24. ENVIRONMENTAL MANAGEMENT PLANS AND REPORTING

24.1 ENVIRONMENTAL MANAGEMENT SYSTEM

24.1.1 Context

This chapter describes the proposed Environmental Management System (EMS) that HCMC has in place, in support of their commitment to undertaking the proposed Project in a sustainable manner that accords with HCMC's guiding principles on environmental management.

As a matter of principle, HCMC will make every reasonable effort to minimize the long-term environmental impacts of the Project, while ensuring that lasting benefits accrue to local communities, and that economic and social advantage is generated for shareholders, employees, and the community at large. To this end, HCMC is committed to the development of resources in a sustainable manner that achieves a balance between the environment, society, and the economy. HCMC's Environmental Policy that will underpin this EMS is described in more detail in Section 24.1.4 below.

With reference to the Application Information Requirements (AIR; BC EAO 2011) for the Project, a description of the EMS is required such that the various discrete and subject area-specific Environmental Management Plans (EMPs) have a point of departure and are aligned with the overarching environmental management objectives that HCMC is committed to. Additionally, it is a requirement of permits issued under the *Mines Act* (1996b) in BC that an EMS should provide the high-level supporting framework for the EMPs.

For an EMS to be effective, it needs to be integrated within the company so that it can be applied in a structured manner. An EMS should thus enable a company to formulate and implement a policy and objectives that take into account the legal and information requirements of relevance to significant environmental aspects of the company's activities. The success of the system will depend on all levels and functions within the organization, and particularly top management, committing to the EMS. HCMC recognizes sound environmental management as a corporate priority and is intent on integrating it into all aspects of their organization.

This chapter is structured according to HCMC's environmental objectives, generic EMS principles, overarching policy commitments, allocation of roles, responsibilities and associated resources, and the way forward with the initial EMS and the currently envisaged EMPs.

24.1.2 Objectives

HCMC's overarching objective is to maintain, as far as possible, the integrity and functionality of the current ecosystem, encompassing both biophysical and human environments, during the entire development cycle, i.e., throughout Construction, Operations 1, Operations 2, Closure, and Post-Closure phases of the Project. This objective will be met by:

- averting undesirable impacts, where feasible;
- mitigating undesirable impacts that are unavoidable; and
- ameliorating where possible those undesirable impacts that cannot be mitigated.

It is intended that HCMC will treat the disturbed areas upon closure and reclamation of the Project such that a level of ecological productivity is established that will match the pre-development conditions as far as possible, while complying with regulatory requirements and applying methodologies that are technically proven and economically feasible.

Fundamental to achieving any stated objective is the demonstration that the means are available for adequate engagement with affected communities on Project issues that could potentially affect them, and that relevant environmental and social information is freely disclosed and disseminated.

24.1.3 Generic Environmental Management System Principles

A typical EMS, such as the ISO 14000 series of standards, is based on the principle of continual improvement. To achieve continual improvement, an iterative process of planning, implementing, checking, and acting is undertaken. Such an adaptive management approach is typically applied in the following manner:

- planning – during which objectives are established and processes defined that accord with the company's ethos (typically represented in an Environmental Policy);
- implementing – during which the defined processes (or actions) are carried out;
- checking – during which the processes carried out are monitored, measured against the objectives (including legal obligations), and reported; and
- acting – during which additional actions are undertaken, if necessary, to achieve continual improvement in the company's environmental performance (may require revising high-level planning, i.e., policy).

Note that the adaptive management approach is usefully applied at subject area-level, per the specific EMPs described in Section 24.2 below.

The initial EMS thus needs to organize and guide all the Project activities throughout the entire life cycle of the mine. This will coordinate and facilitate safe, orderly, compliant, and environmentally and socially responsible operations that can minimize the Project's effects on both the biophysical and human environments. In this way, a systematized framework will be provided within which the discrete, subject area-specific EMPs will be developed, implemented, maintained, and updated.

24.1.4 Parent Company Environmental Policy

YMI strives to be an exemplary leader in environmental management and seeks to meet existing regulatory standards and to minimize undesirable effects on the environment to the extent possible. YMI's Code of Business Conduct and Ethics (www.yellowheadmining.com/s/Governance.asp) makes specific reference in Section VIII, Compliance with Environmental Laws, to the Company's policy being "to comply with all applicable environmental laws and regulations within all jurisdictions in which it operates".

