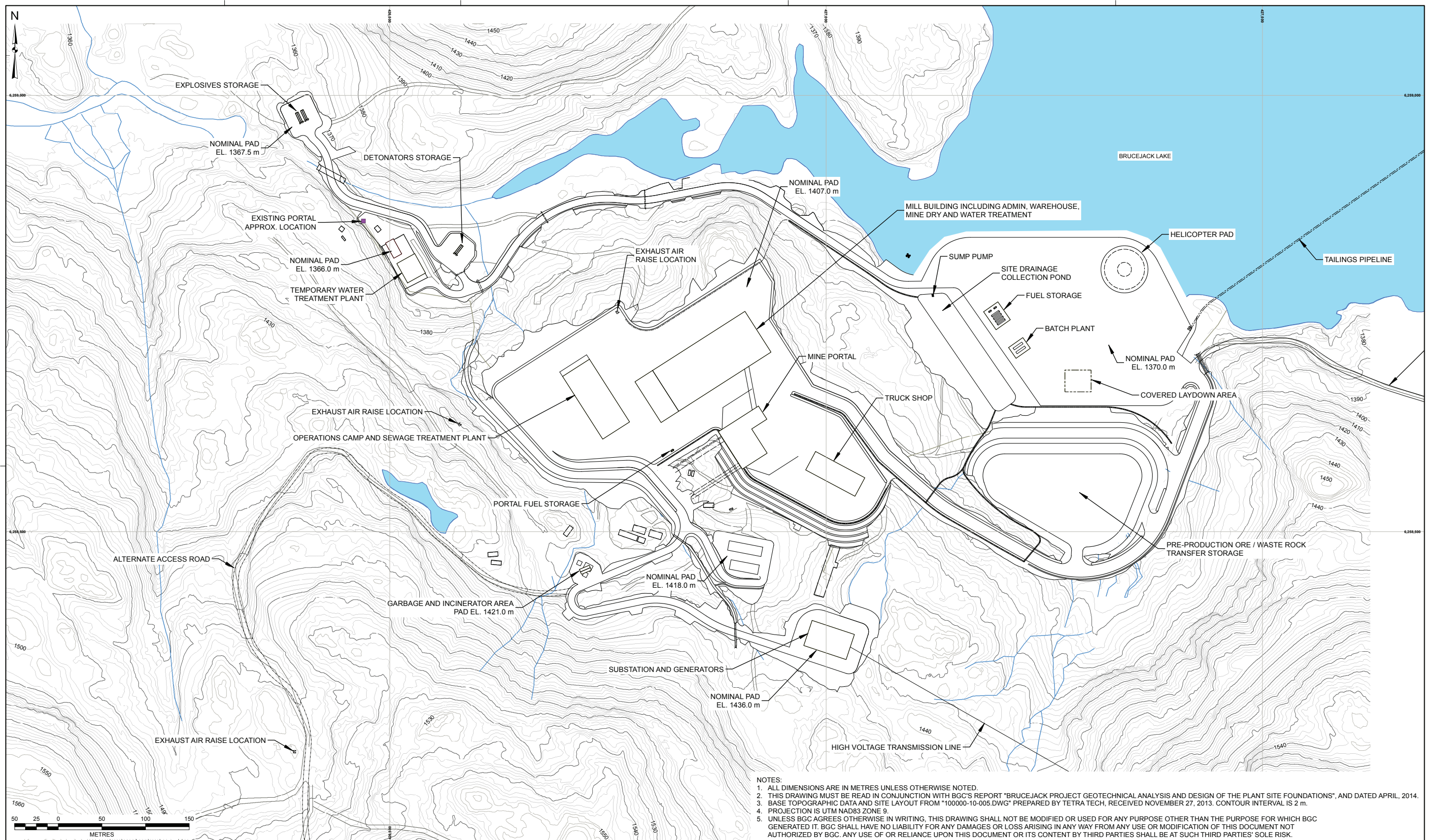
There is a significant enrichment of Ag, As, Cd, Mo, Pb, Sb, Se and Zn in waste rock (relative to non-mineralized rock) of which As, Sb, Ag and Cd soluble release may be a concern with exposure to water.

29.10.3.3 Monitoring

Although all waste rock is treated as PAG in the ML/ARD Management Plan, waste rock monitoring during mining will include an assessment of selected ML/ARD characteristics to continually validate the ML/ARD predictions developed for the Application/EIS (BGC 2014a).

Assessment will include the monitoring of general ABA characteristics and soluble constituents of the waste rock destined for Brucejack Lake or that is to remain in the underground mine as backfill. The ABA characteristics will provide operational confirmation of the percentage of the waste rock that is PAG, while the soluble constituents can be used to track the potential impact of waste rock on the lake water quality.

Figure 29.10-1
Brucejack Gold Mine Project
Site Layout



Source: BGC Engineering Inc. (June 2014).

The excavation of waste rock in the underground will lead to underground exposures. These exposures will be monitored as part of the mine-related contact waters, described in Section 29.10.2.2. Specifically, underground seepages have been identified in the current workings, with large variations to seepage chemistries. Monitoring, by way of collecting aqueous samples from these seeps or associated sump waters, will document the occurrence of groundwater contacting PAG materials and highlight spatial and/or temporal changes to the leachate chemistries. This information, together with continued monitoring of the solid phase (i.e., waste rock) excavation in the underground, will monitor the development through areas with higher or lower ML/ARD risk.

29.10.3.4 *Prevention and Mitigation*

ML/ARD management of waste rock, underground exposures and ore involves four strategies.

1. Temporary storage of waste rock in a stockpile.
2. Collection and treatment of water in the underground workings.
3. Backfill of waste rock in the underground.
4. Waste rock disposal in Brucejack Lake under a minimum 1-m-deep permanent water cover.

The fourth recommendation was also noted by Price (2005) during an assessment of Brucejack. A minimum 1-m water cover, during periods of low water levels, will be achieved for PAG waste rock in Brucejack Lake. This recommendation follows results from a comparative field and laboratory study by Lapakko et al. (2013), which showed placement of sulphidic wastes under a continuous water cover may provide a secure, permanent disposal strategy by reducing the sulphide oxidation rate and minimizing subsequent release of metals and acidity. The ML/ARD prevention and mitigation measures for waste rock are summarized in Table 29.10-3. These measures are closely related to the Water Management Plan (BGC 2014b).

Any and all waste rock stock piles will be removed from surface by the end of Operation and stored subaqueously in Brucejack Lake or in underground workings, to be flooded at Closure. Therefore, the waste rock stock pile will only need to be managed during the Construction and Operation phases. Underground drainage water will be managed/treated during the Construction and Operation phases, as well as during underground flooding (i.e., Closure). Flooding and sealing of adits (underground mine) and maintenance of a 1-m water cover (Brucejack Lake) will effectively curtail ML/ARD in the long term. Groundwater recovery is predicted to occur over several years and a portion of the workings will remain above the water table after Closure. Further details of these processes are provided in the next section on performance monitoring and contingency.

29.10.3.5 *Performance Monitoring and Contingency*

Effects on ML/ARD generation and associated surface and groundwater quality as a result of waste rock subaqueous deposition in Brucejack Lake and storage in the flooded underground mine will need to be monitored to verify the performance of these mitigation approaches. This will require regular monitoring of water quality at specific locations, consistent with sites monitored during the baseline program, to detect possible changes from baseline and/or modelled conditions with time. As well, several contingency plans are described to handle events of poorer water quality, as suggested by performance monitoring results.

Table 29.10-3. ML/ARD Prevention and Mitigation Measures for Waste Rock, Ore, and Underground Exposures

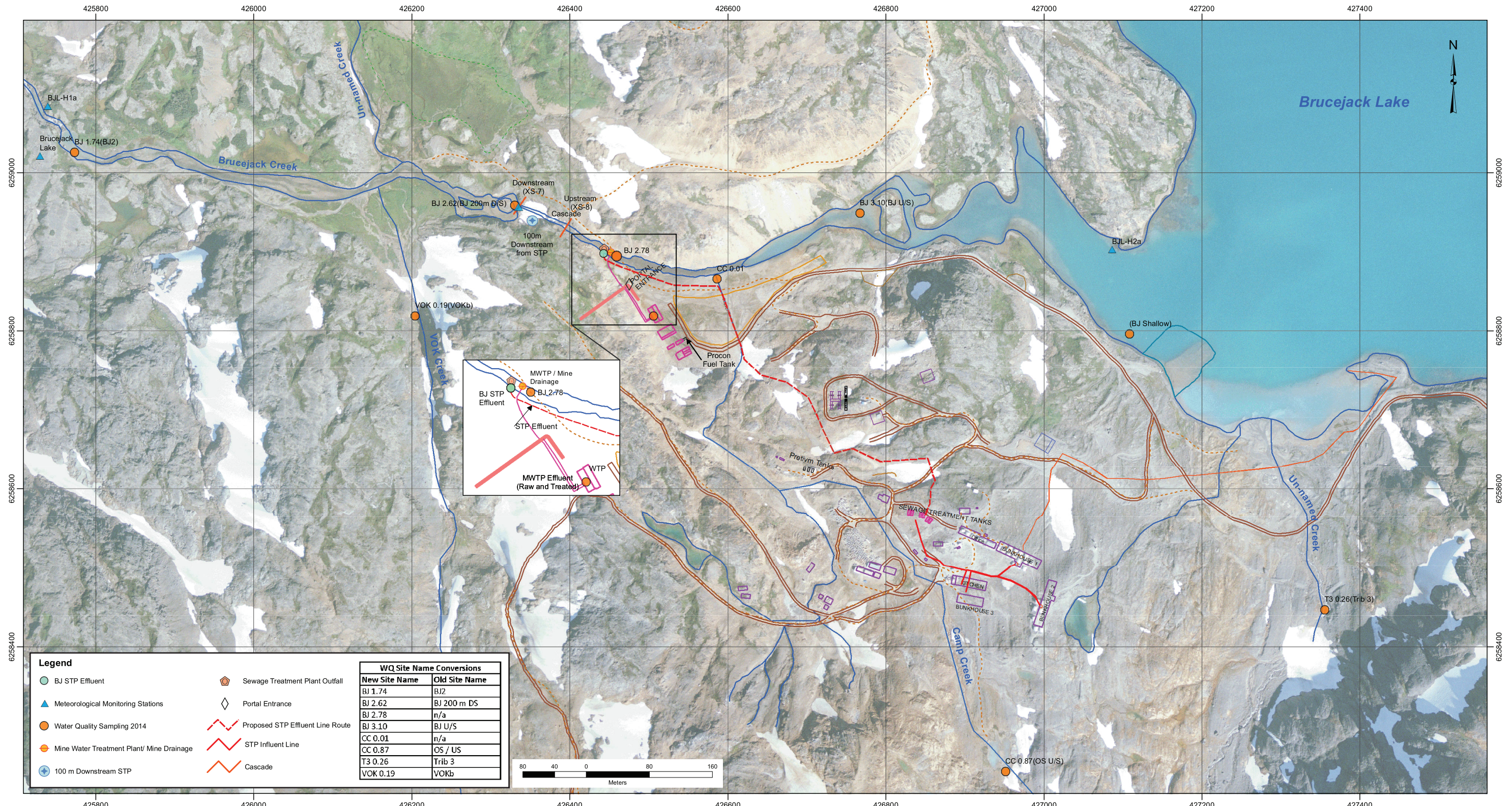
Management Component	ML/ARD Prevention and Mitigation Measures	Construction	Operation	Closure	Post-closure
Temporary stockpile in Knipple Transfer Area	Runoff from the temporary waste rock stockpile will be captured by a perimeter ditch system that is directed to a lined collection pond for contact water from where it will be pumped to the WTP for treatment prior to discharge to the process plant or Brucejack Lake.	X	X		
Pre-production ore stockpile in Knipple Transfer Area	Runoff from the ore stockpile will be collected by perimeter ditches that are directed to the lined collection pond for contact water from where it will be pumped to the WTP.	X			
	Ore stockpile will be located in the mill building. Storage in the mill building will result in small to insignificant drainage from the stockpile. Drainage that is observed will be collected in the contact water pond to be treated in the WTP.		X		
Backfill/underground mine	During the Construction phase, drainage water from the underground mine will be pumped to the WTP and treated before being discharged to Brucejack Creek.	X			
	During Operation, drainage water from the underground mine will be pumped to the WTP for treatment and either: 1) discharged directly to Brucejack Lake; 2) used in the Process Plant as make-up water during ore processing and reporting to the lake with tailings; or 3) used in paste generation and reporting as backfill to the underground workings.		X		
	The addition of cement binders in paste backfill will provide a source of neutralization potential that may serve to delay onset of potential ML/ARD generated from waste rock.		X	X	X
	At mine closure, sealing of adits below the ultimate flooding elevation and flooding of the underground workings will limit the potential for sulphide oxidation to a very small proportion of workings that will remain unsaturated following flooding.			X	X
Disposal in Brucejack Lake	Subaqueous deposition of waste rock (Construction and Operation phases) will mitigate sulphide oxidation and reduce potential for ML; this will require a sufficient water cover (depth) that is permanent (Post-closure phase)	X	X	X	X
	Waste rock will be disposed in Brucejack Lake via an advancing platform/causeway into the lake. The causeway will consist of PAG material, with a minimum of 1-m depth of submersion and capped with non-PAG material.	X	X		

Performance Monitoring

The storage of waste rock in Brucejack Lake and the underground has the potential to affect water quality at both of these areas. For Brucejack Lake, the water quality will be monitored at the following locations:

- o in Brucejack Lake, at the existing station ‘Brucejack Lake’ (not shown); and
- o at the weir planned for the lake outlet, near the current natural outlet control of the lake (Figure 29.10-2).

Figure 29.10-2
Brucejack Gold Mine Project
Water Monitoring, 2014



Source: BGC Engineering Inc. (June 2014).

Monitoring and sampling schedules at these locations are complimentary to those described Section 29.3, Aquatic Effects Monitoring Plan. These locations were also highlighted in the Cumulative Aquatics Resources Baseline report (ERM Rescan 2014a).

The “Brucejack Lake” monitoring station will be monitored (at minimum) quarterly, with at least one month between samples (as per MMER requirements), through Construction and Operation at multiple depths to identify water quality changes as well as chemical/physical gradients that may develop in the water column. In this regard, a Conductivity, Temperature, Depth probe will provide high-resolution vertical profiles that can be used to assess lake mixing properties (e.g., presence of stratification and timing of lake overturn). Depth profiling for a full suite of water quality parameters at the lake station will be used to identify the influence of waste rock deposition on lake water composition with respect to pH, TSS, nutrient parameters, major ions, and trace elements.

Monitoring at the lake outlet will resemble the sampling schedule for the Brucejack Lake monitoring station and involves a full suite of parameters during Construction and Operation as prescribed by permit conditions.

Waste rock exposed and subsequently stored underground has the potential to impact the water quality from the underground workings, which will be monitored during the Construction, Operation, Closure, and Post-closure periods. During Construction, raw influent water to the WTP will be sampled hourly for turbidity and pH, daily for any identified parameters of interest, and (weekly) for complete metal and nitrogen species analyses. These monitoring schedules and frequencies are typical of the standard operating procedures specified by the WTP manufacturer (Veolia) and will be used to monitor changes to bulk underground mine water.

A similar schedule will be maintained during Operation, with increased monitoring locations to account for a multi-stage treatment process. In addition to this sampling, twice-yearly to quarterly sampling of individual underground sump waters (and possibly seeps) will help identify those underground areas at greater risk to ARD development.

Transient simulation results predict that the majority of groundwater table recovery will occur within one to three years after the dewatering pumping is stopped. The groundwater flow system is predicted to approach post-mining steady-state conditions within five years from the start of flooding (BGC 2014f). Therefore, the one- to three-year period is assumed to be reflective of the Closure phase and time periods following Closure are representative of the Post-closure phase. Quarterly water quality monitoring will be conducted during Closure and Post-closure at three locations:

1. Adits (potential seepage).
2. Several groundwater wells (e.g., three to five wells, specific locations to be determined) closest to the flooded underground workings; along the groundwater flow path from the underground towards Brucejack Lake and Brucejack Creek.
3. Along the groundwater flow path from the underground workings towards Sulphurets Creek and Sulphurets Glacier.

The third location will consist of the installation of two nested monitoring wells (1 shallow, 1 deep). These nested wells will be located near the mine and downstream of B JL-H1 station and the second near the confluence of Brucejack Creek to the Sulphurets drainage. These stations will sample groundwater that may contact the underground workings and follow longer (i.e., decadal-scale) flow paths towards the Sulphurets Creek drainage.

Groundwater modelling predicts the majority of the underground workings will flood at Post-closure; however, the twin mine portals and some workings at higher elevation may remain unsaturated (i.e., above the final water table elevation). Seepage from the existing exploration adit location is considered likely to occur in the absence of an engineered adit plug, but is included in performance monitoring stations (as shown above).

The water quality from several groundwater wells will monitor the potential for migration of ML/ARD-affected groundwater following contact with newly submerged workings or interaction with unsaturated zones above the flooded water table. Specific parameters to be highlighted in this closure and post-closure monitoring will serve as vectors for likely ML/ARD-impacted groundwater (e.g. pH, SO₄, or specific trace metals that would be identified during the course of the Operation phase) (Section 29.10.7).

Contingency

During the period of underground flooding, there is the potential for contaminant loadings to be introduced via the dissolution of soluble oxidation products that accumulate within the mine during the Operation phase. To monitor the potential significance of this process, adit waters will be monitored during the one- to three-year period of underground flooding. For a scenario in which parameter concentrations in the underground are unacceptable, a combination of hydrologic containment in conjunction with effluent treatment will provide an effective contingency measure. Specifically, re-activation of underground pumping of adit waters to the WTP could be used to maintain mine water levels at an elevation that minimizes subsurface transport of underground waters to Brucejack Creek and Brucejack Lake. This form of contingency would be maintained until such time as underground concentrations improve to permit flooding of the mine to its maximum elevation, and allow passive subsurface flow to Brucejack Creek and Brucejack Lake. This contingency plan also includes at least one of the two twin portals, located above the predicted/modelled water tables, which will remain unplugged for the purpose of providing access to the underground and ability to implement these contingency strategies.

If monitoring of Brucejack Lake and lake outlet positions during Operation show unacceptable water qualities as a result of waste rock deposition, a contingency measure will be additional temporary storage of waste rock on surface.

29.10.4 Tailings and Paste Backfill

29.10.4.1 Tailings and Paste Backfill Management

Approximately 8.55 Mt or 47% of the total produced flotation tailings will be deposited in the underground workings as paste backfill. The remainder (9.52 Mt or 53%) will be piped as a tailings slurry (about 30% solids-to-liquid [w/w]) to the bottom of Brucejack Lake. At the end of the mining operations, the footprint of the tailings deposit will occupy most of the lake bottom to a depth of approximately 48 m at its edge and a depth of 38 m at the apex of the tailings deposition cone. A detailed description of the tailings pipeline into Brucejack Lake may be found in Section 29.15, Tailings Management Plan.

For the purposes of paste backfill, the tailings discharged from the flotation cells will be directed to a thickener to obtain the desired feed to the paste backfill plant. Paste material consists of tailings and paste cements and will be distributed in the underground mine by pumps. Approximately 6.0 Mm³ of paste, of different strengths, will be required. Specifically, paste will be used as backfill in primary and secondary stopes. Primary stopes require paste to be load-bearing and will consist of paste cements and thickened tailings. Secondary stopes are considered non-load-bearing and paste backfilled

into these areas will contain tailings and paste cements, at lower cement binder content relative to cements used in primary stopes. The proposed management measure for WTP sludges is co-disposal with tailings into Brucejack Lake (discussed in Section 6). Incorporation of sludge in paste backfill for secondary stopes represents a second potential management option for WTP sludge, but is not currently planned.

29.10.4.2 *ML/ARD Assessment*

The acid potential (AP) of the tailings is insignificant (AP less than 2 kg CaCO₃/t) due to the flotation and removal of sulphides during ore processing. Sobek NP of tailings varies between 70 and 90 kg CaCO₃/t, translating to highly positive NPR values (41 < NPR < 96). Paste materials show high neutralization potentials (up to 165 kg CaCO₃/t) that reflect the buffering capacity of the paste cements. Overall, tailings and paste materials are non-PAG (BGC 2014a).

The elemental compositions of tailings and paste show enrichments of Ag, As, Cd, Cr, Mo, Ni, Sb, Mn and possibly Se, relative to non-mineralized rock (crustal abundance). Parameters of concern in the leachates from kinetic tests on tailings are As, Sb, Mo, and Se (BGC 2014a).

29.10.4.3 *Monitoring*

Tailings and paste samples used in ML/ARD predictions were obtained from pilot test plants during the exploration phase. It is recognized that it will be important to repeat these ML/ARD predictions with tailings and paste samples from full-scale process and water treatment plants at the mine site. These materials may differ from previously assessed samples in response to changes to tailings/paste processing and reagents used therein, process water compositions, and the final design of the water treatment plant.

Continued monitoring of tailings and paste solids will include general ABA characteristics, elemental composition, and soluble constituents. Tailings supernatant (water component associated with tailings slurry) will be tested monthly to assess changes in the mobile fraction of the tailings discharge.

29.10.4.4 *Prevention and Mitigation*

ML/ARD Management of tailings and paste involves the discharge of tailings to the bottom of Brucejack Lake and tailings placement as paste backfill in the underground workings. The discharge of tailings to Brucejack Lake will provide an effective means to stabilize the materials both physically and chemically. On the lake floor, suboxic porewater conditions can be expected to develop within a few centimetres of the tailings-water interface. In these suboxic zones, some remobilization of tailings solids can be expected via the reductive dissolution of redox-sensitive phases (e.g., Fe oxides). However, such releases are predicted to be minor given the low abundances of oxidized minerals identified in the ore and/or mineralogically analyzed from tailings materials (i.e., ≤ 0.2%; BGC 2014a).

Fluxes of dissolved species from the tailings to the water column will be predicted to be largely governed by molecular diffusion, which is a slow process. Given the low fluxes predicted, the deep water depth and relatively-rapid flushing time of the lake, diffusive fluxes from the submerged tailings deposits are not predicted to adversely affect water quality. In the long term, following the cessation of tailings discharges, the progressive accumulation of natural sediments on the lake floor will serve to both physically and chemically isolate the tailings materials from the water column.

The assumptions described above are supported by detailed geochemical studies of submerged tailings deposits that have shown no significant adverse effects to water quality associated with post-depositional remobilization (e.g., Pedersen 1983; Pedersen et al. 1991; Pedersen, Mueller, and McNee

1993). Where water quality issues have arisen for subaqueously-stored mine wastes, the problems have been associated with secondary phases generated as part of effluent treatment, historical milling practices (e.g., roasting) and/or post-depositional oxidation in the absence of a water cover (e.g., Martin, McNee, and Pedersen 2001; Martin and Pedersen 2002; Martin, Crusius et al. 2003; Martin, Jambor et al. 2003; Martin, McNee et al. 2003).

The placement of tailings in the underground with paste backfill will also provide an effective means to mitigate ML/ARD. The enhanced NP afforded by the paste cement will provide an effective means to buffer contact with acidic waters that may interact with backfilled materials while the underground remains dewatered. This may serve to delay or prevent significant remobilization of tailings and/or paste materials. Irrespective, all waters pumped from the underground during Operation will be treated through the WTP prior to discharge to Brucejack Lake.

Upon flooding of the underground, the potential for interaction with low-pH water in the underground will diminish. Under conditions of flooding, suboxic conditions can be expected to develop within the pore spaces of saturated paste and implies the potential for some redox-driven dissolution of tailings components. However, as described above for tailings materials in Brucejack Lake, the potential significance of this process is considered to be minor given the low abundance of redox-sensitive phases in tailings materials.

Overall, the ML/ARD prevention and mitigation measures for tailings and paste materials are shown in Table 29.10-4. These measures are closely related to the Water Management Plan (BGC 2014b).

Table 29.10-4. ML/ARD Prevention and Mitigation Measures for Tailings and Paste

Management Component	ML/ARD Prevention and Mitigation Measures	Construction	Operation	Closure	Post-closure
Tailings disposal in Brucejack Lake	Subaqueous deposition of tailings in Brucejack Lake will prevent further sulphide oxidation and minimize potential for metal leaching. Some release of re-mobilized tailings components may be expected via diffusion. Given that rates of diffusive transport are slow, the deep depth of the water cover, and relatively quick lake flushing time, fluxes from the tailings to the water cover are predicted to be minor.		X	X	X
Tailings incorporation in paste and paste backfill to underground mine	NP afforded by paste (i.e., tailings and paste cements) tailings may serve to delay or prevent significant remobilization for zones in potential contact with low-pH water in the underground. Upon flooding, potential interaction with acidic waters in underground will diminish.	X	X		
	Drainage water from the underground mine will be pumped to the WTP and treated before being discharged into Brucejack Creek (Construction) or before being used in the process plant (Operation) for processing of tailings and/or paste materials	X	X		

As is mentioned in Table 4-1, TSS has been identified as a concern for tailings deposition in Brucejack Lake. TSS is not directly linked to results from the ML/ARD assessment and is not described in this document. However, further discussion of TSS can be found in both Section 29.15, Tailings Management Plan, and Section 29.18, Waste Rock Management Plan.

29.10.4.5 *Performance Monitoring and Contingency*

The performance monitoring to verify the effects of tailings disposal in Brucejack Lake and paste backfill in the underground mine will be the same as described for waste rock (Section 29.10.3.5). Contingency measures as described for Brucejack Lake and the underground workings, as described in Section 29.10.3.5, also apply.

29.10.5 **Surface Materials**

29.10.5.1 *Management of Surface Materials*

Along with the development of the underground mine, on-site and off-site surface facilities will be developed during Construction phase activities at the Brucejack Mine Site. On-site facilities and related activities include:

- expansion of the current exploration camp and surface infrastructure;
- construction of the mill, paste plant, WTP, and generator buildings;
- development of the laydown area and waste rock storage facility; and,
- development of the non-PAG quarry.

The development of pads for these facilities will require site levelling involving cut and placement of non-PAG fill materials.

Off-site facilities and activities include:

- minor upgrades to the existing access road, which includes the Knipple Transfer Area; and
- construction of a new aerodrome (Bowser Aerodrome).

29.10.5.2 *ML/ARD Assessment*

A site characterization program was designed to assess the ML/ARD characteristics of surface materials with Chapter 5, Project Description. Twenty-three of the 40 samples from the mine site area show NPR values less than 2.0 and are characterized as PAG material. The majority of samples from access road materials have NPR values greater than 2.0 and are generally considered non-PAG.

Shale sampled along the Brucejack Access Road presents the only lithology to pose a risk for potential ARD. Over half (11 of 19) of the shale samples show NPR values less than 2.0, with 9 (of these 11) samples containing NPR values less than 1.1. Shale samples characterized as PAG material exhibit sulphide-S values greater than or equal to 0.4%, despite modest buffering capacities (i.e., average Sobek NP = 40 kg CaCO₃/t). The remaining non-PAG shale samples (8 of 19) show NPRs greater than 3.0 as per low AP and modest NP values. Most shale samples were encountered along the access road linking Bowser Camp to Wildfire Camp, and are predominantly from the Bowser Lake Group sediments. Samples taken from the aerodrome and quarry are characterized as non-PAG.

The metals As, Ag, Hg and Sb are found at high concentrations relative to crustal abundances in almost all lithologies of the surface materials sampled. The metals Mo, Pb, Zn, Cd and Mo are found at moderate to high concentrations in many surface materials samples while only a few lithologies show an exceedance of Cr and Ni.

29.10.5.3 *Monitoring*

The main aim of the monitoring program is to identify exposed PAG materials (cut and fill) that are exposed by the development of surface facilities and could generate ML/ARD. Similar to waste rock, materials that are PAG require a ML/ARD Management Plan. Sections along the access road denoted by shale samples will be revisited and monitored by a qualified person for inspection of ML/ARD related impact (e.g., staining, seepage, runoff) during Construction and into Operation.

The excavation of the quarry site, for non-PAG construction cut and fill, will be monitored by an on-site geologist who will, in scenarios of changes to quarry lithology and possible PAG characteristics (e.g., increased sulphide proportion), initiate further geochemical sampling. Specifically, sampling will constitute three samples per blast hole cuttings for the purpose of validating the ML/ARD characteristics of the quarry material.

29.10.5.4 *Prevention and Mitigation*

The aim of the prevention and mitigation measures for surface materials on-site and off-site is to prevent or control the generation of ML/ARD in areas where, due to the development of surface facilities, PAG materials are exposed. The ML/ARD prevention and mitigation measures for surface materials are shown in Table 29.10-5 and largely apply to the Construction and Operation phases. The measures are closely related to the Water Management Plan (BGC 2014b).

Table 29.10-5. ML/ARD Prevention and Mitigation Measures for Surface Materials

Management Component	ML/ARD Prevention and Mitigation Measures	Construction	Operation	Closure	Post-closure
Brucejack Mine Site	Install HDPE geomembrane liner in the upper laydown area used for waste rock transfer and pre-production ore storage.	X	X		
	Design system of perimeter ditches to collect contact (runoff) water from the upper laydown area, the mill building, portal site and water treatment plant areas where PAG materials are exposed. The ditches will collect the plant site runoff and direct it to the contact water collection pond from where it is pumped to the WTP for treatment.	X	X		
	Diversion channels with HDPE geomembrane liner will be constructed for non-contact water at the Brucejack Camp, the plant site, and laydown area.	X	X		
	Use compacted non-PAG material (quarry) to cover surface areas where PAG materials are exposed for the purpose of providing additional neutralization capacity to minimize ML/ARD potential	X	X	X	X
	Every effort is made to restore the “natural” drainage system at the Project site. However, in scenarios whereby runoff is likely to contact PAG materials, diversion channels will remain and ensure runoff is diverted to Brucejack Lake for the purpose of incorporating the dilution control from this large waterbody.			X	X
Brucejack Access Road	Minimize potential road widening and cross-cutting of shale sections and, where applicable, engineer runoff diversions to minimize contact with these sections	X	X		

During the Closure phase, all facilities will be closed and the Brucejack Mine Site will be abandoned after reclamation (Chapter 30, Closure and Reclamation). The Post-closure phase will only involve monitoring.

29.10.5.5 Performance Monitoring and Contingency

The majority of surface material excavation will occur during the Construction period, and newly excavated surface materials at the Brucejack Mine Site (not including quarry) are considered PAG material as outlined in the ML/ARD Baseline Report (BGC 2014a). Following the Construction phase, monitoring will be conducted to determine the impact of the excavated material on surface runoff and potentially groundwater. In the event of unacceptable water chemistries, denoting an ML/ARD-related impact, several contingencies will be outlined.

Performance Monitoring

Monitoring will include surveys of on-site and off-site areas (e.g. Brucejack Mine Site, Brucejack Access Road) with existing surface facilities for evidence of ongoing ML/ARD to determine if the prevention and mitigation measures are effective. This will involve quarterly inspections by an identified qualified person or qualified person-trained personnel to identify signs of ML/ARD (staining, high field conductivity, low field pH, etc.) and the condition of the diversion and perimeter ditches.

Runoff and/or groundwater contacting the plant site excavation will be captured by a perimeter ditch system and diverted to a lined contact water pond. Water contacting the mill building area and upper laydown will also be conveyed to the contact water pond via perimeter ditches. All waters collected by the contact water pond will be treated in the WTP from Construction through to Closure phases. Sampling of the contact water pond and/or specific perimeter ditch conveyances will be conducted on an opportunistic basis to identify ML/ARD-impacted waters due to contact with exposed materials.

Runoff from the quarry region will be sampled (at minimum) quarterly for general parameters, nutrients, dissolved, and total metals. Quarry runoff flows into Brucejack Lake, therefore, will be monitored on a regular basis through construction to closure. Material from this area is identified as non-PAG, with a high buffering capacity and low sulphide content. However neutral-pH waters may enable neutral rock drainage whereby select metals can form oxyanionic species and result in increased mobility under these conditions. Therefore, particular consideration will be paid to measured changes to As, Se, Mo, and Cd concentrations.

Contingency

At Closure and in scenarios whereby performance monitoring indicates water qualities from surface runoff are acceptable, every effort will be made to return the site to its natural surface drainage. However, given the dilution impact of Brucejack Lake, proposed reclamation plans include directing the majority of the runoff to the lake to mitigate the potential for unacceptable water quality to flow directly to Brucejack Creek (Chapter 30, Closure and Reclamation). Other contingencies that can build upon this scenario include lining diversion channels with lime additives and/or widening these conduits for erosion control. Further details of closure plans for diversion channels in mine site area will require a detailed look at the predicted surface drainage pattern (at Closure) and iterative discussions with mine site engineers and reference to the Water Management Plan (BGC 2014b).

Contact water and waste rock monitoring of quarry excavation during Construction and Operation will assist with identifying time periods and areas of increased ML/ARD risk. In regards to solid samples, results that show significant change to the mineralogical assemblage of quarry materials, that may or may not enable a negative change to its NPR evaluation, will initiate the following performance monitoring and contingency changes:

- A field evaluation by a qualified person and site geologists to outline the boundaries of the new mineralogical composition;

- an increased sample frequency within the outlined geological boundaries to evaluate if changes to ML/ARD characteristics are concomitant with changes to mineralogy; and
- if the ML/ARD characteristics suggest a higher ML/ARD risk and impact, further excavation in this area is stopped, material is disposed in Brucejack Lake and/or underground with paste backfill, and future infiltration to excavated location is minimized (e.g., application of shotcrete).

A similar scenario may be used for those areas along the access road. If ML/ARD conditions develop along the access road, potential contingency plans include minimizing infiltration to PAG exposures, further construction of diversion ditches to re-route runoff from the affected area, use of neutralizing materials in fills, and/or passive treatment (e.g. bio-reactors, permeable reactive barrier, etc.).

29.10.6 Treatment Solids from Waste Treatment Plant

29.10.6.1 Management of Treatment Solids

Water treatment at the Project will be implemented to treat waters associated with underground dewatering as well as runoff from the plant site area. The latter will include drainages associated with the temporary waste rock and ore stockpiles (Construction and early Operation). Two types of water treatment will be adopted, spanning the Construction and Operation phases.

Construction: This interim WTP (summer 2014 to 16 months into the Construction phase) will be designed to treat nominal flow rates of 3,300 m³/day (with maximum values of 4,250 m³/d). The WTP will facilitate metal removal by the addition of a base (e.g., lime or other alkali) and ferric sulphate (coagulant and absorbent), and suspended sediments will be treated by the addition of flocculant and microsand. The addition of H₂O₂ will assist with nitrite treatment of influent waters. This process is expected to produce 11 t/day of sludge, depending on TSS loadings in raw influent water.

Operation: The permanent WTP will be housed in the mill building and will be designed to treat nominal flow rates of 6,000 m³/day (with maximum values of 9,600 m³/day consistent with high hydraulic conductivity and high recharge mine groundwater inflow scenarios). Treatment has been designed to remove suspended sediments, precipitate soluble metals, and reduce nitrite/ammonia concentrations associated with underground blasting. In this process, metal removal is achieved through a modified High Density Sludge process involving the addition of lime (pH control), sodium sulphide, and ferric sulphate. The precipitated metals and sediment components are then separated from solution via sand ballasted settling, which entails a high-rate coagulation/flocculation/sedimentation process. The Operation WTP will generate an average of 7 t/day of sludge, depending on the TSS loadings in raw influent water.

Further details regarding the design and specifications of the above WTPs will be available in the Technical Assessment Reports submitted for each plant; the Technical Assessment Report for interim WTP will be submitted by the end of June 2014 while the permanent WTP Technical Assessment Report will be submitted in Q3 2014 (Lorax 2014).

Treatment will result in the generation of solid-phase treatment products that will require on-site management and disposal. Sludge co-disposal with tailings into Brucejack Lake is the proposed method for sludge management during the operational period. This is based on two factors. First, the logistics of sludge co-disposal with tailings are simpler to implement than placement with paste in the underground. Second, lake disposal of sludge will eliminate potential interactions with low pH water that may occur in the mine workings, due to the development of acidic conditions. Sludge materials will host secondary phases susceptible to dissolution under low pH conditions, and lake disposal will prevent the occurrence of these reactions. Further discussion of sludge compositions and characteristics are outlined in Section 29.10.6.2.

As outlined in Section 29.10.4.1, approximately 47% of the tailings will report to the underground as paste backfill, with the remainder (53%) reporting to the bottom of Brucejack Lake. In this regard, tailings will not be continuously discharged to the lake. This will necessitate the temporary storage of sludge materials for the days of paste production. The cycle between tailings discharge periods is predicted to be a few days, with a maximum period between lake discharge episodes being less than two weeks. Accordingly, volume requirements for sludge storage are relatively small.

During Construction (prior to tailings deposition and mill building construction), sludge may be stored subaqueously in the HDPE-lined contact water pond, which is designed for a 200-year rain-on-snow event. The volume of the contact water pond (48,700 m³) has the capacity to store the equivalent of 19 years of sludge production (during Construction), assuming the pond is not needed for storm water capacity. As outlined previously, water from this pond is pumped to the WTP. Sludge storage during Operation will include an engineered cell or tank in the mill building until it can be added to the tailings stream and pumped to Brucejack Lake for secure long-term disposal.

29.10.6.2 ML/ARD Assessment

Solids generated as part of water treatment will comprise two general types of materials:

1. Sediments generated as part of underground and surface activities: These materials will represent detrital sediment components that reflect the composition of underground wall rocks and surface materials. Sediments will comprise largely of silt- and clay-sized particles that are pumped to the WTP in association with: 1) mine dewatering; and 2) surface drainages that collect in the plant site sediment control pond. This sediment component, which closely resembles the waste rock signature, will comprise the bulk (about 65%) of the treatment solids volume (Veolia, pers. comm.). In this regard, the management considerations that apply to waste rock also apply to this sludge component.
2. Secondary precipitates generated within the WTP: The addition of treatment reagents such as lime and ferric sulphate during the Construction and Operation treatment processes will result in the formation of fine-grained secondary precipitates. These secondary phases are predicted to comprise largely secondary Fe-oxides, owing to addition of ferric salts as coagulant and co-precipitant, with a lesser component of metal hydroxides and secondary carbonates. The specific nature of the metal-bearing phases cannot be stated with certainty, but can be presumed to include metal hydroxides (e.g., Zn(OH)₂), metal-bearing Fe hydroxides and secondary sulphides. Collectively, these secondary precipitates will comprise a smaller proportion of the total sludge volume (about 35%).

In terms of geochemical characterization, treatment solids associated with the Construction and Operation WTP processes have not been specifically evaluated. However, detailed characterization has been conducted on sludge materials generated from the WTP that operated at Brucejack from January 2013 through part of summer 2014. This WTP was commissioned primarily to allow for the removal of suspended sediments from waters pumped from the underground. In this process, flocculation/sedimentation methods (including the addition of montmorillonite), in conjunction with solids-liquid separation (filter press), were used to remove solids from underground effluents. The final sludge product represents a reliable proxy for the sediment-component of the sludge to be generated during Construction and Operation, and therefore the physical and chemical data for the existing material have direct relevance to the composition of future treatment solids.

Treatment solids generated as part of first Brucejack exploration WTP have been examined through several methods, including:

- particle size distribution;
- elemental abundance;
- Acid-Base Accounting;
- mineralogy (Rietveld X-ray diffraction);
- SFE;
- synthetic precipitation leaching procedure; and
- subaqueous test work (i.e., aging tests).

Four sludge samples were submitted for the above analytical tests and the results presented as part of a Technical Assessment Report in support of mine water treatment for the on-going exploration phase (Lorax 2014). In summary of these findings, the sludge materials are fine grained, with relatively equal proportions of clay (less than 4 microns) and silt (4 to 63 microns).

Sludge samples show enrichment of several trace elements, with values for Ag, As, Cd, Mo, Pb, Sb, Se and Zn exceeding mean continental crustal values by a factor of 3 in some or all samples. Values for Zn, Ag, Cd and Pb show higher values in sludge materials in comparison to tailings and waste rock. In terms of ABA characteristics, sludge samples show low sulphide-S content (approximately 1%) and relatively low neutralization potential. Net potential ratios (Sobek NP/SAP) range from 1.4 to 1.5 (intermediate to that of waste rock and tailings), demonstrating that the sludge materials are potentially acid generating.

The mineralogical assemblage (as defined by X-ray diffraction) is dominated by quartz > muscovite > chlorite \cong calcite > microcline, with lesser amounts of pyrite and kaolinite. The potential for the release of soluble constituents associated with sludge placement in saturated settings (e.g., Brucejack Lake) was examined by SFE, synthetic precipitation leaching procedure, and aging test work. The data show the potential for the release of several trace elements (e.g., As, Cd, Mn, Ni, Se, and Zn) under conditions of neutral pH to slightly acidic conditions (i.e., ~ pH 6 -7). SFE data for sludge materials show higher values for sulphate, Ag, Cd and Pb, in comparison to tailings and waste rock.

The secondary precipitate components of the sludges that will be generated during Construction and Operation cannot be explicitly characterized until each of those WTPs is operating. However, based on several sources of information (e.g., predicted inflow composition to the WTP, the proposed treatment process, input from Veolia, and a literature review of other sludge materials [MEND 2014]), various secondary phases can be expected to be included in sludge produced at the Project site. These secondary phases can include discrete metal hydroxides, metals bound to Fe hydroxides, and secondary sulphide minerals. Geochemical modelling of the treatment process using synthetic influent chemistries demonstrates that secondary Fe oxides will comprise the bulk of the secondary precipitate mass (Veolia, pers. comm.). Although the magnitude of metal sorption to Fe oxides phases cannot be quantified, it is likely that these phases will be an important repository for trace metals such as As and Zn, which show strong affinities for Fe oxide surfaces.

29.10.6.3 *Monitoring*

The absence of geochemical characterization data for WTP sludges, which are expected to be generated as part of the proposed Construction and Operation treatment systems, presents a limitation in the site-specific understanding of how these materials will behave following deposition. In particular, the higher secondary precipitate component of Operation sludges translates to an increased potential for chemical instability associated with lake deposition, relative to Construction phase sludge disposal.

The efforts required to generate sludge materials at a pilot scale are onerous and impractical. For example, the generation of a sufficient amount of secondary precipitate material to be used in laboratory experiments requires approximately 5,000 L of underground water (or synthetic analogue). Based on these assessment limitations and the perceived low risk associated with sludge deposition in Brucejack Lake, it is proposed that experiments be conducted in the Construction/Operation period at times of readily available tailings and sludge materials. In addition, samples may be taken (at minimum) twice-yearly of WTP solids generated during Operation for the purpose of continually characterizing and validating sludge ML/ARD characteristics demonstrated from earlier test work in Construction and at the start of Operation. Further discussion and support for this plan is provided in the following sections.

29.10.6.4 *Prevention and Mitigation*

ML/ARD management of sludge materials must consider the potential for both acid generation and metal leaching. Sludge materials are low sulphur and low NP materials that have been previously characterized as potentially acid generating. On one hand, the predicted predominance of secondary Fe-hydroxides within sludge materials implies there is the potential for post-depositional chemical instability or the remobilization of redox-sensitive phases upon placement in Brucejack Lake. On the other hand, the placement of sludge materials in the lake will eliminate the potential for interaction with low pH water that could occur with placement in proximity to acidic seepages or conditions in underground mine workings. Therefore, the potential for sludge chemical instability in Brucejack Lake will relate primarily to redox-related processes.

Suboxic conditions can be expected to develop in the lake deposits and some reductive dissolution of sludge phases can be expected. In submerged tailings and lake sediments, Fe-oxide reduction is often observed within a few centimetres of the sediment-water interface (e.g., Martin et al. 2003). Given the mixing characteristics of Brucejack Lake, its oligotrophic nature (i.e., low rates of algal production), and the predicted presence of oxygenated bottom waters throughout the year, the near-surface porewaters are predicted to be aerobic in nature.

Overall, the risk of adverse water quality effects from sludge materials is considered to be very low based on the following rationale. First, sludges will comprise a very small proportion (i.e., estimated to be less than 0.5%) of the tailings mass. Specifically, the Operation sludge production rate (7 t/day) is very small in comparison to the tailings discharge rate to Brucejack Lake (1,430 t/day). Based on a secondary precipitate proportion of 35% in the sludge, this more reactive component will be present in exceedingly low proportions in association with the bulk tailings mass (less than 0.2% by mass). The low abundance of reactive phases in the lake deposits will minimize the potential for large-scale fluxes of sludge-derived components into the water column.

Second, the transport of remobilized sludge components into the water column will be largely governed by molecular diffusion across the tailings-water interface. Molecular diffusion is a slow process and mine-related case studies pertaining to diffusion-controlled problematic water qualities have been characterized by the following conditions: 1) high concentration (abundance) of redox sensitive phases in surface deposits; 2) shallow water covers (1 to 4 m in depth); and 3) relatively long-water residence times (Martin et al. 2005). None of these features apply to the Brucejack Lake system. Specifically, the sludge components will be present in very low abundances, as described above. Further, the deep water column (maximum depth of 50 m at mine closure) and relatively-rapid lake flushing (water residence time of 450 to 500 days at the end of Operation) will greatly decrease the potential risk of water quality degradation associated with tailings-water exchanges.

Conditions within the lake deposits will also serve to mitigate the flux of redox-sensitive components. As outlined above, it is predicted that aerobic conditions will persist at the surface of sludge-bearing

tailings deposits in the lake. This aerobic zone will serve to attenuate a portion of the upward flux of remobilized Fe and other metals that migrate towards the tailings-water interface. Upon Closure, the progressive burial of the tailings deposits by natural sediments will provide a further means to physical and chemically isolate the sludges from the water column. Collectively, the behavioural aspects of the sludge materials described here suggest that these materials are unlikely to have a measureable influence on water quality in Brucejack Lake.

Overall, the major elements relating to the prevention and mitigation of ML/ARD associated with the sludge materials are summarized in Table 29.10-6 and include:

- avoidance of sludge placement in the underground workings, thereby preventing the potential for sludge interaction with low-pH water;
- subaqueous storage in an engineered cell (or tank) or in the contact water pond, and within Brucejack Lake during Operation, to eliminate the potential for acid generation and minimize potential for metal leaching;
- co-disposal with tailings materials in Brucejack Lake during Operation which will result in the dilution of sludge phases to very low abundances in the lake deposit (i.e., less than 0.5% by mass); and
- disposal in a lake environment that will minimize the potential for large-scale remobilization and release of sludge components.

Table 29.10-6. ML/ARD Prevention and Mitigation Measures for Sludge

Management Component	ML/ARD Prevention and Mitigation Measures	Construction	Operation	Closure	Post-closure
Sludge storage	During the Construction phase, and prior to tailings discharge, treatment solids will be stored subaqueously in the contact water pond or stored in an engineered cell or tank prior to mill building, to mitigate potential for acid generation. The contact water pond hosts sufficient storage capacities for sludge production during Construction or Operation and exceeds maximum temporary sludge storage requirements. Water that accumulates in the contact water pond reports to the WTP for treatment.	X			
	Sludge will be placed in an engineered cell or tank, located in the mill building, at times when tailings are used in paste backfill to underground.		X		
	At Closure, any sludge produced from ongoing WTP activities will be run through a filter press to dry materials and removed off-site to a licensed facility				X
Sludge co-disposal with tailings to Brucejack Lake	Placement of sludge materials under permanently saturated conditions will mitigate potential for acid generation.		X	X	X
	Co-disposal with tailings materials will result in the dilution of sludge phases to very low abundances in the lake deposit (less than 0.5% by mass). This will minimize the potential for large-scale re-mobilization and release of sludge components.		X	X	X
	Brucejack Lake is characterized by relatively deep water depths, and short residence time (450 to 500 days) will reduce impact to water quality associated with tailings-water exchanges		X	X	X

To support the assumptions provided here, a rigorous monitoring and contingency framework has been developed (discussed in Section 29.10.6.5).

29.10.6.5 Performance Monitoring and Contingency

As described above, given the low adverse risk of sludge materials to water quality in Brucejack Lake, and the impractical logistics associated with the generation of sludge materials representative of operational conditions, it is proposed that such materials be examined when they become available after mine permitting. Planned future geochemical test work, as well as further water quality modelling, is outlined in the sections below.

Water Quality Model Sensitivity Analysis

As per the recommendations of the BC MEM, sensitivity modelling will be conducted to examine the potential effects of sludge materials on water quality. This modelling exercise will adopt conservative assumptions with regards to sludge loadings. In this manner, overestimating parameter loadings from the sludge solids will allow the development of a conservative interpretation of sludge behaviour.

The release of soluble loadings from the sludge materials will be associated with the diffusion-controlled release of dissolved parameters across the tailings water interface. In this regard, the sensitivity analysis will incorporate flux information for case studies that have examined the behaviour of reactive and abundant secondary tailings phases in lake settings (e.g., Martin et al. 2001; Martin and Pedersen 2002; Martin, Jambor et al. 2003; Martin, Crusius et al. 2003). The fluxes calculated in these studies would represent overestimates of the likely fluxes in Brucejack Lake, given the low abundance of reactive phases in the tailings and sludge mass. The data in these studies have relevance to several key parameters for the Project, including arsenic and zinc. The generation of favourable water quality predictions, in light of conservative inputs, would lend more confidence in the approach to obviate detailed geochemical test work at the current time.

Geochemical Assessment of Treatment Sludges (Interim Water Treatment Plant)

As described in Section 29.10.6.1, an interim WTP was commissioned in 2014 and will operate until near the beginning of the Construction phase, at which time it will be upgraded to address predicted water quality conditions during Construction. Although this treatment process differs somewhat from the operational plant, there are several common elements, including addition of alkali (pH controlled metal precipitation) and ferric salts (to promote metal sorption with Fe oxides). In this regard, the sludge materials generated in the interim WTP will provide an early opportunity from which to build upon the existing understanding of sludge composition and behaviour. Geochemical tests on interim WTP sludges could be specifically used to assess the following:

- define metal phases associations within the sludge via high-resolution microscopy methods (e.g., scanning electron microscopy) in conjunction with selective extractions (exchangeable, reducible, weak-acid dissociable and oxidizable phases);
- identify the primary parameters of concern based on the results of selective extraction test work and elemental analysis of sludge solids;
- examine the behaviour of sludge materials under conditions of submergence and suboxia through the initiation of column-based saturated kinetic testwork; and
- provide a database that can be used to better direct geochemical test work on operational materials once they become available.

Geochemical Assessment of Treatment Sludges and Tailings (Operational Water Treatment Plant)

Sludges generated during the Operation phase will represent the vast proportion of WTP solids to be generated over the life-of-mine. Such materials are not expected to be available until month 16 from start of Construction (when mill operations are scheduled to begin). The results of additional sludge geochemical test work to be conducted for the existing WTP, and then augmented following WTP upgrade for Construction, will be used to inform the geochemical testing program for the Operation sludge materials. It is envisioned that a similar suite of experiments will be conducted as described above for the WTP sludges from the first Brucejack WTP that operated to mid-2014.

In terms of column tests, it is proposed that two columns be initiated for the Construction phase WTP, one with just treatment sludges, and the other admixed with tailings in proportions dictated by their respective production rates. Collectively, this type of kinetic testwork in combination with the other components described above (e.g., SEM, selective extractions) would be used to address the following objectives:

- define the dominant metal-phase associations in the sludge materials;
- assess the geochemical stability of sludge materials under conditions of permanent saturation;
- examine how sludge co-disposal with tailings affects flux rates into the water column; and
- use flux information to ground-truth the assumptions associated with predictive water quality monitoring.

Performance Monitoring

Performance monitoring during the pre-construction, Construction, and Operation phases will be used to validate the assumptions with respect to sludge behaviour presented above. Monitoring during the period of the Construction WTP will include the following:

- as soon as available, one-time collection of sludge samples for geochemical testing (static test data, selective extractions, mineralogy);
- initiation of column tests, as described above; and
- monthly collection of water quality samples from the contact water pond to provide an indication of the subaqueous chemical stability of sludge materials.

During the Operation phase, monitoring will entail:

- one-time collection, as soon as available, of sludge samples for geochemical test work (static test data, selective extractions, mineralogy), with samples collected thereafter on a quarterly basis for static test analysis;
- initiation of column tests as described above;
- sludge sample collection (at minimum) to be conducted twice-yearly and submitted for geochemical testing (static test data, selective extractions, mineralogy); and
- collection of water quality samples from Brucejack Lake and contact water pond (if used for sludge storage) as described in Section 29.10.3.5.

Contingency Measures

If geochemical test results or on-site monitoring predict sludge materials will result in unacceptable water quality in Brucejack Lake, there are several contingency measures available. First, there is the

option of encapsulating the sludge materials with tailings on the lake floor. This would involve cessation of sludge deposition and continued placement of tailings to the bottom of Brucejack Lake. Burial by only a few 10s of centimetres would be required to physically and chemically isolate the sludge materials from the water column of the lake (i.e., diffusion barrier). Depending on the potential risk to water quality, this could occur immediately during Operation or (at a minimum) near the end of mine life, if placement of a diffusion barrier is deemed necessary.

In conjunction with the above, there are alternative potential options for sludge deposition. The placement of sludges (as a component of paste) within secondary stopes presents a practical contingency measure. As outlined in Section 29.10.4, secondary stopes do not require the same level of geotechnical support as their primary stope counterparts. The primary advantages associated with underground placement of sludge materials are the hydrologic containment in conjunction with available treatment. The primary disadvantages are the increased logistics associated with underground placement and the increased risk for the re-mobilization of sludge components associated with potential exposure to acidic conditions. During Operation, any contaminated water derived from sludge dissolution will be contained within the mine and pumped to the WTP for treatment. During the flooding period at Closure, the potential for the migration of contaminant water along groundwater flow paths can be minimized by maintaining water levels below a certain elevation. This would be achieved by pumping water at a calculated rate to the WTP. Another consideration is that the hydrologic conductivity of a paste-backfilled stope is about 10 times slower than the estimated conductivity of the surrounding fractured bedrock. Therefore, paste-backfilling will implement a permeability control to slow potential fluid migration to fracture-controlled flow pathways.

29.10.7 Post-closure Monitoring

Post-closure water quality monitoring to evaluate the long-term performance of the waste management strategies at the Project is planned at three locations: Brucejack Lake, the adits, and Brucejack Creek. The water quality at each of the three monitoring locations will reflect the effects of mine waste stored in (1) Brucejack Lake, (2) the underground mine, and (3) both.

Planned Post-closure water quality monitoring will involve quarterly sampling at three stations over a minimum period of five years. The chemical analyses of the water samples from each station will be similar to those used for the baseline water quality assessment. The evolution of the water quality over the five-year period at each of the three stations will be interpreted to predict the likely evolution of their long-term water quality. If necessary, the monitoring period can be extended beyond five years.

29.10.7.1 Brucejack Lake

The monitoring station in Brucejack Lake is the same as described in Section 29.10.3.5 and Section 29.3, Aquatic Effects Monitoring Plan, and has been sampled frequently in the past. The monitoring station is selected to measure in-situ properties of the water column and interpret its physical stability (stratification, turnover). The chemical composition of water samples collected at regular depth intervals will be used to monitor temporal and vertical changes in the chemical composition of the water column. Additional details of the water quality monitoring program are provided in the AEMP.

29.10.7.2 Adits

Currently, the main twin decline portal for the underground mine is predicted to be at a higher elevation than the position of the groundwater table after full recovery from underground dewatering activities (BGC 2014e; Section 29.15, Tailings Management Plan). As such, groundwater discharge from the twin decline portals is not expected. However, groundwater was flowing from the existing exploration adit under baseline conditions and the potential for seepage from this location, even when

plugged, should be anticipated. Further details regarding the underground mine design can be found in Chapter 5, Project Description.

Any seepage from the adits or portals will be monitored at the discharge to surface location (e.g., at the existing exploration adit location). If there is no adit seepage, the groundwater wells (proximal to the underground workings) will be sampled on a quarterly basis during the closure period and the post closure monitoring period to monitor potential impacts to local groundwaters by contact with flooded underground mine waters. Temporal changes in the chemical composition of the seepage water and in the groundwater wells are considered likely to reflect the evolution of the water quality in the flooded mine.

29.10.7.3 Brucejack Creek

The planned monitoring station in Brucejack Creek is BJ 200m D/S (BJ 2.62), which is the attainment location point shown on Figure 29.10-2. The water quality at monitoring station BJ 200m D/S (BJ 2.62) reflects the contributions from waters of Brucejack Lake and the flooded mine. This monitoring station will have a very long record of water quality data extending from the EA baseline through Construction and Operation. Data from this site will assist with interpreting long-term water quality trends downstream of the Project. Additional details of the water quality monitoring program for Brucejack Creek are provided in Section 29.3, Aquatic Effects Monitoring Plan.

29.10.8 Temporary or Early Closure Scenarios

It is possible that mine operations may require a temporary shutdown and/or early closure. If either event occurs, the following describes contingency plans that will be applied to manage mine waste materials. Further details of periods of temporary or early closure can be found in Chapter 30, Closure and Reclamation.

29.10.8.1 Temporary Closure

At times of temporary halts to mine operations, ML/ARD management will be continued (including operation of the WTP). As well, the following will be implemented to reduce or mitigate potential ML/ARD risk:

- all temporary waste rock piles stored on surface will be promptly stored underground with paste backfill and/or disposed in Brucejack Lake;
- tailings will be disposed to Brucejack Lake or underground; and,
- WTP sludge can be temporarily stored in the contact water pond or in an engineered cell (or tank) housed in the mill building.

29.10.8.2 Early Closure

In the event of early closure (i.e., before the planned 22 year mine life), closure and post closure programs will be under taken.

29.11 NOISE MANAGEMENT PLAN

29.11.1 Purpose

Noise is generally defined as undesirable sound that may adversely affect people and wildlife in the local area. A change in the noise environment may be irritating, disturb rest or sleep patterns, cause loss of hearing, or otherwise affect the quality of life of affected individuals. Noise can result in psychological and physiological effects (e.g., stress), mental health effects, and effects on residential

behaviour (World Health Organization, WHO; 1999). In addition, noise may negatively affect wildlife by causing them to avoid important habitats and/or take time away from their key behaviours such as feeding, breeding, or watching for predators, which can ultimately lead to reduced reproduction and increased mortality.

In order for there to be an adverse impact from noise there must be a noise source (e.g., blasting or a passing truck), a pathway for the noise to travel along (typically through the air), and a receptor (i.e., something to be affected by the noise, such as people or wildlife). By controlling or removing any of these (source, pathway, or receptor), the impact of the noise will be mitigated.

Noise was assessed as an intermediate component through the Application/EIS scoping process due to the potential impacts on humans (workers and users of the area) and wildlife. Chapter 8, Noise Predictive Study, provides a description of potential effects of the Project on noise levels, relevant mitigation measures, and predicted changes to noise levels. The determination of significance of these predicted changes to noise levels is presented in Chapter 18, Assessment of Potential Wildlife Effects, and Chapter 21, Assessment of Potential Health Effects, respectively.

The purpose of this Noise Management Plan is to provide measures to control the noise sources, i.e., to reduce the overall noise from the Project. Management plans that address wildlife well-being (Sections 29.21, Wildlife Management and Monitoring Plan) and human well-being (Chapter 21, Assessment of Potential Health Effects) include measures to reduce noise impacts from the perspective of humans and wildlife as receptors. This structure is used for the various Environmental Management and Monitoring Plans that deal with intermediate components such as noise, to prevent repetition of measures between these and the receptor valued components.

This Noise Management Plan also outlines when noise monitoring may be required.

29.11.2 Regulatory and Policy Framework

There is currently no federal or provincial legislation that stipulates noise levels for mine development projects. However, there are regulations for human health. The CEAA 2012 requires that the environment is protected from significant adverse environmental effects caused by a designated project (CEAA 2012).

This management plan takes account of current best practice and the following relevant guidelines:

- WHO *Guidelines on Community Noise* (1999);
- BC Oil and Gas Commission *Noise Control Best Practices Guideline* (2009);
- Alberta Energy and Utilities Board *Directive 038: Noise Control* (2007);
- Health Canada's *Useful Information for Environmental Assessments* (2010);
- ISO 1996-2:2007: *Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise levels* (ISO 2007); and
- Ontario Ministry of Environment *NPC 119: Blasting* (1978).

These guidelines provide recommended noise limits to minimize sleep disturbance, annoyance, and hearing loss. Suggested limits are provided for average noise levels as well as peaks in noise levels. For example, the *Guidelines on Community Noise* (WHO 1999) suggest that:

- “If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise”; and
- “For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{max} more than 10 to 15 times per night.”

Typically, noise effects are assessed for human receptors not employed by the Project and outside of the Project boundaries. Work camps such as those associated with the Project are specifically excluded from the requirements of Directive 038 (Alberta Energy and Utilities Board 2007). However, current best practice is to assess sleep disturbance at on-site mine camps as well. As such, this plan has considered noise effects both outside and inside the Project boundaries.

There are also no legislated noise limits that apply to wildlife, but there is considerable academic and industrial monitoring research that provides guidance on the types of noise that can cause adverse effects to wildlife. These effects relate to sub-optimal utilization by wildlife of the habitats where the noise occurs, to the wildlife’s ultimate physiological disadvantage.

29.11.3 Performance Objectives

This Noise Management Plan focuses on the noise generated at the Project sources and the monitoring program. As mentioned, specific performance objectives with respect to managing noise impacts on human health and wildlife are included in Chapter 21, Assessment of Potential Health Effects, and Section 29.21, Wildlife Management and Monitoring Plan, respectively.

The objectives of this plan, in conjunction with the human health and wildlife plans, are to:

- ensure all relevant human health regulatory requirements and published best practice recommendations are met;
- manage and minimize the impact of noise from mining operations on possible human receptors and the environment wherever possible, so that no reasonable noise complaints are received;
- maintain an effective response mechanism to deal with any issues and complaints to ensure that any complaints are responded to promptly and a plan to investigate and address the issue is developed as soon as is feasible; and
- ensure that the results of noise monitoring comply with applicable criteria.

29.11.4 Environmental Protection Measures

There are three main mitigation strategies for noise control. These noise mitigation strategies should follow a hierarchy of control, with source control always being the preferred option where reasonable and feasible, and control at the receptor the least favourable option.

29.11.4.1 Controlling Noise at the Source

Best management practices can be used to control noise at the source.

29.11.4.2 Controlling the Noise Pathway

There are two approaches to controlling the noise pathway:

- the use of barriers; and
- land use controls, which attenuate noise by increasing the distance between source and receiver.

29.11.4.3 *Controlling Noise at the Receptor*

This is the least-preferred control option and is applied when all other methods of noise control have been evaluated and implemented and further improvements are still required for the receptor. If further controls are required, the most effective options should be evaluated by a noise specialist in order to maximize the effectiveness of mitigation. This would be undertaken on an as-needs basis and could include noise mitigation measures such as increasing the thickness of window glazing, reviewing HVAC systems, and improving the construction of exterior facades. Implementation of each of the three strategies for the Project is addressed in the following sections.

This plan focuses on the first of these mitigation strategies (controlling noise at the source); measures to control the noise pathway and noise at the receptor are addressed in Chapter 21, Assessment of Potential Health Effects, and Section 29.21, Wildlife Management and Monitoring Plan, respectively.

29.11.4.4 *Mobile Equipment*

The following recommendations will be considered concerning mobile equipment, particularly those operating near worker camps during sleeping hours (sleeping hours are defined as any time workers are sleeping, and are not limited to nighttime due to the continuous production nature of the mine):

- consider noise ratings when selecting equipment;
- properly maintain equipment to minimize noise, including lubrication and replacement of worn parts, especially exhaust systems;
- optimize the operation of equipment to minimize noise, e.g., reducing vehicle speeds;
- optimize the site layout to minimize noise impact, e.g., through use of natural screens such as buildings, locating doors away from noise sources and facing away from relevant receptors, and minimizing the need for mobile equipment to use their backup alarms;
- maximize the distance between roads servicing mobile equipment and worker camps;
- optimize site procedures to minimize the noise impact, e.g., keeping doors closed;
- conduct loud procedures indoors, where possible;
- optimize hours of operation for loud procedures to minimize noise impact and/or restricting operation to specific hours so that workers know when to expect particularly annoying noise events during sleeping hours;
- use barriers, when possible, to minimize noise impact; and
- turn off equipment when not in use to avoid unnecessary idling.

29.11.4.5 *Stationary Equipment*

The following recommendations will be considered concerning stationary equipment:

- ensure that stationary equipment, such as generators for light and power, incinerators, etc., are not placed in close proximity to worker camps or other possible human receptors;
- fit all diesel-powered equipment with silencers (mufflers) meeting manufacturers' recommendations for optimal attenuation, and maintaining these silencers in effective working condition;
- locate generators within a noise enclosure, if possible;
- use sound-muffling cladding on bins, crushers, and conveyors; and

- specify low noise conveyors throughout.

29.11.4.6 *Blasting*

The following recommendations will be considered concerning blasting activities:

- avoid blasting configurations that could result in simultaneous detonation of multiple charges;
- ensure blast holes are adequately stemmed for the depth of the hole and stemmed with suitable material; and
- publish blasting schedule for workers so they can plan on wearing earplugs if blasting coincides with sleep times.

29.11.4.7 *Indoor Equipment*

All equipment located indoors will not exceed an interior reverberant level of 85 decibels (dBA), or as specified by occupational noise limits.

29.11.4.8 *Mitigation Plans*

Operational noise-mitigation plans will be developed, as required, based on the above best practice guidelines. Mitigation plans will be triggered if warranted, based on complaints received from the community or stakeholders.

29.11.4.9 *Complaint Procedure and Register*

Upon receipt of a complaint from human receptors, preliminary investigation will commence as soon as practicable to determine the likely causes using information such as prevailing climatic conditions, the nature of activities taking place, and recent monitoring results. A response will be provided as soon as possible, which may include the provision of relevant monitoring data, if requested.

When specific complaints are received in relation to noise at a particular receptor site, noise monitoring may be undertaken at or near the site if the complaint is deemed to be valid.

Every effort will be made to ensure that concerns are addressed in a manner that facilitates a mutually acceptable outcome for both the complainant and the Project. All community complaints and follow-up actions will be recorded.

The following information related to noise complaints from the public will be recorded:

- name;
- address;
- contact telephone number;
- date and time of registering complaint;
- date and time when noise occurred;
- subjective assessment of magnitude; and
- detailed description of noise.

29.11.5 Monitoring Program

The objective of noise monitoring is to make sure that noise levels propagated from the Project will meet human health and wildlife standards and guidelines as identified in Chapter 21 and Section 29.21, respectively. Noise monitoring will provide relevant stakeholders with timely and concise information that indicates whether the environmental management plans developed to mitigate negative effects are on track to achieve their stated objectives.

If noise monitoring measurements are required to be performed, they will be in compliance with the International Organization for Standardization standard (ISO 1996-2:2007), which provides guidelines for the measurement of environmental sound and encompasses the following aspects:

- instrumentation system;
- calibration;
- monitoring locations;
- evaluation of measurement results;
- measurement uncertainty; and
- documentation.

The acoustic instrumentation system—consisting of a microphone, wind screen, cable, and recorder—should conform to class 1 or class 2 requirements as defined by the International Electrotechnical Commission (IEC) 61672-1 standard (2002). The sound level meters will be field calibrated immediately before and after each measurement with a class 1 calibrator in accordance with IEC standard 60942-2 (2003). Windscreens should always be used during outdoor measurements and should be clean, dry, and in good condition.

Records of noise-monitoring activities and associated management action, including operational controls and mitigation, shall be retained to ensure the continued safe and economical management of noise-generating activities.

29.11.6 Work Planning and Schedule

Noise monitoring will be conducted if it is identified as being required.

Any noise monitoring will be coordinated so that measurements can be conducted during representative conditions. Noise monitoring occurring over a short time period (such as with blasting) may be attended; however, monitoring occurring over longer time periods may be unattended. Representative conditions include source operating conditions and weather conditions.

29.11.7 Reporting Requirements

If noise monitoring is undertaken at any point during the life of the project, an appropriate measurement report for each monitoring session will be used to:

- demonstrate compliance with the Noise Management Plan;
- demonstrate compliance with calibration standards in case the measurement is challenged by an external party;
- permit repeating the measurement in the future to evaluate a change in source or propagation conditions or in case the measurement is challenged by an external party;

- permit comparison with similar situations; and
- permit an external party to perform more detailed measurements and/or analyses without needing to repeat the original measurement.

Measurement reports will be completed after a monitoring session.

The measurement report contents will minimally include:

- the relevant noise limit (if applicable);
- the reference time interval(s), e.g., eight-hour period, as per the criteria;
- a description of the noise source(s) included in the reference time intervals;
- a description of the operating conditions of the noise sources;
- a description of the assessment site including the topography, building geometry, ground cover, and condition and locations including height above ground, of the microphone(s) and source(s);
- the time, day, year, and place of the measurements;
- the instrumentation used (i.e., models and serial numbers) and calibration results;
- the measurement time intervals;
- a description of weather conditions during the measurements, particularly wind direction and speed, cloud cover, and whether precipitation was present; as well as temperature, barometric pressure, humidity, and the location of the weather instrumentation;
- a description of the residual sound;
- a description of any procedures used to correct for contamination by residual sound, including a description of any noise modelling performed, including prediction standard and calculation settings;
- the rating level and the components, including acoustic levels contributing to the rating level;
- whether or not the measurement demonstrates compliance with the noise limit (if applicable);
- a figure showing monitoring locations on a map;
- discussion of uncertainties in the monitoring results; and
- a photograph of microphones as set up.

Many of these items can be recorded while at the site on a field data sheet. All measurement data, photographs, and field data sheets will be stored electronically to permit future access as required.

In addition, records should be maintained by the blasting contractor regarding the details of every blast event. Records should include, but not be limited to, the date and time of blast, environmental conditions, if blasting above ground (e.g., temperature, cloud conditions, and wind speed and direction) that may affect the noise/vibration characteristics of the blast and location of blast (mine coordinates, elevation, and description).

29.12 RARE PLANT MANAGEMENT PLAN

29.12.1 Purpose

The purpose of this Rare Plant and Lichen Management Plan (RPMP) is to maintain natural levels of plant and lichen biodiversity through avoidance and other mitigation strategies during the Construction, Operation, Closure, and Post-closure stages of the Project. This plan provides strategies and mitigation measures for the ongoing management of rare plants and lichens at the Project site and is based on the guiding principles outlined by the *Species at Risk Act* (2002c), the *Wildlife Act* of British Columbia (BC; 1996), *Identified Wildlife Management Strategy* (Cichowski, Kinley, and Churchill 2004), and the Cassiar Iskut-Stikine Land and Resource Management Plan (CIS LRMP; BC ILMB 2000).

The 2012 and 2013 rare plant and lichen surveys in the proposed Project area resulted in the detection of 77 species of conservation interest within the Local Study Area (LSA), some of which are of high global priority due to their worldwide rarity, habitat limitations, small populations, vulnerability to extirpation, or other considerations. Rare plant and lichen populations were found in portions of the study area in localized habitats such as alpine scree, cliffs, glacier forelands, gossan outcrops, meadows, seepages, tundra, and wetland habitats. Many of those rare plant and lichen populations were found to co-occur in the same habitats, and thus can receive collective protection. However, none were found within the predicted mill and ancillary facilities footprint.

Mitigation of rare plant and lichen populations can involve avoidance (prevention of direct impacts and maintenance of buffer areas), transplantation, reduction of indirect impacts, and compensation. Avoidance is the only method of ensuring that direct impacts will not harm or extirpate rare plant and lichen populations (California Native Plant Society Rare Plant Scientific Advisory Committee 1998; Fahselt 2007).

Reduction of indirect impacts may help to protect rare plant and lichen populations located in the vicinity of, but not within development areas. Dust control measures, direct application of herbicides (rather than broadcast application) to any invasive species, and preventing the spread of invasive species are important strategies for reduction of indirect impacts. When avoidance is deemed unfeasible, transplantation has historically been employed (by moving rare species out of harm's way). However, transplantation is usually ineffective (Fahselt 2007; Howald 1996; Hubbard et al. 2001; Schemske et al. 1994) as rare plants and lichens are mostly highly habitat-specific and the unique combinations of environmental conditions that characterize their habitats are also rare. As well, transplantation often is highly injuring to rare plants and lichens, contributing to a low survival rate. Finally, the appropriate level of post-transplant care can be very labour intensive, and personnel shortages can result in fatal neglect of post-transplant populations.

Implementation of the RPMP will reduce harm to native plants and lichens that have been deemed rare in BC through avoidance. The RPMP will also ensure compliance with regulatory requirements.

29.12.2 Regulatory and Policy Framework

The following legislation, guidelines, management plans, and governing agencies are of relevance for the provincial management of rare species:

- *Species at Risk Act* (SARA; 2002c). Federal legislation that aims to protect species at risk from becoming extinct. Certain species are also protected under SARA as part of wildlife habitat and in accordance with the Canadian Biodiversity Strategy. The Canadian Biodiversity Strategy provides federal legislation that supports the conservation of particular species and populations

to ensure continuance of biological diversity over time (Federal-Provincial-Territorial Biodiversity Working Group 1995).

- The BC *Wildlife Act* (1996l). Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species, and also enables the protection of habitat in a Critical Wildlife Management Area.
- *Forest and Range Practices Act* (2002b). Under the BC *Forest and Range Practices Act*, species at risk can be designated as Identified Wildlife by the Deputy Minister of Environment, if the species requires special management to address the impacts of forest and range activities. The terms "wildlife" and "species at risk" have been defined in the Act so that endangered, threatened, or vulnerable species of vertebrates and invertebrates, endangered or threatened plant, and plant communities, and regionally important vertebrates may be designated as Identified Wildlife.
- *Towards an Environmental Mitigation and Offsetting Policy for British Columbia: A Discussion Paper* (BC MOE 2010c). Provides a framework to consider when setting mitigation strategies for rare organisms and habitats.
- Cassiar Iskut-Stikine LRMP (BC ILMB 2000). Provides direction and management of endangered plants.

29.12.3 Performance Objectives

The RPMP is designed to provide environmentally responsible, realistic, and operationally feasible guidance for ecosystem, soils, and vegetation management related to rare plants and lichens and their associated habitat. The performance objectives of the RPMP plan are to:

- avoid direct harm to delimited rare plant and lichen populations through alignment of footprint boundaries when possible; and
- minimize indirect impacts on rare plant and lichen populations through the invasive plant management plan and the air quality management plan.

29.12.4 Environmental Protection Measures

Inventory and species-by-species approaches to rare plant and lichen management are required to effectively prevent diminishment of biodiversity through the phases of the Project. Rare plant and lichen populations correspond to specialist habitats in the Project area, and rare species tend to occur in a clustered pattern in the landscape. Specialist habitats are uncommon environmental settings (e.g., cliffs, scree, seepages) embedded within the more common and widespread matrix habitats (e.g., dense conifer forest). Often, occurrences of specialist habitats host multiple rare plant and lichen populations.

Habitats are complex combinations of abiotic (i.e., snow duration, soil chemistry, hydrology) and biotic components (i.e., canopy competition, herbivory, guano-enrichment) that result in exclusion of species not specially adapted to those settings. Minimizing effects to these specialist habitats where rare plant and lichen populations have been identified and delimiting exclusion zones will help to maintain the high levels of biodiversity in the Project area.

Impacts to rare plant and lichen populations will be minimized through the following actions:

- optimizing alternatives to ensure that rare plant and lichen populations are avoided, where feasible;

- applying adaptive Project design changes that avoid harm to rare plant and lichen populations, where feasible;
- adherence to best management practices (described below); and
- performance evaluation of the RPMP.

The following best management practices are to be applied to all vegetation-clearing activities as appropriate on site and will help to avoid and reduce impacts to rare plants and lichens and their habitats:

- identify known locations of rare plants and lichens and their habitats in relation to planned Project activities;
- appoint environmental personnel to be responsible for the management of rare plants and lichens and their habitats;
- avoid surface disturbance in areas with known rare plant and lichen populations;
- avoid use of all herbicide sprays within 200 m of rare plant and lichen populations and limit such use to direct application rather than broadcast sprays;
- create a buffer from known rare plant and lichen habitats to avoid direct disturbance and to minimize effects related to fugitive dust transport, weed invasion, vehicular activities, and accidental chemical spills;
- ensure that a qualified environmental monitor, capable of identifying rare plants and lichens is on site (at the clearing location) during vegetation-clearing activities;
- where avoidance is not feasible and development is permitted within buffer areas around plant populations, erect temporary fencing or other barriers around the nearby rare plant and lichen populations to avoid further disturbance to the site;
- lessen the impact of fugitive dust on rare plant and lichen populations through adherence to established buffers and dust control measures. While new roads should not be built within buffer areas around rare plants and lichens, pre-existing roads with an expected increase in traffic should be managed for dust during the growing period (June through August). If possible, dust abatement applications should be comprised of water only, with minimal use of magnesium chloride or other chemicals;
- avoid alteration and disturbance of the hydrological setting that influences rare plant and lichen populations;
- monitor for population plant and lichen vigour and survival will be undertaken if Project activities ingress into the zone of potential Project effects beyond currently anticipated infrastructure.

The Environmental Manager will disseminate the performance objectives and actions to all Project personnel that have the potential to directly or indirectly influence rare plants and lichens on site during the Construction, Operation, Closure, and Post-closure activities. Communication of this information and sign-off by individuals will be recorded.

29.12.5 Work Planning and Schedule

Monitoring will occur during the growing season (June through August) and be performed by a qualified rare plant and lichen botanist, under the direction of the Project's Environmental Manager who will ultimately be responsible for the development, implementation, and monitoring of the RPMP. The Mine Manager on behalf of Pretium will be responsible for ensuring that the performance objectives are achieved and reported.

29.12.6 Reporting Requirements

Reporting of the environmental monitoring will include the following information:

- summaries of the records of inventory and monitoring, including a photographic record of surveyed locations as well as a copy of all rare plant and lichen data forms filled in for that survey (collectively, this information will be used as a means of tracking progress and determining future management activities, and will contribute to the BC CDC Plant at Risk Observation Database);
- quality assurance and quality control protocols employed to ensure data accuracy, to confirm that species are identified correctly by comparing against verified specimens, and that there are no blanks or duplicates in any pertinent database fields;
- assessment of the effectiveness of the monitoring methodologies and actions taken to improve the program if relevant;
- identification of any emerging negative population and biodiversity trends likely attributable to the Project identified by such monitoring surveying;
- proposed revisions to the RPMPs to address emerging negative trends, or to adjust monitoring programs, if required; and
- adaptive management applied to address any negative trends.

29.13 SOILS MANAGEMENT PLAN

29.13.1 Purpose

The purpose of a Soils Management Plan is to minimize the disturbance of the soil resource in order to conserve ecosystem function, ecologically valuable soil characteristics (including fertility, permeability, water holding capacity, biological diversity of the soil microbe and faunal community), and soil quantity (through soil salvage and the mitigation of erosion). Essentially, this is accomplished through both minimizing soil disturbance and by following best practices when disturbance is required, in order to avoid soil degradation.

Mine development activities result in soil disturbance in portions of a project footprint. However, the amount of soil loss and degradation associated with disturbance is largely subject to the extent of the soils resource in the areas to be disturbed and management of those soils. There are significant areas within the development footprint of the Project with no soil cover (bedrock, coarse rubble, glacial ice, and water). A Soil Management Plan presents the objectives of soil management, and targets to be used to measure effectiveness in meeting these objectives. How these objectives are met and targets achieved are subject to management decisions taken within the context of the on-the-ground conditions. A plan provides a suite of management tools that can be employed to effectively manage soil, the use of which will be site and condition specific.