To meet the compliance objective, the YMI has developed an Environmental Policy for the Project (Yellowhead Mining Inc. n.d.), which also applies to HCMC. The following is an excerpt from the policy:

> *Yellowhead Mining Inc. ("Yellowhead") and its subsidiary Harper Creek Mining Corporation ("HCMC") are committed to a policy of sustainable resource development which embodies the protection of life, human health and the environment.*
>
> *We will respect the needs and culture of the local communities.*
>
> *All of our employees are responsible for incorporating into their planning and work the actions necessary to fulfil this commitment.*
>
> *Yellowhead and HCMC will ensure that it employees have the necessary resources to:*
>
> - *Conduct our business in an environmentally sound manner.*
> - *Integrate environmental policies, programs and practices into all aspects of our operations.*
> - *Develop, construct, operate, close and rehabilitate our facilities to comply with all applicable laws and to meet all applicable regulatory requirements.*
> - *Use the best available technologies and the best available management practices to minimize risks to health, safety and the environment.*
> - *Develop and maintain comprehensive environmental monitoring, compliance verification and reporting programs.*
> - *Develop and maintain appropriate emergency preparedness and response plans to ensure protection of life, human health and the environment.*
> - *Continually improve the safe, efficient use of energy, resources, and materials.*
> - *Communicate openly with employees, stakeholders, First Nations and government on our plans, programs and performance.*

It will be the responsibility of every employee of YMI and HCMC to carry out their daily activities in accordance with the Environmental Policy.

24.1.5 Resources and Responsibilities

With reference to the planning and implementing iterations in a typically cyclical EMS application, it is necessary that resources are allocated to the tasks. These resources will comprise both human and material resources.

24.1.5.1 Human Resources

YMI and HCMC will allocate human resources to environmental management throughout its managerial levels, although it should be noted that these responsibilities may be conducted by personnel who have wider responsibilities and that their environmental management roles may typically be part of a portfolio of management responsibilities that each carries.

The arrangement of the organizational structure is such that objectives can be defined and met. These will comprise of early warning and response to environmental shortcomings, compliance with and response to changes to regulatory and policy requirements, and the evaluation and revision of environmental performance. The objectives are ultimately aimed at demonstrating diligence and transparency in HCMC's environmental management undertakings.

The organizational arrangement of the responsible personnel is as follows:

- Chief Executive Officer (CEO);
- Vice President (VP) Operations;
- VP Environment, Community and First Nations Relations;
- Mine Manager; and
- Mine Environmental Supervisor.

Reference is also made below to contractors' environmental responsibilities.

Based on the current operational workforce envisaged for the Project, the following is the proposed organizational structure and responsibilities for environmental management on site. It should be noted that refinement and confirmation of the organizational structure will emerge as the permitting process progresses.

Chief Executive Officer

The CEO will carry the ultimate responsibility for environmental management, both in terms of statutory compliance as well as corporate citizenship, and will direct, instruct, and approve the execution of such management on site.

Vice President Operations

The VP Operations will ensure that the resources required to develop, apply, and monitor an effective EMS and array of appropriate EMPs are made available. In this respect, the VP Operations will maintain a staff-function relationship with the VP Environment, Community and First Nations Relations, and a line-function responsibility to the Mine Manager and Mine Environmental Supervisor.

Vice President Environment, Community and First Nations Relations

The VP Environment, Community and First Nations Relations will appoint the Mine Environmental Supervisor, in consultation with the CEO and VP Operations, and will be responsible for the development, application, and monitoring of an effective EMS and array of appropriate EMPs. The Mine Environmental Supervisor will have a staff-function reporting responsibility to the VP Environment, Community and First Nations Relations.

Mine Manager

The on-site Mine Manager will carry line-function accountability for the Project's environmental performance, as one of a portfolio of management responsibilities. The Mine Manager will instruct and approve the on-site systems and resources, by delegation to appropriate line-function personnel and with the support and advice of the Mine Environmental Supervisor for planning, oversight, monitoring, and reporting.