This plan contains three components that provide a management framework for addressing soils-related issues arising from interactions of the project with soil and terrain; Soil Salvage and Handling, Erosion and Sediment Control, and Soil Metal Contamination Prevention.

29.13.2 Regulatory and Policy Framework

A number of legislated requirements exist to guide mining proponents on the development of a mine site and on the management of terrain and surface soil disturbance. These requirements include the *Mines Act* (1996i), the *Forest and Range Practices Act* (2002b), the federal *Fisheries Act* (1985c), and

BC EMA (2003a). General guidance for various soils parameters is also provided via the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2007). Each of these requirements and the guidance is discussed in the following subsections in relation to terrain, surficial geology, and soil management and monitoring. Some provisions of the *Nisga'a Final Agreement* (NFA; NLG et al. 1998) are also applicable.

Legislation and Standards

British Columbia's *Mines Act* (1996i) governs mining activities in BC from exploration through to development, production, closure, and reclamation. The Project proponent must obtain a permit approving the work system and reclamation program prior to conducting any mining activities. To obtain this permit, a detailed Mine Development Plan and Reclamation Program must be submitted to the BC MEM for approval.

Under the *Mines Act* (1996i), the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008) requires proponents to provide:

- information on surficial geology, terrain mapping, soil characterization (including soil metals);
- plans for salvaging and stockpiling of soils and overburden; and
- an erosion control plan.

Relevant information requirements set under the Fish Habitat Protection and Pollution Prevention provisions of the *Fisheries Act* (1985c) include descriptions of measures that will be taken to avoid or minimize any effects on the aquatic environment, shoreline, or riparian areas during Project development or its subsequent operation (Section 37). The *Fisheries Act* (1985c) also regulates the discharge of harmful substances into the fish habitat, including sediment (Section 34). Consideration of the above legislation is particularly important in cases when Project development takes place near shorelines, or riparian areas where migration of chemical contaminants and sediment into the aquatic environment could occur. The management of soils potentially contaminated by hazardous materials (hydrocarbons and reagents) is provided in the sections on waste management and spills/malfunctions, Sections 29.17 and 29.14, respectively.

The Ministry of Environment's Environmental Protection Division (EPD) administers the BC EMA (2003a) by setting criteria to define when "sediment yield" becomes a "pollutant" (Clark et al. 2012). Provincial water quality guideline documents provide targets of acceptable levels of sediment in water that are typically used when determining the performance of control measures when undertaking in-stream works (*Ambient Water Quality Guidelines (Criteria) for Turbidity, Suspended and Benthic Sediments*; BC MOE 2001).

Erosion prevention and watercourse sedimentation resulting from accelerated soil erosion are the focus of various best management practices. Unpaved roads have the potential to contribute significantly to soil erosion. The Brucejack Access Road is approved under the *Mines Act* (1996i); however, Pretivm works to the spirit of the forestry Codes for road construction. The aspect of forest-related legislation that applies to Pretivm is for vegetation removal (cutting authorizations). MLFNRO has acknowledged that this authorization will only apply along the transmission line, along the access road (road improvement sections only, the aerodrome, and Knipple Transfer Area); road construction and maintenance within Provincial forests is governed in BC by the *Forest and Range Practices Act* (2002b). The Act requires that road construction and maintenance conducted under *Forest Act* authority adhere to codes provided in the Forest Service Road Use Regulation (BC Reg. 70/2004), which focuses extensively on erosion prevention.

Matters related to contamination of the soil and its impact on various potential land uses are regulated by the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2007). These guidelines provide Canada-wide standards for the maximum limits of various toxic substances (e.g., metals, hydrocarbons, pesticides, etc.) in the soil. The Contaminated Sites Regulation (BC Reg. 375/96) included in the BC EMA (2003a) lists soil criteria for toxicity to soil invertebrates and plants. These provide numerical standards to define whether a site is contaminated, to determine liability for site remediation, and to assess reclamation success.

A detailed mine plan and reclamation program will be submitted as part of the combined *Mines Act* and *Environmental Management Act* Permit application. The following sections outline the general provisions to be included in these documents in terms of erosion prevention and sediment control, soil salvage, and prevention of soil contamination.

29.13.3 Soil Salvage and Handling

Baseline studies of the project soil resource indicate that the resource within the Project footprint is of varying suitability and extent. Bedrock outcrops are extensive in the mine site area and shallow soils are common to the aerodrome area. Soil material suitability for reclamation is commonly limited by excessive coarse fragments and excess slope gradient may preclude or impact salvage efficiency in some areas.

Soil salvage is anticipated for all areas where soils exist that will be either excavated, filled, or subject to levelling (minor cuts/fills) operations. Salvaged soils, and possibly, suitable overburden in the mine site area, will be used during mine reclamation to facilitate the restoration of functioning ecosystems. To achieve this goal, these materials (soils and suitable overburden) need to be salvaged, handled, transported, and stored in a manner that does not result in excessive losses of suitability and future productivity.

29.13.3.1 Performance Objectives

The objectives of the Soil Management Plan related to soil salvage and handling are to retain and preserve suitable soil available for use in mine reclamation. Targets of the Soil Salvage and Handling include the following:

- preserving adequate volumes of soil, and suitable overburden as required, for use in reclamation as specified by Chapter 30, Closure and Reclamation;
- minimize sediment release by salvaging soil under appropriate weather and soil moisture conditions;
- retain native fertility of soils during storage by preventing mixing with lower quality material; and
- preventing soil erosion during soil handling operations (salvage operations, to and from stockpiles, and during replacement).

29.13.3.2 Environmental Protection Measures

General Measures

Environmental protection measures are specific actions and practices that mitigate environmental damage. For soil salvage, specific measures will include the following:

- the operation will be adequately planned, and supervised following a predetermined soil salvage plan;

- soil salvage will include mineral and organic materials identified in the soil salvage plan. In practice, this means humus form (if present) materials will be salvaged and stored with the salvaged mineral soil, while excess vegetation (e.g., large tree limbs, root-balls, logs, etc.) will not be placed in the soil stockpile but may be retained for spreading as part of the final reclamation;
- prolonged exposure of bare soil to the elements will be avoided; whenever possible, soil salvage will immediately follow vegetation clearing;
- soil salvage will not be conducted when soils are too wet or too dry, as working in these conditions can degrade soil quality; and
- when practical, “bouldery” mineral coarse fragments larger than 25 cm in diameter will be separated during salvaging. This will enable equipment operators to effectively shape the soil stockpile. It will also improve the quality of the soil for use in future reclamation efforts.

Where storage of suitable soil and overburden is to occur (project footprint), it will adhere to the following guidance:

- stockpiles (including windrows) will be designed to be geotechnically stable;
- stockpiles will be located on stable foundations, on level ground where possible, outside of active floodplains and riparian areas;
- stockpile design will incorporate setbacks to ensure materials are not inadvertently displaced outside approved areas or impacted by routine project activities;
- where both are suitable for use as growth media, soil and overburden will be segregated in separate stockpiles, if deemed appropriate;
- stockpiles will be constructed as soil salvage activities progress. As portions of the stockpile become completed, the slopes will be contoured to ensure stockpile stability, minimize erosion, and to help vegetation establishment;
- traffic in stockpile areas will be limited to stacking and shaping the stockpiles in an effort to minimize compaction. If required, stockpile areas will be lightly de-compacted prior to seeding/planting activities;
- where deemed necessary stockpiles will be surrounded by runoff diversion and collection ditch catchments and shaped in a way that will promote slow, efficient drainage of the slopes;
- completed portions of stockpiles (both slope and top) will be protected, possibly by re-vegetation, to minimize soil erosion, maintain soil quality, and control weeds. The overburden stockpiles will require fertilizer for vegetation establishment. No further maintenance is planned unless erosion and/or excessive establishment of invasive species are reported; and
- stockpiles will be accessible and, with the exception of windrows along the access road, will be marked in the field with permanent signs. Information on stockpile quantity and quality will be recorded.

Sequencing and Handling Criteria

Progressive soil replacement and reclamation helps maintain a healthy environment, increases effectiveness of erosion control, and reduces closure-related capital costs at the cessation of mining activities. Where possible, planning and management strategies employed during mine development and operation will attempt to minimize surficial disturbance and reclaim affected areas early as indicated in the phases of the Closure and Reclamation Plan (Chapter 30).

Mixing surface and subsurface soils during salvaging operations (admixing) will be avoided, where possible, as excessive mixing of surficial organic (O, LFH) and mineral horizons (A and B) with deeper soils (C) can degrade the quality of the topsoil. A designated person will be responsible for determining salvaging depth by visual inspection of the material as it is being salvaged.

Mechanically disturbing excessively wet soils can result in soil compaction and the promotion of “massive” soil structure. Mechanical disturbance of excessively dry soils can result in wind erosion and destruction of soil aggregates. Where practical, soil salvage scheduling will consider preferred soil moisture content and occur in moderate weather conditions as soon as possible after vegetation removal to avoid prolonged exposure of bare soils. In areas either affected by natural seepage or where the water table is near the surface, soil salvaging operations will be preferentially scheduled during dry or frozen conditions to the extent feasible.

Salvaged soil and overburden will be stockpiled and re-vegetated, as appropriate, in a timely manner. Stockpiles will be located outside of the general work areas so they will not be re-disturbed by or interfere with Construction and/or Operation activities or with infrastructure expansion.

To retain the quality of the soil during reclamation, the soils will be reapplied in a manner that preserves their value. A ‘rough and loose’ replacement technique will be used to minimize compaction and increase microsite variability. Compaction, if encountered, may be mitigated by ripping or other means to encourage deeper rooting.

29.13.3.3 *Monitoring Program*

Monitoring of salvaged soils will form part of the Project environmental program and will complement the Soil Management Plan’s salvage and handling component. The results of the monitoring program will be used to measure the success of the management strategies and to identify where additional mitigation is necessary.

29.13.3.4 *Reporting Requirements*

Reporting will be included in the annual reclamation report as required by the *Mines Act* (1996i) and the Health, Safety and Reclamation Code for Mines in British Columbia (Sections 10.1.5.[4] and [5] of the Health, Safety and Reclamation Code for Mines in British Columbia; BC MEMPR 2008). Annual inspection reports may include where appropriate:

- a description of completed mitigation activities;
- a log, when possible, of photographs related to soil and suitable overburden salvage, stockpiling, and replacement;
- a summary of monitoring results; and
- a list of any required corrective actions.

The annual report will be submitted to the Ministry of Energy and Mines.

Oversight of soil salvaging and stockpiling operations, inspection reports, implementation, and associated reporting of the Soil Management Plan will be the responsibility of the site Environmental Manager.

29.13.4 Soil Erosion Prevention and Sediment Control

The energy required to detach soil particles and create soil erosion is dependent on soil texture, soil moisture content, slope steepness and aspect, microtopography, and slope length. Generally this energy requirement is less on steep slopes and finer textured soils (although certain clay soils can be less prone to surface erosion and more at risk of mass wasting, due to high surface area of the clay particle itself). Due to the common occurrence of steep slopes, terrain instability and thin veneers over bedrock, erosion prevention, and sedimentation control will be important during Construction, Operation, and Closure.

29.13.4.1 Performance Objectives

The primary objectives of soil erosion prevention and sediment control are to mitigate the degradation and loss of soils due to erosion throughout the Project's life, and to prevent damage to other ecological values as a consequence of soil erosion. The following goals are implicit in achieving this primary objective:

- conserving soil quantity and quality in areas that are subject to erosion (i.e., areas with fine textured soil, cleared areas, disturbed areas located on slopes, stockpiles);
- minimizing natural drainage disruption along access roads and around mine infrastructure;
- protecting disturbed, erodible materials in a timely manner; and
- reducing or controlling the potential for accelerated sediment delivery into watercourses.

29.13.4.2 Environmental Protection Measures

Environmental protection measures related to erosion prevention and sediment control will generally include the following:

- trained staff to be available during critical periods;
- sufficient supply of erosion prevention and sediment control materials to be kept at site for the spring melt through autumn fall period;
- provision of management options appropriate for the anticipated conditions; and
- keeping records of mitigation of erosion events, to improve on management techniques (adaptive management).

General Measures

Vegetation cover plays a vital role in erosion control. Thus, soil and associated vegetation disturbance will be minimized where possible in both areal extent and duration. Areas where vegetation has been temporarily removed (e.g., road shoulders, ditches, soil stockpiles, etc.) will be re-vegetated using an appropriate re-vegetation strategy (seed mix and/or planting) as soon as possible. Where required, additional means of soil surface stabilization (e.g., mulch or soil binder) will be used to hold the soil in place while the vegetation is established. Disturbed, non-soil areas, i.e., bedrock, coarse rubble and gravel bars, will generally not be treated but assessed for potential erodibility and only treated if required.

During Construction and Operation, additional erosion prevention and sediment control strategies may include, as appropriate:

- terracing and/or installing fibre logs, geotextiles, erosion control mats, weed-free mulch or straw bales, or gravel bags and surface roughening;

- controlling and directing runoff from disturbed areas by grading slopes and ditching;
- minimizing runoff energy by limiting the length and steepness of bare, exposed slopes and by applying appropriate surface drainage techniques (e.g., ditch blocks, ditch surface lining, rip-rap); and
- stabilizing water diversion channels and ditches and protecting channel banks with willow, rocks, gabions, or fibre mats.

Some amount of soil erosion may occur, even with the erosion prevention and sediment control strategies outlined above. Therefore, where required, prevention and control measures will be implemented to capture sediments before they are released to the receiving environment. Sediment control measures may include, as appropriate, installing and/or constructing:

- silt fences;
- weed-free straw bales;
- check dams;
- fabric-covered triangular dikes;
- gravel-filled burlap bags;
- sedimentation ponds; and
- rip-rap along channels and ditches.

Road Construction and Deactivation Considerations

As described in the Brucejack Access Road Upgrade Prescription (Cypress Forest Consultants 2014), new road construction for the Project will be limited to improvements of the existing Brucejack Access Road; very short segments at the aerodrome and Knipple Transfer Area; and short roads at the Brucejack Mine Site. This road construction and improvement work will follow the objectives of the practices presented in the *Forest Road Engineering Guidebook* (BC MOF 2002). Maintenance will be conducted to prevent or minimize landslide risk and to provide for continuous, efficient, controlled water drainage. Road design and construction will include consideration of the following:

- existing slope stability, drainage patterns, and soil types;
- potential impact of proposed structures on streams during and after construction;
- potential for adverse upslope, downslope, and downstream drainage impacts;
- confinement of sensitive operations in anticipation of weather and snow melt events;
- proper disposal of slash and debris;
- adequate supply and proper installation of erosion and sedimentation control devices; and
- where feasible, timely re-vegetation of disturbed slopes.

It is anticipated that all planned Brucejack roads will be required throughout the life of mine. In the currently unforeseen circumstance of any road or road section being no longer required before mine closure, it will be deactivated and reclaimed in accordance with the mine reclamation plan.

Construction Phase

Erosion prevention and sediment control measures will be used in conjunction with the Water Management Plan (Section 29.19) to address sediment control during Project Construction. One of the most important aspects relevant to sediment control will be development sequencing, particularly at the Brucejack Mine Site. For example, the contact water pond will be constructed before the contact water ditches, and erosion prevention and sediment control measures will be used during the construction of both. Construction runoff interception ditches and sediment control structures will be in place before ground disturbance activities are to occur. The water diversion structures will serve to keep non-contact water out of the primary development area.

Where disturbance of wet areas cannot be avoided, measures such as drainage ditches, sediment fences, and erosion cloth will be used as appropriate to minimize surface erosion. Both the baseline soils mapping and data and visual surveys of construction activities will help identify potential sites that require focused attention on erosion and sedimentation. Attention will be given to potential erosion sites, ditch failure, culvert blockage, or outside seepage to reduce the potential of slope/road failure and sediment transport.

The scheduling of ground-disturbing activities during periods of high precipitation or snow-melt events will be avoided, where feasible given the constraints posed by the short snow-free season. Stormwater runoff and sediment control measures, including isolation of work areas from surface waters and the use of temporary diversion methods (i.e., ditches, flumes, dam-and-pump) will be implemented as appropriate. Measures and materials will be implemented as described above in Section 29.19, Water Management Plan. Personnel will be trained in the use of these measures.

Proper installation and maintenance of ditches, including roadside, perimeter, and cross-ditching, will be implemented to control surface runoff and sediment transport as appropriate. Culverts will be installed following best management practices to avoid erosion to the cut banks, the subgrade, or the road surface. Energy dissipaters, sediment barriers, or trenches will be installed as appropriate in areas downslope of culverts where there is a potential for erosion.

Near-stream and in-stream activities will be designed to maintain bank stability and mitigate or repair any stream bank damage caused by Project activities. Watercourse crossings will be constructed such that natural drainage will be maintained.

Repetitive off-road vehicle travel can intensify soil compaction and soil erosion. Travel corridors will be clearly demarcated and vehicle travel will be discouraged outside of these areas.

Operation Phase

Once complete, the mine contact water management system will contain and treat (including addressing sediment) all contact water within its containment boundaries. Erosion prevention and sediment control measures will continue to be important throughout the life of the mine for the small mine site facility areas located outside of the primary water management containment area (e.g., substation).

Much of the Operation phase erosion control measures will be related to the maintenance of the established erosion and sediment control facilities. The monitoring of the functionality of these facilities will be conducted routinely to assess continued functionality. If repairs and or improvements to the type, sizing, and frequency of installations of some systems are identified then these will be undertaken as required. Some new construction activity may be anticipated during the Operation phase and measures, as noted previously, will apply.

29.13.4.3 *Monitoring Program*

A soil erosion and sediment control monitoring program will be initiated early during the Project's Construction phase; this will be described as part of the Erosion Prevention and Sediment Control Plan to be included in the *Mines Act* and *Environmental Management Act* Permit Application. In addition to monitoring conducted by Pretivm staff and contractors, workers will be encouraged to communicate to their supervisors any observations or concerns related to erosion and sedimentation.

Ditches, culverts, and adjacent slopes will be inspected as appropriate, especially after high rainfall and/or melt events. Identified erosion and sediment concerns, such as blockages, siltation, gullying, or slope failure, will be addressed as soon as possible to protect road infrastructure and the adjacent environment.

Evidence of erosion on disturbed and sparsely vegetated (non-rock) areas will be assessed; if erosion is observed, affected areas will be treated as soon as possible to avoid acceleration of erosion. Temporary measures, such as surface roughening, weed-free straw bales, and silt fences, will be checked regularly to ensure they are functioning properly. These will be replaced or serviced, as required. Long-term measures such as rip-rap, gabions, and ditches will be installed and monitored at the beginning and end of each season or after high rainfall events to ensure that they are operating properly.

Any sites determined to require ongoing monitoring will be located on a map and information including their GPS coordinates, erosion type, intensity, and the extent of the affected area, as well as existing control measures and assessment of their performance, will be documented as appropriate. Affected sites will be regularly checked for evidence of erosion, particularly after high rainfall events, until erosion is not a concern. Targeted field measurements, such as turbidity measurements, will be implemented as appropriate. Monitoring results may be used to trigger an appropriate adaptive management response.

Embankment condition and evidence of sediment transport into watercourses will be assessed along water diversion channels, drainage ditches, ponds, and waterway crossings along roads. The waterbodies adjacent to construction sites will be visually inspected for introduced sediment. Water sampling and/or turbidity testing may also be carried out if discolouration occurs. Regular inspection of areas releasing sediment will be carried out until sediment is no longer released.

29.13.4.4 *Reporting Requirements*

A communications strategy will be established on the Project site to report on the effectiveness of the plan(s) to the Environmental Manager. In the event of a significant sediment and erosion control failure, notifications will be given immediately to appropriate supervisors. As appropriate, these notifications will be extended to senior construction/operations managers, the Mine Manager and regulatory agencies, such as for incidents in which fish and aquatic habitat could be adversely affected, or if potential geohazards result from the erosive event.

Inspection reports will include, where appropriate:

- a description of erosion type, intensity;
- extent of the affected area;
- existing control measures;
- an assessment of their performance;

- additional mitigation activities undertaken (if any); and
- a log of dated photographs.

The monitoring results and corrective actions will be included in the site documentation management system and reported to senior construction/operations managers, the Mine Manager and regulatory agencies, as required.

Designated, trained personnel will oversee the erosion monitoring program, maintain inspection reports, and provide guidance.

29.13.5 Soil Metal Contamination Prevention Plan

Metals are a natural component of soils. In the vicinity of the Project, they occur in extractable concentrations, and 11 metals listed in the CCME Soil Quality guidelines are of low enough concentration to be non-limiting for even the most stringent uses listed. However, according to baseline studies, seven metal species occur in concentrations that exceed some land use guideline limits at least once. These include Sb, As, Cr, Cu, Ni, Tl, and V.

The majority of the soils in the study area are strongly acidic. Acidic soils have much higher metal mobility than neutral or basic soils, due to the increased solubility of metals within low pH environments, as well as other factors.

Metal enrichment and subsequent mobility can result in reduced soil biota function, the potential contamination of water and uptake by vascular plants, if at levels that exceed safe threshold concentrations.

It is important to both prevent the unnatural accumulation of metals in the soil, and be able to discern the difference between what is background and what may be an enriched and/or potentially limiting soil metal concentration relative to background.

Brucejack is a challenging site to define what baseline metal content in soils is in a meaningful manner. The Brucejack Mine Site is located in a large gossan that extends for more than 13 km north-south and 8 km east-west. A number of mineral deposits have been found within the gossan; the Brucejack-Snowfield areas of Pretium mineral claims, the adjacent KSM deposits to the west and north, Treaty Creek mineralization further north, and other mineralized zones to the south. Many of the soils natural background metal levels exceed the Contaminated Sites Regulation (BC Reg. 375/96) criteria for industrial use. Common soil geochemistry exploration techniques demonstrate that metal in soil contents can range over hundreds to thousands of parts per million over short distances. Natural variability of metals content in soils is documented for the Brucejack area. The metal species found to exceed land use guidelines had wide ranges of concentrations: Sb 0.05 to 47.8 ppm, As 2.12 to 883 ppm, Cr 2.93 to 96.0 ppm, Cu 5.47 to 130.0 ppm, Ni 1.49 to 73.4 ppm, Tl 0.07 to 1.42 ppm and V 5.85 to 149 ppm. As, Cu and Ni exceeded guidelines along the access road LSA demonstrating that metal species that could be considered as a source of metal contamination are not confined to the known mineralized areas at Brucejack.

The most significant potential sources of metal contamination exposure, direct and indirect, for soils in the Project area, are most commonly in the mine site area: (i) the ore stockpile, (ii) ML/ARD bedrock types (road cuts and waste rock), (iii) poor soil handling practices, and (iv) dust. Of these sources only road cuts, in ML/ARD material, may be an issue along the access road. Miscellaneous spills or accidents involving the release of metal-bearing chemicals or products are discussed separately in Section 29.14, Spill Prevention and Response Plan.

29.13.5.1 Performance Objectives

The primary objective of this plan is the protection of soils from metal substances from Project sources or activities that have the potential to exert an adverse effect on soil quality, and/or its function.

Simply stated the objective is that the activities associated with Project development and Operation will not cause any regulated substances (e.g., metals,) to exceed natural levels or, where they are higher, concentration limits listed in the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (CCME 2007) or exceed the Soil Criteria for Toxicity to Soil Invertebrates and Plants listed in the Contaminated Sites Regulation (BC Reg. 375/96) included in the BC EMA (2003a).

29.13.5.2 Environmental Protection Measures

The primary environmental protection strategies are to:

1. identify potential sources of metals; and
2. employ techniques to control their potential for release to the environment and potential to impact soils.

These measures include:

- o identification of ML/ARD sources both naturally occurring (as related to potential quarries and road cuts) and process related (storage and disposal of ML/ARD wastes; see ML/ARD Baseline Report and the Project Description);
- o salvage of suitable soil or overburden, if any, from the footprint of area(s) of proposed ML/ARD ore and rock storage/stockpiles or handling areas (all within the Brucejack Mine Site footprint);
- o dust control (ore and waste handling/stockpile areas and, as appropriate, along Project roads); and
- o water management and sediment control (collection and treatment of contact water prior to discharge).

The above noted measures are parts of the Project design and other management plans (Air Quality, including dust management; Water Management, mine site contact water system; and ML/ARD Management plans). Together these measures reduce the potential for metal contamination of the local soils resource.

Despite the introduction of dust control methods (e.g., road watering), dust generated during Construction and Operation could potentially migrate to areas surrounding the mine facilities, i.e., beyond the footprint (as per current modelling results). A phased approach to monitoring will be undertaken. Firstly, dust monitoring at the Brucejack Mine Site, Knipple Transfer Area, and Bowser Aerodrome will determine if soils are potentially being impacted by fugitive dust accumulations. Secondly, if dust monitoring results indicate impacts to the soil are likely then mitigative measures will be formulated and instituted to reduce impacts. Further monitoring will follow to determine the effectiveness of mitigation measures.

29.13.5.3 Monitoring Program

Soil Metal Contamination Prevention monitoring programs are established early during Project Construction to detect potential metal deposition / mobility patterns related to dust. Non-dust soil metal issues are managed through ML/ARD prevention and monitoring programs, site water management, and/or soil salvage management programs.

Predictive studies of metals released in discharges to air at the Brucejack Mine Site indicate only low levels of discharge. Such low level discharges may result in an increase in metals in soils near the Brucejack Mine Site; however, detection of low-level changes of metal content, when natural metal contents are high and variable, cannot be relied upon to be the result of emissions rather than natural small-scale spatial variability. Therefore a soil metal monitoring program that includes soil sampling for metals at control points will not be instituted at the Brucejack Mine Site. Instead the dust monitoring program as part of the Air Quality Management Plan (Section 29.2) will be relied upon to monitor for emissions, acting as a proxy for soil loadings, and any mitigation measures that may be required as a result of that dust monitoring will serve to mitigate near-mine increases in metal in soils.

Beyond the Brucejack Mine Site, proper dust monitoring will also be the key element to monitoring metals loading in soils. Activities at the Knipple Transfer Area and Bowser Aerodrome will also be primarily dust monitoring with any mitigation requirements resulting from that dust monitoring serving to mitigate increases in metal loading in soils at that site. Historically, the Knipple Transfer Area was the site of a Newhawk camp and their transfer station to glacier travel vehicles. As well the aerodrome was used by Newhawk for the same purpose.

If dustfall consistently exceeds 30-day dustfall objective levels, the need for soil metal and/or soil function monitoring, would be identified based on soil quality guidelines or similar rationale as approved by regulators. Soil function such as nutrient cycling, possibly related to organic matter decomposition could be tested. Monitoring of litter bags at impacted and control sites would be an example of the next stage of potential investigations.

Adaptive management measures for soil impacts would be triggered where soil function is demonstrably impaired.

29.13.5.4 Reporting Requirements

Dust monitoring will be reported in the annual report submitted to the BC MEM. Any mitigation measures instituted as a result of dust monitoring and monitoring of those mitigation measures will be subsequently reported.

Predicted and actual dust loading results, both quantitative and qualitative, from the dustfall monitoring will be included for all monitoring sites.

If mitigation measures are undertaken reporting would include results from any additional monitoring, methodologies employed, and summary of any corrective actions taken.

The Environmental Manager will be responsible to oversee implementation of the soil contamination monitoring program and any reporting requirements.

29.14 SPILL PREVENTION AND RESPONSE PLAN

29.14.1 Purpose

The purpose of this Spill Prevention and Response Plan for the proposed Project is to safeguard as far as possible against accidental spills of harmful substances that may negatively affect the environment. This will be achieved by, firstly, instituting spill prevention systems that will see the avoidance of such accidents, and secondly, responding in a timely and efficient manner if spills do occur, thereby containing and mitigating the negative environmental consequences.

This plan will equip site personnel to be prepared for an accidental spill emergency and will comprise a component of an envisaged environmental management system for the Project. Note that the information contained in this plan is at a level of detail appropriate for the Application/EIS submission and that it will be further developed into a detailed plan for specific permitting prior to commencement of each phase of the Project.

29.14.2 Regulatory and Policy Framework

There are a number of legislative requirements applicable to accidental spills and a synopsis of these and their applicability is as follows:

- *BC Environmental Management Act* (2003a) - Describes overall direction on how wastes are to be managed.
- Spill Reporting Regulation (BC Reg. 263/90) - Prescribes threshold limits requiring reporting.
- Spill Cost Recovery Regulation (BC Reg. 250/98) - Describes the quantum of fee recovery for provincial resources used in spill response, from any party.
- *Fisheries Act* (1985c) - Prohibits the release of a deleterious substance to fish habitat.
- *Transportation of Dangerous Goods Act* (1992); *Transportation of Dangerous Goods Regulations* (SOR/2001-286) - Provides specified transportation requirements for dangerous goods and includes a substance classification system.
- *Canadian Environmental Protection Act* (1999); *Environmental Emergency Regulations* (SOR/2003-307) - Stipulates the preparation of an Environmental Emergency Plan, contingent on the presence of listed substances (excluding explosives, *inter alia*) at quantity limits above certain thresholds.

Note that the federal Environmental Emergency Regulations (SOR/2003-307) specifically require the preparation of an Environmental Emergency Plan if minimum quantities of specific hazardous materials are stored at site. An appropriate Spill Prevention and Response Plan that satisfies the requirements of an Environmental Emergency Plan will be developed if minimum quantities of hazardous materials are determined to be used at site. Such plans will be prepared before such substances are to be delivered to site.

29.14.3 Performance Objectives

The primary objective of the Spill Prevention and Response Plan is the avoidance of accidental spills. A management strategy is therefore vital for the handling, transportation, and storage of solid and liquid materials in such a manner that the risk of spills that might adversely affect the biophysical and socio-economic environment is reduced.

The secondary objective of the plan is the response component, to establish a purpose-designed course of action to be implemented in the event of a spill. It will provide practical steps as to how to safely assess an incident and to implement an appropriate response, as well as to complete the follow-up and any corrective action safely and efficiently.

The approach to preparing this Spill Prevention and Response Plan has assumed that best management practices have been adopted as the default for the plan, that it will be further refined during final permitting, and also as needs dictate throughout the life of the Project.

It should be noted that certain actions and responses that underpin the objectives of the Spill Prevention and Response Plan overlap with other management plan components of the Project. Examples are the Emergency Response Plan (Section 29.6), the Hazardous Materials Management Plan (Section 29.7), and the Waste Management Plan (Section 29.17). An integrated approach will thus be adopted in the application of the various components of environmental management and reporting for the Project.

29.14.4 Environmental Protection Measures

29.14.4.1 Spill Prevention

The preferred manner to deal with spills is by avoidance through appropriate storage, handling, and transportation measures. The prevention of spills is achieved through the implementation of initiatives such as:

- the design of facilities to incorporate best management practices for spill containment including:
 - double containment of all fuels and dangerous or hazardous materials, with protective barriers where there is potential for impact from vehicles;
 - secondary containment with capacity to accommodate 110% of the largest vessel in the area;
 - individual container shut-off valves where more than one container share a distribution line; and
 - separate storage and sump systems for storage areas of incompatible products;
- documented operational procedures for tasks that have an identified risk, such as fuel handling, explosives manufacturing and handling, and waste management;
- certification of vehicles and drivers for transportation of dangerous goods;
- ensuring that vehicle cargos are adequately contained and secured;
- a high level of preventative maintenance of vehicles, equipment, storage containers, etc.;
- regular housekeeping and environmental audits of facilities to ensure maximum protection is in place;
- a risk assessment program for identifying vulnerabilities and management of improvements; and
- documented inspection schedules and procedures for dangerous goods and hazardous materials stored on site.

29.14.4.2 Risk Assessment

The analysis of risk to inform the development of management measures is a standard component of the planning for emergencies such as accidental spills. Identification and risk-based assessment of potential incidents, their failure mechanisms, and their potential impacts will be used on an ongoing basis to identify potential high-risk areas and ensure procedures are in place to address these situations. A Risk Register will be developed for the Project.

An analysis of the risks of selected spill types is provided in Table 29.14-1. The list is not comprehensive, but addresses the materials of greatest concern.

Table 29.14-1. Analysis of Risks per Selected Spill Type

Area of Concern	Cause of Spill	Potential Effect	Potentially Impacted Area	Preventive Measures	Available Response Resources
<i>Moderate and High Risk of Occurrence</i>					
Tailing spill	Tailings pipeline failure	Low	Absorbed into soil; enter Brucejack Lake	Instrumentation (differential flow and pressure alarms); preventive maintenance; visual inspections	Using heavy equipment and available trucks to contain and clean up spills on land; call for assistance
Small hydrocarbon spills	Human error during handling; equipment failure; vehicle accident	Low	Absorbed into soil; enter local creeks; human health	Storage containers in secondary containment; handling procedures	Spill kits strategically located around site and on vehicles; call for assistance
Process reagents	Rupture of container during transport; spill in mill building	Low	Absorbed into soil; enter local creeks; human health	Transport safety procedures; proper storage areas	Spill kits; call for assistance
<i>Low Risk of Occurrence</i>					
Large diesel spill	In situ pipeline rupture in or adjacent to underground workings	Moderate	Absorbed into surface or underground substrate; enter local creeks; human health	Instrumentation (differential flow and pressure alarms); preventive maintenance; visual inspections	Use mining equipment and available trucks to contain and clean up; oil booms; absorbent pads; call for assistance
Large diesel spill	Rupture of container during transport	Low	Contaminate soil; enter local creeks	Use of newer equipment; transport safety procedures	Spill kits on transport trucks; call for assistance
Ethylene glycol spill	Spill during transport; spill in shops; radiator puncture	Low	Absorbed into soil; enter local creeks; human health	Transport safety procedures; proper storage areas	Spill kits on transport trucks; spill kits strategically located around sites; call for assistance

29.14.4.3 *Materials-specific Actions*

Tailings

The tailings pipeline will run downslope from the mill building to enter Brucejack Lake for subaqueous deposition. It will be buried to protect it from avalanche hazards and potential disturbance from surface activities. While several diversion channels and a stormwater pond will manage surface water flow, a tailings pipeline leak or failure close to the surface of the lake would discharge into the lake. While highly unlikely, such a spill may be considered as an upset condition to the subaqueous deposition. Prevention measures will include the design and operation of the pipeline system with features such as:

- instrumentation to detect pipeline ruptures;
- preventive maintenance program to ensure pipeline integrity;
- containment channels around sections of the pipeline where practicable; and

- purpose-designed structures to encase the tailings pipeline in the section where it traverses the lake shore.

Petroleum Products

Petroleum products will be used at a number of Project locations. Significant spills may occur in the following locations:

- at the Brucejack Mine Site, including the underground workings, mill building, substation, batching plant, fuel storage, laydown area, operations camp, explosives and detonator storage areas, waste management and treatment facilities, and internal roads;
- along the Project access roads;
- at the Knipple Transfer Area; and
- at the Bowser Aerodrome.

Site fuel tanks will be built and installed to comply with all regulatory and best management practices, including the British Columbia Ministry of Water, Land and Air Protection's (BC MWLAP's; 2002) *Field Guide to Fuel Handling, Transportation and Storage*. All fuel storage vessels will include secondary containment with a sump, and all transfer stations will have appropriately lined spill pads complete with oil/water separators. Tanks and sumps will have high-level alarms. All storage and transfer locations will also be equipped with appropriate spill kits.

An inspection schedule will be developed for each fuel storage site, taking into account the volume of fuel stored at each site and the respective risks related to that storage. Inspections will include tanks, pipelines, connections, valves, gauges and meters, sumps and separators, and inventory records. Inspections will be recorded and filed with the Mine Manager or his/her delegate.

Fuel transfer procedures will include best management steps to ensure no overtopping of tanks or spillage. In addition, inventories will be tracked regularly to check on any possible losses. All spills or accidents will be reported immediately. Employees and contractors responsible for transporting or storing hydrocarbons or for fuelling vehicles will receive training in proper operating procedures and emergency response.

Dangerous Goods and Hazardous Materials

The proper storage procedures described in the Hazardous Materials Management Plan (Section 29.7) will be followed to minimize the risk of spills of those products. Hazardous materials will be clearly labelled and stored in proper containers in secure locations, where they will be accessed by trained personnel only. Secondary containment will restrict the spread of any spilled product and conveniently located MSDSs and spill kits will facilitate safe and timely cleanup.

29.14.4.4 *Spill Emergency Response*

Background

If a spill does occur despite the above precautions, timely and safe response is the key to minimizing adverse effects. This section on response to spill emergencies provides a policy-level overview that will be further expanded and refined as the application and permitting processes progress. The plan will be updated and integrated into the Project's Emergency Response Plan (Section 29.6) before Construction starts. Note that Pretium has an *Emergency Response Assistance Plan for Transportation of Dangerous*

Goods (Mine Site Procedure BJ-037, August 28, 2013c) already in place for their current exploration activities on the Brucejack Mine Site.

An emergency response plan sets out the basic mechanisms, organizational structures, responsibilities, and procedures to guide staff in responding to emergencies. For the plan to be effective, all employees must be made aware of its provisions and their responsibilities under the plan.

Spills may happen as a result of a number of different reasons, which include:

- equipment malfunctions;
- human error; and
- natural events (*force majeure*).

An emergency spill is a spill of materials that affects either the environment; the health, safety, or welfare of employees or the community; Project property; or operational efficiency, the magnitude of which requires a controlled and coordinated response. Many factors influence the intensity or complexity of an emergency spill.

In the event of an emergency spill, the mine management will respond by:

- ensuring the safety of the Project employees, site personnel, and the public;
- mobilizing the necessary equipment and crews to contain and clean up the spill and rehabilitate the site to a pre-spill or acceptable state; and
- ensuring that the appropriate stakeholders are notified. These include government agencies and any nearby communities or stakeholders, and their prompt notification, most importantly the BC Provincial Emergency Program, is essential.

A site-wide communication system will ensure rapid notification of any observed spills. The site will have a trained and properly equipped emergency response team to contain and recover spills, to reduce the size of any spill and thus reduce any potential adverse environmental or health effects.

In the event of a spill, certain standard actions are undertaken and these typically comprise the following:

- identification and control of immediate dangers to human life or health;
- identification and control of spill source;
- elimination of additional potential spill sources;
- containment of spill;
- notification of authorities, as appropriate;
- recovery and cleanup; and
- incident investigation and reporting.

Initial Responses

In the event of a spill on the Project, the following initial response steps will be taken:

- the safety of the site for all personnel and the public will be ensured;

- immediate hazards associated with the spill material or near the spill (e.g., aromatic substances, flammable material, or ignition sources) will be mitigated;
- responsible Environmental Manager and health and safety representative will be notified;
- the spill material and source of the spill will be identified;
- if safe to do so:
 - measures will be taken to stop the flow; and
 - barriers will be constructed with available materials (e.g., snow, earth, or absorbent pads) to prevent the spread of material; in particular, to prevent the spill from entering any watercourse; and
- if the material or circumstance is unsafe, the relevant Environmental Manager and health and safety representative will be notified that an emergency response team is required.

Secondary Response

Once the initial response has been undertaken, possibly affected environmental receptors will be identified and protected, particularly surface waterbodies. If the spill cannot be handled by on-site trained personnel or on-site available spill response equipment, an external spill response contractor will be arranged to attend to the situation. A plan for cleanup and remediation will be developed by the relevant Environmental Manager in coordination with external consultants, if required.

Statutory Reporting

A Spill Report will be completed for all spills on the Project. In addition, certain of the legislation described in Section 29.14.2 above requires that a Spill Report is submitted within 24 hours to the BC Provincial Emergency Program at 1-800-663-3456, if prescribed spill quantities are exceeded (BC EMA 2003a; Spill Reporting Regulation BC Reg. 263-90).

Spill Kits

A key component of spill response is having appropriate materials readily available to contain and abate a spill in a timely manner. Pretivm will compile spill kits designed for specific areas, with contents selected to manage the potential materials, volumes, and environmental sensitivities of each area. Typical contents will include oil absorbent pads and booms, skimmers, absorbent socks, granular absorbent, and dike materials, as well as protective equipment such as gloves, goggles, and suits. Kits will be stored in weather-resistant containers and located in visible locations. They may also be contained on a trailer or truck, as required, for rapid deployment to a spill scene, and will be easily transferable to allow for helicopter delivery, should that be necessary. They will be inspected on a regular basis to confirm that they are complete and functional. Pretivm's mine management will maintain a list of suppliers of specialized spill response services and materials that can be contacted to provide support on short notice.

Appropriate spill recovery kits will be located at the Project site at Brucejack Lake, as well as at the Knipple Transfer Area and at the Bowser Aerodrome, to ensure availability throughout the Project.

Spill Clean-up Procedures

Typical cleanup techniques for major or serious spills will include the following:

- construction of berms around the spill with gravel, earth, or overburden using heavy equipment (e.g., loader, dozer, or excavator);

- excavating a sump using a backhoe, lining it with appropriate impervious material (e.g., tarp or poly), and diverting the spill into the sump;
- blocking culverts with plywood, poly, and/or sandbags;
- diverting spill into stormwater pond or diversion channels where it can be isolated;
- diverting spill into site drainage sump and block inlet and/or outlet;
- using absorbents (e.g., oil booms or pads) for hydrocarbon spills;
- using granular absorbents where appropriate;
- using emergency response kit; and
- using overpack barrel (310-L size) for containing a leaking 205-L barrel if the leak cannot be stopped.

Specific spill cleanup and disposal procedures will be developed for:

- a tailings spill near the lake surface;
- a fuel spill;
- a reagent spill;
- a concentrate spill; and
- an explosives spill.

If an emergency response is triggered, control of the situation will be transferred to the emergency response team. The team will be guided by Pretivm's overall Emergency Response Plan, of which this plan is a part.

Triggering of Spill Prevention and Response Plan

Initiation of the Spill Prevention and Response Plan will be the responsibility of the Mine Manager (or designate). Response mobilization will depend on the nature of the spill, the substances involved, and the location. Members of the emergency response team will be called in for assistance, as they will have been trained in response methods and will have the knowledge of required resources and their locations. All other personnel will be directed to predetermined locations.

Muster stations will be clearly identified around the Project site and site personnel will have been made aware of them during orientation and follow-up training programs.

Communications

Communications during an emergency spill situation are of vital importance. The Communications Coordinator referred to in Section 29.6.4.2 of the Emergency Response Plan will be responsible for undertaking communications with regulatory agencies during an emergency spill situation. This responsibility will include a strategy that will address when and how key surrounding communities and stakeholders will be advised of spill emergencies related to the Project.

29.14.5 Monitoring Program

Since accidental spills are unpredictable, reliance must be placed on ensuring preparedness to deal with such events. Monitoring of equipment and operations may provide some pre-emptive indications of possible spills. Inspection and maintenance of the spill kits, and assurance of their availability and

functionality, will be undertaken in a scheduled and systematic manner. Section 29.14.4.1 above describes the spill prevention actions that will be applied on the Project.

In the event of an accidental spill, and once it has been brought under control, the Emergency Response Plan Coordinator appointed by the Mine Manager will launch an investigation of the event. Together with the Emergency Response Planning Committee, key members of Pretivm's mine management and relevant health and safety personnel (as appropriate), a joint incident investigation and root cause analysis will be undertaken. The findings of the investigation, which may include monitoring of specified remediation actions, will serve to modify the Spill Prevention and Response Plan if the investigation shows that shortcomings pertained. Such modifications will be subject to the regular annual review of the plan, to ensure optimal effectiveness.

29.14.6 Work Planning and Schedule

Work planning and scheduling for spill prevention and response will largely amount to maintaining a high level of preparedness of both personnel and equipment.

A Spill Prevention and Response Plan requires that personnel generally, but particularly those with specified responsibilities, are subjected to purpose-designed training. This will require that a spill prevention and response component is included in the emergency preparedness briefings that all newcomers to the Project site are subjected to as part of their health and safety induction. Similarly, the one-off emergency response training sessions to be held on a scheduled basis, as well as the training and practice sessions required for specified responsibilities such as mine rescue teams and firefighting teams will include a spill prevention and response component.

In summary, Spill Prevention and Response Plan training will be scheduled according to a Practice Session Plan and Training Plan described in Sections 29.6.4.19 and 29.6.4.18 of the ERP.

29.14.7 Reporting Requirements

29.14.7.1 Reports

Detailed reports will be compiled on every emergency incident that occurs and on every incident that might have become an emergency if not for timely response. Reports will be forwarded to relevant government agencies as required by regulations and licences. All reports will be reviewed internally by the Emergency Response Planning Committee in order to identify necessary improvements in the emergency prevention and response procedures.

With reference to the statutory reporting of spills in particular, a Spill Report will be completed for all qualifying spills on the Project, per the legislation described in Section 29.14.2 above. This requires that such a Spill Report is submitted within 24 hours to the BC Provincial Emergency Program at 1-800-663-3456, if prescribed spill quantities are exceeded. The Spill Report stipulates that the following information is recorded:

- the reporting person's name and telephone number;
- the name and telephone number of the company;
- the location and time of the spill;
- the type and quantity of the substance spilled;
- the cause and effect of the spill;
- details of action taken or proposed to comply with regulations;

- a description of the spill location and of the area surrounding the spill;
- the details of further action contemplated or required;
- the names of agencies on the scene; and
- the names of other persons or agencies advised about the spill.

29.14.7.2 Reporting Responsibilities

The Mine Manager will carry ultimate responsibility for the Spill Prevention and Response Plan, and will appoint an Emergency Response Plan Coordinator and an Emergency Response Planning Committee whose roles will include spill prevention and response. The Environmental Manager (responsibilities will be decided before Construction begins) will likely act as or designate a person to act as the Emergency Response Plan Coordinator. The Emergency Response Plan Coordinator will be a key member of Pretivm's mine management and will have the full support of the operating company to successfully implement the Spill Prevention and Response Plan. The Emergency Response Plan Coordinator will engage the Emergency Response Planning Committee in the development of spill prevention and response measures, and in their regular review to ensure optimal effectiveness.

29.15 TAILINGS MANAGEMENT PLAN

29.15.1 Purpose

The Project is expected to create approximately 18.07 million tonnes of flotation tailings over the 22-year life of the mine. About half of this volume of tailings will be used in paste backfill in the underground workings, while the rest, about 9.52 million tonnes, will be deposited in Brucejack Lake. With reference to acid base accounting test work already done, the tailings are not anticipated to be acid generating.

The envisaged tailings discharge pipeline will enter Brucejack Lake at its southwestern shoreline and run for approximately 510 m under water to the deepest part (80 m) in the central eastern area of the lake. Much of the overland alignment of the pipeline, amounting to approximately 1,150 m in length, may be subject to avalanche impact risk. Accordingly, the overland pipeline will be trenched and backfilled to provide the necessary protection. The pipeline will also have a continuous downward slope from the mill building to the lake shore to permit the line to drain during shutdowns.

The purpose of this Tailings Management Plan is to describe the control measures and operational procedures that have been formulated to minimize the potentially adverse environmental effects of the disposal of the mine tailings. Recognizing that half of the volume of tailings will be returned underground as a thickened and treated form of paste backfill, this plan is focused on the subaqueous deposition of tailings in Brucejack Lake. Management of tailings paste backfill will be an important aspect of mine operation though will have relatively little environmental risks and thus is not presented further here. Geochemical characterization of paste backfill material is provided in Section 5.6 of the Application/EIS. The engineering design features of subaqueous tailings deposition that address the avoidance of the transport of fine particulate solids to the surface layer of the lake, and to its outflow into Brucejack Creek, are of particular importance.

The alternative of thickened tailings disposal in Brucejack Lake is currently under investigation.

29.15.2 Regulatory and Policy Framework

Requirements for the design, operation, and closure of tailings management facilities on mine sites are legislated under the British Columbia *Mines Act* (1996i) and are covered by sections of the Health,

Safety and Reclamation Code for Mines in British Columbia (the Code; BC MEMPR 2008). The *Water Act* (1996j) regulates the diversion and use of water. Water licenses will be required for the Brucejack Lake outlet structure, which constitutes the outlet of the waste rock and tailings storage facility, and for withdrawal and use of water from Brucejack Lake for process water, or to maintain flow in the tailings discharge pipeline while tailings are being directed to the backfill plant.

Water discharged from Brucejack Lake to Brucejack Creek must meet end-of-pipe water quality criteria under the Metal Mining Effluent Regulations (MMER; BC MEMPR 2008) of the *Fisheries Act* (1996c), as well as discharge criteria that will be established in the provincial Effluent Permit that will be issued for the Project under the BC EMA (2003a).

The *Mines Act* (1996i) requires mine proponents to obtain a permit approving the work system and reclamation program. To obtain this permit, a detailed mine plan and reclamation program must be submitted to the BC MEM for approval. Information specific to the Brucejack Lake tailings disposal facility that must be included in this permit application includes a plan of the tailings deposition facility; ML/ARD prediction, prevention, and mitigation information (refer to Sections 29.10 and 29.15); and information on water quality predictions for Brucejack Lake (Chapter 13), mitigation measures and monitoring (Section 29.19).

The deposition of tailings in navigable waters, as defined by the current *Navigation Protection Act* (1985g)² and described in Section 22 thereof, is allowed to within a depth of 36.6 m from surface of a navigable water.

Plans for the control and diversion of water on the Project site, including water withdrawal from Brucejack Lake, are provided in the Water Management Plan (Section 29.19). The unlikely occurrence of spills from the overland section of the tailings pipeline is addressed in the Spill Prevention and Response Plan (Section 29.14).

Detailed mine development and reclamation plans will be submitted as part of the *Mines Act* Permit application for mine construction and operations.

The report prepared for Pretium titled *Brucejack Gold Mine Project: Brucejack Lake Tailings System Design* (Rescan 2013) provides best management practices for subaqueous tailings deposition and was used as the primary reference for this Tailings Management Plan.

29.15.3 Performance Objectives

The performance objectives for the management of tailings described here are essentially informed by the environmental protection measures detailed in the next section. These objectives may be categorized as follows:

- **Water Quality:** To ensure that water discharging from Brucejack Lake is of acceptable quality, i.e., that total suspended solids (TSS) derived from all sources (not only tailings but waste rock and any other source) do not exceed the prescribed limits. These limits are 15 mg/L as a monthly mean, and a maximum of 30 mg/L for any individual sample, per the MMER (BC MEMPR 2008); and a maximum of 30 mg/L for any individual sample for the Effluent Permit that will establish discharge limits from Brucejack Lake. These water quality standards are also

² Due to be revised during 2014.

reflected in the Aquatic Effects Monitoring Plan, Waste Rock Management Plan, and ML/ARD Management Plan (Sections 29.3, 29.18, and 29.10, respectively).

- Flow: To provide a constant flow through the subaqueous tailings discharge pipeline into Brucejack Lake at all times, such that the deposit at its outfall remains fluidized. This constant flow will be achieved by means of diluting the tailings to a maximum concentration of 35% weight per weight (w/w) and, using a variable frequency drive discharge pump, maintaining a flow of approximately 320 m³/hour, i.e., a velocity of 3.4 m/second. The pipeline is also designed with a continuous downward slope, to promote complete drainage in the event that no water is available to maintain pipeline flow.
- Secure positioning: To prevent sections of the subaqueous pipeline from floating to the surface, air will need to be kept out of the system. Installing air valves along the length of the pipeline will achieve this. Their functionality will be particularly critical during start up and shut down of the system.
- Pressure: Two subaqueous discharge pipelines are envisaged, running in parallel, with the primary pipeline ending at approximately 80 m and the secondary pipeline ending at a depth of about 60 m. This approach will allow the primary pipeline to continue in operation unless the deposit at the outfall imposes a pressure greater than approximately 45 m of head. At this time, discharge can be directed to the secondary pipeline.
- Volume: Ultimately, the overall footprint of the tailings at the end of the 22-year life of the mine is envisaged to occupy most of the lake bottom, to a depth below the lake surface of approximately 48 m to 59 m at its edge and a depth below the lake surface of 44 m at the apex of the deposition cone. Recording the volume of tailings directed to both subaqueous and underground disposal will provide a useful performance measurement insofar as the intended approximate 50% portioning of each are concerned. The recording of volumes of tailings deposited in Brucejack Lake will be done in conjunction with regular (once every two years) bathymetric surveys of the lake floor, such that information is gathered about the shape and extent of the deposition cone as it develops.

29.15.4 Environmental Protection Measures

Protection measures to bring about proper environmental controls over the disposal of tailings are integrated into the engineering design of the system, i.e., the best available technology has been applied. A brief description is provided below to demonstrate that the functioning of the tailings disposal system provides the necessary level of environmental protection.

During Operation, a deposit of solids will intentionally be allowed to build over the end of the outfall, further covering it and acting as a filter that intercepts the majority of fine tailings particles in a manner similar to a sand filter. This feature will reduce the likelihood of suspended solids entering the upper layers of the lake's water column.

Tailings discharged from the flotation cells in the mill building will be directed to a thickener to provide a 40 to 65% (w/w) solids concentration feed to the paste backfill plant. Tailings destined for discharge to Brucejack Lake will then be diluted in a separate agitated mix tank to approximately 35% solids w/w. Besides enhancing flow, this dilution will ensure efficient operation of the agitator, pump, and pipeline while keeping the deposit at the lake bed fluidized. The degree of dilution will also ensure that air is purged from the slurry. The mixing tank will be approximately 2 m in diameter and 3-m tall, and equipped with a double-pitched blade turbine impeller driven by a 5 horsepower motor.

Water for dilution will be sourced from the process water tank and supplied to the control valve at the mixing tank at a minimum pressure of 60 kilopascals. Maximum required water flow will be approximately 300 m³/hour through the valve.

As mentioned, the related performance objective is to maintain a total flow in the outfall of 320 m³/hour, which translates into a velocity of 3.4 m/second. Two pumps, one operational and the other as a standby, will be located downstream of the mixing tank to provide the necessary head to transport the tailings slurry through the pipelines and the outfall.

Two discharge pipelines are envisaged, running in parallel, with the primary pipeline ending at the maximum depth of the lake at -80 m and the secondary pipeline ending at a depth of -60. There will be a constant flow through the active pipeline at all times to keep the deposit at the end of the outfall fluidized. When the thickened tailings are diverted to the paste backfill plant, water will continue to be discharged through the subaqueous tailings discharge system to maintain a fluidized pathway in the mound covering the discharge point.

With reference to the primary and secondary sub-aqueous pipelines, manual isolation valves will be located in the mill building to permit manual switching between the two. As described previously, the primary pipeline will discharge at a depth of about 80 m with a total length of 1,150 m, of which 510 m will be underwater. The secondary pipeline will discharge at a depth of about 60 m with a total length of about 1,140 m and about 400 m underwater.

The design of the pipelines are such that they will maintain a continuous downward slope from the mill building to their discharge points in the lake. This configuration is desirable to promote complete drainage in the event that no water is available to maintain pipeline flow. The maximum slope of 15% upstream of flatter sections will prevent a settled solid bed from sliding into the flatter section on emergency shutdown.

The route of the overland section of the pipeline is close to an avalanche risk area near the lake and will need to be properly protected and supported. This will be achieved by trenching the pipeline, with a grating or backfill cover, and installing culverts at the two pipeline road crossings. Such trenching will also provide containment of tailings in the event that the pipeline is accidentally ruptured in sections where it is exposed, as referred to in the Spill Prevention and Response Plan (Section 29.14). The pipeline will be insulated but not heat traced, since the head loss (energy dissipated as friction) in the pipeline will be sufficient to prevent the lines from freezing and the lines will drain freely by gravity on shutdown.

The outfall pipelines will be laid on the lakebed and stabilized with rock bolts and/or concrete ballast weights. Ballasting is required to prevent the pipe from floating when discharging clear water and in the event that a significant volume of air enters the outfall in the unlikely event of air valve malfunction. Concrete ballast weights (or collars) will each be precast in two pieces and bolted together, clamping the pipe between them. The outfalls, complete with the attached weights, will be launched and sunk as one piece.

Air valves will be installed at critical locations along the tailings pipeline to prevent air entering the underwater section of the pipeline, as a large air bubble entering the underwater section could potentially cause sections of the pipeline to float. The valves will primarily function during planned start up and shut down of the pipeline.

The development of detailed procedures will ensure proper operation of the system during start up and shut down, when the air valves will play a critical role in avoiding sudden flows through the tailings mound that could release suspended solids into the water column.

29.15.5 Monitoring Program

Given its reliance on engineering design features and specified equipment, elements of the tailings management system for the Project will be monitored remotely and by means of telemetry. The monitoring described here is largely derived from the tailings system design report (Rescan 2013).

A radar level transmitter will ensure a set level is maintained in the slurry mixing tank by transmitting a signal to actuate the water control valve. Most of the flow to the process water tank is overflow from the tailings and concentrate thickeners but some make-up water will be required and will be supplied from Brucejack Lake. Additional details regarding water use are provided in the Water Management Plan (Section 29.19).

Water flow to the mixing tank will vary based on the slurry concentration and solids throughput reporting to the tank. The final concentration of the solids in the mixing tank will also vary with solids throughput but the solids concentration will not exceed the designed figure of 35% w/w.

A flow meter will be located downstream of the discharge pump. The flow meter signal will be transmitted to the discharge pump, which will maintain a constant velocity of 3.4 m/second in the pipeline by adjusting the speed of the pump motor. When the tailings slurry flow rate into the mixing tank decreases, supply to the discharge pump will be maintained by addition of water to the mixing tank.

The water control valve will automatically respond to varying levels in the mixing tank and maintain the level within set limits. Records from the flow meter and control valve actuation will provide adequate monitoring of the operational parameters for tailings deposition and enable monitoring of the system's efficiency.

Water quality will be monitored as described in the Aquatic Effects Monitoring Plan (Section 29.3) and in accordance with Effluent Permit and MMER requirements.

29.15.6 Work Planning and Schedule

A schedule for routine inspection and instrumentation monitoring will be developed prior to commissioning of the subaqueous tailings discharge system, based on the mine Construction and Operation schedule. Much of this monitoring will be a visual adjunct to the inspection and maintenance of equipment.

29.15.7 Follow-up Program

While the system of subaqueous tailings deposition has been successfully applied elsewhere in the world and has been adopted by a project in the United States (Rescan 2013), monitoring will be required and some field adjustments may be necessary once the system has been in operation for a period of time. Follow-up monitoring and measures will be implemented to verify that the system meets the following key design criteria, and to implement additional mitigation or remedial measures (such as those described in Section 29.14, Spill Prevention and Response Plan) if necessary to achieve these:

- meet the prescribed TSS standards for water discharging from Brucejack Lake;
- maintain a constant flow through the tailings discharge pipeline of 320 m³/hour volume, or a velocity of 3.4 m/second; and
- ensure pipelines remain submerged and anchored to the lake floor.

29.15.8 Reporting Requirements

Monitoring results will be included in the site documentation management system and reported to senior management and regulatory agencies as required.

29.15.8.1 Reports

Review and evaluation of the visual and instrumentation monitoring data will be carried out regularly to identify the need for contingency measures if performance objectives are not being met. Such reporting will be in accordance with a schedule of monitoring inspections and record keeping that will be undertaken in a structured manner such that the management of tailings can be accurately tracked. Of importance is the ongoing recording of the shape and extent of the deposition cone as it develops.

Inspections will cover on-site facilities such as the on-land tailings mixing tank, pipelines, trenches, culverts, and isolation valves enclosure. The frequency of scheduled inspections will be dictated by operational conditions; however, components of the monitoring in support of the required reporting, e.g., recording volumes handled, will be continuous while tailings are being produced.

If emergency or spill incidents occur these will be reported as per the requirements of the Emergency Response Plan and Spill Prevention and Response Plan (Sections 29.6 and 29.14, respectively).

29.15.8.2 Reporting Responsibilities

The Project's Mine Manager is ultimately responsible for mine operations and will carry line responsibility for monitoring and reporting on the management of tailings, although this may be delegated to appropriate technical personnel. Pretium will be responsible for ensuring that the performance objectives and protection measures outlined in this plan are achieved. Appropriately qualified personnel will be employed throughout the life of the Project to supervise, direct, monitor, and implement the management actions identified in this Tailings Management Plan.

Since the management of tailings is essentially a technical engineering matter, all reports will be reviewed internally by the responsible line manager and the Mine Manager. The Environmental Manager will review the reports in order to identify shortcomings from an environmental perspective, and institute improvements in the system if warranted. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and permits.

29.16 TRANSPORTATION AND ACCESS MANAGEMENT PLAN

29.16.1 Purpose

The purpose of the Transportation and Access Management Plan is to control access to and from the Project site, ensure that roads are designed and maintained in such a manner that the safety of road users is maximized, and minimize adverse effects on the environment and wildlife. In addition to design and maintenance, the manner in which the roads are used will be such that user health and safety are not compromised, and adverse social and environmental effects are ultimately avoided.

Restricting access to lands within the Project's wildlife Local and Regional Study Areas is particularly important since increased access can potentially expose wildlife resources to increased pressure from fishing, hunting, and trapping activities. Similarly, an increase in vehicular traffic along the access road could elevate direct wildlife mortality and disruption of movement.

Road access to the Project site will be via the Brucejack Access Road from Highway 37 to the Knipple Transfer Area located at the western end of the road. There a constructed ramp allows tracked

vehicles to access the Knipple Glacier, which is traversed for about 12 km to the proposed Brucejack Mine Site. Note that this Transportation and Access Management Plan also addresses vehicular travel over the Knipple Glacier, as well as at the Mine Site.

29.16.2 Regulatory and Policy Framework

The exploration access road is located on mineral claims registered to Pretivm under the *Mineral Tenure Act* (1996h) and was constructed under a *Mines Act* Permit for exploration activities. No roads other than those to be permitted under the *Mines Act* (1996i) are currently being considered.

Implications to fisheries from the construction and use of roads are regulated under the federal *Fisheries Act* (1985c) and guidance on their construction, maintenance, and deactivation is provided by the *Fish-stream Crossing Guidebook* (BC MFLNRO, BC MOE, and DFO 2012). The *Wildlife Act* (1996l) and federal *Species at Risk Act* (2002c) regulate effects from roads and traffic on wildlife and require mitigation of potential effects on specific wildlife species.

29.16.3 Performance Objectives

This Transportation and Access Management Plan is designed to achieve the following performance objectives:

- to design, construct, and maintain the Brucejack Mine Site and access roads so that they are safe for designated uses;
- to avoid the possibility of the Project access roads becoming barriers to wildlife movement;
- to minimize wildlife mortality due to vehicle collisions along mine site and access roads;
- to prevent mine site and access roads from becoming wildlife attractants;
- to ensure that all authorized users of roads follow stipulated procedures;
- to protect personnel and the public, and minimize potential adverse effects of increased human presence on the environment, by controlling access along the Project roads, with the objective of zero unauthorized use; and
- to minimize adverse effects on fish and fish habitat by complying with guidance for the construction, maintenance, and deactivation of the Project site and access roads.

29.16.4 Environmental Protection Measures

29.16.4.1 Surfaced Roads

General Measures

The mine site roads will be designed, constructed, and maintained with user safety and minimizing potential environmental effects, in mind. The Brucejack Access Road will be used during all phases of the Project to deliver and remove supplies and materials, and to ship concentrates to market. The supplies will include diesel fuel, mill consumables, mining consumables including explosives, and camp supplies.

It is anticipated that supply traffic during the Construction period will exceed supply traffic during Operation. The average number of supply trucks over Construction will be approximately 10 per day, while it is expected that approximately four trucks per day will deliver supplies to the Project during Operation. Project-related traffic during the Closure and Post-closure phases is expected to be significantly less than those estimated during Operation.

Where practicable, alignments on the existing Brucejack Access Road have been placed to avoid areas subject to geohazards, such as potential landslides, debris flows and floods, and snow avalanches. Where hazards cannot be avoided due to terrain constraints, control measures such as avalanche control and vehicle scheduling base on road conditions, and monitoring will be initiated. A separate Avalanche Management Plan (Section 29.4) has been prepared for this particular hazard.

The Brucejack Access Road will be a key component of the overall site infrastructure and will be subject to a comprehensive and ongoing maintenance program. This program will include regular inspection of the road surface, culverts and bridges, grading, snow ploughing, application of granular material for traction control in the winter, dust control (water sprays) in the summer, ditch cleaning, and shoulder vegetation management. The road will have appropriate signage to establish speed limits and warn of road-use hazards.

Detailed emergency and hazardous spill response plans will be developed. These will support the operation of the Project site and roads and measures such as using purpose-designed containers for storage and transport of hydrocarbons are stipulated. All equipment will be in good working order and will be equipped with appropriate spill kits.

Measures to Protect Wildlife

A range of design and maintenance features for site and access roads will be used to mitigate potential adverse effects on wildlife. Some of these features are discussed below. More detail can be found in the Wildlife Management and Monitoring Plan (Section 29.21).

Barriers to Movement

Barriers to movement will generally be avoided, by means of providing:

- gaps at corners in roadside snowbanks - wildlife may congregate on ploughed roads in the winter to avoid deep snow and may then become trapped if the roadside snow banks are too high or continuous to permit escape from approaching traffic;
- sufficiently elevated bridges - where practical, to allow for free movement of wildlife beneath bridges; and
- toad tunnels - where required in known or suspected western toad migration corridors, and equipped with drift net fencing to guide the animals to the tunnel entrance.

Road as Attractants

The use of road salts for winter road management will be avoided to reduce the potential of attracting ungulates to the road. Sand or stone chippings will be used as the preferred methods to provide winter traction. Vegetation will also be managed to reduce roadside attractiveness. Where high-quality browse is present, road verges will be cleared to increase wildlife visibility to drivers. Clearing will be site specific to ensure a balance between low vegetation and maintaining high value and sensitive habitat. Pre-clearing surveys for bird nests will be conducted prior to brush cutting to ensure nests are not destroyed if it is nesting season.

Re-vegetated verges will be seeded with a low-diversity seed mixture with low or no clover content that are less attractive wildlife forage, especially to moose, mountain goats, and black bears. In accordance with British Columbia's best management practices for raptors (BC MWLAP 2005), vegetation will be managed through manual and mechanical mowing and brushing without the use of herbicides, except if required for invasive species control.

Ditches and culverts will be managed to minimize pooling of water. Free draining roadside ditches will eliminate pools that may be attractive as toad breeding areas. Roadside pools that are formed will be drained before they can become habitat for wildlife.

Carrion will be removed from roads to minimize attracting wildlife to the road, thereby reducing the risk of conflicts between vehicles and wildlife.

Dust production from moving vehicles will be managed through enforced speed limits and through the use of dust suppressants, the latter as described in the Air Quality Management Plan (Section 29.2). Water will be used as the preferred dust suppressant. If this approach is not successful, alternatives will be investigated taking into account the risk of other suppressants acting as wildlife attractants.

Protection of Fish and Fish Habitat

Once construction permits are received, the main Brucejack Access Road will require additional upgrading to improve safety and to handle the higher traffic loadings from both Construction and Operation activities. The work will include minor re-alignments of the sharper curves, reductions of the steeper grades, and additional surfacing of some sections. However, it is not anticipated that any upgrades to stream crossings will be required.

Nevertheless, relevant measures referred to in the *Fish-stream Crossing Guidebook* (BC MFLNRO, BC MOE, and DFO 2012) will be applied, such as eliminating or reducing sediment-related problems during nearby roadworks and preventing deleterious substances from entering streams.

Measures to Control Speed and Access

In recognition of the need to reduce wildlife collisions, Pretivm has committed to a 40 km per hour speed limit on the Brucejack Access Road. This speed limit will be clearly posted and will be actively enforced and adjusted as necessary, to reflect current circumstances regarding safety concerns and wildlife interactions. Areas with a higher risk of wildlife collisions will be identified as far as possible, i.e., will be managed in an adaptive manner, so that appropriate warning signs may be posted promptly. Signage will also identify potentially hazardous areas such as avalanche-prone areas.

Pretivm will maintain a locked gate at the intersection with Highway 37 to control access to the Brucejack Access Road. The gate will be staffed at all times and only authorized vehicles will be permitted to pass the gate. The access gate will remain in operation throughout all phases of the Project, until the road is deactivated.

Measures to Control Traffic Noise

During the Construction and Operation phases of the Project, humans and wildlife may be disturbed by traffic noise. A separate Noise Management Plan (Section 29.11) has been prepared to ensure that noise levels during all phases of the Project are acceptably low for human and wildlife receptors of concern in the vicinity of the Project. Typical noise mitigation measures will include:

- consideration of noise specifications when selecting equipment;
- maintaining vehicles regularly;
- imposing speed limits;
- installing and maintaining mufflers on vehicles; and
- applying noise dampening measures where possible.

Measures to Manage Spills

Traffic along the access road will include trucks hauling fuel, concentrate, reagents, and explosives components. Spills of these materials may have adverse environmental effects if not dealt with quickly and efficiently. The Project's Spill Prevention and Response Plan (Section 29.14) will address accidental spills and road users (Pretivm employees and contractors) are expected to be knowledgeable in relevant spill-response techniques and protocols. Spill kits will be available on vehicles transporting dangerous goods or hazardous materials, and mobile spill response kits will be available at the Brucejack Mine Site and Knipple Transfer Area.

29.16.4.2 *Glacier Road*

Context

The last 12 km of the existing access road to the Brucejack Mine Site traverses the main arm of the Knipple Glacier, which is maintained as a groomed snow surface during winter months but is an ice surface during the summer. The Knipple Transfer Area will be constructed near the base of the Knipple Glacier to facilitate the transfer of goods and materials from highway trucks to tracked vehicles for travel across the glacier, and for transfer of concentrate from tracked vehicles to highway trucks for shipment to the port of Stewart.

Due to the surface of the glacier dropping, Pretivm has established a new access ramp onto Knipple Glacier, which provides access to the ice earlier and eliminates the need to traverse through an area of high avalanche activity and rock falls. It is expected that this approach will require regular maintenance to maintain a safe gradient as the glacier melts further.

Note that Pretivm has in place a procedure that addresses travel on the glacier, titled *Procedures and Guidelines Glacier and Travel in Spring/Summer* (Mine Site Procedure BJ-031, May 25,2013h), during exploration activities on the Brucejack site. The procedure specifies the following aspects for safe travel on the glacier:

- tools and equipment;
- safety requirements;
- responsibilities of supervisors, operators, the mountain safety technician; dispatch, and health and safety coordinator;
- personal protective equipment;
- check in/out procedures;
- road and route maintenance;
- hazards; and
- communications.

Surface Management Measures

The glacier access ramp has been constructed using snowcats, crawler tractors, and composite mats as necessary. It will be rebuilt, as required, to deal with snow accumulation. An avalanche control crew will monitor the route continually throughout the construction and hauling periods.

During the winter months, the glacier section of the road is covered in many metres of snow. Pretivm has experience using snow packing snowcats to prepare the running surface for use by other tracked

equipment. The snowcats are equipped with blades on the front to distribute the snow across the road surface and break through snow drifts. A hydraulically powered tiller on the rear of the snowcat then mixes the new snow with previous layers, reduces chunks, and beats the air out of the snow. A plastic comb then compresses the snow into a ribbed running surface. The end result is a snow surface that is dense enough for other tracked equipment to run on. The road surface is maintained as high above the ice level as possible to provide a snow running surface well into summer.

Summer maintenance of the glacier section of road consists mainly of leveling the snow surface as it melts in the warmer months. Running water is kept off the road surface as much as possible to avoid channeling on the road. The melting snow exposes crevasses and mill holes, which pose a hazard to small vehicles and personnel on foot. Avalanche and glacier technicians will survey the ice conditions daily, marking safe travel areas to thereby avoid the larger ice hazards.

Usage Measures

During periods of particularly poor visibility vehicles hauling on the glacier will travel in convoys. Rescue caches will be located at the mine rescue training room, the Knipple Transfer Area, the Bowser Aerodrome, and in the snowcats. Haul equipment will have Global Positioning System navigation devices and will remain in radio communication with other haul equipment and the camps.

The road route will be demarcated with closely spaced, high-visibility bamboo stakes that will provide a visual reference for operators at night and in low-visibility weather. Personnel on foot will not wander from the safe zones. The road route will be inspected during the summer months and altered to avoid particularly large hazards as needed. A crevasse survey will be completed each summer so that a safe route can be planned for the winter when the hazards are obscured by snow bridging.

The length of road to the south of Brucejack Lake known as Lakeshore Drive, between the Knipple Glacier and the Brucejack Mine Site, often has high avalanche risks. During periods when it is unsafe to travel on Lakeshore Drive, an alternate snow route over the VOK is available. This VOK bypass road traverses around to the south of the mine development, eventually meeting the Knipple Glacier at km 71 of the Brucejack Access Road. This road will only be available in the winter and will also be used to provide access to the upper elevations of the mine precinct for avalanche control measures.

Glacier travel guidelines and glacier emergency response plans have been developed and implemented by Pretivm. Personnel operating on the glacier receive additional safety training and are issued additional personal protective equipment such as rescue harnesses, avalanche beacons, rope rescue equipment, and avalanche rescue equipment.

29.16.5 Monitoring Program

Monitoring will be implemented to track the effectiveness of the proposed environmental protection measures for transportation and access to the Project site. These will include:

- tracking of road safety incidents to determine trends and to identify areas requiring further mitigation;
- monitoring of sediment release from Construction and Operation in the proximity of stream crossings, to identify if any additional remedial measures are required;
- tracking of unauthorized use of access roads;
- enforcement of speed limits on access and mine site roads;
- tracking of wildlife observations and incidents to identify wildlife sensitive areas;

- use of inspections, as required, for dirt and mud possibly containing invasive plant material on vehicles entering the Project site; and
- monitoring of vertical ablation through the loss of snow, ice or water from the glacier road and access ramp, the latter possibly needing realignment from time to time (note that Pretivm is currently monitoring ablation along the length of the road).

29.16.6 Work Planning and Schedule

The Environmental Manager will disseminate the performance objectives and measures related to transportation and access management to all Project personnel that have a direct or indirect influence on such management during the Construction, Operation, Closure, and Post-closure phases.

A notional indication of a monitoring schedule for transportation and access management includes the following:

- daily survey of ice conditions on glacier section of the road during summer months;
- daily inspection and concomitant maintenance of glacier section of the road as a suitably dense snow surface road with proper route demarcation during winter months;
- monitoring of the avalanche risk based on local conditions and regional reporting from the Canadian Avalanche Centre;
- monthly inspection of all site and access roads, to monitor the effectiveness of the measures listed in the previous section and initiate corrective actions as required;
- monthly review of all recorded transportation and access incidents and initiate corrective actions where trends or anomalies are apparent; and
- annual assessment of the ramp onto Knipple Glacier, to ascertain whether new alignment or additional excavation is required.

29.16.7 Reporting Requirements

29.16.7.1 Reports

In respect of wildlife, reporting shall follow the procedure in the Wildlife Management Plan. Reports will be made over the radio to alert other operators that there is wildlife in the area and to travel with caution. These records will provide a basis for identifying locations of considerable risk for collisions between wildlife and vehicles and for developing appropriate mitigation measures.

Collisions between vehicles and wildlife will be documented and will include information on the location of the collision along the site and access roads. Employees and drivers working for regular contractors hauling concentrate and materials for the Project will be trained on reporting in the event of a collision. All information on collisions will be shared with relevant government agencies. Locations where wildlife collisions take place will be prioritized for adaptive mitigation.

29.16.7.2 Reporting Responsibilities

The Project will have an Environmental Manager and health and safety personnel who will share responsibility in a coordinated manner for the monitoring and reporting on transportation and access management.

29.17 WASTE MANAGEMENT PLAN

29.17.1 Purpose

This Waste Management Plan has the primary purposes of protecting workers, the public, and the environment from potentially adverse effects associated with the management of waste from the Project. The plan is also intended to describe planned measures to achieve compliance with regulatory requirements and Pretivm's Environmental Policy (2013e) and Waste Management Plan (BJ-038; 2013g).

The secondary purpose of the plan is to minimize the risk and cost associated with the recycling, storage, handling, removal, and disposal of waste from all aspects of the Project. Note that a material is considered a waste when it can no longer be used for its original purpose.

This Waste Management Plan documents Pretivm's approach to waste management and outlines strategies that will be used to process the various Project waste streams to ensure maximum safety and environmental protection. It will be reviewed regularly and revised as required to ensure continued best practices and compliance.

It should be noted that this plan is focused on how waste generated by the normal activities that comprise the Project will be managed. It includes the disposal of hazardous materials. Aspects related to transport, receiving, non-waste generating use, as well as upset conditions and non-compliance related to hazardous materials are addressed within the Hazardous Materials Management Plan (Section 29.7) and Spill Prevention and Response Plan (Section 29.14), respectively.

Note that the information contained in this plan is at a level of detail considered to be appropriate for the Application/EIS submission and that it will be further developed into a detailed plan(s) as required for permit applications.

29.17.2 Regulatory and Policy Framework

The minimum standards of acceptability for this Waste Management Plan are to comply with the following federal and provincial legislation:

- *BC Environmental Management Act* (2003a) and its regulations, particularly Hazardous Waste Regulation (BC Reg. 63/88);
- *Health Act* (1996e);
- *Fisheries Act* (1996c);
- *Water Act* (1996j);
- *Mines Act* (1996i) and Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008);
- *Wildlife Act* (1996l);
- *Land Act* (1996g);
- *Canada Transportation Act* (1996a);
- *Canadian Environmental Protection Act* (1999);
- *Hazardous Products Act* (1985d);
- Controlled Products Regulations (SOR/88-66); and
- *Transportation of Dangerous Goods Act* (1992).

29.17.3 Performance Objectives

The performance objectives for this Waste Management Plan are to ensure that:

- all employees and contractors on the site have at least an overview training in waste management strategies on the Project site, achieved through site orientation training;
- every work area has a designated waste collection or disposal area; and
- every waste collection or disposal area has designated and secure areas or containers for disposal of specific waste types.

In order for the Waste Management Plan and its associated procedures to function to their full efficiency, all personnel on the site must be made aware of the plan and their corresponding responsibilities. All Project personnel, including contractors, need to be active participants.

29.17.4 Environmental Protection Measures

29.17.4.1 Waste Reduction, Reuse, Recycling, and Recovery

This Waste Management Plan focuses on the wise use of resources, which includes the four R's of waste management, namely to reduce, reuse, recycle, and recover. Where feasible, these methods will be exhausted before disposing of waste materials.

Waste Reduction

Reducing the amount of material that is consumed is the most effective way of reducing the amount of waste that is generated. Consumption will be assessed by evaluating all procedures, processes, and consumed materials for possible reductions in material usage, as well as possible reductions in generated waste volumes. Examples of waste reduction include:

- product review, selection, and substitution - recyclable/reusable and non-hazardous materials used instead of non-recyclable/non-reusable and hazardous materials;
- ordering chemicals or lube products in bulk/returnable containers;
- keeping a workable minimum inventory to prevent expiration of products and resulting generation of waste;
- decreasing the amount of solid waste by reducing the use of disposable items;
- training personnel on waste minimization and reuse; and
- decreasing the amount of packaging on supplies by requesting that suppliers provide less packaging materials on over-packaged products.

Reuse and Recycling

Materials brought to the Project site will be used to the maximum extent feasible, and where applicable, reused on the site. Examples of potentially reusable materials include:

- scrap metal, conveyor belts, and wood;
- chemical containers that can be returned to the supplier to be refilled; and
- waste oils, glycols, and solvents that can be reused for secondary applications.