Mine Environmental Supervisor

The Mine Environmental Supervisor will have the functional responsibility for all matters related to environmental management and will provide line-function accountability to the Mine Manager and staff-function reporting to the VP Environment, Community and First Nations Relations. The Mine Environmental Supervisor will interact via a staff-function role with relevant on-site personnel that have specified environmental management responsibilities. Compliance reports will be submitted to the Mine Manager and VP Environment, Community and First Nations Relations.

The role and span of responsibility of the Mine Environmental Supervisor may be a component of a broader portfolio that encompasses the management of health and safety on the mine. A scheduled and systematic system of support and monitoring of environmental performance as carried out at the workplace will be maintained, and compiling, reviewing, and seeking approval from the Mine Manager (or line-function delegate) for environmental management method statements and work instructions will be undertaken.

Contractors' Environmental Personnel

The previous paragraphs describe the human resources that YMI and HCMC will have in place. Additionally, contractors appointed to undertake certain aspects of the Project may be required to meet the prescribed environmental performance standards and to this end will be expected to have their own environmental management personnel (or delegated responsibility) in place. Such personnel will typically provide an environmental oversight role for activities associated with the particular contract being carried out. HCMC's Mine Environmental Supervisor for the Project will interact closely with the contractor's environmental personnel, whose task will usually 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 the contractor's personnel.

24.1.5.2 Material Resources

The undertaking of an EMS requires material resources to be allocated for particular actions and procedures. The elements of an Environmental Policy described in Section 24.1.4 above provides for material resources via the mandates contained in the responsibilities allocated to identified personnel. This is manifested in the commitment to implement various environmental actions such as procurement policies, protection measures, remedial practices, closure work, etc.

Material resources in the form of budgets, facilities, and materials will be provided for the training of personnel who have the responsibility of meeting environmental performance targets. Material resources will also be allocated for the dissemination of EMS information.

24.1.6 Formulation of Management Plans

24.1.6.1 Common Elements of Management Plans.

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.

24.1.6.2 Structure of Environmental Management Plans

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.

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, Operations 1 and 2, 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.

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.

24.1.6.3 Detailed Permitting

The detailed permitting requirements that will follow the Application/EIS submission and the issuing of an Environmental Assessment Certificate 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.

24.1.6.4 Currently Envisaged Environmental Management Plans

As described previously, the EMS provides a supporting framework for a series of written plans outlining the scope of environmental management for the Project that will ensure compliance with both regulatory requirements and YMI and HCMC's environmental policy. These currently comprise the following:

- Air Quality Management Plan;
- Archaeology and Heritage Management Plan;
- Emergency Response Plan;
- Explosives Handling Plan;
- Fish and Aquatic Effects Monitoring and Management Plan;
- Fuel and Hazardous Materials Management Plan;
- Groundwater Management Plan;
- Mine Waste and ML/ARD Management Plan;
- Noise Management Plan;
- Sediment and Erosion Control Plan;
- Selenium Management Plan;
- Site Water Management Plan;
- Soil Salvage and Storage Plan;
- Spill Prevention and Response Plan;
- Traffic and Access Management Plan;
- Vegetation Management Plan;

- Waste Management Plan; and
- Wildlife Management Plan.

The following sections of this chapter describe each of the EMPs and each EMP makes reference inter alia to the regulatory and policy framework, performance objectives, environmental protection measures, monitoring, scheduling, and reporting. The EMPs thus provide continuity in the progression from the overarching EMS described in this section, to the physical execution of the Project as proposed.

24.2 AIR QUALITY MANAGEMENT PLAN

24.2.1 Purpose

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

- the legislation and standards relevant to emissions associated with the Project;
- operational measures that will be established to avoid, control, and mitigate emissions associated with all phases of the Project;
- monitoring measures to collect on-site air quality data to meet regulatory requirements and to enable the implementation of adaptive follow-up programs as needed; and
- reporting requirements relevant to the Project.

This plan is dynamic and will be updated based on management reviews, regulatory requirements, consultation, and Project operational needs.