Recyclable materials will be shipped off site to the nearest recycling facility. Products that will be shipped off site include:

- used oil filters (oil removed, crushed, and recycled separately);
- lead-acid and alkaline batteries;
- plastic petroleum pails;
- used/damaged vehicle parts;
- oil-based paints; and
- empty drums.

Some combustible, non-reusable, non-recyclable, materials such as food-soiled packaging and non-reusable wood products will be used to fuel incinerators to aid in the combustion of other materials.

Recovery

Recovery is the final level of waste minimization and involves extracting usable material or energy as a by-product for other uses. Opportunities for recovery will be evaluated throughout the life of the Project.

29.17.4.2 Waste Types

The types of waste that will typically be generated during Construction, Operation, Closure, and Post-closure of the Project are listed in Table 29.17-1. With respect to hazardous materials, note that the table refers to the types of wastes generated rather than the type of management that the materials may require, the latter being addressed in the Hazardous Materials Management Plan (Section 29.7).

29.17.4.3 Waste Collection and Disposal Facilities

Construction

The current Brucejack exploration camp includes an office and equipment storage, kitchen and dormitories, maintenance and generator shed, fuel storage, sewage plant, and water treatment and storage. It is managed according to a *Mines Act* Permit for mineral exploration (MX-1-842) and various *Health Act* (1996e; potable water and kitchen) and BC EMA (2003a; sewage treatment plant effluent) authorizations.

Construction camps for the Brucejack Mine Site and Knipple Transfer Area will have incinerators to handle putrescible kitchen waste. The Bowser and Tide Staging Area camps will have their putrescible kitchen waste hauled away to appropriate disposal facilities. Sewage treatment and disposal will vary with the camps. The largest camp - Brucejack camp - will continue to use a portable sewage treatment plant (rotating biological contactors or other similar units) to handle both black and grey water waste. Sludge from the plant will be incinerated and the ash added to the paste backfill, or hauled off site for disposal at a licensed facility. The smaller existing (Bowser) and proposed (Knipple Transfer Area and Tide Staging Area) camps do or will have septic tank and associated drainfield systems designed for the maximum camp populations. Sludge will be removed as required for efficient operation of the plants and hauled for disposal to a permitted sewage lagoon. Solid inert waste and hazardous waste will be stored until it can be transferred to appropriate disposal facilities.

Table 29.17-1. Typical Domestic, Industrial, Chemical and Hazardous Waste Generated at the Brucejack Gold Mine Project

Type of Waste	Example of Waste	When Generated			
		C	O	Cl	PC
Domestic Waste	Aluminum cans and glass	X	X	X	X
	Domestic garbage	X	X	X	X
	Paper materials	X	X	X	X
	Plastics	X	X	X	X
	Putrescible food waste	X	X	X	X
Industrial Waste	Aerosols	X	X		
	Batteries	X	X	X	
	Building materials and bulk debris	X	X	X	
	Cement	X	X	X	
	Conveyor belts		X	X	
	Culvert pieces	X	X	X	
	Fluorescent light ballasts	X	X	X	
	Glass	X	X	X	
	Incinerator ash	X	X	X	
	Insulation material scraps	X	X	X	
	Packaging	X	X	X	X
	Rebar	X	X	X	
	Scrap metal	X	X	X	
	Scrap wood	X	X	X	
	Steel balls		X		
	Tires	X	X	X	
	Transformers	X	X	X	
Vehicles	X	X	X		
Wiring	X	X	X		
Chemical and Hazardous Waste	Acids	X	X	X	
	Biohazardous waste (first aid room waste)	X	X	X	
	Glycol	X	X	X	
	Hydraulic oil	X	X	X	
	Laboratory chemicals	X	X	X	
	Oil filters	X	X	X	
	Oily rags	X	X	X	
	Sharps (razors, needles)	X	X	X	
	Solvents	X	X	X	
	Used absorbent pads	X	X	X	
Used oil	X	X	X		

C = Construction, O = Operation, Cl = Closure, PC = Post-closure

Clearly labelled sealable containers will be provided at each camp and staging area for the different types of materials (e.g., hazardous waste and recyclable waste). Electric fencing will be used to deter

bears from entering waste disposal facilities (i.e., incinerator). Sealed containers from the camps will be hauled for disposal at the nearest accessible disposal point. Inert non-reactive solid waste materials that cannot be recycled, reused, or burned in an incinerator will be stored until they can be disposed of by hauling via public roads to licensed off-site landfills.

Operation

Project waste collection and disposal facilities will include incinerators near the Brucejack operating camp and at the Knipple Transfer Area, waste collection areas for recyclable and hazardous wastes, and sewage effluent and sludge disposal. Waste will be recycled to the extent feasible. Waste collection areas will have provisions to segregate waste according to disposal methods and facilities to address spillages, fire, and wildlife attraction. Specific procedures and separate secure storage areas will be designated for waste prior to recycling or removal from the site.

The waste collection areas and sewage effluent/sludge disposal systems will have waste containment and runoff control structures as appropriate to prevent escape of untreated liquid waste to surface or groundwater. Regular inspections of these waste containment and runoff control structures will be conducted and the records will be kept for review upon the request of the Environmental Manager or Mine Manager. Regular inspection audits will be conducted on all the disposal systems as well, to ensure that the waste is being handled correctly and filtered into the correct waste streams.

Waste Collection Areas

The waste collection areas will function as storage areas for waste until it is processed further or transferred off site to the appropriate approved recycling or disposal facilities or landfill. The waste collection areas will be designed to adequately and safely store a sufficient quantity of waste over a prescribed time limit of one to three months. Where required, the waste collection areas will be covered and fenced to prevent attraction of wildlife and to provide protection from weather. Additionally, hazardous waste disposal facilities will be adequately designed to contain spills.

A waste collection area will typically consist of three parts:

- Recycle/Reuse Area: This area will contain the items that can be recycled or reused on the site. Inert materials to be stored in this area include tires, scrap metals, and waste wood. These items will be placed in designated containers or areas within the recycle/reuse area of the waste collection area. This method will allow personnel to search the recycle/reuse area of the waste collection area for materials to reuse. Once these containers or areas become full, the contents will be either disposed of in a designated on-site facility or shipped off site for recycling at an approved facility.
- Hazardous Waste Area: The hazardous waste area will contain hazardous waste that is required to be shipped off site. Hazardous waste, including used glycol, acids, solvents, laboratory chemicals, oil that cannot be burned in incinerators, oily rags, absorbent pads, hydraulic fluid, and any other hazardous chemicals, will be stored in a bermed containment area. Hazardous waste will not be permitted to accumulate to excessive volumes, but will be shipped off site to avoid crowding.

The waste in the waste collection areas will be segregated and stored using accepted management practices that include the following:

- fire prevention systems adequately designed for the materials being stored;

- spill kits, protective equipment, and other necessary equipment to clean and mitigate spills will be used;
- only containers in good condition used to store items;
- containers and liner materials compatible with the waste being disposed;
- containers and drums labelled to identify the waste content and initial date of storage;
- sufficient storage space between containers to allow for their safe access and handling; and
- incompatible waste not to be stored in the same containers and stored at a safe distance from each other.

Incinerators

Incinerators will be used for waste disposal at the Brucejack mine camp and at the Knipple Transfer Area camp. The incinerators will be used to dispose of all waste that is a wildlife attractant, including food waste and food-related products. Food waste is a prime wildlife attractant and will therefore be incinerated in a timely manner, thus leaving no trace of attractants for wildlife. Kitchen, dining room, office, and accommodation waste will be incinerated to reduce the potential of attracting wildlife. Resultant incinerator ash will be hauled for off-site disposal in a permitted landfill.

Incinerator areas will be fenced, further reducing wildlife interactions.

Sewage Plant Effluent/Sludge

A sewage treatment plant will be located at the Brucejack mine camp. This facility will consist of rotating biological reactors or other similar units. The facilities at the Knipple Transfer Area and Tide Staging Area camps will be septic systems with appropriately sized tile fields; the same type of system has been installed at the Bowser Camp and will remain in place for as long as these camps remain in use. The sludge from these facilities will be periodically pumped out and disposed of in an appropriate manner, as described previously.

29.17.4.4 Procedures for Managing Specific Waste

The waste collection areas will provide a means to collect the waste streams and transfer them to their correct disposal areas. Specific areas will be designated for each type of waste and will be clearly labelled.

Table 29.17-2 shows the typical waste types to be expected at the Project, their treatment strategies, and handling/disposal methods.

29.17.4.5 Hazardous Waste

Hazardous waste will be produced at all the Project sites in all the phases. It includes materials such as waste oil, laboratory chemicals and solvents, lead-acid batteries, oil filters, and used oily rags and absorbent pads. The Hazardous Waste Regulation (BC Reg. 63/88) under the BC EMA (2003a) provides the relevant definition of hazardous waste.

Hazardous waste requires special handling and training procedures. All employees, contractors, and sub-contractors who are handling hazardous waste for the Project will be provided with training to enable them to identify hazardous waste and know how to handle it appropriately. See the Hazardous Materials Management Plan (Section 29.7) in this regard. This training will also cover the receiving, off-loading, and storing of potentially hazardous materials, as well as the storage and shipment off site of hazardous waste.

Table 29.17-2. Waste Types, Treatment and Disposal

Type	Treatment	Disposal
Hazardous Waste		
<i>Petroleum Waste Stream</i>		
Used oil	Incinerate when appropriate/off-site recycling otherwise	Oil storage tank at vehicle maintenance shops
Oily rags and absorbent pads	Off-site disposal	Waste collection areas
Oil and fuel filters	Off-site recycling	Waste collection areas
Hydraulic fluid	Off-site recycling	Waste collection areas
<i>Chemical Waste Stream</i>		
Glycol	Off-site recycling	Waste collection areas
Acids	Off-site recycling	Waste collection areas
Solvents	Off-site recycling	Waste collection areas
Waste batteries	Off-site recycling	Waste collection areas
Aerosol cans	Disposal in approved facility	Waste collection areas
Paints	Reuse/off-site recycling	Waste collection areas
Laboratory chemical waste	Disposal in approved facility or return to supplier	Waste collection areas
Process plant reagents	Return to supplier	Process plant/reagent storage area
Biological waste	Incineration/disposal in approved facility	Waste collection areas
Explosives materials and detonators	Return to supplier	Explosives magazines
Non-hazardous Waste		
<i>Inert Solid Waste</i>		
Paper and corrugated cardboard	Reuse/incineration/off-site recycling	Incinerators/waste collection areas
Plastics	Reuse/recycle/disposal	Waste collection areas
Tires and conveyor belts	Reuse/recycle/disposal waste	Waste collection areas/tire recycling facilities
Vehicles	Reuse/recycle	Waste collection areas
Scrap metal	Off-site recycling	Waste collection areas
Waste lumber	Recycling/disposal	Waste collection areas/incinerators
Electrical equipment	Recycle	Waste collection areas
<i>Solid Domestic Waste</i>		
Food waste	Incineration	Incinerator
General camp waste	Incineration	Incinerator
<i>Sewage</i>		
Sewage	Sewage treatment plants	Brucejack Mine Site and Knipple Transfer Area
Sewage sludge	Incinerate or Disposal	Off-site licensed lagoon

All hazardous materials and dangerous goods will be stored in clearly labelled containers or vessels and handled in accordance with regulations appropriate to their hazard characteristics. Hazardous waste that needs to be disposed of off site will be transferred to an approved hazardous waste facility that will issue a certificate of destruction.

The Brucejack exploration site is registered as a Hazardous Waste Generator per Provincial Identification Number BCG 10829, September 6, 2013, in accordance with Section 13 of the Hazardous Waste Regulation (BC MOE 2013).

Petroleum Waste Stream

Petroleum products will be used widely at the Project. The waste generated from petroleum products will include used oil, diesel fuel, lubricants, gasoline, jet B, oily rags and absorbent pads, and solvents. The handling, storage, and spill contingency for petroleum products are outlined in the Spill Prevention and Response Plan (Section 29.14).

Used Oil

Oil will be used for every vehicle, piece of equipment, and generator on the Project site. Used oil will be generated from their regular maintenance and will be collected and stored in used oil storage tanks located in the vehicle maintenance shops with secondary containment areas. Used oil generated during the Construction phase will be collected in barrels in secondary containment areas at camps or staging areas. The used oil will be reused where possible, such as for fuelling incinerators, or disposed of through a waste oil burner when appropriate, otherwise shipped off site to a licensed disposal facility for recycling. A *Clean Burn CB-3250* waste oil burner equipped with an oil scrubber is currently in use at the Brucejack Camp, where the exhaust heat generated provides the primary heat source in the heavy equipment shop.

Oil and Fuel Filter

Used oil and fuel filters will be crushed and stored in marked barrels. The barrels will be inventoried and stored in the bermed hazardous waste section of the waste collection areas until they are shipped off site to a licensed disposal facility for recycling. During the Construction phase they will be stored adjacent to the used oil containers. Oily rags and absorbent pads will also be shipped off site to a licensed disposal facility, or if permitted, incinerated.

Hydraulic Fluid

Hydraulic fluid that is not reused will be stored in marked drums in secondary containment in the vehicle maintenance shops or within the bermed hazardous waste section of the waste collection areas, until it is shipped off site to a licensed disposal facility for recycling.

Chemical Waste Stream

Typical chemical waste will comprise glycol, acids, and solvents. Materials or containers that have chemical implications include spent batteries, aerosol cans, and paints.

Glycol

Glycol (antifreeze) is used in vehicles and various types of equipment. It is a toxic substance that has an adverse effect on the environment and can be a wildlife attractant if spilled because of its sweet smell and taste. Used glycol will be stored in labelled containers, which will be inventoried and stored in secondary containment areas of the vehicle maintenance areas or in the bermed hazardous waste section of the waste collection areas, until they are shipped off site to a licensed disposal facility for recycling.

Acids

Old lead acid batteries from vehicles will be labelled, inventoried, and stored in the bermed hazardous waste section of the waste collection areas, until they are shipped off site to a licensed disposal facility for recycling.

Solvents

Solvents are used as degreasing agents for vehicle and equipment parts. Non-toxic citrus-based alternatives, detergents, and jet-streams will be used as much as possible in lieu of petroleum-based solvents. Where petroleum-based solvents are required, they will be recycled to the greatest extent possible until they no longer have their desired cleaning properties before being considered waste. Waste solvents will be stored in labelled containers, which will be inventoried and stored in the bermed hazardous waste section of the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

Spent Batteries

Rechargeable batteries will be used to the extent feasible to minimize the amount of waste produced. Containers will be placed in buildings around the Project site to collect spent batteries. Spent batteries will be stored in the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

Aerosol Cans

Pump bottles will be used as much as possible in place of aerosol cans to reduce the amount of waste produced. Aerosol cans that are misdirected into the incinerator waste stream can pose a safety concern. Therefore separate waste containers for aerosol can collection will be placed around the camps and other facilities, and cleaning staff will be alerted to separate aerosol cans that make it into the waste stream. Empty aerosol cans will be hauled off site and disposed of in an approved landfill.

Paints

When paint cans are completely emptied and dried they will be hauled off site and disposed of in an approved landfill. Residual paint from latex-based paints will be dried before disposal in a landfill. Residual paint from oil-based paints will be collected for off-site recycling. The cans from oil-based paints will be properly sealed and stored in crates in the waste collection areas until they are shipped off site to a licensed disposal facility for recycling.

Biological Waste Stream

Small amounts of hazardous waste in the form of needles, syringes, scalpel blades, and blood- and tissue-contaminated materials will be generated by the on-site paramedic and from the first aid areas. This waste will be properly contained in biohazard containers in the first aid area under the supervision of the first aid staff. The blood- and tissue-contaminated materials will be incinerated and the other biohazardous waste will be shipped off site to an approved disposal facility.

29.17.4.6 Non-hazardous Waste

Non-hazardous waste will be produced at all the Project sites in all the phases. It includes materials such as domestic garbage, food waste, paper materials, aluminum cans, glass, plastics, inert bulk waste, etc.

Inert Solid Waste

Paper

Paper waste consists of office paper, newspaper, general packaging, and food packaging. Paper waste will be reduced in a number of ways, such as minimizing the use of paper, recycling, and reusing. Minimizing the use of paper will be achieved by using voice message devices, telephone or verbal messaging, emails, and printing and photocopying on both sides of the paper. Reusing paper waste will be achieved by such approaches as using shredded paper as packaging material and reusing paper from

the recycling bins for notepads. Paper packaging from food products will be burned in the incinerator. Paper recycling boxes will be placed in all the buildings where paper will be used (offices, accommodation buildings, kitchens, etc.). The recycling boxes will be emptied into a crate in the waste collection areas to either be shipped off site to a paper recycling facility or (depending on available storage and shipping constraints) burned in the incinerator.

Corrugated Cardboard

Corrugated cardboard waste will be generated mainly from packaging of materials. Standard cardboard will be collected along with the paper and will be stored in a crate in a dry location in the waste collection areas to either be shipped off site to a paper recycling facility or incinerated. Cardboard waste from explosives packaging will continue to be burned in a burn pit following special safety procedures per current practice at the exploration site.

Plastics

Plastic waste will mainly be generated from food packaging, cleaning products, and lubricants. To reduce the amount of plastic waste produced, the maximum practical package size will be purchased for products, and disposable plastic dishes will not be used. Some of the plastics, such as pails and barrels, will be reused. Clean materials of appropriate plastic types will be collected at waste collection areas for off-site recycling.

Plastics that contained food products will be incinerated to prevent attracting animals. Plastics that contain non-hazardous materials and that cannot be incinerated will be sent to an off-site landfill for disposal. Plastics that contained hazardous materials will be fully drained and stored in the waste collection areas before being shipped off site to an approved disposal facility.

Tires and Conveyor Belts

Tires that are not reused in some way, such as impact barriers at road intersections, will be inventoried and stored in the waste collection areas for transport to a tire recycling facility.

Conveyor belts have a finite life. When they can no longer be used, the belts, along with other large rubber items from the mine operation, will be assessed for other uses such as floor pads and protective material in loading docks, etc. Rubber that cannot be reused will be sent to an off-site landfill.

Vehicles

Regular maintenance will prolong the life of vehicles and equipment. When they are no longer usable for the Project, they will be driven or shipped off site to be reused or recycled. The unusable vehicles and equipment will be stored in a laydown area until they are shipped off site.

Air Filters

Air filters will be collected in bins in the truck shops and disposed of in off-site landfills.

Scrap Metal

Scrap metal will be generated during the construction and maintenance processes and will contain ferrous and nonferrous types. Scrap metal will be minimized by prompt maintenance of equipment, and will be reused wherever possible for on-site needs and projects. The scrap metal will be segregated and placed in designated laydown areas and bins for reuse or salvage. The unused scraps will be shipped off site to a licensed disposal facility for recycling.

Waste Lumber

Waste lumber will be generated during Construction and throughout the Project life from building by-products. Waste lumber will be reused as much as possible on the Project site. Waste lumber not immediately reused will be placed in designated bins in the waste collection areas for incineration. Pressure-treated lumber will be shipped off site to a permitted landfill.

Electrical Equipment

Waste electrical equipment will consist of generators, transformers, and distribution lines that have reached the end of their service. When they are no longer functional or re-buildable, usable parts will be salvaged for reuse and the rest of the parts will be shipped off site to a licensed disposal facility for recycling. Note that any pieces of waste electrical equipment that may contain hazardous materials, such as oil-filled transformers in the substation, will be dealt in an appropriate manner.

Solid Domestic Waste

Domestic waste will include putrescible food waste, recyclable containers (cans and bottles), packaging, inert non-combustible domestic waste, and paper products.

- Food Waste: Putrescible food waste and packaging from food materials will be incinerated in a timely manner to minimize the attraction of wildlife. The ash from the incinerator will be disposed of off site in a permitted landfill.
- General Camp Waste: General camp waste will consist of waste from accommodations, offices, and recreation areas. Personnel will be informed of the items that are recyclable and need to be placed in the recycling containers. The remainder of the materials will be incinerated when appropriate, otherwise hauled off site to a permitted landfill.

Sewage Sludge

Section 29.17.4.3 above deals with the disposal of sewage sludge.

29.17.4.7 Transporting Waste

Certified transportation contractors will be used for the transport of goods and materials to and from the site. Project personnel will periodically inspect the transporters' performance and compliance with BC and federal transport regulations, contract requirements, and overall performance.

29.17.4.8 Closure and Decommissioning

Activities during the Closure phase will be similar to the activities during the Construction phase. A range of materials will become available for salvage, recycling, or disposal with the dismantling and removal of buildings, surface structures, fuel tanks, etc. Chapter 30, Closure and Reclamation, describes closure and reclamation of the Project.

Waste Management during Closure

Significant amounts of waste will be generated from the dismantling of buildings and process-related materials. The approach for waste management during Closure will be to identify feasible salvage and recycling options.

Upon Closure, the buildings, facilities, and process equipment will be dismantled and removed from the site for recycling and/or disposal. Any equipment or materials with market value will be removed for capital recovery.

Decommissioning of Waste Management Facilities

Facilities will be dismantled and/or removed from the Project site. Certain of the waste management facilities at both the mine and Knipple Transfer Area sites, such as the waste collection areas, incinerators, and the sewage plants, will be retained to support continuing site maintenance and inspection activities until no longer required, at which time they will be dismantled and removed. All scrap metal will be disposed of in a manner acceptable to an agency inspector. After the removal of structures, the remaining area will be reclaimed in accordance with permit requirements.

29.17.5 Monitoring Program

Monitoring and enforcement of the waste management procedures are fundamental in ensuring that the plan is functioning to its optimum efficiency for the life of the Project. Waste will be monitored by each department and key sites with potential for procedural non-compliance will be inspected on a regular basis defined by the level of the risk.

Off-site and on-site disposal will be monitored through periodic audits of waste type, method of disposal, and location. Inspections will cover on-site facilities such as waste collection areas, incinerators, and sewage plants, as well as related documentation such as inventories, manifests, and logbooks. The frequency of scheduled inspections will be dictated by the relevant policies, plans, and procedures but are unlikely to be more than three months apart. The Environmental Manager will appoint a small audit team whose responsibility will be to:

- inspect Project facilities and waste disposal areas for proper waste segregation, storage, and disposal;
- perform periodic reviews of the waste collection areas including procedures, training, equipment, records, and employee awareness; and
- review the inspection findings with area supervisors, operation personnel, transporters, and contractors to correct deficiencies, improve procedures, maintain awareness and communication, and recognize positive or negative performance.

Monitoring and inspection program findings will be used to alert management when enforcement is necessary to ensure compliance with the plan and procedures.

29.17.6 Work Planning and Schedule

The Environmental Manager will disseminate the performance objectives and measures related to waste management to Project personnel with a direct or indirect influence on such management during the Construction, Operation, Closure, and Post-closure activities.

Personnel requiring specific training in the management of waste will be identified by Pretivm and will receive such training prior to assuming any related responsibility, or within a reasonable time if their current level of training allows it to be delayed. All employees will be made aware of the general issues and concerns surrounding the management of waste as part of their routine health and safety induction and training.

29.17.7 Reporting Requirements

29.17.7.1 Reports

Routine reporting according to a schedule of monitoring/audit inspections will be undertaken in a structured manner.

Audit/inspection reports will be reviewed internally by the responsible line manager and the Environmental Manager, in order to identify necessary improvements in the monitoring system. Reports will be made available to the relevant government agencies upon request as stipulated by regulations.

Where emergency or spill incidents occur as a result of upset conditions or non-compliance with the Waste Management Plan (Section 29.17), these will be reported per the requirements of the Emergency Response Plan (Section 29.6) and Spills Prevention and Response Plan (Section 29.14).

29.17.7.2 Reporting Responsibilities

The Project's Environmental Manager will carry line responsibility for monitoring and reporting on the management of waste. The Mine Manager will be responsible for ensuring that the performance objectives and protection measures are achieved. Appropriately qualified personnel will be employed throughout the life of the Project to supervise, direct, monitor, and implement the management actions required by this Waste Management Plan.

29.18 WASTE ROCK MANAGEMENT PLAN

29.18.1 Purpose

The Project will result in approximately 5 Mt of waste rock being produced during the 22-year life of the mine. The current understanding of the geology of the site is that waste rock is likely to be acid-generating and a comprehensive metal leaching / acid rock drainage (ML/ARD) characterization using acid base accounting (ABA) data has determined the neutralization potential of representative samples of the waste rock. Three geological model units constitute 87% and 88% of the waste rock destined for re-deposition in the underground mine and disposal into Brucejack Lake respectively, and contain 77% to 85% potentially acid generating (PAG) material (BGC 2014a). The implication is thus that a high percentage of the waste rock material generated at the Brucejack Mine Site will pose an ARD generation risk.

ML/ARD prevention planning for the mine (refer to the ML/ARD Management Plan, Section 29.10) includes a strategy for subaqueous disposal of waste rock in Brucejack Lake during the Construction period, followed by disposal both as backfill in the underground mine workings and in the lake for the remainder of mine life. The underground mine will be allowed to flood at Closure, such that waste rock disposed underground will also become subaqueously disposed at that time.

The purpose of this preliminary Waste Rock Management Plan is to outline health, safety and environmental protection measures specific to the deposition of waste rock in Brucejack Lake, while recognizing that 40% of the waste rock from the underground workings will be used as backfill underground. Use of waste rock as backfill is described in Section 5.8.2.7 and [Appendix 5-A](#) of the Application/EIS and will be further detailed as part of Pretivm's application for a *Mines Act* Permit.

29.18.2 Regulatory and Policy Framework

BC *Mines Act* (1996i) provides guidance and requires approvals for all activities on a mine site, from exploration to development, production, closure, and reclamation. It also requires a project proponent to obtain a permit approving the work system and reclamation program. To obtain this permit a detailed mine development plan and reclamation program must be submitted to the Chief Inspector of the BC MEM for approval.

The Project is subject to both provincial and federal legislation, including the British Columbia *Environmental Assessment Act* (BC EAA; 2002a) and the CEAA 2012. While ministerial approvals of the

Project are required under these two acts, they are not the only legislation of relevance for the Project to proceed.

Other provincial and federal authorizations will be required to address the technical and administrative details to construct, operate, decommission and close the Project. With particular reference to the management of waste rock, the Project requires:

- a Permit Approving the Mine Plan and Reclamation Program under the *Mines Act* (1996i), as mentioned above;
- authorization for the discharge or management of waste under the BC EMA (2003a);
- environmental monitoring and surveillance programs of effluent discharges are requirements of the Metal Mining Effluent Regulations (SOR/2002-222) pursuant to the *Fisheries Act*; and
- approval for any work in, on, over, under, through, or across navigable waters, as defined by the *Navigation Protection Act* (1985g) and described in Section 5 thereof, if the current enquiry into the status of Brucejack Lake results in it being classified as a navigable water.

The *Mines Act* (1996i) and its associated Health, Safety and Reclamation Code for Mines in British Columbia (the Code; BC MEMPR 2008) lay out a range of technical requirements that must be met before a permit will be issued and during the term of the permit. The standards prescribed by the Code have a bearing on the proposed subaqueous deposition of waste rock, and address the following:

- measures to protect the occupational health and safety of workers;
- personal safety and emergency preparedness;
- machinery and equipment;
- electrical power systems;
- mine design and procedures; and
- reclamation and closure.

The Project's facilities for the management of waste rock have been designed and will be constructed, operated, and closed in a manner consistent with these standards. Detailed mine development and reclamation plans will be submitted as part of the *Mines Act* Permit applications for the Construction and Operation phases.

The BC EMA (2003a) regulates the discharge of air contaminants, liquid effluent, and refuse into the environment and establishes the authority for the issuance of permits for such discharges. Discharge from Brucejack Lake during the Construction and Operation phases will require an effluent discharge authorization under the BC EMA that will apply to the cumulative influence on lake outflow water quality from all waste streams directed to the lake, including subaqueous deposition of waste rock. The Project will be constructed, operated, and closed in a manner that is consistent with the requirements of this act, including obtaining and complying with the conditions of any required permits or approvals.

29.18.3 Performance Objectives

This Waste Rock Management Plan has as its primary objective the construction and operation of a waste rock disposal system that performs in a safe and efficient manner. Implicit in such performance is the prevention or minimization of the potential adverse environmental effects related to waste rock management. These potential effects are primarily chemical (e.g., ML/ARD, and nitrite residue from

blasting) but include physical effects such as dust generation, substrate erosion, release of suspended solids, gross pollutants from blasting activities, and removal of land in its natural state.

This Waste Rock Management Plan provides the initial point of reference for the stable storage and deposition of the waste rock generated by underground mining activities as well as from surface works (e.g., bulk earthworks and quarrying). The plan is intended to provide a basis for the monitoring of performance objectives. These performance objectives are inherent in the technical assumptions that informed the design of the waste rock management system throughout Construction, Operation, Closure, and Post-closure of the mine. An important performance component is occupational and public health and safety. The requirements of the Code will thus provide a suite of related performance objectives.

In considering the potential adverse environmental effects caused by waste rock management, the following performance objectives will apply:

- ensuring the occupational health and safety of personnel responsible for the transportation, handling, and deposition of waste rock, by providing appropriate standard operating procedures and related training;
- minimizing the water quality effects of waste rock deposition, by ensuring that PAG waste rock is placed at an adequate depth below the surface of Brucejack Lake in a timely and controlled manner (see also Section 29.10, ML/ARD Management Plan);
- minimizing the physical effects of waste rock disposal, by ensuring that dust, erosion, suspended solids, and gross pollutants resulting from aeolian and fluvial processes are managed in a timely and controlled manner (see also Section 29.2, Air Quality Management Plan; Section 29.13, Soils Management Plan; and Section 29.17, Waste Management Plan); and
- monitoring water quality of the affected catchment, per the technical indicators contained in the Aquatic Effects Monitoring Plan (Section 29.3), such that anomalies in these indicators can be responded to by applying appropriate mitigation.

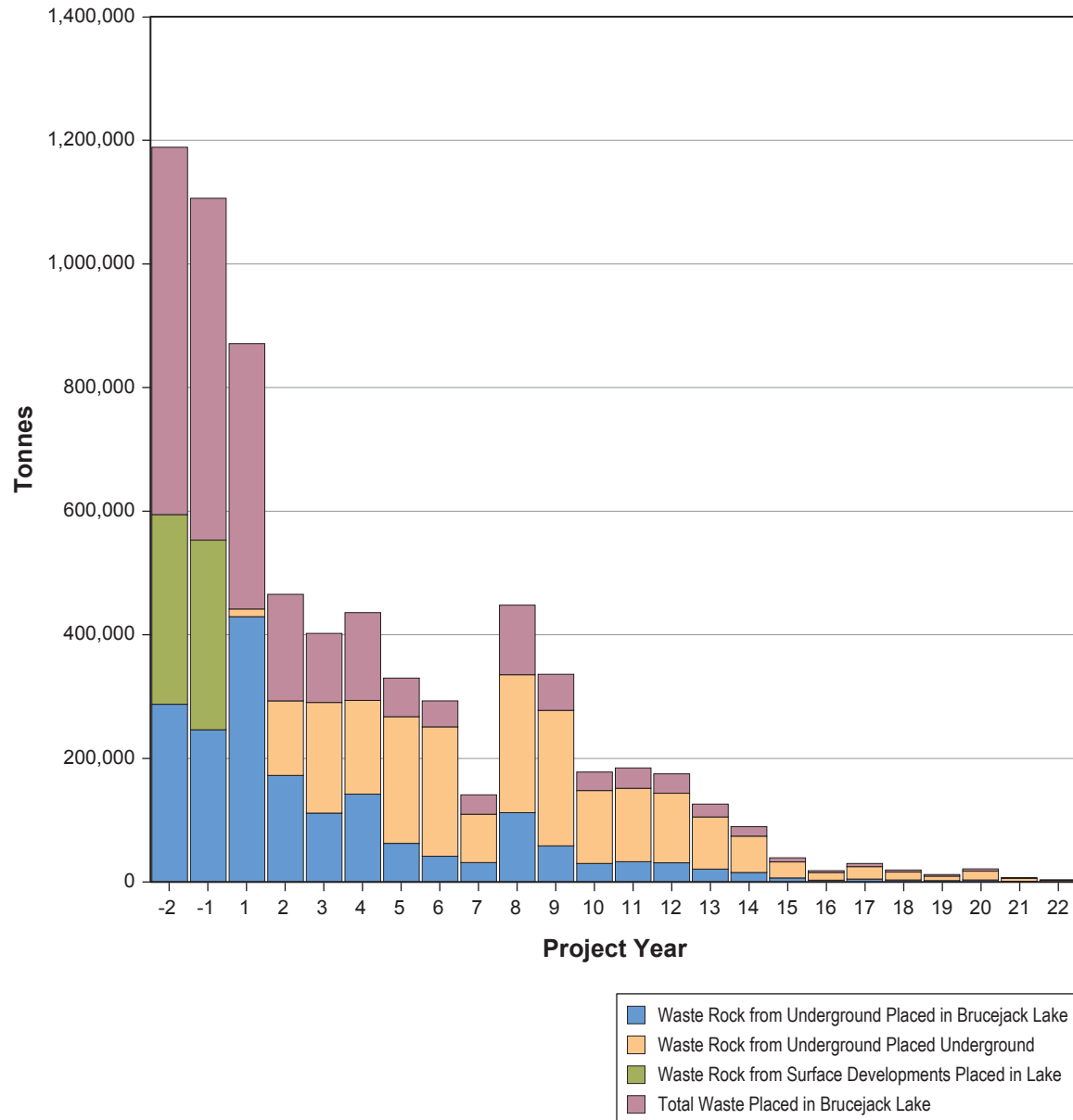
29.18.4 Environmental Protection Measures

Waste rock will be generated from two sources at the Project site:

- general surface construction activities during Brucejack Mine Site Construction, where rock excavation is required to create site roads and level areas for building construction, and associated pads; and
- underground mine construction activities (primarily development of the twin declines (Section 5.8.2.2) during the early stage, and throughout the life of the mine for access for stope development.

During the first ~18 months of Construction, mine development waste rock will be exclusively disposed of in Brucejack Lake. Once stope voids become available, some of the waste rock (about 40% over the life of the mine) will be used to fill stope voids while the balance will be disposed of in Brucejack Lake (Figure 29.18-1). The volume placed in the lake on an annual basis will decrease over time. Approximately 4.4 Mm³, will be disposed of in Brucejack Lake. Note that approximately half of tailings from milled ore cannot be placed back underground and will also be disposed of in Brucejack Lake, as described in Section 5.11.1.3 and in the Tailings Management Plan (Section 29.15).

Figure 29.18-1
Waste Rock Disposal
by Year



The overriding environmental protection measure being adopted for waste rock management relates to the minimization of ML/ARD via subaqueous deposition as discussed in the ML/ARD Management Plan (Section 29.10).

The segregation of PAG rock from non-PAG rock is typically an important consideration in ML/ARD management. However, the current assessment of Project waste rock (Section 5.6, Geochemical Characterization; [Appendix 5-B](#), Brucejack Environmental Assessment ML/ARD Baseline Report) has concluded that waste rock segregation will be difficult. For this reason it is assumed that all waste rock from the underground workings and surface pad development will be PAG. Waste rock that cannot be backfilled to the underground mine will be deposited subaqueously into Brucejack Lake.

The proposed measures to achieve health, safety, and environmental protection related to subaqueous disposal of waste rock are described in the following sections.

29.18.4.1 Transport and Handling

A haul road will be constructed for underground trucks to travel from the underground mine's south portal to the pre-production ore storage area, the waste rock transfer storage area, or the Brucejack Lake waste rock dump.

When conditions allow, underground trucks will haul waste rock directly to the Brucejack Lake waste rock dump. During adverse conditions, when the traction capabilities of the underground trucks are limited by the haul road gradient of -7%, waste rock will be dumped at the waste rock transfer storage area and relocated by surface dump truck to be deposited into Brucejack Lake. Snow removal and clearly marked paths will be maintained in the waste rock transfer storage area for safety during winter operations.

29.18.4.2 Deposition

A haul road will be constructed for underground trucks to travel from the underground mine's south portal to the pre-production ore storage area, the waste rock transfer storage area, or the Brucejack Lake waste rock deposition site.

When conditions allow, underground trucks will haul waste rock directly to the Brucejack Lake waste rock deposition site. During adverse conditions, when the traction capabilities of the underground trucks are limited by the haul road gradient of -7%, waste rock will be dumped at the waste rock transfer storage area and relocated by surface dump truck to be deposited in Brucejack Lake. Snow removal and clearly marked paths will be maintained in the waste rock transfer storage area for safety during winter operations.

Current plans are that the waste rock pile in Brucejack Lake will be constructed by advancing a platform or causeway of PAG waste rock out into the lake, and that this PAG platform will be capped by non-PAG waste rock. The PAG rock will be end-dumped from haul trucks onto the platform/causeway and then either pushed over the side by a bulldozer or cast over the side by an excavator ([Appendix 5-D](#), Geotechnical Stability of Waste Rock Deposition in Brucejack Lake; BGC 2013), in order to ensure a minimum 1-m depth of submersion.

For planning purposes it is assumed that the submerged waste rock pile will have an overall slope of about 2H:1V due to lateral spreading failures ([Appendix 5-D](#), Geotechnical Stability of Waste Rock Deposition in Brucejack Lake; BGC 2013). The platform/causeway will be monitored during construction of the waste rock pile to ensure a safe operating environment for personnel and equipment. Care will be taken to sequence the deposition of waste rock and tailings in order to avoid geotechnical instability. In this regard, the rate of deposition of waste rock will begin more rapidly than the rate of tailings deposition and it is likely that the lateral extent of the waste rock pile will

have been established by the time the edge of the tailings deposition cone reaches the waste rock pile. The rate of tailings deposition will peak in about year six, while the rate of waste rock deposition will by then have slowed to 8% of the initial rate. Nevertheless, monitoring of the lateral extent and profiles of the waste rock pile and tailings deposition cone will allow redirection of the former if there is a danger of it being placed on top of tailings.

Snow removal and clearly marked paths will also be maintained on the dumping platform for safety during winter operations. Past experience has shown that waste rock dumping activity in Brucejack Lake has kept the surface ice-free during winter. However, an aerator will be installed if it proves necessary to provide additional measures to prevent ice formation for year-round deposition.

It should be noted that Newhawk Gold Mines Ltd. (Newhawk) previously disposed of waste rock and ore in Brucejack Lake as part of site remediation work undertaken in 1999. This activity followed advanced exploration work at the site and comprised a similar approach of using a causeway to place waste rock berms that were then bulldozed over the sides and the surface lowered by an excavator to approximately 1 m below the water level of the lake.

Over 80% of the total volume of waste rock that will need to be disposed of in the lake will be available between Year 2 and Year 4 (Figure 29.18-1). This schedule is due to waste rock being derived, firstly, from surface construction earthworks and, secondly, from the initial years of underground development before voids are created to accommodate waste rock as backfill.

Related to waste rock volumes is the necessity of temporary surface storage of waste rock while awaiting final deposition in the lake. The waste rock will be exposed to oxidization during these periods and the resultant water quality issue from surface runoff will be dealt with by means of a collection channel that will capture all the runoff from this area as well as from the pre-production ore storage area. Collected water will be directed to a lined contact water collection pond and then pumped to the Water Treatment Plant. The Water Management Plan (Section 29.19) and ML/ARD Management Plan (Section 29.10) address this issue in detail.

29.18.4.3 Physical Controls

During the 1999 Newhawk lake disposal activities, significant quantities of debris from blasting activities were removed from Brucejack Lake. This material comprised several hundred bags of spent blasting caps, detonator cord, wire, and the like. Pretium currently have a wire mesh screen and boom in place across the lake outlet to Brucejack Creek to collect these gross pollutants. Similar pre-emptive measures will be maintained throughout the life of the mine.

Mitigation measures will be implemented to address suspended sediments originating from the waste rock. Although the lake itself will provide for some settling of suspended sediments from the waste rock, a turbidity curtain will be installed between the waste rock disposal area and the lake outlet to minimize sediment discharge from the lake (refer to Section 5.12.22).

As described, the underground workings will be progressively backfilled with waste rock and tailings throughout the operational life of the mine. Once mining operations are completed, the underground will be allowed to flood.

29.18.5 Monitoring Program

29.18.5.1 Physical Conditions

Volumes of waste rock deposited in Brucejack Lake will be monitored by reference to the records kept as part of the mine plan. These records will provide a basis for the purpose-designed monitoring of the dumping platform and waste rock pile described in the following section.

The dumping platform will require monitoring throughout the period of deposition of waste rock in Brucejack Lake. This requirement is due to likely foundation failures occurring as the waste rock pile advances over the lake bottom sediments (Section 5.11.1.4, [Appendix 5-D](#), Geotechnical Stability of Waste Rock Deposition in Brucejack Lake. The safety of personnel and equipment operating on the dumping platform is essential. Purpose-designed monitoring and safety procedures will be developed that include visual observation for cracking and slumping that may indicate deformation of the pile. Such observation will be conducted continuously while deposition is actively taking place on the waste rock pile. During high snow fall conditions, such monitoring will be more difficult and greater reliance will be placed on the instrumentation described below.

Monitoring and responding to any deformation of the waste rock pile is critical to maintaining its stability. Wireline extensometers are appropriate instrumentation for such monitoring and Pretivm will investigate their use or the use of similar instrumentation. Limiting the rate of advancement of the crest line will also prevent waste rock from being deposited too rapidly onto the lake bottom sediments. The current conceptual layout (BGC 2014d) recommends a maximum crest advancement rate of 1 m per day. Haul trucks will also maintain a minimum distance of no closer than 10 m from the active crest when dumping their loads. This minimum distance will be re-evaluated as operational, site specific experience is gained.

If dump failures occur, they will cause suspended solids to be released into the water column. This issue will be addressed as described above via the lake settling capacity and sediment curtains.

29.18.5.2 Water Quality

Water quality related to subaqueous waste rock deposition is addressed in the monitoring program described conceptually in Section 29.3, Aquatic Effects Monitoring Plan.

29.18.6 Work Planning and Schedule

The continual operation of the waste rock facility is critical to the execution of the Project mine plan. The planning and scheduling of waste rock disposal activities is thus a technical engineering competence. To ensure that the planning and scheduling of waste rock disposal is aligned with the specified environmental performance criteria, the Mine's Environmental Manager will review the information collected from the mine plan monitoring.

The relevant information from an environmental perspective will relate to the stability of the dumping platform and waste rock pile, as well the volumes of waste rock in the lake and in stockpiles. The monitoring of water quality as it relates to waste rock management is addressed in the Aquatic Effects Monitoring Plan (Section 29.3).

29.18.7 Follow-up Program

The Aquatic Effects Monitoring Plan (Section 29.3) includes a follow-up program for those elements of water quality that are related to the management of waste rock, i.e., where confirmation of the effectiveness of the performance measures is required.

29.18.8 Reporting Requirements

29.18.8.1 Reports

Routine reporting according to a schedule of monitoring inspections and record keeping will be undertaken in a structured manner such that the management of waste rock can be accurately tracked. Inspections will cover on-site facilities such as the haul roads, waste rock transfer storage area, and the dumping platform, as well as related documentation such as manifests and logbooks of waste rock

transportation and handling. The frequency of scheduled inspections will be dictated by operational conditions; however, components of the monitoring in support of the required reporting, e.g., recording volumes handled, will be continuous while waste rock is being produced.

Since the management of waste rock is essentially a technical engineering matter, reports will be reviewed internally by the responsible line manager and the Mine Manager. The Environmental Manager will review the reports in order to identify shortcomings from an environmental perspective, and institute improvements in the system if warranted. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and licences.

If emergency or spill incidents occur as a result of upset conditions or non-compliance with the Waste Rock Management Plan, these will be reported per the requirements of the Emergency Response Plan (Section 29.6) and Spills Prevention and Response Plan (Section 29.14).

29.18.8.2 Reporting Responsibilities

The Mine Manager will carry line responsibility for monitoring and reporting on the management of waste rock, although this task may be delegated to appropriate technical personnel. Pretivm will be responsible for ensuring that the performance objectives and protection measures are achieved. Appropriately qualified personnel will be employed throughout the life of the Project to supervise, direct, monitor, and implement the management actions required by this Waste Rock Management Plan.

29.19 WATER MANAGEMENT PLAN

29.19.1 Purpose

Water is a key component in the mining process in that it is required for, and affected by mining activity. Both water quantity and water quality may be affected during the life of a mine. Effective water management is important for a variety of reasons including compliance with operation permits and applicable legislation, uninterrupted operation of the mine, and minimization of effects on the receiving environment.

The purpose of the Water Management Plan (WMP) is to provide an operational guide for management of surface water during the Construction, Operation, Closure, and Post-closure phases of the Project. Water management infrastructure and the water balance model are presented in Section 5.10 and in [Appendix 5-C](#) (BGC 2014b). This document focuses on actions for avoidance, mitigation, and control, as well as a water management monitoring program. Water management infrastructure and plans for the underground workings are not discussed in this document. By incorporating principles of adaptive management, this WMP provides a framework for ongoing review and improvement of management practices. It is intended to be used in conjunction with the Soils Management Plan (Section 29.13), the ML/ARD Management Plan (BGC 2014c), and the Aquatic Effects Monitoring Plan (Section 29.3), in addition to any other applicable plans.

This WMP addresses the following targeted goals:

- to protect water-related, ecologically sensitive sites and resources, and avoid harmful impacts on fish and wildlife habitat;
- to supply and retain water for mine operations;
- to define water-related environmental control structures; and
- to manage water to ensure that any discharges are in compliance with the applicable water quality levels and guidelines.

29.19.2 Regulatory and Policy Framework

The WMP has been developed to support guidelines and requirements specified by the following legislation:

- *BC Environmental Management Act* (SBC 2003). Regulates the discharge of air contaminants, liquid effluent, and refuse into the environment, and regulates the management of hazardous wastes.
- *BC Mines Act* (RSBC 1996). Provides guidance and approvals for all activities on the Brucejack Mine Site, including exploration, development, production, closure, and reclamation.
- Health, Safety, and Reclamation Code for Mines in British Columbia (BC MEMPR 2008). Under the *Mines Act* (1996i), requires the proponent to provide:
 - designs and details for water management structures, water storage, and water treatment facilities;
 - the source, use, and water balance for any water required in the operation;
 - a plan for erosion control and sediment retention; and
 - a reclamation plan.
- *Fisheries Act* (RSC 1985). Information requirements set under the Fish Habitat Protection and Pollution Prevention provisions of the *Fisheries Act* (1985c) include descriptions of measures that will be taken to avoid or minimize any effects on the aquatic environment, shoreline, or riparian areas during Project development and Operation. The *Fisheries Act* (1985c) also regulates the discharge of harmful substances into fish habitat and imposes reporting requirements in case such a discharge occurs.
- Metal Mining Effluent Regulations (MMER 2002). Environmental monitoring and surveillance programs of effluent discharges are requirements of the Metal Mining Effluent Regulations (SOR/2002-222) pursuant to the *Fisheries Act*.
- *Canada Water Act* (RSC 1985). Provides the framework for joint federal-provincial management of Canada's water resources. Approvals and licences under provincial water acts are required to authorize the construction of works for the purposes of diverting, storing, or using water, or causing changes in and about a stream for any purpose.
- *BC Water Act* (RSBC 1996). Administers the allocation and management of surface waters in British Columbia. It is the primary legislation for regulating surface water diversion, storage, and use, and managing water quality.
- *Navigation Protection Act* (RSC 1985). Regulates works that interfere with navigation built in, on, over, under, through, or across navigable waters in Canada. Navigable waters are defined as all bodies of water that can be navigated by any type of floating vessel for transportation, recreation, or commerce.
- *International River Improvement Act* (RSC 1985). Enacted to ensure Canada meets its obligations under the *Boundary Waters Treaty* (1909). The intent of the *Treaty* is to ensure that Canada's water resources in international waters are developed and used in the best national interest. Under the *Act*, a permit is required if the construction of the Project changes the natural flow of an international river (the Unuk River in this case).
- *BC Forest and Range Practices Act* (SBC 2002). Requires that road construction adheres to codes provided in the Forest Service Road Use Regulation (BC Reg. 70/2004), which focuses extensively on erosion prevention. Pretivm works to the spirit of the forestry codes for road construction (Section 29.13).

The following documents were used as primary sources for mitigation and management measures:

- *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012b);
- *Forest Practices Code of British Columbia Forest Road Engineering Guidebook* (BC MOF 2002). Pretivm works to the spirit of the forestry codes for road construction (Section 29.13);
- *Operational Statement for Overhead Line Construction* (Fisheries and Oceans Canada 2007a); and
- *Operational Statement for Maintenance of Riparian Vegetation in Existing Rights-of-Way* (Fisheries and Oceans Canada 2007b).

29.19.3 Performance Objectives

The WMP provides guidance for achieving the following performance objectives during all phases of the Project:

- ongoing compliance with regulatory commitments, guidelines, and objectives;
- implementation of environmental protection measures in a timely, effective, and cost-efficient manner;
- integration of water management activities with other management and monitoring programs;
- interception and diversion of non-contact water (freshwater) away from work areas using ditches, berms, or other diversion structures;
- collecting contact water from disturbed areas and treating it to meet discharge standards prior to release;
- maintaining an adequate supply of water for mine operations; and
- minimizing the use of freshwater through water recycling whenever possible.

Specific measures that will be implemented to achieve performance objectives are summarized in Table 29.19-1. In addition, the table lists other applicable management plans for each performance objective.

29.19.4 Environmental Protection Measures

29.19.4.1 General Actions to Avoid, Control, and Mitigate

Effective water management requires an integrated, adaptive approach. Measures that will apply throughout all phases of the mine include:

- incorporate adaptive management as part of the WMP;
- caches of site water management resources will be established and maintained;
- adverse weather shutdown criteria and procedures will be established and communicated to all personnel;
- snow handling will follow best practices to minimize the transport of fine materials into streams via meltwater;
- ML/ARD materials handling will adhere to the guidelines and procedures described in the ML/ARD Management Plan (Section 29.10; BGC 2014c).

These general measures are broadly applicable to all activities on the site and are described in more detail below.

Table 29.19-1. Water Management Performance Objectives and Corresponding Management Measures

Project Phase	Activity or System	Performance Objectives	Management Measure	Other Applicable Management Plans
All phases	Adaptive management	Ongoing compliance with regulatory commitments, guidelines, and objectives ¹ Implementation of environmental protection measures in a timely, effective, and cost-efficient manner ¹ Integration of water management activities with other management and monitoring programs ¹	Implement scheduling and staging for all site-specific work plans prior to beginning work Familiarize all site personnel with the purpose and content of the WMP, and their responsibilities in its implementation Maintain collaboration and communication among site manager/supervisors, environmental personnel, and contractors Regularly assess and modify WMP to adapt to changing work plans and site conditions	Soils Management Plan (Section 29.13), Aquatic Effects Management and Monitoring Plan (Section 29.3),
	Maintaining site resources	Reduction, elimination, or mitigation of flow blockage or erosion	Maintain caches of equipment and materials for water management/erosion and sediment control in locations that are easily identifiable and accessible Inventory and maintain caches on a regular basis	Soils Management Plan (Section 29.13)
	Adverse weather shutdown	Reduction, elimination, or mitigation of environmental effects due to extreme weather conditions	Conduct operations in susceptible areas (e.g., adjacent to streams, areas with high erosion potential) during dry weather or frozen conditions when possible	n/a
	Snow handling	Reduction, elimination, or mitigation of fine materials erosion into stream channels	Pile snow in undisturbed areas with low slopes outside of riparian zones Install perimeter sediment control (e.g., sediment fencing or berms) around snow piles where necessary	n/a
	Contact Water handling	Interception and diversion of non-contact water Collecting and treating contact water	Stormwater runoff and seepage from PAG rock areas will be collected in a perimeter ditch system and pumped to the water treatment plant	ML/ARD Management Plan (Section 29.10), Waste Rock Management Plan (Section 29.18)
Construction	Diversion and collection ditch construction	Interception and diversion of non-contact water Collecting and treating contact water		n/a
	Access road upgrades and transmission line construction	Reduction, elimination, or mitigation of erosion and sediment yield Interception and diversion of non-contact water	Adhere to best practices as specified in the Soils Management Plan (Section 29.13) Construct roads in accordance with the <i>Forest Road Engineering Guidebook</i> (BC MOF 2002) Follow guidelines specified in the <i>Operational Statement for Overhead Line Construction</i> (DFO 2007a) and <i>Operational Statement for Maintenance of Riparian Vegetation in Existing Rights-of-Way</i> (DFO 2007b)	Soils Management and Monitoring Plan (Section 29.13)

(continued)

Table 29.19-1. Water Management Performance Objectives and Corresponding Management Measures (completed)

Project Phase	Activity or System	Performance Objectives	Management Measure	Other Applicable Management Plans
Operation	Site drainage and ditch operations	Reduction, elimination, or mitigation of erosion and sediment yield Interception and diversion of non-contact water Collecting and treating contact water	Water management and sediment control structures and facilities will be regularly inspected and maintained according to the monitoring schedules specified in this plan and the Soils Management Plan (Section 29.13) Non-contact (freshwater) diversion channels will be constructed around the operations camp, plant site, and laydown area and will discharge to Brucejack Creek or Brucejack Lake Surface contact water will be captured by a perimeter ditch and pumped to the Water Treatment Plant (WTP) for treatment prior to discharge into Brucejack Lake	Soils Management Plan (Section 29.13), Aquatic Effects Monitoring Plan (Section 29.3)
	Water treatment plant and runoff collection pond	Collecting and treating contact water	Mine water and plant site contact water will be treated in the WTP Contact water will be treated in the WTP. Excess treated water beyond process requirement will be discharged to Brucejack Lake	n/a
	Process water supply system	Maintaining an adequate supply of water for mine operations Minimizing use of freshwater	Water requirements for the process plant will be met with treated underground seepage water and recycling process water.	n/a
	Tailings disposal	Maintaining an adequate supply of water for mine operations	Tailings will either be diverted to the paste backfill plant or diluted and discharged to the bottom of Brucejack Lake as fluidized tailings	Tailings Management Plan (Section 29.15)
	Potable water supply system	Maintaining an adequate supply of water for mine operations	Potable water for camp and mill building will be supplied from groundwater wells and treated (chlorination and filtration) prior to delivery	n/a
Closure and Post-closure	Site closure and reclamation	Ongoing compliance with regulatory commitments, guidelines, and objectives ¹	Water management/erosion and sediment control structures will be dismantled and sites will be restored to pre-disturbance condition Underground workings will be flooded to minimize development of acid rock drainage and associated leaching of metals	Aquatic Effects Monitoring Plan (Section 29.3), Closure and Reclamation (Chapter 30), and ML/ARD Management Plan (Section 29.10)

Note: Information is from Chapter 5, Project Description, unless otherwise noted.

n/a: not available (no separate management plan currently exists; topic is addressed in Water Management Plan)

¹Performance objective is applicable to all activities throughout all phases of mine

Adaptive Management

Adaptive management is a process for continually improving management practices by learning from the outcomes of operational approaches (e.g., Bunnell et al. 2009, BC MOFR 2013). To be effectively implemented, it requires a prompt response to field observations of changing environmental conditions and limitations or deficiencies in existing water management structures.

When properly implemented, adaptive management enables a cost- and time-effective hierarchical response to potential water management issues. BMPs and a corresponding inspection, maintenance, and monitoring program constitute the basis of water management planning. The adaptive management approach promotes proactive measures, with the caveat that contingency plans and materials should be in place prior to the initiation of work so that additional measures can be quickly implemented if needed.

Communication is essential to successful application of the WMP. All personnel working at the site, including cross shifts, should be advised and trained about the WMP's goals and purpose, and their responsibilities in order to implement the WMP successfully. Personnel should be informed of changes in a timely manner. Appropriate training and field supervision are important elements of the WMP. Personnel should understand why water management measures are needed and how to implement them correctly.

Site Resources

Caches of equipment and materials for water management should be maintained in locations that are easily identifiable and accessible (e.g., in storage sheds adjacent to work sites). These caches should include materials for routine BMP maintenance and repair as well as contingency supplies to be used in the event of an emergency. The on-site caches of materials should be regularly inventoried as part of the maintenance and monitoring program, and materials that are depleted should be promptly replaced.

Adverse Weather Shutdown

The potential for environmental impact increases markedly during periods of severe weather, for example, shutdowns of ground-disturbing activities during periods of very high rainfall (e.g., >50 mm/day) or extended periods of high rainfall. Adverse weather shutdown procedures are triggered by severe weather criteria. Shutdown will be based on safety concerns, environmental effects, and protection of infrastructure. A shutdown instruction would be issued by the Mine Manager; however, individual workers have the responsibility of notifying supervisors if they have reasonable cause to believe that safety or environmental protection would be endangered by severe weather.

Snow Handling

During the winter, proper handling of cleared snow is required. Gravel, topsoil, and organic matter can be entrained during snow removal. As snow melts, coarse materials drop out and fine materials may be transported with meltwater. To prevent the delivery of fine materials into stream channels, snow should be piled in undisturbed areas with low slopes outside of riparian management areas. Sediment fencing or berms may be required around snow piles to trap sediment.

Contact Water Handling

The majority (85%) of waste rock generated at the Project contains at least 77% PAG materials (Section 29.10; BGC 2014c). Stormwater runoff and seepage from PAG rock areas (mill pad cut and pre-production ore storage areas) will be collected in a perimeter ditch system and pumped to the water treatment plant. Contact water collection system during the Construction and Operation phases are described in the following sections.

29.19.4.2 *Actions to Avoid, Control, and Mitigate during Construction*

During Construction, water management will include the following:

- Freshwater diversion ditches will be constructed around the plant site. Diversions will also be constructed for the operations camp, laydown area, and garbage and incinerator area (Figure 29.19-1). The diverted water will discharge to Brucejack Lake or Brucejack Creek.
- Runoff from the plant site excavation and from the temporary waste rock stockpile will be captured by a perimeter collection ditch system, directed to the lined collection pond, and pumped to the water treatment plant for treatment prior to release to Brucejack Lake. Construction of the mill building and portal site will require an extensive cut into bedrock, some of which is currently assumed to be PAG.
- Groundwater from the underground workings will be pumped to the water treatment plant and treated before either being used in process or discharged into Brucejack Lake.
- A sewage treatment plant (STP) will be constructed. The STP will treat the daily effluent, which will be discharged to Brucejack Creek during Construction (and into the lake during Operation).

Water management activities to ensure environmental protection during the Construction phase will emphasize BMPs to minimize disturbance to vegetation, soil, and natural drainages. The physical characteristics of the Project area - steep slopes, high precipitation, terrain instability, and thin veneers over bedrock - make erosion and sediment control vital during all phases of mine life. Sites are particularly susceptible to erosion while construction work is ongoing and prior to surface stabilization (e.g., stabilization by vegetative re-establishment or placement of gravel pads). Erosion and sediment control measures are described in detail in the Soils Management Plan (Section 29.13).

Diversion and Collection Ditch Construction

Perimeter water diversion and sediment collection structures will be established as a first step to work activities. In addition to perimeter diversion ditches, small-scale runoff collection and treatment measures may be used locally. Work areas will be isolated from water flow paths.

Non-contact water will be routed around the site by freshwater diversion channels that will be constructed around the operations camp, plant site and laydown area, and garbage and incinerator area. These channels will typically follow access roads or the base of rock cuts. Channels will have a trapezoidal shape with a bottom width of about 2.5 m, and side slopes of 2H: 1V. Culverts have been designed so that the hydraulic grade line does not overtop the roads.

Contact water collection ditches and the associated contact water collection pond are designed for the 24-hour, 200-year rain-on-snow event. A high-density polyethylene (HDPE) geomembrane liner will be placed under the channels as required to prevent leakage. A 300-mm (minimum) thick cushion layer of 30-mm minus granular material (<10% passing 0.75 mm) will be placed under the liner. Channels will be armoured as required to prevent damage from erosion and equipment used to maintain and clean out the channels. The contact water collection ditches will drain to the contact water collection pond, which will also be lined. Water in the pond would be treated in the WTP then used in the process or discharged directly to Brucejack Lake.

Access Road Upgrades and Transmission Line Construction

The existing 73-km exploration access road crosses steep slopes and areas of erodible soils. Planned road upgrades will include minor re-alignments of the sharper curves, reductions of the steeper grades, and additional surfacing of some sections; it is not anticipated that any upgrades to stream crossings will be required.

Roads will be constructed according to the *Forest Road Engineering Guidebook* (BC MOF 2002) and maintained to ensure low landslide risk and continuous, efficient, controlled water drainage. Road design and construction will include consideration of the following:

- existing slope stability, drainage patterns, and soil types;
- potential impact of proposed structures on streams during and after Construction;
- potential for adverse upslope, downslope, and downstream drainage impacts;
- confinement of sensitive operations in anticipation of weather and snowmelt events;
- proper disposal of slash and debris;
- adequate supply and proper installation of erosion and sediment control devices; and
- timely re-vegetation of disturbed slopes.

The proposed transmission line alignment follows bedrock-dominated terrain that is characterized by gentle to moderate slopes, bedrock hummocks, and discrete debris flow/snow avalanche tracks. Transmission line construction is anticipated to have minimal implications for water management as construction by use of helicopters rather than by use of land vehicles is planned. No road crossings are planned at streams; however, if required the construction and maintenance of stream crossings along the transmission line alignment will be consistent with the Fisheries and Oceans Canada Pacific Region *Operational Statement for Overhead Line Construction* (DFO 2007a) and *Operational Statement for Maintenance of Riparian Vegetation in Existing Rights-of-Way* (DFO 2007b).

29.19.4.3 Actions to Avoid, Control, and Mitigate during Operation

During Operation, water management will include the following:

- Non-contact water (freshwater) will be directed away from the site via diversion channels around the plant site, operations camp, laydown area, and garbage and incinerator area (Figure 29.19-1). The diverted water will either discharge to natural drainages or to Brucejack Lake.
- Contact water from the upper laydown area (including storage pads for waste rock transfer and pre-production ore) and mill building/portal site will be contained in lined perimeter collection ditches. Contact water will first be directed to the lined collection pond, then pumped to the WTP for treatment prior to use as process water or directly released to Brucejack Lake.
- Groundwater seepage to the underground mine will be pumped to the WTP and treated. The priority use for this treated water will be the process plant. When there is a surplus of treated water after fulfilling process plant requirements, the excess will be used as fluidizing water for the tailings discharge pipeline or discharged to Brucejack Lake.
- Water exuded from the paste backfill will be pumped out and treated with the underground seepage water.
- Tailings will either be diverted to the paste backfill plant or diluted and sent to Brucejack Lake, but never concurrently. A constant flow will be maintained through the tailings disposal pipelines at all times using fluidizing water, which will be sourced from excess underground seepage and reclaim water from the surface of Brucejack Lake.

A water balance model for Project Operation was developed using a monthly time-step (BGC 2014b). The model schematic is presented in Figure 29.19-2. Water balance volumes during the Construction, Operation, Closure, and Post-closure phases of the Project are presented in [Appendix 5-C](#) (BGC 2014b).

Figure 29.19-1
Freshwater Diversion and Contact Water Collection Systems

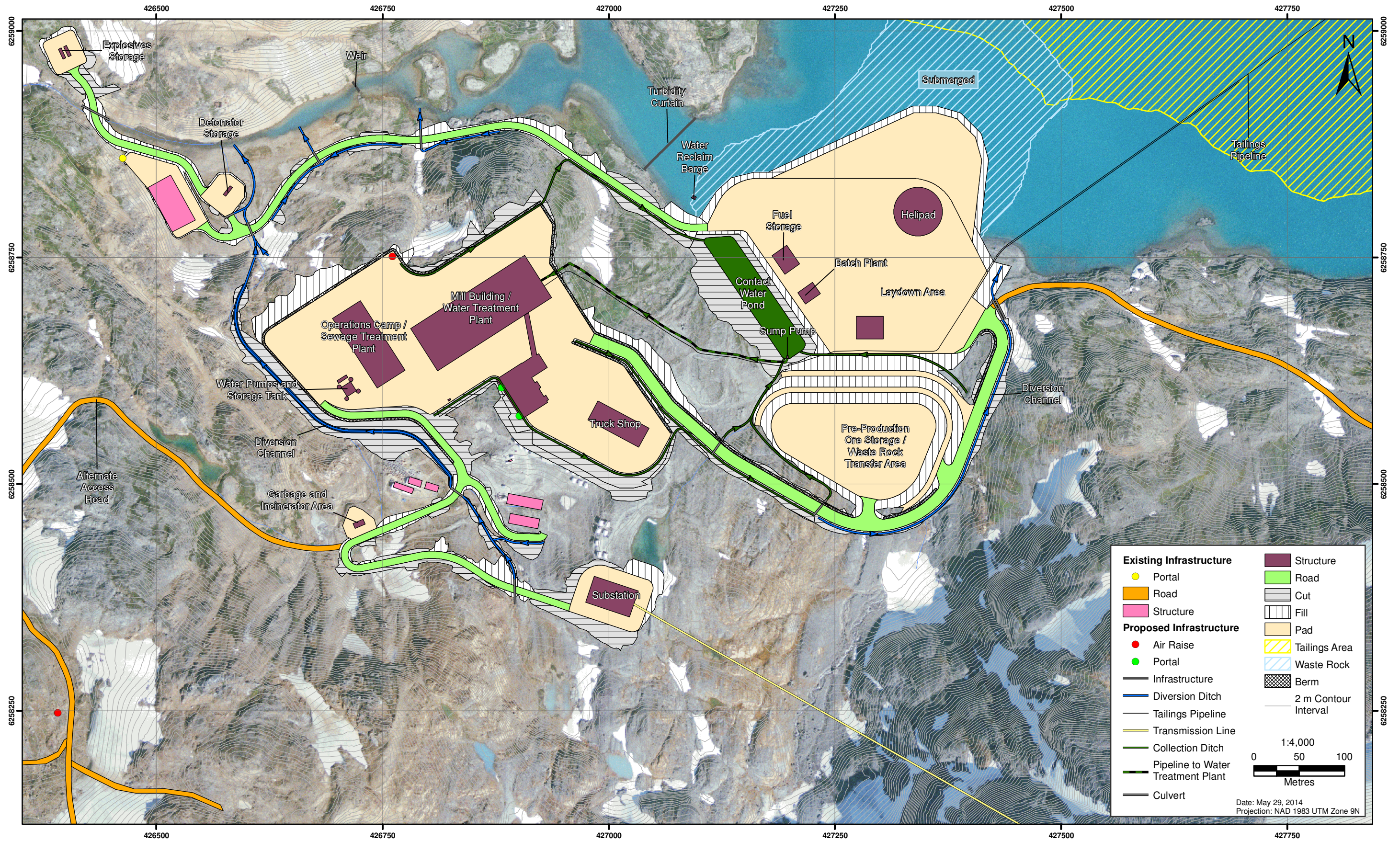
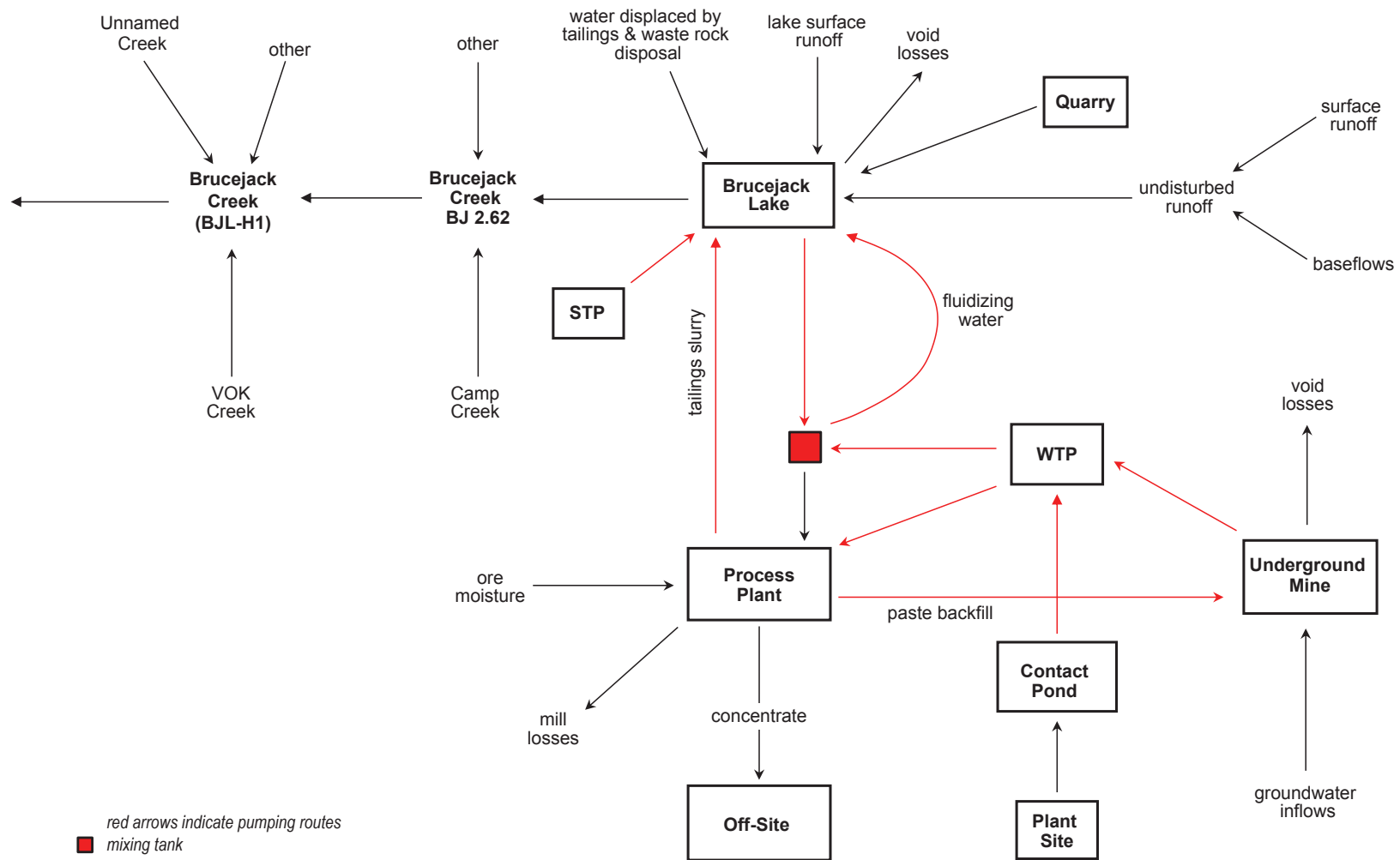


Figure 29.19-2
Brucejack Lake Water
Balance Model Schematic



Source: BGC Engineering Inc.

Environmental protection measures in the Operation phase will primarily focus on monitoring and maintenance of established water management structures and facilities. If necessary repairs and/or improvements to these systems are identified, these will be undertaken on a timely basis. Key water management systems for the Operation phase include diversion and collection ditches, road drainage features (e.g., roadside ditches, cross-drain culverts, stream crossings), the water treatment plant and lined contact water collection pond. The major water usage requirements will be the process plant, the camp and mill, and fluidizing water for tailings disposal.

Water management practices, structures, and systems for the mine Operation phase are described in more detail below, with an emphasis on environmental protection measures to be incorporated into system operations.

Site Drainage and Ditch Operations

Positive site drainage will be maintained at all times. Existing drainage courses will be preserved to the greatest extent possible, as this typically minimizes potential environmental impacts and leads to the most economical drainage design. Water accumulation on work surfaces will be avoided or minimized as much as possible. Surface water accumulation will be minimized by grading work areas to establish and maintain a slope that allows water to drain toward a low point, where it may be collected in a sediment detention structure such as a sump or routed to the water treatment plant via perimeter collection ditches.

Non-contact water will be diverted around the site, and contact water will be collected for treatment. Proper ditch installation and maintenance will be crucial, as ditches that are poorly designed, constructed, or maintained may underperform during moderate flows and fail during high flows. The Soils Management Plan (Section 29.13) should be consulted for an overview of best management practices for ditches.

Water Treatment Plant and Contact Water Collection Pond

During the Construction phase, water treatment will be accomplished using a temporary treatment plant that was installed in 2014 to treat water produced from the exploration/bulk sample work. This temporary plant will have a footprint of about 16 m by 20 m and will have a capacity of about 140 m³/hour based on worst-case inflow turbidity levels. If required, the unit capacity can be increased to over 200 m³/hour depending on inflow turbidity levels. If inflows exceed this capacity, a second train will be added to supplement the first train. The plant is located near the exploration portal. This treatment plant will be used until the new, permanent water treatment plant is constructed and operational. The temporary plant will be removed once the operation of the new water treatment plant has stabilized. The Operation phase capacity of the new water treatment plant will be 400 m³/hour.

Sludge from the water treatment plant will be stored in a tank in the mill building until it can be added to the tailings stream and pumped to Brucejack Lake for secure long-term disposal. The contact water collection pond has been designed with sufficient storage capacity to contain the 24-hour, 200-year return period rain-on-snow event ([Appendix 5-C](#), BGC 2014a). The contained water will be pumped into the WTP at a maximum rate of 200 m³/hour. The pond will be lined with an 80-mil high-density polyethylene (HDPE) geomembrane liner. A 300-mm (minimum) thick cushion layer of 30-mm minus granular material (<10% passing 0.75 mm) will be placed under the liner. Appropriate armouring will be placed over the liner to protect it from erosion and damage by equipment. Sludge from the pond will be excavated periodically and transported to the paste plant for inclusion in the paste product.

Process Water Supply System

The average water requirement for the Brucejack process plant will be 131 m³/hour, based on a mill throughput of 2,700 t/day. Process water is required for tailings slurry to Brucejack Lake, the underground paste backfill, and the concentrate slurry. There will be additional minor evaporative losses within the plant.

The main source of freshwater for process plant operations will be treated underground seepage water pumped from the water treatment plant. Average groundwater seepage into the underground workings, under the default seepage scenario ([Appendix 5-C](#), BGC 2014b), is expected to be 206 m³/hour ([Appendix 5-C](#), BGC 2014b). Since groundwater seepage into the underground workings varies throughout the life of mine, reclaim from Brucejack Lake will be occasionally required, as there will be periods when groundwater inflows are predicted to be less than the process requirement.

Freshwater will be held in a fresh/fire water storage tank. The tank will be equipped with a standpipe, which will ensure that the tank always contains at least a two-hour supply of fire water. Freshwater will be primarily used for:

- fire water for emergency use;
- cooling water for mill motors and mill lubrication systems;
- gland water for the slurry pumps;
- reagent make-up; and
- process water make-up.

In addition to freshwater usage, the overflow solutions from the concentrate thickener and tailings thickener will be reused in the process circuit. All process water required in the process plant will be distributed from an approximately 8.0-m diameter by 8.0-m high process water tank.

Tailings Disposal

The Project is expected to create about 16 Mt of flotation tailings over the life of the mine. Approximately 47% of the flotation tailings will be used in paste backfill in the underground workings, while the remaining 53% will be deposited in Brucejack Lake. A Tailings Management Plan (Section 29.15) has been developed to minimize potential adverse environmental effects of tailings disposal.

Although the tailings pipeline to the lake will be operational less than 50% of the time, a constant flow will be required through the line at all times to keep the deposit at the end of the outfalls fluidized. Therefore, when the thickened tailings are directed to the backfill plant rather than discharged to the lake, pipeline flow will be maintained with fluidizing water, which will be sourced from excess treated underground seepage water and reclaim water from the surface of Brucejack Lake ([Appendix 10-B](#), BGC 2014b).

Potable Water Supply System

There will be three potable water supply systems – one located in the mill/administration complex to service the mill building and camp, a second at the Knipple Transfer Area, and a third at the Tide Staging Area during the Construction phase. Potable water will be supplied from wells or surface water, as appropriate for each site, and will be treated to achieve the necessary quality for human consumption.

The camp potable water requirements will be approximately 104 m³/day during Construction (and less during Operation) based on an average usage rate of 230 L/day per person and a camp population of up to 440 people.

The existing exploration camp at Brucejack Lake has an ozone/UV potable water treatment package sized to service 180 people. This camp will be used during the Construction period in addition to the new camp.

29.19.4.4 Actions to Avoid, Control, and Mitigate during Closure and Post-closure

Closure will involve the removal of all structures and equipment, closure of the portals, flooding of the underground mine workings, and site rehabilitation. The primary goal of water management activities during the Closure and Post-closure phases will be to minimize the long-term effects on the environment and return the site to as close to its pre-disturbance condition as practical.

When roads are no longer required, they will be deactivated according to standards outlined in the *Forest Road Engineering Guidebook* (BC MOF 2002). These standards include, but are not limited to:

- removing all culverts and bridges;
- contouring potentially unstable road shoulders;
- installing water bars (interceptor dikes);
- ripping the road surface; and
- re-vegetation with an approved native seed mix.

At final closure, all diversion channels will be decommissioned to restore stream hydrological patterns back to baseline conditions.

The underground workings will be progressively backfilled with tailings and waste rock throughout mine Operation and, once mining is completed, the remaining underground voids will be allowed to flood. The ventilation shafts and underground portals will be sealed with concrete plugs. Some seepage may occur; this is not expected in the two new mine portals but it may occur in the existing, lower, portal. The seepage water from the lower portal will be monitored during the Closure and Post-closure phases to estimate potential metal loadings to Brucejack Creek. If required, discharge from the lower portal can be directed to the WTP and discharged to Brucejack Lake during the Closure phase. However, ongoing treatment is not predicted during the Post-closure phase.

Following the removal of all above-ground buildings and structures, all gravel surfaces (e.g., the helicopter pad and the roads), will be ripped to a shallow depth to increase shallow water infiltration and reduce the potential for surface erosion and instability. The above-ground pipes that carry tailings to the lake will be removed and disposed of off site. Buried pipes will remain buried.

29.19.5 Water Management Monitoring Program

A Water Management Monitoring Program will be implemented at the initiation of Construction activities. The monitoring program will focus on inspection and maintenance of structures related to water management, with an emphasis on adaptive management to quickly evaluate and respond to changing conditions and requirements. The key objectives of the Water Management Monitoring Program are:

- to assess the performance of water management structures and systems; and
- to identify and promptly address areas where maintenance, upgrades, modifications, or additional mitigation measures are necessary.

Additional mitigation and management measures relevant to the Water Management Plan are provided in the following environmental monitoring and management plans:

- Section 29.3, Aquatic Effects Monitoring Plan (AEMP);
- Section 29.10, ML/ARD Management Plan;
- Section 29.13, Soils Management Plan;
- Section 29.15, Tailings Management Plan;
- Section 29.16, Transportation and Access Management Plan; and
- Section 29.18, Waste Rock Management Plan.

The Environmental Manager or other designated person will be responsible for overseeing the water monitoring program, maintaining inspection and maintenance records, ensuring water monitoring reporting, and providing guidance on any changes or needs to the program.

Trained environmental personnel will be employed at the Project. The environmental personnel will inspect, evaluate, and report on the effectiveness of water management strategies and mitigation measures, with respect to regulatory permits, approvals, and authorizations. Under the supervision of the Environmental Manager or other designated persons, the environmental personnel will have the responsibility of confirming that water management measures are properly implemented, and will have the authority to stop work if conditions are not met or if, in their technical opinion, the continuation of work will lead to conditions not being met. Project staff and contractors will report any potentially adverse incidents of erosion, structural, or function failure, culvert debris accumulation, spills, seepages, leaks, or similar occurrences to the environmental department.