24.2.2 Performance Objectives

The objective of the Air Quality Management Plan is to establish measures to mitigate emissions from Project activities to meet air quality legislative requirements and to reduce the Project effects to reasonable levels. The sources included for consideration are suspended particulate matter (total suspended particles [TSP], PM_{10}, and $PM_{2.5}$), dustfall, and greenhouse gas (GHG) emissions. Exposure to airborne dust in the workplace is regulated by Workplace BC under Part 5 of the Occupational Health and Safety Regulation and by the British Columbia Ministry of Energy and Mines (BC MEM) under Part 2 of the Health, Safety and Reclamation Code for Mines in British Columbia (WorkSafeBC 2014; BC MEMPR 2008).

The relevant objectives and standards for ambient air quality, and the reporting regulations for GHG emissions, are provided below.

24.2.2.1 Air Quality

The applicable standards relating to the Project include:

- National Ambient Air Quality Objectives (NAAQOs; CCME 1999);
- Canadian Ambient Air Quality Standards (CAAQS; CCME 2013a);

- British Columbia Ministry of Environment (BC MOE) Air Quality Objectives and Standards (BC MOE 2013a);
- Pollution Control Objectives for the Mining, Smelting, and Related Industries (BC MOE 1979);
- Canada-wide Standards for Dioxins and Furans (CCME 2000a); and
- Canada-wide Standards for Mercury emissions (CCME 2000b).

Further details of the relevant federal and provincial ambient air quality criteria are provided in Chapter 9, Air Quality Effects Assessment.

In addition, under the authority of the *Canadian Environmental Protection Act* (1999), owners or operators of facilities that meet published reporting requirements are required to report to the Environment Canada National Pollutant Release Inventory (Environment Canada 2014b).

24.2.2.2 Greenhouse Gas

In support of Canada's GHG mitigation targets, since 2010, facilities emitting over 50,000 tonnes (t) CO_2e have been required to report emissions to Environment Canada for the Greenhouse Gas Emissions Reporting Program (Environment Canada 2014a), under the jurisdiction of section 46 of the *Canadian Environmental Protection Act* (1999).

In BC, 2010, facilities emitting over 10,000 t CO_2e must report to the BC MOE, and those emitting over 25,000 t CO_2e must also 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* (2008).

24.2.3 Operational Control Measures

In order to eliminate or reduce the potential for adverse effects on air quality during all phases of the Project, mitigation measures to reduce emissions and fugitive dust will be put in place. Details of these mitigation measures are described below.

24.2.3.1 Emissions Reduction

Mitigation measures will be in place during all phases of the Project to reduce suspended particulate matter and GHG emissions. The following sources of emissions have been identified:

- equipment exhaust emissions from vehicles such as dozers, haul trucks, forklifts, graders, and fuel trucks; and
- stack emissions, such as crushers, generators, and incinerators.

Based on experience from other mine projects, the following mitigation measures will be investigated and implemented as appropriate.

<u>General</u>

- Implementation of energy efficiency measures.
- Procurement policies to identif6y fuel and equipment specifications.
- Regular servicing of all mobile and stationary equipment to maintain efficiency.
- Necessary training and instruction for on-site staff with duties related to the operation of equipment that emit air pollutants or controls air emissions (e.g., the required measures to be implemented during start-up, shut down, and emergency conditions):
  - The site operator will maintain training requirements for each operational post and keep a record of the training received by each person.
- Adherence to all permits, authorizations, and approvals.

<u>Equipment Exhaust</u>

- Older engines will be retrofitted, as required in BC for models manufactured between 1989 and 1993 that weigh over 8,200 kilograms (kg; BC Ministry of Transportation and Infrastructure 2014).
- Minimization of vehicle and equipment idling, when not in use, taking account of differing operational requirements in summer and winter.
- Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination.
- Use of electric powered equipment in the open pit where practical, reducing the overall volume of exhaust emissions.
- Ensuring vehicles are driven at designated speeds on site roads.

<u>Stack Emissions</u>

- Use of emission control systems (e.g., wet scrubbers, baghouses, and filters) on stacks and on relevant ventilation systems where appropriate.
- Recycling program to minimize waste.
- Implementation of a waste segregation program (i.e., materials that are unsuitable for incineration, such as chlorinated plastics, will be diverted to alternate waste disposal facilities).