All site employees and contractors will be encouraged to communicate concerns to their supervisors related to erosion and sedimentation, improper site drainage, debris or snow jams in drainage-ways and at stream crossings, and contaminant releases.

29.19.6 Work Planning and Schedule

Visual inspection and assessments of water management structures and systems will be incorporated on an ongoing basis as part of general site operations. On active work sites, these informal visual surveys will be augmented by formal, regularly scheduled inspections to be performed by environmental technicians on a monthly basis or more often as dictated by site conditions. In frozen conditions, formal inspection frequency may be reduced. Inspections of all sites will be conducted within 24 hours of any rainfall event of greater than 50 mm in a 24-hour period.

Water management and erosion, and sediment control structures will be regularly inspected and maintained. Maintenance procedures will include prompt attention to potential ditch or culvert blockage or failure, or outside seepage, because such problems could lead to structure failure and sediment transport. Maintenance will also include routine removal of accumulated sediment from ditches and retention structures.

Water management indicators and their monitoring frequency are outlined in Table 29.19-2. Monitoring frequency may be increased as required based on the results of the AEMP and other relevant monitoring programs. Inspection criteria may be modified on a site-by-site basis or as conditions require.

Table 29.19-2. Water Management Monitoring Variables, Frequency, and Expected Targets

Monitoring Variable	Monitoring Frequency	Targets
Performance of water management structures and systems (e.g., diversion ditches, site collection pond)	Monthly ¹ or after high rainfall/runoff ² events	functioning as required
Site and Brucejack Access Road drainages ³	Monthly ¹ or after high rainfall/runoff ² events	positive drainage maintained at all times; no ponding
Supply of water management/erosion prevention and sediment control materials	Monthly	sufficient supply is always available on-site

¹Frequency may be decreased during winter when ground is frozen

²Combined rainfall and snowmelt runoff events (rain-on-snow events) pose the most significant risk to water management structures and systems. Surveys of structures and systems prior to winter break-up are required to assess functionality and potential maintenance requirements (e.g., removal of excess snow/ice from ditches and basins, repair or replacement of blocked/frozen culverts and pipes).

³For more information, see the Soils Management Plan (Section 29.13)

29.19.7 Reporting Requirements

The Project’s Environmental Manager will ultimately be responsible for reporting on observations and monitoring results (Table 29.19-3). Reporting of all environmental monitoring data will be conducted in accordance with all permit and approval conditions. Regulatory requirements are anticipated to entail formal annual reports, including disclosure of issues of non-conformance.

Table 29.19-3. Water Management Reporting Requirements, Frequency, and Responsibilities

Report Type	Frequency	Reporting Responsibilities	Submitted to
Site inspection and maintenance logs	After each inspection	Environmental Technician	Environmental Manager
Water management materials inventories	After each inventory	Environmental Technician	Environmental Manager
Water treatment facility operation logs	TBD	Facilities operator	Environmental Manager
Annual report	Annually	Environmental Manager	Mine Manager, regulatory authorities
Environmental incident report	As soon as possible after occurrence	Initial notification by attending manager	Environmental Manager

Water management records will be maintained during all Project phases, including a description of surface water flow paths in relation to each major infrastructure footprint, existing surface water management/treatment measures and assessment of their performance, undertaken repairs or mitigation activities, and a log of dated photographs. The reports will be kept in the Project office or another designated area.

A log of all site inspections, recording the date and pertinent observations, will be established. At a minimum the form will include the work site, time, date, weather conditions, current site activity, list of water management practices or structures, and a date-stamped photo.

Environmental incidents will be communicated by the individual who detects an incident to their supervisor who will report to the appropriate environmental department individual.

All formal documents and reports will follow version-control procedures to ensure they are approved before use and the internal and external users are accessing the most current information.

29.20 WETLANDS MONITORING PLAN

29.20.1 Purpose

This plan provides a framework for monitoring wetlands, such that effects on wetlands along the Brucejack Access Road during the Construction and Operation phases of the Project can be identified and mitigated if required. This plan does not present management-level details as recommendations for wetland management are presented in other management plans, specifically:

- Section 29.5, Ecosystem Management Plan;
- Section 29.7, Hazardous Materials Management Plan;
- Section 29.9, Invasive Plants Management Plan;
- Section 29.12, Rare Plants and Lichens Management Plan;
- Section 29.13, Soils Management Plan (which includes soil salvage and handling, soil erosion, and soil contamination prevention); and
- Section 29.16, Transportation and Access Management Plan.

The purpose of this plan is to monitor potential effects to wetland extent and function; specifically hydrological.

29.20.2 Regulatory and Policy Framework

There are a number of federal and provincial policy statements and acts pertaining to aspects of wetlands such as function, wildlife, and fish habitat; these include:

- Federal Policy on Wetland Conservation (Environment Canada 1991);
- *Migratory Birds Convention Act* (1994);
- *Species at Risk Act* (2002c);
- *Fisheries Act* (1985c);
- *British Columbia Wildlife Act* (1996l); and
- *Forests and Range Practices Act* (2002).

Although no single act specifically addresses all wetlands or wetland functions, the various acts listed above can relate to specific types of wetlands at specific times of the year. For example some wetlands that provide fish habitat are protected as such under the *Fisheries Act*. The federal policy on wetland conservation is the responsibility of Environment Canada to meet.

Cox and Cullington (2009) developed a series of draft BMPs for a variety of industries in BC. The following BMPs were developed for mine Construction, Operation, and Closure:

- conserving intact wetlands;
- controlling leaching and sedimentation;
- ensuring dewatering production process does not affect wetland hydrology;
- limiting the effects of noise;
- re-vegetating using pre-development area species;

- using low impact re-vegetation techniques;
- re-establishing functional wetland loss; and
- monitoring enhancement, restoration, and creation activities to ensure success (Cox and Cullington 2009).

The BMPs also emphasize caution around planning, construction, and use of trails and roads because they can:

- be a major source of sediment;
- cause habitat loss and/or fragmentation through infilling or dewatering;
- enable invasive species encroachment; and
- provide opportunities for recreational impacts (Cox and Cullington 2009).

Riparian ecosystems, which can include wetlands, are protected by the *Forests and Range Practices Act* (2002a). Recommendations for management zones around riparian and wetland areas are contained within the *Forest Practices Code Riparian Management Area Guidebook* (BC MOF 1995). Furthermore, the provincial BMPs (BC MOE 2012a) recommend developers avoid ecosystems listed by the BC Conservation Data Centre (BC CDC).

These acts, policies, and BMPs relate to ways that project effects on wetlands can be minimized, avoided, or otherwise mitigated. These strategies and requirements are incorporated into Chapter 17, Assessment of Potential Wetlands Effects.

29.20.3 Monitoring Program

The wetland monitoring program will focus on collecting information to identify effects to wetland extent along the Brucejack Access Road and wetland hydrological function. This section presents the sites that were selected for monitoring, the annual monitoring schedule, and a description of each of the specific studies that will be undertaken.

The components of wetlands selected for monitoring were identified because they are elements of wetland function that can be used to indicate broad ecosystem changes.

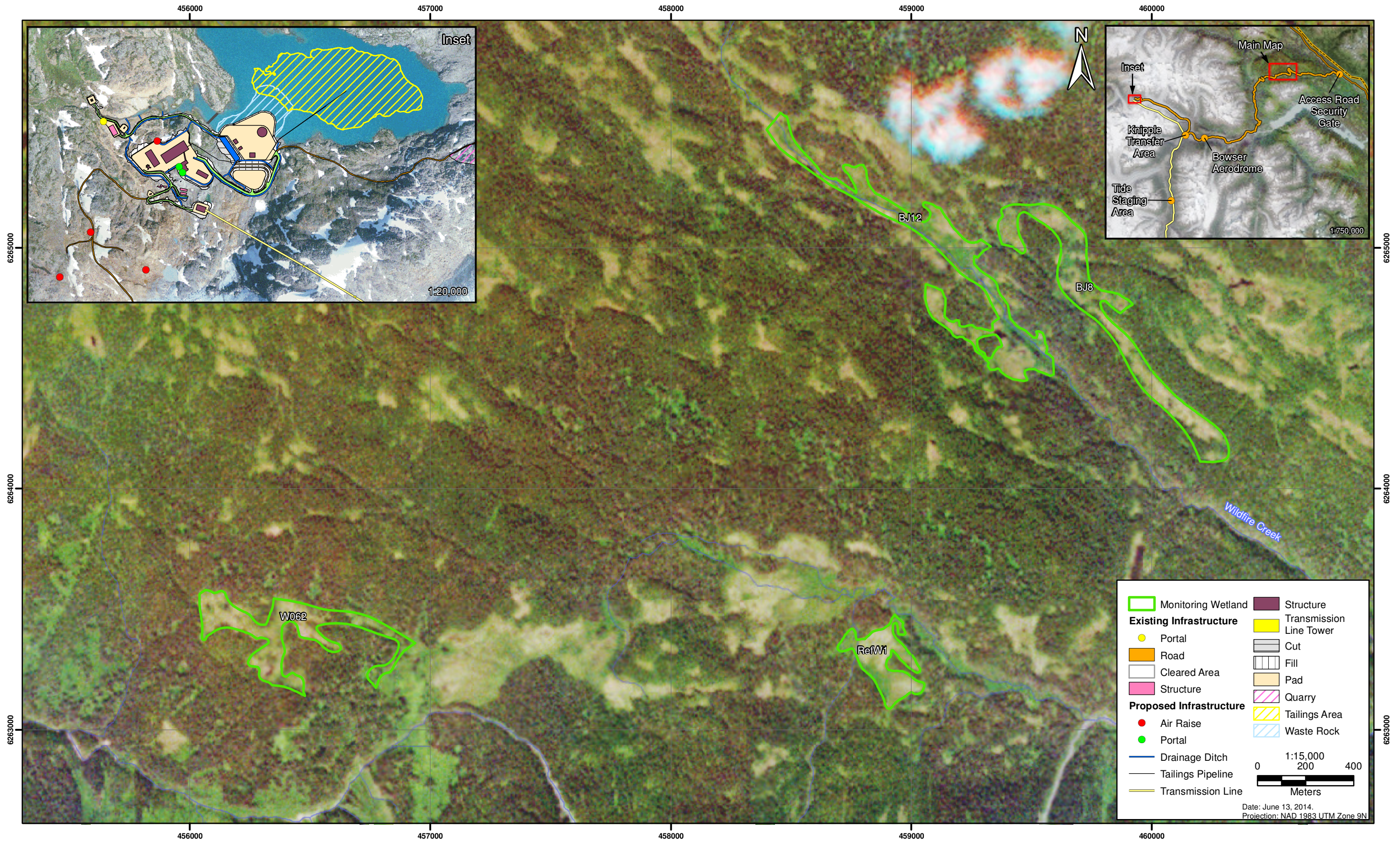
29.20.4 Site Selection

Three wetland sites potentially impacted by the Brucejack Access Road currently in use, together with a reference site, were identified in 2013. Pretivm monitored these sites following initial construction of the access road in 2013. Going forward, continued monitoring at these sites is planned under this Wetlands Monitoring Plan. Monitoring site locations are presented in Table 29.20-1 and Figure 29.20-1.

Table 29.20-1. Proposed Wetland Monitoring Sites

Site ID	Easting	Northing	Elevation (masl)
BJ08	460214	6264263	975
BJ12	459202	6264641	971
W062	456705	6263447	1002

Figure 29.20-1
Proposed Wetland Monitoring Sites



The identification and selection of these three sites do not preclude the selection of additional sites in the future should new information become available. Data collected from these sites will be used to determine if more sites or more in-depth studies of wetland function are in order.

29.20.5 Schedule

Monitoring would be completed on an annually basis until spoil areas adjacent to the road are fully vegetated and no longer present a risk of mobilizing sediments over wetlands. Annual monitoring would include at least two site visits to each monitoring wetland (Table 29.20-2). Once soil areas adjacent to the road have stabilized and are fully vegetated, the need for ongoing monitoring would be re-evaluated based on monitoring observations. The monitoring components and recommended timing for monitoring is presented in Table 29.20-2; details on individual tasks are provided in the following sections.

Table 29.20-2. Monitoring Schedule

Monitoring Date	Subsurface Hydrology Measurements	Wetland Extent Survey	Wildlife Observation
June	x	x	x
September	x		x

29.20.6 Ecological Function

29.20.6.1 Surface and Subsurface Hydrology

A set of four shallow groundwater piezometers will be set in each monitoring wetland (Section 29.20.4). Monitoring of subsurface water levels will be accomplished using push-in PVC standpipes and a combination of manual water-level measurements and water-level data loggers. At the three monitoring sites where the wetland is intersected by the Brucejack Access Road (BJ08, BJ12, WO62), standpipes will be placed on both sides of the road to determine the potential influence it may have on subsurface flow within the wetlands. Standpipes elevations will be surveyed on an annual basis in relation to local road survey control.

29.20.7 Ecological Function

29.20.7.1 Wetland Extent Survey

Visual wetland extent surveys will be conducted once each year in the monitored wetlands to determine changes to wetland extent and vegetation. These surveys will follow standard operating procedures ([Appendix 29-A](#)) and a Wetland Habitat Inspection Form (WHIF) will be completed at each monitoring wetland. These data will be used to identify changes in wetland extent and the effect that any sedimentation has on the vegetation composition.

29.20.8 Habitat Function

29.20.8.1 General Wildlife Observations

General wildlife observations will be made during each environmental monitoring trip and incidentally by environmental crew while conducting other management and/or monitoring duties in the area of the monitored wetlands. Wildlife observations will be recorded and tabulated.

29.20.9 Work Planning and Schedule

Wetland monitoring will be conducted twice annually until spoil areas adjacent to the road are fully vegetated and no longer present a risk of mobilizing sediments over wetlands. After this period the wetland monitoring frequency can be reduced.

29.20.10 Reporting Requirements

The Project's Environmental Manager will ultimately be responsible for the implementation and reporting on observations made during wetland monitoring. Environmental personnel may be employed throughout the Construction and Operation phases to supervise, direct, and conduct monitoring activities.

The wetland monitoring program requires minimal reporting, which will be completed in conjunction with other environmental monitoring reporting so that no specific wetland monitoring report is generated.

29.21 WILDLIFE MANAGEMENT AND MONITORING PLAN

29.21.1 Purpose

This section provides an overview of the Wildlife Management and Monitoring Plan for the Project. The objective of the plan is to minimize the potential effects on wildlife and wildlife habitat from the Project during the Construction, Operation (including potential temporary shut downs), Closure, and Post-closure phases, while taking into account operational requirements and the safety of Project employees. The plan has taken into consideration the Cassiar Iskut-Stikine Land and Resource Management Plan (CIS LRMP; BC ILMB 2000), the Nass South Sustainable Resource Management Plan (SRMP; BC MFLNRO 2012), relevant provincial and federal legislated requirements for wildlife and wildlife habitat management, and current BMPs.

The Wildlife Management and Monitoring Plan focuses on reducing the risk of direct and indirect wildlife mortality, mitigating the potential for human-wildlife conflicts, and minimizing the level of disturbance to wildlife and wildlife habitat as a result of activities or infrastructure related to the Project. Minimizing disturbance will prioritize staged management measures in order to reduce impact to sensitive areas or periods. These measures include avoiding sensitive timing windows, conducting pre-clearing surveys, and/or reducing or limiting on-site activities to include only essential activities.

The management measures for achieving protection of wildlife and wildlife habitat focus on the same wildlife valued components (VCs) that were selected for the environmental effects assessment (Valued Components; Section 18.3.3.1) and are relevant to species occurring within the RSA and the LSA.

The management and monitoring of wildlife will take an adaptive approach. Management measures implemented will be reviewed periodically and updated based upon initial outcomes and on current BMPs and methods.

Potential effects on wildlife from the Project could include:

- habitat loss and alteration;
- sensory disturbance;
- disruption of wildlife movements patterns;
- direct mortality;

- indirect mortality;
- attraction to the Project due to attractants; and
- health effects due to chemical hazards.

The management measures that will be implemented to minimize and avoid adverse effects on wildlife and wildlife habitat include:

- Section 29.21.3, Wildlife Protection Measures;
- Section 29.21.5, Wildlife Access and Traffic Management Plan;
- Section 29.21.6, Wildlife Helicopter Management Plan;
- Section 29.21.7, Wildlife Light Management Plan;
- Section 29.21.8, Employee Wildlife Education and Training Program;
- Section 29.21.9, Wildlife Effects Monitoring Program;
- Section 29.2, Air Quality Management Plan;
- Section 29.3, Aquatic Effects Monitoring Plan;
- Section 29.4, Avalanche Management Plan;
- Section 29.11, Noise Management Plan;
- Section 29.17, Waste Management Plan;
- Section 29.19, Water Management Plan; and
- Section 29.20, Wetlands Monitoring Plan.

29.21.2 Regulatory and Policy Framework

The following legislation and standards apply to wildlife and wildlife habitat:

- *BC Wildlife Act* (1996l);
- *BC Species at Risk Act* (2002c);
- *Migratory Bird Convention Act* (1994);
- *Forest and Range Practices Act* (2002b);
- *BC Environmental Assessment Act* (2002a);
- *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in BC* (BC MWLAP 2004b);
- *British Columbia Best Management Practices for Raptors* (BC MWLAP 2005);
- *British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears* (MacHutchon 2001);
- *Cassiar Iskut-Stikine Land and Resource Management Plan* (BC ILMB 2000);
- *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (BC MOE 2006);
- *Identified Wildlife Management Strategy* (Cichowski, Kinley, and Churchill 2004);

- *Management Plan for the Mountain Goat in British Columbia* (BC MOE 2010a);
- *Migratory Birds Environmental Assessment Guideline* (Milko 1998);
- Nass South Sustainable Resource Management Plan (BC MFLNRO 2012);
- Ungulate Winter Range (goat) U-6-002 Order, sections 9(2) and 12(1) of Government Actions Regulation (BC MOE 2008; BC Reg. 582/2004); and
- *Wildlife Habitat Features Summary of Management Guidelines: Northern Interior Forest Region* (BC MWLAP 2004c).

29.21.3 Performance Objectives and Targets

The overall objectives of the Wildlife Management and Monitoring Plan are to:

- minimize wildlife mortality as a direct consequence of the Project; and
- avoid and/or minimize adverse effects on wildlife with special attention to their habitats, breeding activities, feeding activities, and species of conservation concern.

Specific targets related to achieving the objectives are to:

- Meet legislation requirements with regard to:
 - active bird nests or mammal dens disturbed or destroyed during site clearing for the Construction phase, incremental growth of Project infrastructure during the Operation phase, and general Project activities;
 - active or inactive raptor nests destroyed during Construction and Operation; and
 - mortality of animals directly attributable to the Project, particularly species of conservation concern and migratory birds.
- Minimize loss of high-quality habitat;
- Minimize the disruption to wildlife movement;
- Prevent disturbance to goats and moose within high-rated habitat and designated and candidate Ungulate Winter Range (UWR) during the winter and high-rated summer habitat during the kidding period; and
- Prevent disturbance within candidate grizzly bear Wildlife Habitat Areas during periods of greatest sensitivity.

29.21.4 Wildlife Protection Measures

29.21.4.1 Project Design Considerations

The following Project design considerations were integrated into Project planning:

- The surface footprint of the Project was designed to minimize disturbance to wildlife habitat.
- Important habitats were avoided where practicable alternatives were available (e.g., habitat loss was minimized in wetland habitat near Brucejack Lake).
- The Brucejack Transmission Line - South Option was selected after an alternatives assessment was conducted on two possible alignments. The south option was the optimal choice due to the minimal amount of wildlife habitat removal required, the high elevation of the line, and because no new roads would be constructed, eliminating additional access into the area.

- The transmission line will be designed to include features that reduce the risk of bird collisions and electrocutions, following best management practice (APLIC and USFWS 2005; APLIC 2006). Examples of design features may include increasing the visibility of the transmission line and preventing raptors from nesting on posts.
- There is a controlled locked manned gate at the beginning of the Brucejack Access Road off Highway 37 to minimize access to hunters. This security gate will be functional during the Construction, Operation, and Closure phases of the Project. Its active staffing will eventually terminate at Post-closure. Removal of the access road bridge over the Bell-Irving River adjacent to the security gate will be considered later in the life of the mine if permanent decommissioning of the road is undertaken. Access closure signs will be posted.
- Buildings will be designed and maintained to exclude wildlife wherever possible, such as covering vents with mesh and skirting to prevent bats, birds, and furbearers from entering and ensuring the siding of buildings is constructed to prevent wildlife from entering.

29.21.4.2 Construction Phase

Wildlife Sensitivity Timing Windows

During the Construction phase an environmental staff member, reporting to the Environmental Manager, will be employed on site to identify sensitive wildlife features and implement appropriate measures to minimize potential adverse effects to these areas. For each wildlife VC, there are time frames during which wildlife individuals will be more sensitive to disturbance (e.g., breeding). Table 29.21-1 summarizes key sensitive periods for wildlife VCs applicable to the Project, and highlights legislation or BMPs relevant to each VC.

Where possible, Project construction activities that may disturb wildlife (e.g., vegetation clearing), will be avoided during sensitive periods. If avoidance is not possible, pre-clearing surveys will be conducted to identify features that must be avoided. These surveys are described in more detail for each VC below.

Moose

If vegetation clearing must occur during the calving period (April to July) an aerial survey will be conducted for current, localized evidence of calving moose before construction proceeds, followed by monitoring of the construction area, if necessary. This may be conducted in conjunction with pre-clearing surveys for bird nests. The survey will be conducted along the Brucejack Transmission Line alignment from the Tide Staging Area north of the Granduc Access Road to the Knipple Transfer Area; provincial approval is required to conduct this survey. The aerial survey will ensure that calving areas are identified. Vegetation clearing will be avoided near identified moose calving areas, wherever possible, and a forested buffer will be established and maintained to provide security cover for animals. If the area must be disturbed due to Project constraints, the relevant regulating body will be consulted, e.g., British Columbia Ministry of Forests, Lands, and Natural Resource Operations (BC MFLNRO), to develop appropriate mitigation strategies.

In order to protect important winter forage and thermal habitat characteristics, vegetation clearing during winter, in habitat rated as highly suitable or within candidate provincial moose UWRs, will be avoided wherever possible. Priority will be given to the maintenance of mature and old seral forest stands along floodplains, watercourse riparian areas, and wetlands. Connectivity between winter range habitat areas will also be protected wherever possible.

Table 29.21-1. Wildlife Sensitive Periods Applicable to the Project

VC	Sensitive Period	Season/Life Requisite/ Habitat Feature	Summary of Guidelines	Legislation and Standards
Moose	April - July and Nov to May	Calving and natal habitat / winter range	Nass SRMP directs minimal disturbance from November 1 to May 1. If moose are observed, work will be halted until moose are 300 m away. Moose UWRs within the RSA are currently candidate; however, typical moose UWRs require special management that includes no disturbances from November to April.	The Nass South SRMP (BC MFLNRO 2012)
Mountain Goat	November 1 to June 14	Winter range	Schedule activities within 500-m horizontal distance of mountain goat winter habitat to take place between June 15 and October 31.	Ungulate Winter Range U-6-002 Order, sections 9(2) and 12(1) of Government Actions Regulation (BC MOE 2008; BC Reg. 582/2004), unless an exemption is granted
	May 1 to July 15	Kidding period	Maintain 500-m disturbance buffer from kidding habitat (e.g., flight paths, road construction) and avoid facility development within 2 km of confirmed natal areas.	Management Plan for Mountain Goat in BC (BC MOE 2010a); Wildlife Habitat Features - Summary of Management Guidelines - Northern Interior Forest Region (BC MWLAP 2004c)
	April to November	Mineral licks	Avoid destruction of licks. Minimize disturbance within 100 m of licks from April to November. Avoid locating new roads near a lick to avoid isolating the lick from nearby escape cover.	Cassiar Iskut-Stikine LRMP (BC ILMB 2000); Nass South SRMP (BC MFLNRO 2012); Wildlife Habitat Features - Summary of Management Guidelines - Northern Interior Forest Region (BC MWLAP 2004c)
	September to November	Wallows	Avoid destruction of wallows. Minimize disturbance within 100 m of wallows from May to November.	Wildlife Habitat Features - Summary of Management Guidelines - Northern Interior Forest Region (BC MWLAP 2004c)
Black Bear	October to April	Denning	Conduct clearing outside of denning season. Maintain forested buffer zones around any identified active dens (one tree length radius forested buffer - tree length based on average height of the main tree canopy layer).	Wildlife Habitat Features - Summary of Management Guidelines - Northern Interior Forest Region (BC MWLAP 2004c) and British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears (MacHutchon 2001)
Grizzly bear	November to April	Denning	Conduct clearing outside of denning season. Maintain buffer zones with a 60-m radius around any identified active dens.	BC Environmental Assessment Guidelines for Grizzly Bears and Black Bears (MacHutchon 2001) and Accounts and Measures for Managing Identified Wildlife - Northern Interior Forest Region (BC MWLAP 2004a)

(continued)

Table 29.21-1. Wildlife Sensitive Periods Applicable to the Project (continued)

VC	Sensitive Period	Season/Life Requisite/ Habitat Feature	Summary of Guidelines	Legislation and Standards
Furbearers	March to May (e.g., fisher) and January to May (e.g., wolverine)	Denning	If clearing must be completed during this time, pre-clearing surveys for dens will be conducted to identify areas where tree clearing will be prohibited. Maintain forested buffer zones around any identified active dens. Protect wolverine, fisher and marten natal and maternal dens (January to May).	Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia (BC MOE 2006) British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears (MacHutchon 2001)
Hoary Marmots	growing season (i.e., all times of the year)	Colony dens	Conduct pre-grubbing surveys for active hoary marmot colonies prior to construction activities, and mitigate if marmots are observed. If construction activities are scheduled during the winter when marmots are hibernating, conduct pre-clearing surveys during the previous fall.	
Bats	May to September	Maternal roosts	Conduct pre-clearing surveys for bat maternal roosts if construction occurs within the breeding period. If maternity roosts are identified, maintain a buffer of at least 50- to 125-m radius around the roost.	
Migratory Birds	March 15 to August 15	Nesting/fledging	Schedule vegetation clearing activities outside of the general breeding bird period, where possible. If clearing must be completed during the breeding period, conduct pre-clearing surveys to identify areas where clearing will be prohibited. Buffer zones around any identified active nests will be maintained, where possible.	<i>Migratory Bird Convention Act</i> (1994) <i>BC Wildlife Act</i> Section 34 (1996l)
Raptors	March 1 to August 15	Nesting/fledging	If nest is intact, the tree is protected under Section 34 of the <i>Wildlife Act</i> (1996l). Avoid construction, blasting, helicopter disturbance between March 1 and August 15 within 200 to 500 m of the nest tree (BC MWLAP 2005). If nests are observed, establish a forested buffer around the tree of 100 to 300 m (BC MWLAP 2005).	<i>BC Wildlife Act</i> Section 34 (1996l): protects the nests of eagles, peregrine falcons, gyrfalcons and ospreys year round Wildlife Habitat Features - Summary of Management Guidelines - Northern Interior Forest Region (BC MWLAP 2004c) Wildlife Habitat Features - Summary of Management Guidelines - Northern Interior Forest Region (BC MWLAP 2004c)

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Table 29.21-1. Wildlife Sensitive Periods Applicable to the Project (completed)

VC	Sensitive Period	Season/Life Requisite/ Habitat Feature	Summary of Guidelines	Legislation and Standards
Western Toad	May to October	Breeding ponds/toadlet dispersal	<p>Avoid construction activities in areas adjacent to potentially high-quality western toad breeding habitat from May through October.</p> <p>If this is not possible, conduct pre-clearing surveys and if breeding ponds are observed, establish a buffer zone of at least 30 m, or, if this is not possible, contact the appropriate government agency (e.g., BC MOE) regarding alternative mitigation (e.g., translocation) or potential compensation/offset options.</p>	<p><i>Species at Risk Act</i> (Schedule 1; 2002c)</p> <p>Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in BC (BC MWLAP 2004b)</p>

Mountain Goat

Construction activities will be avoided in occupied winter habitat during the winter (November 1 to June 14) and in kidding habitat during the summer (May 1 to July 15), unless monitored by a qualified environmental staff member and the habitat is confirmed to be unoccupied. The BC Mountain Goat Management Plan recommends a 500-m buffer zone (2-km buffer zone for canyon-dwelling mountain goats) in which no industrial activity takes place adjacent to winter range and kidding/early rearing habitat.

Mineral licks are important habitat features that goats rely on for providing supplemental minerals, which can help to stabilize dietary intake of other minerals (BC MOE 2010a). Mineral licks can be dry earth exposures, muck (wet) licks, and rock face licks (BC MOE 2010a). A mineral lick is considered to be a significant wildlife habitat feature if it is used by multiple individuals and is rare on the landscape, requiring goats to travel greater than 1 km away from escape terrain to access the lick (BC MWLAP 2004c). If mineral licks are found within the proposed area of disturbance, where possible, destruction of the lick will be avoided and the integrity of the trails between mineral licks will be maintained. If activities must occur within 100 m of a lick, disturbance will be minimized during high-use periods (May to November). When possible, a 500-m buffer zone will be applied to a mineral lick between May 1 and July 15 (BC MORE 2010a). If a mineral lick must be disturbed due to Project constraints, the relevant regulating body will be consulted (e.g., BC MFLNRO) to develop appropriate mitigation strategies.

Specific guidelines exist for provincial mountain goat UWRs and the Project overlaps #U-6-002. Clearing activities will not occur within 500 m of #U-6-002 UWR areas from November 1 to June 14, unless an exemption is granted (BC MOE 2004), or if surveys indicate the habitat to be unoccupied. Helicopter activities will be limited during the winter (November 1 to June 14) and will maintain at least a 2-km buffer from #U-6-002 UWR areas during that period where weather permits, unless an exemption is granted.

Black Bear and Fisher Dens

Effort will be made to avoid disturbing or destroying active black bear or fisher dens during site clearing. Vegetation clearing will be avoided in high-quality black bear and fisher denning habitat (e.g., hybrid spruce and large cottonwood associated with riparian forest in the Interior Cedar-Hemlock biogeoclimatic zone) during the black bear denning period (October to April) and fisher natal and maternal denning period (March to May), unless pre-clearing surveys are conducted. If active dens are identified during pre-clearing surveys, a forested buffer of approximately one tree length (based on the average height of the main tree canopy layer in the surrounding stand) will be maintained. This buffer will retain thermal protection and climbing trees for cubs (BC MWLAP 2004c). If an active den cannot be avoided or work must be undertaken within buffer areas, the relevant regulators will be consulted to develop appropriate mitigation strategies.

Grizzly Bear Dens

Effort will be made to avoid disturbing or destroying active grizzly bear dens. Vegetation clearing, excavations, and snow removal will be avoided in high-quality habitat (e.g., alpine areas at greater than 1,100-m elevation with primarily morainal or colluvial soil materials on moderate slopes in the BAFA/CMA and ESSF/MH BEC zones) during the grizzly bear denning period (November to April), unless pre-clearing surveys are conducted. If an active grizzly bear den is identified during pre-clearing surveys, a buffer of 60 m will be maintained (BC MWLAP 2004a). If an active grizzly bear den cannot be avoided or work must be undertaken within buffer areas, the relevant regulators will be consulted to develop appropriate mitigation strategies.

Wolverine Dens

Effort will be made to avoid disturbing or destroying active wolverine natal dens during construction, snow removal activities, and avalanche control operations. Clearing, excavations, and snow removal will be avoided in high-quality natal denning habitat (e.g., in high elevation areas from the edge of the treeline and above that have deep snowpack, good avalanche stability, moderate slopes, and are relatively near a prey source, such as goat winter range) during the wolverine natal denning period (January to May or until the snow melts), unless pre-clearing surveys are conducted. If an active wolverine natal den is identified during pre-clearing surveys, a buffer similar to that of grizzly bears of approximately 60 m will be maintained. If an active den cannot be avoided or work must be undertaken within buffer areas, the relevant regulators will be consulted to develop appropriate mitigation strategies.

Bats

Active bat maternity roosts will not be disturbed or destroyed. Pre-clearing surveys will be conducted for bat maternity roosts if clearing is scheduled to occur between May and September (BC MWLAP 2004b). Surveys will only be conducted if there are known roosting sites in the area, as noted during the collection of baseline environment data, and will focus on suitable maternal roosting structures such as large diameter trees. Ground searches are not required for bat hibernacula because the Unuk River karst formation is not suitable for forming structures that may support hibernacula.

If active maternity roosts are identified that belong to the provincially blue-listed northern long-eared myotis or the federally listed little brown myotis, a buffer of at least a 125-m radius (BC MWLAP 2004c) will be maintained where possible, or BC MFLNRO (or the applicable agency) will be notified and alternative mitigation enacted. If the active maternity roost consists of other bat species (e.g., western long-eared myotis, silver-haired bat), a buffer or retention patch of at least a 50-m radius will be maintained where possible, or BC MFLNRO (or the applicable agency) will be notified and alternative mitigation enacted. The retention patch, if implemented, will include high-quality bat habitat (e.g., foraging habitat, corridor to foraging habitat, large diameter trees, cliffs/caves), if available nearby. In addition, blasting or construction will not occur within this buffer, unless there are no other options. If activities must occur within the buffer, the relevant regulating body will be consulted (e.g., BC MFLNRO) to develop appropriate mitigation strategies.

Migratory Birds

Active bird nests will not be disturbed or destroyed during site clearing for infrastructure. Vegetation clearing activities will be scheduled outside of the general breeding period for waterbirds and landbirds (May 1 to July 31) to avoid contravention of Section 34 of the *Wildlife Act* (1996), where practical. If clearing must be completed during the breeding period, pre-clearing surveys will be conducted to identify locations of active nests and disturbance-free buffers applied until the nest is inactive. Harlequin duck pair surveys will be conducted prior to any work on crossings of streams with wet widths greater than 10 m. If any nests are identified, buffer zones with a 50-m radius will be maintained throughout the breeding season, where possible, or the appropriate regulators will be consulted to develop appropriate mitigation strategies.

Raptors and Great Blue Heron

Active raptor nests will not be destroyed during Construction and Operation. Inactive raptor nests or nests found outside of the breeding season will also be maintained or relocated, in consultation with appropriate regulators (*Wildlife Act* 1996; Demarchi, Bentley, and Sopuck 2005).

Prior to construction activities, a reconnaissance survey for large raptor nests will be conducted. If nests of eagles, osprey, or great blue heron are found, the following guidelines will be followed:

- if nest is intact, the tree is protected under Section 34 of the *Wildlife Act* (1996l);
- avoid construction, blasting, and helicopter disturbance between March 1 and August 15 (February 15 and August 31 for great blue heron) within 200 to 500 m (depending on the species) of the nest tree where possible; and
- establish a forested buffer of a 100- to 300-m radius (depending on the species) around the tree to provide perching and roosting sites and security cover where possible.

Amphibians

Vegetation clearing activities will be avoided in areas adjacent to high-quality western toad breeding habitat from May through October, unless pre-clearing surveys are conducted. Where avoidance is not possible, and in accordance with best management practices for amphibians (BC MWLAP 2004b), pre-clearing surveys will be conducted and a buffer zone of at least 30 m will be established between construction activities and identified breeding habitat.

The following mitigation measures will be implemented to minimize potential effects on amphibians, particularly western toad:

- identify and avoid sensitive habitat, such as wetlands and breeding ponds adjacent to work sites;
- minimize standing water in roadside ditches of access roads and monitor ditches for use as breeding sites for western toads;
- report western toad observations and incidents, including mass toad movements near access roads; and
- survey wetlands and ponds and monitor for amphibian breeding prior to construction activity.

During the Construction phase, Standard Operating Procedures (SOPs) will include procedural guidance in the event that western toad breeding or mass dispersal is identified. This may include guidance on buffer distances from identified breeding sites, and salvage or relocation requirements and techniques in the event work must be undertaken at breeding sites.

29.21.4.3 Operation

During the mine Operation phase, on-site environmental personnel will monitor the mine activities and infrastructure for potential hazards to wildlife or wildlife habitat, record incidents, and implement mitigation measures. Specific BMPs required during Operation to meet the targets outlined in Section 29.21.3 are presented in Table 29.21-2.

If construction of buildings or roads occurs during the Operation phase then the measures described in Tables 29.21-1 and 29.21-2 will apply. Where possible, Project construction activities during the Operation phase that may disturb wildlife or wildlife habitat (e.g., vegetation clearing), will be avoided during sensitive periods. If avoidance is not possible, pre-clearing surveys will be conducted to identify features that must be avoided. An environmental staff member will identify sensitive wildlife features and implement appropriate mitigation measures to minimize potential adverse effects to these areas during construction.

Table 29.21-2. Actions to Achieve Wildlife Management Targets during Operation

Target	Actions
<u>Mammals</u>	
Mortality of mammals, particularly protected species, will not be directly attributable to the Project.	<ul style="list-style-type: none"> • Minimize wildlife attractants and incident through proper management of garbage and waste as defined in the Waste Management Plan (Section 29.17). • Restrict public access along the Project access road through the implementation of the Transportation and Access Management Plan (Section 29.16) and the Wildlife Access and Traffic Management Plan (Section 29.21.5). • Implement a no hunting policy on-site to avoid mortality to mammals due to hunting. • Implement adaptive management measures that will prevent wildlife entering into hazardous areas (e.g., toxicants in water). • Prevent and minimize wildlife/vehicle mortality through implementation of the Transportation and Access Management Plan (Section 29.16) and the Wildlife Access and Traffic Management Plan (Section 29.21.5). • Install fencing/skirting to prevent furbearer access to site infrastructure (e.g., buildings). • Implement measures to exclude bats from the mine portal and ventilation shafts. • Minimize Mountain goat and wolverine mortality according to the Avalanche Management Plan (Section 29.4), where applicable. • Educate all on-site temporary and full-time employees about wildlife sensitivities, risks, reporting requirements, and prohibitions with an induction to the Employee Wildlife Education and Training Program (Section 29.21.8).
Species richness, abundance, and diversity of mammals will not decline due to the Project.	<ul style="list-style-type: none"> • Implement wildlife monitoring program for bears and ungulates (WEMP) (Section 29.21.9). • Avoid helicopter disturbance to goats by following the BC Management Plan for the Mountain Goat (BC MOE 2010a) and the Wildlife Helicopter Management Plan (Section 29.21.6). The latter recommends that helicopters maintain a 2,000-m horizontal and 400-m vertical separation from mountain goat habitat. To minimize disturbance, aerial support, including helicopter access, will be directed along controlled routes or flight paths that follow the guidelines, where safety of the pilot and the aircraft is not compromised. Specific flight paths will be determined before construction commences and will be followed, unless extreme weather and safety of pilots require them to fly within the buffer. Locations of these flight paths and the reasons they must be used will be communicated to all workers involved in aviation support. Pilots will be required to follow flight paths • Mountain goats will be managed within UWRs according to UWR legislation, unless an exemption permit is granted.
Minimize loss of high-quality habitat and disruption to movement	<ul style="list-style-type: none"> • Modify the design of the Project and location of Project infrastructure to minimize habitat loss or alteration of the proposed grizzly bear Wildlife Habitat Area, proposed moose UWR, and the mountain goat UWR U-6-002. • Prevent the transmission line right of way from acting as a barrier to movement for furbearers by maintaining some vegetation, where possible, (Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia; BC MOE 2006). • Prevent Pretivm-controlled access road from acting as barriers to movement for mammals through implementation of the Wildlife Access and Traffic Management Plan (Section 29.21.5). • Retain some tree snags and stumps to provide additional habitat for bat species that use tree crevices (e.g., long-eared myotis [<i>Myotis evotis</i>]) for maternal roosts (Rancourt, Rule, and O’Connell 2005). • Model loss or alteration of moose, mountain goat, and grizzly bear habitat at various stages of operation to ensure that total loss does not exceed the amount identified in the Application/EIS.