24.2.3.2 Fugitive Dust Reduction

Mitigation measures will be in place during all phases of the Project in order to minimize fugitive dust emissions. The following sources of fugitive dust have been identified:

- fugitive dust on unpaved roads from vehicles travelling on site roads; and
- fugitive dust emissions from mining activities such as bulldozing, grading, stockpiling, drilling, and blasting.

Based on experience from other mine projects, the following mitigation measures will be investigated and implemented as appropriate.

General

- Erection of windbreaks around identified problem areas to limit the dust emissions from equipment and stockpiles, and other activities likely to generate dust.
- Adherence to the Open Burning Smoke Control Regulation (BC Reg. 145/93), if land is cleared during construction.
- Reclaim and re-vegetate decommissioned areas as soon as practical.
- Training and instruction for on-site staff with duties related to activities that may cause fugitive dust:
  - The site operator will maintain training requirements for each operational post and keep a record of the training received by each person.
- Adherence to all permits, authorizations, and approvals.

Unpaved Roads

- Ensuring all-unpaved roads are regularly compacted and kept in good repair.
- Application of water or other commercial dust suppressants to roadways to minimize dust from ore and waste rock haulage and grading, when ambient air temperatures permit.
- Ensuring vehicles will be driven at designated speeds on site roads.
- Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination.
- Enclose or cover loads carried by vehicles when practical.

Mining Activities

- Crushing facility will be equipped with a dust suppression/collection system to control fugitive dust that will be generated during crushing, material loading, and related operations.
- Overland conveyors will be semi closed to prevent dust generation.
- Enclose discharge from crushers onto conveyors or into other equipment as far as is practicable (e.g., free fall of materials from conveyors carrying material to be fitted with a full hood).
- Minimize the discharge heights from the crushers onto conveyers and conveyors onto stockpiles.
- Using water sprays on materials that are likely to generate dust at transfer points when temperatures allow.
- Use of dust curtains on blast hole drilling equipment.

- Timing of blasting, where practical, for calm days or calm periods of the day, particularly in exposed areas near or above the pit rim, or use of delay blasting techniques.

24.2.3.3 Summary

A summary of the various Project phases and relevant emissions mitigation is shown in Table 24.2-1.

Table 24.2-1. Mitigation Schedule

Mitigation [a]	Construction	Operations 1	Operations 2	Closure	Post-Closure
Emissions reduction measures	Yes	Yes	Yes	Yes	No; Not considered necessary
Dust reduction measures	Yes	Yes	Yes	Yes	No; Not considered necessary

[a] *The plan will be re-evaluated as necessary.*

24.2.4 Monitoring

Evaluation of predicted effects will be conducted through facility-specific monitoring. The monitoring, quality control, and reporting procedures detailed in this plan will be used to:

- assess the effectiveness of mitigation and management measures;
- identify Project effects requiring further mitigation efforts;
- comply with permit and regulatory requirements;
- comply with requests from regulators and stakeholders; and
- adapt to changes in the regulations or the Project.

Monitoring will be the principal mechanism to provide feedback to continually gauge the effectiveness of environmental mitigation measures.

The Air Quality Monitoring Program will consist of the following components:

- performance monitoring and preventive maintenance of emission control works;
- dustfall monitoring as per permit requirements;
- meteorological monitoring; and
- GHG emission tracking to determine whether reporting is required.

Monitoring will be conducted by qualified personnel. Data will be submitted to the appropriate authorities in compliance with permit requirements and will be kept and made available to others for review upon request.

24.2.4.1 Dustfall Monitoring

Baseline dustfall data collection has taken place since 2011 and will continue to be conducted during construction and operation of the mine. Dustfall stations will be placed at similar locations to the baseline monitoring; however, locations may shift due to the development of the mine. The baseline dustfall monitoring program was developed in accordance with sampling method ASTM D1739-98 (ASTM Standard D1739-98 Reapproved 2010) and the guidelines outlined in the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators* (BC MOE 2012), and will continue to use this method for future monitoring.