(continued)

Table 29.21-2. Actions to Achieve Wildlife Management Targets during Operation (completed)

Target	Actions
<u>Birds</u>	
Mortality of birds, particularly protected species, will not be directly attributable to the Project.	<ul style="list-style-type: none"> • Implement adaptive management measures to keep birds out of hazardous areas. For example, use of Brucejack Lake by waterbirds will be monitored during operation and appropriate steps will be taken to deter birds from the lake if deemed necessary. Deterrent systems will be adapted over time if necessary and the need to deter birds will be periodically evaluated based on operating experience. • Minimize bird/vehicle mortality through implementation of the Wildlife Access and Traffic Management Plan (Section 29.21.5). • Monitor the transmission line to ensure design features intended to minimize bird interactions are in good condition, and repaired and/or replaced if necessary. If carcasses are found, these will be recorded and reported.
Raptor abundance and habitat use	<ul style="list-style-type: none"> • Minimize disturbance to raptor nests and monitor active nests.
<u>Amphibians</u>	
Mortality of amphibians, particularly protected species, will not be directly attributable to the Project.	<ul style="list-style-type: none"> • If western toads are observed within the Project footprint, salvaging may occur at discrete times corresponding to each incremental increase in the footprint during operation. Adult western toads will be moved to an unaffected suitable wetland within the LSA in order to augment the breeding population in that wetland. A 30-m minimum buffer area around toad breeding sites will be applied where practical, or the appropriate regulatory agency (e.g., BC MOE or Canadian Wildlife Service) will be contacted for alternative mitigation strategies (BC MWLAP 2004b). • Minimize amphibian mortality along roads through implementation of the Wildlife Access and Traffic Management Plan (Section 29.21.5).
Minimize loss of high-quality habitat and disruption to movement	<ul style="list-style-type: none"> • Assess western toad habitat within wetlands adjacent to the access road, sharing data from the Wetlands Monitoring Plan (Section 29.20), and apply mitigation measures to sites that require protection from sedimentation events. (Mitigation Measures for Alterations of Wetland Functions, Section 17.5.2.2). • Facilitate the movement of western toad through the use of tunnels such as concrete box culverts. Toad tunnels and/or other measures to facilitate movement may be added if toad crossing sites are an issue (see Wildlife Access and Traffic Management Plan, Section 29.21.5).

29.21.4.4 Temporary Shut-down

In the event of temporary shut-down periods, access along Project roads will continue to be managed to minimize indirect mortality (i.e., hunting) of wildlife and access will continue to be controlled by personnel at the security gate at Highway 37. Signs will be posted to indicate access closure warnings. The Project infrastructure and camp will also be managed by removing all wildlife attractants and through continued implementation and enforcement of the Waste Management Plan (Section 29.17), Wildlife Access and Traffic Management Plan (Section 29.21.5), and the Transportation and Access Management Plan (Section 29.16).

29.21.4.5 Closure and Post-closure

During the Closure and Post-closure phases of the Project, inactive Project components will be decommissioned when possible and re-vegetated as outlined in Chapter 30, Closure and Reclamation. Wildlife mortality will be prevented through application of the following Closure and Post-closure mitigation measures:

- continue to operate the controlled locked gate through the Closure phase, staffed by security personnel, at the beginning of the Brucejack Access Road off Highway 37 to minimize access to hunters; removal of the access road bridge over the Bell-Irving River adjacent to the security

gate will be considered during the Post-closure phase of the Project if permanent closure of the road becomes a possibility; and

- post access closure signs.

29.21.5 Wildlife Access and Traffic Management Plan

Management protocols for the access roads, mine site haul roads, and highways are outlined below. If high levels of wildlife harvest, conflicts, or sightings are found in particular areas, the management plan will be reviewed and adapted as necessary. Additional mitigation measures could include increasing access control, taking into consideration the line-of-sight along access roads, altering speed limits, and installing active wildlife warning systems.

29.21.5.1 Access Management

To mitigate for the potential effects of increased access on wildlife, the following mitigation measures will be implemented (see also Section 29.16, Transportation and Access Management Plan):

- install gates and signs at the security checkpoint at the Brucejack Access Road turnoff from Highway 37 that prohibits entry by non-authorized vehicles;
- design gates and security measures that control access at the junction with Highway 37 to prevent the access of snow machines, and all-terrain vehicles (ATVs); winter access by snow machines or ATV's by cross-country travel will not be controllable other than prohibiting the use of the access road for travel;
- limit access to authorized vehicles only;
- implement speed limits;
- draft company policy that will prohibit the possession of personal firearms or other hunting weapons by employees and contractors within the Project area;
- at Closure, deactivate all non-essential roads if long-term Post-closure monitoring access is not required;
- implement and enforce a no hunting policy for employees and contractors; and
- eliminate personal vehicles at the Project site, by transporting personnel via aircraft, busses or designated company transport vehicles from communities or central collection sites at the start and end of each shift during the mine's Construction and Operation phases (see Section 29.16, Transportation and Access Management Plan).

29.21.5.2 Prevent Barriers to Movement

To prevent roads from acting as barriers to wildlife movement, the mitigation measures described below will be implemented.

Drainage culverts have been reported as effective wildlife passages for marten and other small mammals, and provide habitat connectivity and greatly reduce the risk of mortality of amphibians on roads (Fahrig et al. 1995; BC MWLAP 2004b). In general, drainage culverts assist in mitigating the potentially harmful effects of roads by providing a vital biological corridor that links habitats (Clevenger, Chruszcz, and Gunson 2001). Drainage culverts have been installed along the exploration access road and may facilitate the movement of marten, small mammals, and western toad that could use them as passages under the road.

Similarly, amphibians are more likely to use large, short, well-lit, and ventilated tunnels with natural vegetation. The materials used in tunnel construction for amphibians are also critical for tunnel effectiveness. Steel is an undesirable construction material because of its high conductivity, coldness during spring, and possible leaching of toxic metals (Fitzgibbon 2001). Amphibians will avoid using tunnels that promote change in interior microclimatic conditions, including moisture, temperature, and light. A combination of large (more than 1-m diameter), box culvert design are recommended. These structures help to maintain natural airflow and moisture, and are also suitable for marten and small mammals.

Drift net fencing is also an important feature of amphibian underpass systems and serves to guide or funnel animals to tunnel entrances. The fencing must be at least 0.5-m high, extend a sufficient distance along the road, and be constructed with sturdy materials to withstand ploughing and snow build up (BC MWLAP 2004b).

29.21.5.3 *Avoid Wildlife/Vehicle Interactions*

Wildlife/vehicle interactions can be minimized through modification of driving behaviour. This will include adhering to speed limits, giving wildlife the right-of-way, and communicating wildlife sightings (described below). Travel outside of daylight hours will be undertaken with extreme caution, recognizing that both crepuscular hours (i.e., dawn and dusk) and night are periods of high wildlife activity.

Adherence to Speed Limits:

- Speed limits will be posted along the access and haul roads; vehicles will also be directed to adhere to open road speed limits for Highway 37 and 37A. Road signs will be installed along Project roads to alert drivers to speed limits and of wildlife sensitive areas such as migration routes and seasonal feeding areas.
- The site and access road speed limits and signage will be adaptively managed to respond to changes that recognize sensitive areas such as potential wildlife movement corridors.

Wildlife Right-of-Way:

- An education program will be developed to ensure drivers know that wildlife have the right-of-way along Project roads and the highway.
- Any encounter with wildlife (including observations or interactions) will be reported and records kept. The radio will be used to alert other operators that there is wildlife in the area and to travel with caution. These records will provide a basis for identifying locations of considerable risk for wildlife/vehicle collisions, and for developing appropriate mitigation strategies for those areas. If a large number of wildlife (e.g., moose) are present on or adjacent to the road, a temporary road closure may be instigated at the discretion of the Environmental Manager in consultation with the Mine Manager.

Wildlife/Vehicle Interactions:

- Locations along the access road identified as having a higher likelihood for vehicle collisions with wildlife will be managed adaptively.
- Collisions between Project vehicles and wildlife will be documented and will include information on the location of the collision along Project roads and the highway. Employees and drivers will be trained on reporting in the event of a collision. All information on collisions will be shared with relevant government agencies. A simple tracking and reporting system will be in place to ensure truck drivers accurately report all wildlife collisions.

Roadway Attractants:

- Use of road salts for winter road management will be avoided to reduce the potential of attracting ungulates to the road. Sand or stone chippings will be used as the preferred methods to provide winter traction.
- Vegetation management will be implemented to reduce site attractiveness and roadway edges will be cleared to increase visibility of wildlife to drivers (e.g., a cleared buffer zone of appropriate size). Clearing will be site specific to ensure a balance between low vegetation and maintaining high value and sensitive habitat. To reduce herbivore use of vegetation within corridor areas where concerns exist for vehicle collisions and high-quality browse is present (e.g., willow, birch), vegetation maintenance activities (e.g., brush-cutting) will be conducted every three years or on a different schedule if local conditions warrant, in the early summer months of June and July to minimize attractiveness to herbivores such as moose and deer (Rea et al. 2010). Pre-clearing surveys for bird nests will be conducted prior to brush-cutting to ensure nests are not destroyed.
- To minimize potential wildlife/vehicle collisions along the roadside, the verge (i.e., the vegetated strip adjacent to the roadway) will be seeded with a low diversity seed mixture with low or no clover content that are less attractive forage to wildlife, especially to moose, mountain goats, and black bears. If erosion control is the main objective of seeding, ground cover will be the overriding factor in seed choices.
- In accordance with BC's BMPs for raptors (BC MWLAP 2005), vegetation will be managed through manual and mechanical mowing and brush-cutting without the use of herbicides.
- Refuge areas will be ploughed along the road during winter; gaps in snow banks on roads will be created at best spacing to allow an escape for wildlife, preferably on corners to allow moose to escape.
- Ditches and culverts will be designed to minimize pooling of water. Free draining roadside ditches will eliminate pools that may form attractive toad breeding areas.
- Carrion will be removed from roads to minimize attracting wildlife to the road, thereby reducing the risk of conflicts between vehicles and wildlife.
- Dust production from vehicles along the road will be managed through enforced speed limits and the use of dust suppressants. Water will be used as the preferred dust suppressant to avoid calcium chloride or other chemicals which may attract wildlife to the road. If this approach is not successful, alternatives will be investigated taking into account wildlife sensitivities.

Regional Implications for Wildlife/Vehicle Interactions

Since there is a broader implication for wildlife interactions that could result from an increase in vehicle use of Highways 37 and 37A, a regional transportation perspective is required. The Application/EIS will consider regional transportation in Section 18.9, Cumulative Effects Assessment for Wildlife.

29.21.5.4 Monitoring

All truck drivers will be required to report wildlife collisions/mortalities along the haul roads, access roads, and highways. The location along the road and species will be recorded and monthly mortalities will be summarized to identify conflict "hot-spots", which may then be used as part of an adaptive management plan to further mitigate conflicts between road users and wildlife.

29.21.6 Wildlife Helicopter Management Plan

BC MOE guidelines for helicopter use (BC MOE 2006c, 2010a) recommend helicopters observe a buffer distance from mountain goat habitat, 2-km horizontal and 400-m vertical separation from all mountain goat habitat, where possible (BC MOE 2010a). The BC management plan also recommends that low-altitude flights be avoided during the critical natal period for mountain goats (April to July). Where possible, flight paths will be planned and/or rerouted to at least 500 m or greater from known natal areas during this period, and flights will be flown at higher altitudes. In addition, locating helicopter landing areas (e.g., heli-ports or heli-pads) within 2 km of confirmed natal areas will be avoided.

To minimize disturbance, aerial support, including helicopter access, will be directed along controlled routes or flight paths that follow the guidelines. However, if construction activities are required in identified mountain goat habitat a survey will be undertaken beforehand to ensure that habitat is not occupied by mountain goats. Specific flight paths will be determined before construction commences and will be followed, unless extreme weather and safety require pilots to fly within the buffer. Locations of these flight paths and the reasons they must be used will be communicated to all workers involved in aviation support. Pilots will be required to follow flight paths.

29.21.7 Wildlife Light Management Plan

To avoid over-lighting the level of illumination will be the minimum required for safe completion of tasks. The potential effects of sensory disturbance on wildlife by exposure to light will be mitigated through infrastructure design and by applying applicable measure as present in various guidelines (e.g., *Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia*; *Migratory Birds Environmental Assessment Guideline*; BC MOE 2006).

Lighting at the Brucejack Mine Site will be designed to minimize potential effects on wildlife while ensuring safe operational conditions. The final lighting design will include the following considerations:

- minimize the level of illumination required for the task to avoid over-lighting;
- use directed lighting rather than broad area lighting wherever possible;
- shield lighting and direct it downwards using full cut-off fixtures; and
- switch on lighting only when it is necessary for safe mine site operation.

29.21.8 Employee Wildlife Education and Training Program

An education program for employees and contractors will be developed to promote stewardship and limit human conflicts with wildlife. This program will be supported by Standard Operating Procedures, standard reporting forms, information sheets, posters, and signage. The education program will include an emphasis on:

- employee awareness of wildlife sensitive times of year;
- waste management/wildlife attractant protocols;
- no feeding or intentionally attracting wild animals;
- policies banning firearms and hunting;
- bear awareness training and response plan;
- legal and policy obligations concerning working near mountain goats and UWRs and bird nests;

- responsibilities for pilots to use designated flight paths and maintain appropriate distances from wildlife and wildlife habitat (e.g., ungulate winter range);
- operating protocols for the roads; and
- wildlife reporting and response procedures.

The effectiveness of the education program training will be continually reviewed and amended as required.

29.21.9 Wildlife Effects Monitoring Program

A Wildlife Effect Monitoring Program (WEMP) will be implemented and conducted as shown in Sections 29.21.9.1 to 29.21.9.2. In general, the WEMP will follow these principal guidelines with respect to population and habitat monitoring programs:

- on-site bird, mammal, and amphibian monitoring will be conducted annually and include recording of incidental observations, breeding evidence, mortality events and/or interactions with Project infrastructure;
- monitoring programs will include suitable treatment (i.e., close to the Project) and control sites (i.e., away from potential impacts due to the Project) that will be monitored using provincial Resources Information Standards Committee (RISC) methods, or other approved methods;
- data from monitoring programs will be analyzed using best practices and assessed for statistical power to detect changes in wildlife populations or habitat availability;
- the monitoring data, analyses, and power analyses will be reported in a WEMP report; and
- adaptive management will be implemented if local-area effects are reported for a wildlife VC, or if the monitoring report shows a decline in the VC population near the Project (i.e., treatment area) compared to control areas.

29.21.9.1 Moose Monitoring Program

Objectives

If moose mortalities are recorded at a rate higher than average mortality rates in the northwest region of BC, it will trigger this Program to monitor for any effects of the Project on moose and to monitor effectiveness of mitigation measures. The primary objectives of the Moose Monitoring Program are to:

- monitor for changes in moose distribution, behaviour, and demographics (e.g., productivity) and adaptively manage, where necessary; and
- monitor habitat loss and alteration to ensure total loss does not exceed the amount identified in the Application/EIS.

Site Monitoring

If triggered, a site monitoring program will be initiated during Construction and continue throughout the Operation phase to monitor for effects of the Project on moose and to monitor the effectiveness of mitigation measures. The following site monitoring will be conducted for moose:

- incidental observations of moose within the development and transportation infrastructure footprint will be monitored and recorded;

- direct interactions of moose with infrastructure (e.g., roads, camps, etc.) will be monitored and recorded;
- vehicle collisions with moose along Project site and access roads will be monitored and reported (Wildlife Access and Traffic Management Plan, Section 29.21.5), including collisions with transport vehicles associated with the Project on highways while transporting ore, materials, etc.; truck drivers will be informed of their obligations and protocol of reporting consistent with the protocol outlined in the Wildlife Access and Traffic Management Plan (Section 29.21.5) and the Wildlife Employee Education Training Program (Section 29.21.8);
- observations of illegal access, harvest, or harassment associated with access roads and infrastructure will be reported, with special attention given to monitoring the effectiveness of the security gate at preventing access; and
- incidental observations, incidents, and mortality events of moose will be recorded and reported.

Monitoring of moose incidental observations, incidents, mortality, and movement within the development footprint and transportation infrastructure will be conducted during Construction and Operation. Vehicle collisions with moose or mortality by other means will be reported to, and recorded by, the environmental personnel and immediately receive further investigation. High frequency of mortality or incidents will trigger a review of current management and mitigation measures.

All workers will be expected to contribute to the protection of wildlife, as defined during their Employee Wildlife Education and Training Program (Section 29.21.8), while the environmental personnel will be responsible for interpreting any information received, conducting follow-up monitoring if required, and summarizing the observations in a detailed WEMP report.

Moose Population Monitoring

A population monitoring program will be conducted every five years from construction start-up of the Project if moose mortalities are recorded at a rate higher than average mortality rates in the northwest region of BC, to monitor for any effects of the Project, on moose and to monitor effectiveness of mitigation measures. The following local population monitoring will be conducted for moose:

- moose monitoring (conduct aerial surveys) will be conducted every five years to track population, distribution, and productivity, and if changes are detected and deemed to be as a result of the Project, adaptive mitigation measures will be implemented;
- record loss and alteration of moose habitat will be recorded if major changes are planned to the Project infrastructure footprint (e.g., approximately every five years) by overlaying the mine updated footprint with the baseline habitat suitability maps to compare predictions derived from the effects assessment of moose habitat; and
- water quality and dust fall across the LSA will be monitored as part of the Aquatic Effects Monitoring Plan (Section 29.3) and Air Quality Management Plan (Section 29.2); this information may then be used to evaluate potential effects on moose health, if necessary.

Changes in winter population or distribution due to the Project in the RSA will trigger a review of regional population trends and of current management and mitigation measures. Loss of high-quality habitat greater than the amount identified in the Application/EIS will also trigger a review of management and mitigation measures. It is anticipated that with the current Project design these targets will be met. Additional mitigation measures may be needed if a change in the disturbance area increases.

Moose population monitoring will follow industry standard (e.g., BC MFLNRO Wildlife Branch guidelines for managing ungulates in the Skeena). Inventory methods will be similar to baseline data collection and adhere to RISC standards (RIC 2002). Aerial surveys for moose will be conducted in the LSA during the winter to ensure population, productivity, and distribution remains within anticipated natural variation (Gaillard et al. 2000). Survey units delineated during the baseline inventory will be used during the monitoring program. Data analyses will follow standard methods for moose population surveys (e.g., Demarchi 2011). Sex and productivity ratios will be calculated and compared over years. An observed trend of reduced population will trigger a review of the moose management plan to determine if the Project is influencing moose population declines.

29.21.9.2 Mountain Goat Monitoring Program

Objectives

If mountain goat mortalities are recorded at a rate higher than the average mortality rates in the northwest region of BC, it will trigger to this program to monitor for any effects of the Project, on mountain goats and to monitor effectiveness of mitigation measures. The primary objectives of the Mountain Goat Monitoring Program are to:

- monitor for changes in mountain goat distribution and behaviour and adaptively manage, where necessary; and
- monitor habitat loss and alteration to ensure total loss does not exceed the amount identified in the Application/EIS.

Site Monitoring

If triggered, an on-site monitoring program will be initiated during Construction and continue throughout the Operation phase to monitor for effects of the Project on mountain goats and to monitor the effectiveness of the mitigation measures. The following monitoring will be conducted for mountain goats:

- direct interactions of goats with infrastructure (e.g., roads, adit, etc.) will be monitored and recorded;
- mountain goat incidents and mortality events will be monitored, recorded, and reported;
- vehicle collisions with mountain goat along Project site and access roads will be monitored and recorded;
- incidental observations of mountain goats will be recorded and reported as per government requirements;
- avalanche management zones H, G, F, D, and C are associated with goat habitat and will therefore be assessed prior to blasting activities to determine the extent of the slide areas to be monitored (Section 29.4, Avalanche Management Plan). Goat monitoring will be conducted in avalanche zones prior to avalanche control activities if the extent of potential slide activity has been identified near occupied goat habitat; however, poor visibility conditions may prohibit monitoring during heavy snow accumulations; and
- observations of illegal access, harvest, or harassment associated with access roads and infrastructure will be reported.

Monitoring will be conducted during Construction and throughout Operation. High frequency of mortality or incidents will trigger a review of current management and mitigation measures.

Mountain goat monitoring will include recording mountain goat observations within the development footprint and transportation infrastructure. All workers will be expected to contribute to the protection of wildlife as defined during their Employee Wildlife Education and Training Program (Section 29.21.8), while the environmental personnel will be responsible for interpreting the information and conducting follow-up monitoring if required.

Vehicle collisions with mountain goats or mortality by other means will be immediately recorded by the environmental personnel and receive further investigation. More intensive monitoring will be conducted during sensitive periods in association with construction and avalanche control, if applicable.

Mountain Goat Population Monitoring

A population monitoring program will be conducted every five to ten years from construction start-up of the Project, if mountain goat mortalities are recorded at a rate higher than the average mortality rates in the northwest region of BC, to monitor effects of the Project on mountain goat and to monitor effectiveness of mitigation measures. A population monitoring program will be conducted every five years during the Operation phase to monitor the effects of the Project on mountain goats and to monitor effectiveness of mitigation measures. The following monitoring will be conducted for mountain goats:

- mountain goat populations will be monitored (e.g., aerial surveys) every five years and if changes are detected, and are deemed to be as a result of the Project, adaptive mitigation measures will be implemented; and
- loss and alteration of mountain goat habitat will be recorded at various stages of Operation if significant changes are planned to the Project infrastructure footprint (e.g., approximately every five years) by overlaying the mine footprint with the baseline habitat suitability maps to confirm predictions derived from the effects assessment of mountain goat habitat.

If monitoring identifies reduced kid to adult ratio due to the Project or loss of high-quality habitat greater than the amount identified in the Application/EIS will trigger a review of management and mitigation measures. It is anticipated that with the current Project design, these targets will be met.

Mountain goat population monitoring will be conducted every five years, following industry standards (e.g., BC MFLNRO Wildlife Branch guideline for managing ungulates in the Skeena). Inventory methods will be similar to baseline data collection and adhere to Resources Information Standards Committee standards (RIC 2002). Aerial surveys for mountain goat will be conducted in the LSA during the winter and summer to ensure population, productivity, and distribution remains within anticipated natural variation. Survey units delineated during the baseline inventory will be used during the monitoring program and will include the UWR north and south of the access road, particularly above Knipple Glacier, along Mount Knipple, and northwest of the Brucejack Mine Site. An observed trend of reduced population will trigger a review of the goat management plan to determine if the Project is causing goat population declines.

29.21.10 Work Plan and Schedule

The management measures that will be implemented to minimize and avoid adverse effects on wildlife and wildlife habitat will occur throughout the various Project phases. Table 29.21-3 summarizes when the management activities associated with wildlife-related management plans will occur. Table 29.21-4 summarizes the frequency of monitoring for the WEMP.

Table 29.21-3. Management Plans Describing Mitigation and Management Measures Applicable to Wildlife and Wildlife Habitat, and Associated Project Phases

Management Plan	Construction	Operation	Closure	Post-closure
Wildlife Management and Monitoring Plan	X	X	X	X
Wildlife Access and Traffic Management Plan	X	X	X	X
Avalanche Management Plan	X	X	X	
Noise Management Plan	X	X	X	
Waste Management Plan	X	X	X	X

Table 29.21-4. Frequency of Monitoring Activities for the Wildlife Effects Monitoring Program

Type of Monitoring Activity	Focal Species	Monitoring	Frequency
Site Monitoring	Birds, Mammals, Amphibians	Incidental observations	Annually
Site Monitoring	Birds, Mammals, Amphibians	Incidents and mortality events	Annually
Site Monitoring	Birds, Mammals, Amphibians	Breeding evidence in or near infrastructure (e.g., nest in infrastructure, western toad breeding ponds)	Annually
Site Monitoring	Birds, Mammals, Amphibians	Interaction with infrastructure (e.g., waterfowl and Brucejack Lake, bats and adits, furbearers and building skirting)	Annually
Moose Monitoring Program	Moose	Population monitoring	If triggered, every 5 years
Mountain Goat Monitoring Program	Mountain Goat	Population monitoring	If triggered, every 5 years

29.21.11 Follow-up Program

A follow-up program is required to be considered for a comprehensive study type of EA and when - in conjunction with project phases, Construction, Operation, Closure, and Post-closure (CEA Agency 2013). The follow-up program will include the suitability and effectiveness of measures implemented to mitigate or compensate for impacts on moose and mountain goats. As an adjunct to the objectives identified in the WEMP, the follow-up program will evaluate the implementation and effectiveness of mitigation measures, verify the predictions of the EA, and identify opportunities for adaptive management. This program will also define meaningful and relevant (if any) indicators, thresholds, and/or clear definitions of acceptable change, to facilitate adaptive management and aid in determining when additional mitigation, monitoring or reporting is necessary.

29.21.12 Reporting Requirements

A summary of the monitoring data collected under the WEMP will be included in an annual WEMP report to government officials. The report will summarize wildlife conflicts and identify any adaptive management measures that were employed.

If population monitoring is required as a result of mortality rates, results will be presented in the years they are conducted. The total area of habitat lost (if any) and the area that was reclaimed and re-vegetated (if any), will be presented in the WEMP report for that year (Chapter 30, Closure and Reclamation). Results of the ungulate population monitoring programs will be presented in the WEMP report as they are conducted. The WEMP will include analyses of the results with comparisons to data

collected from earlier years (i.e., baseline and previous monitoring years) and will include recommendations (if any) for changes to wildlife monitoring and management practices.

Reporting on the application of the WEMP will be the responsibility of the Environmental Manager.

29.22 REPORTING

29.22.1 Introduction

This section of the Application/EIS describes both compliance and voluntary reporting Pretium will undertake, and cross-references the information presented to the relevant EMPs described previously in Sections 29.2 to 29.21 of this chapter.

To maintain compliance with permit conditions, Pretium will undertake a reporting program that will be applied throughout the life of the mine. Compliance reporting will comprise the necessary reporting to address general legal requirements as well as the prescribed provincial and federal statutes. Voluntary reporting may be undertaken to supplement the statutory reporting and will be at the discretion of Pretium.

29.22.2 Compliance Reporting Requirements

The Application/EIS process currently underway is in pursuit of the statutory authorization required for the Project to proceed, in accordance with both federal and provincial regulatory obligations. Applications will be submitted for the necessary authorizations and permits for particular Project components and activities beginning during the EA review process.

Table 29.22-1 below presents expected reporting requirements for various authorizations, including applicable legislation and responsible agency. References to particular EMPs are provided as appropriate. The table will be maintained in an updated form as the Project progresses, including in response to any changes in the authorization or permitting conditions. The final suite of reporting requirements will be formulated based on permit conditions and in consultation with the responsible regulatory agencies.

29.22.3 Voluntary Reporting

The EMPs provided in Sections 29.2 to 29.21 include mitigation measures that will be implemented to reduce and manage possible environmental effects in a systematic manner. EMPs are in part based on the principle of adhering to recognized best management practices and achieving an acceptable level of mitigation of identified environmental effects.

Pretium may undertake certain voluntary reporting in cases where the reporting has a clear purpose and is properly defined. An example would be participation in information gathering specific to a particular subject area that would contribute to Provincial databases, such as BC's Invasive Alien Plant Program.

29.22.4 Reporting Responsibility

A fundamental objective of reporting is to provide a measurement of performance. The standards against which performance is to be measured must be established and this requires that responsibilities be specifically defined.

Table 29.22-1. Statutory Reporting Requirements for the Project

Legislation	Responsible Agency	Permit/ Authorization/ Program	Anticipated Compliance Reporting Requirements	Required Environmental Management Plan (if applicable)
<i>BC Environmental Assessment Act (2002a)</i>	BC EAO	EA Certificate	Submission of reports as required in the EA Certificate and Schedule B, Table of Conditions.	As listed in Schedule B of the EA Certificate.
<i>Mineral Tenure Act (1996h)</i>	BC Ministry of Energy and Mines	Mining Lease	Heritage Inspection Permit issued by BC Archaeology Branch.	29.8: Heritage Management Plan.
<i>Mines Act (1996i)</i>	BC Ministry of Energy and Mines	<i>Mines Act Permit; Explosives Storage and Use Permit; Health, Safety and Reclamation Code for Mines in British Columbia (the Code; BC MEMPR 2008)</i>	By March 31 of each year, deliver to the Chief Inspector a report for the previous calendar year outlining workplace conditions as per Section 1.9.3 of the Code.	29.6: Emergency Response Plan. 29.7: Hazardous Materials Management Plan.
			Establish a written program (as per Section 2.1.3 of the Code) to monitor workplace contaminants to ensure employees shall not be exposed to airborne concentrations of chemical agents or noise in excess of the levels specified in Section 2.1.1 of the Code, and retain a written record of monitoring results to transfer to the Chief Inspector upon abandonment of the mine.	29.7: Hazardous Materials Management Plan. 29.17: Waste Management Plan.
			In the event of an accident or dangerous occurrence, notify the Chief Inspector and provide a report, as laid out in Section 1.7 of the Code.	29.6: Emergency Response Plan. 29.7: Hazardous Materials Management Plan. 29.14: Spill Prevention and Response Plan.
			Develop and file with the Chief Inspector, a Mine Emergency Response Plan, which will be kept up to date as per Section 3.7.1 of the Code.	29.6: Emergency Response Plan.
			A Construction Management Plan will be developed and submitted prior to the start of construction, relevant to the planned construction activities.	29.1.3.4: Project Phases.
			As specified in Section 10.1.4(5) of the Code, submit an annual report of reclamation and environmental monitoring work performed under Section 10.1.4(4).	30: Closure and Reclamation.
			Upon closure or declared closure of a major impoundment, submit a report to the Chief Inspector in accordance with Section 10.6.10 of the Code.	30: Closure and Reclamation.
			Prior to operation of each applicable tailings or water management facility, submit an “as-built” report to the Chief Inspector certifying that the facility was designed and constructed according to Section 10.1.5 of the Code.	29.15: Tailings Management Plan. 29.19: Water Management Plan.

(continued)

Table 29.22-1. Statutory Reporting Requirements for the Project (continued)

Legislation	Responsible Agency	Permit/ Authorization/ Program	Anticipated Compliance Reporting Requirements	Required Environmental Management Plan (if applicable)
<i>Mines Act</i> (1996i) (cont'd)			An Explosive Management Plan will be submitted by the explosives contractor for review and approval prior to any blasting being conducted.	29.7: Hazardous Materials Management Plan.
			Results of the ML/ARD analytical testwork (including raw data, sample descriptions, QA/QC and deposition inventory) will be reported in the Annual Reclamation Report.	29.10: ML/ARD Management Plan.
			Monitoring results of water quality and quantity, including interpretation of the results and any implications for management, will be reported in the Annual Reclamation Report.	29.3: Aquatic Effects Monitoring Plan. 29.19: Water Management Plan.
<i>Environmental Management Act</i> (2003a)	BC Ministry of Environment	Waste Discharge Regulation (BC Reg. 320/2004; effluent and air permits); Municipal Wastewater Regulation (BC Reg. 87/2012; sewage treatment plant registration); Hazardous Wastes Regulation (BC Reg. 63/88; hazardous waste registration); Petroleum Storage and Distribution Facilities Storm Water Regulation (BC Reg. 168/94; storage facilities registration); Spill Reporting Regulation (BC Reg. 263/90; spill reporting)	Annual water quality report (combined report is submitted to MEM and MOE to meet the requirements of both agencies), aquatic effects monitoring, reporting of any reportable spills; hazardous waste registration updates as applicable; fuel storage reporting (include in annual report); and monthly dustfall report.	28: Environmental Management System. 29.2: Air Quality Management Plan. 29.3: Aquatic Effects Monitoring Plan.
			A Construction Management Plan will be developed, submitted for approval, and implemented.	29.1.3.4: Introduction; Project Phases.
			Annual summary report which includes the previous calendar year sampling results.	29.3: Aquatic Effects Monitoring Plan. 29.19: Water Management Plan.
			An erosion control plan will be developed, submitted for approval, and implemented.	29.13: Soils Environmental Management Plan.
<i>Heritage Conservation Act</i> (1996f)	BC Ministry of Forests, Lands and Natural Resource Operations	Permit	Reporting to Archaeology Branch.	29.8: Heritage Management Plan.
<i>Water Act</i> (1996j)	BC Ministry of Forests, Lands and Natural Resource Operations	Water License Section 8 Approval	Water volumes withdrawn.	29.19: Water Management Plan.
<i>Land Act</i> (1996g)	BC Ministry of Forests, Lands and Natural Resource Operations	License of Occupation	Confirmation of transmission line structure locations, cutting area, vegetation management/reclamation, shape file of area to be converted to Stat ROW.	29.5: Ecosystem Management Plan. 29.13: Soils Management Plan.

(continued)

Table 29.22-1. Statutory Reporting Requirements for the Project (continued)

Legislation	Responsible Agency	Permit/ Authorization/ Program	Anticipated Compliance Reporting Requirements	Required Environmental Management Plan (if applicable)
<i>Forest Act</i> (2002b)	BC Ministry of Forests, Lands and Natural Resource Operations	Occupant License to Cut	Confirmation of timber volumes harvested, shape file of area.	29.13: Soils Management Plan.
<i>Drinking Water Protection Act (Drinking Water Protection Regulation)</i>	Northern Health Authority	Waterworks Construction and Operations	Monthly sampling of potable water; submission of results	29.19: Water Management Plan.
<i>Weed Control Act</i> (1996k)	Ministry of Agriculture	Weed Control Regulation (BC Reg. 66/85)	Inspection reports as required.	29.9: Invasive Plants Management Plan.
<i>BC Greenhouse Gas Reduction (Cap and Trade) Act</i> (2008a)	BC Ministry of Environment	BC Reporting Regulation (BC Reg. 272/2009)	For those calendar years that the proposed Project meets the GHG emissions mandatory reporting criteria (over 10,000 t CO ₂ e/year): prepare a GHG emissions report and submit by March 31 the following year. For emissions over 25,000 t CO ₂ e/year, emissions must first be verified by an independent and accredited third party before the report is submitted.	29.2: Air Quality Management Plan.
<i>Canadian Environmental Protection Act</i> (1999)	Environment Canada	National Pollutant Release Inventory (NPRI; Environment Canada 2013)	For those calendar years that the proposed Project meets the NPRI reporting requirements (as per the NPRI Notice published in the Canada Gazette): create, certify, and submit an NPRI inventory report by June 1 (or whichever deadline the Notice states) the following year.	Only if emissions from previous year warrant it.
		Greenhouse Gas (GHG) Emissions Reporting Program; Ozone-depleting Substances Regulations (SOR/99-7)	For those calendar years that the proposed Project meets the GHG emissions mandatory reporting criteria (over 50,000 t CO ₂ e/year) specified in the annual notice published in the Canada Gazette: prepare a GHG emissions report and submit by June 1 (or whichever deadline the Notice states) the following year.	29.2: Air Quality Management Plan.
		Environmental Emergency Regulations (SOR/2003-307); Spill Reporting Regulation (BC Reg. 263/90)	A report on the release of a substance listed in the regulations (SOR/2003-307), detailing the substance and the company's response to the release; (BC Reg. 263/90) specifically requires the preparation of a plan to deal with environmental emergencies.	29.6: Emergency Response Plan. 29.7: Hazardous Materials Management Plan. 29.14: Spill Prevention and Response Plan. 29.17: Waste Management Plan.

(continued)

Table 29.22-1. Statutory Reporting Requirements for the Project (completed)

Legislation	Responsible Agency	Permit/ Authorization/ Program	Anticipated Compliance Reporting Requirements	Required Environmental Management Plan (if applicable)
Fisheries Act (1985c)	Environment Canada	Metal Mining Effluent Regulation (MMER; SOR/2002-222), Sections 21 to 24; Schedule 5 Sections 8, 14, 17, 19, 21, 23, and 25	Once the Project becomes subject to Section 7 of the MMER, complete weekly to monthly monitoring of surface water flow and effluent characterization, monthly to quarterly acute toxicity testing, and quarterly monitoring of receiving environment water quality, with quarterly and annual summary reports.	29.3: Aquatic Effects Monitoring Plan. 29.10: ML/ARD Management Plan. 29.19: Water Management Plan.
			Complete and report on effluent characterization, water quality monitoring, and sublethal toxicity testing in annual reports.	29.3: Aquatic Effects Monitoring Plan. 29.10: ML/ARD Management Plan.
			Reports every 36 or 72 months on biological monitoring study (water quality, sediment, benthos, and fish) designs and study results.	29.14: Spill Prevention and Response Plan. 29.19: Water Management Plan.
			Develop Emergency Response Plan - for unplanned release of deleterious substances.	
		Metal Mining Effluent Regulation (MMER; SOR/2002-222), Section 31	Immediate reporting (or within <30 days) of the abnormal release of a deleterious substance into a waterbody.	29.3: Aquatic Effects Monitoring Plan. 29.6: Emergency Response Plan. 29.7: Hazardous Materials Management Plan. 29.14: Spill Prevention and Response Plan.
<i>Canadian Environmental Assessment Act, 2012 (2012)</i>	CEA Agency Environment Canada Natural Resources Canada	EA Decision Statement	Follow-up reporting if required, per Section 5 of CEAA 2012.	If required.

The reporting responsibilities for the Project will be managed as an integral component of Pretivm's Environmental Management System (EMS) as described in Chapter 28. An EMS typically reflects the organizational structure that supports environmental management and in the case of the Project, Pretivm's Environmental Policy (Pretivm 2013) provides the point of departure. The reporting responsibilities will be managed by Pretivm personnel specifically assigned the respective tasks, including oversight of contractors' reporting duties.

Through operating in compliance with all applicable health, safety, and environmental statutes, the Project will afford the proper attention to protecting worker safety. Meeting these responsibilities also addresses responsible management of fish and wildlife habitat, the potential release of contaminants and waste products to the air, water and soil, and the protection of heritage resources.

Pretivm will appoint an Environmental Manager who will be responsible for all matters related to environmental management of the Project. The Environmental Manager will provide line-function accountability to Pretivm's executive management and staff-function accountability to the Mine Manager, to whom compliance reports will be submitted. The Environmental Manager and his/her support personnel will work in collaboration with the Project's health and safety personnel, in the interests of integration and functional efficiency.

The Mine Manager will carry line-function accountability for the Project's environmental performance, with the support and advice of the Environmental Manager, which will include planning, oversight, monitoring and reporting. Environmental management tasks will typically comprise undertaking regular inspections, recording and reporting on inspection findings, initiating corrective actions for non-compliance, and maintaining an acceptable level of training and awareness among personnel.

The Environmental Manager will have the authority to suspend specific activities where non-compliance or infractions are occurring, until such time as the non-compliance or infraction is satisfactorily rectified. The importance of incident reporting of non-compliance or infraction is thus clear, contingent upon permit requirements, regulations and commitments being properly understood at the workplace level and managed accordingly for the Construction, Operation, Closure, and Post-closure phases of the Project.

The Project's Environmental Manager will be supported by Pretivm personnel assigned to defined tasks as required. In this way, a system of support and monitoring of environmental performance as carried out at the workplace can be provided. Contractors appointed to undertake aspects of the Project will also be required to meet prescribed environmental performance standards and to this end will be expected to provide personnel with defined environmental responsibilities.

29.22.5 Notification

Pretivm will make the various reports and plans described above available to the relevant government agencies. The media in which the reports and plans will be provided, as well as the format, content, and frequency of reporting will be defined by permit conditions or discussed and agreed to by the appropriate parties.

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