HCMC will apply for a *Mines Act* Permit authorizing construction and operation of the mine and an *Environmental Management Act* Permit authorizing air emissions from the ore processing facilities. Terms and conditions of the permits will specify any monitoring requirements, including dustfall monitoring. HCMC will comply with the monitoring and reporting requirements of the permits. If adverse conditions are found in a particular area, adaptive management policies will be implemented.

24.2.4.2 Meteorological Monitoring

Meteorological conditions are an important consideration when assessing air quality as they influence the behaviour of emissions following release. A meteorological station was installed at the Project Site in 2011. The station will continue to operate throughout the Construction and Operations phases of the Project, though relocation of the station will be necessary. The station is a self-contained, solar/battery-powered system and includes instrumentation to measure hourly values of temperature, wind speed, wind direction, relative humidity, solar radiation, and rainfall.

24.2.4.3 Greenhouse Gas Monitoring

Sources of GHG emissions (e.g., fuel use for power, mobile and stationary equipment operation) will be tracked. A desktop assessment of GHG emissions based on fuel consumption will be carried out annually to determine whether reporting is required under existing federal or provincial GHG legislation.

24.2.4.4 Work Planning and Schedule

Table 24.2-2 provides a schedule of when monitoring activities will occur.

Table 24.2-2. Air Quality Monitoring Schedule

Monitoring	Construction	Operations 1	Operations 2	Closure	Post-Closure
Dustfall monitoring	As per permit requirements	As per permit requirements	As per permit requirements	No; Monitoring is not considered necessary; however, the plan will be re-evaluated as required.	
Meteorological monitoring	Yes	Yes	Yes	No	
GHG tracking	Yes	Yes	Yes	No; Monitoring is not considered necessary; however, the plan will be re-evaluated as required.	

24.2.4.5 Record Keeping

Record keeping will be conducted by the proponent. Data will be entered into suitable electronic databases, checked for quality control and assurance purposes, and stored. Data will be entered in a format and program that allow for comparison over time and storage in a single file format for each type of survey or monitoring activity. Designated personnel will coordinate preparation, review, and distribution, as appropriate, of the data and reports required for regulatory purposes.

24.2.4.6 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) measures will be undertaken at three key stages in monitoring activities: 1) during data gathering; 2) during data entry and analysis; and 3) through reporting and reassessment of methods as part of the evaluation of the effectiveness of the plan.

The process of data gathering in the field will be quality controlled through the use of qualified personnel and a system of pre- and post-field checks to ensure that consistent, repeatable data are being gathered. All personnel will have necessary training and accreditation.

24.2.4.7 Adaptive Management

Results from the monitoring programs will be reviewed annually to determine if any trends are evident and if regulatory 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. Indications of the need for corrective actions and additional control measures may include:

- monitoring data showing concentrations greater than applicable standards;
- monitoring data showing an increasing trend in contaminant concentrations; and
- issues raised by on-site staff, regulators, or local communities.

The cycle of mitigation activities, monitoring and evaluation, and instituting new mitigation activities if required, will provide adaptive management of air quality issues identified and arising as a result of the Project.

The proponent will conduct an annual (or as necessary) evaluation of the efficacy of mitigation and management activities and of monitoring activities using appropriate methods. This plan may be updated as frequently as every year, or not at all, if the mine plan and methods for mitigation and monitoring are found to be robust.

24.2.5 Reporting

The application of the Air Quality Management Plan will be reported in relevant reports each year during Construction and Operations as required by the applicable permit terms and conditions or other regulatory requirements, and will be submitted to the appropriate regulatory authorities as appropriate.

The Air Quality Management Plan is a "living document" and components of the plan may be revised over the life of the Project based on regulatory changes and/or technological advances.

24.3 Archaeology and Heritage Management Plan

24.3.1 Purpose

The purpose of the Archaeology and Heritage Management Plan is to outline:

- the legislation and standards relevant to protected heritage resources associated with the Project;
- control measures that will be established to mitigate effects on known archaeological sites during the Construction phase;
- chance find procedures that will be implemented to manage unknown archaeological and paleontological sites uncovered during the Construction phase; and
- reporting requirements relevant to the Project.

Two archaeological sites (EiQw-2 and EjQw-2) were identified as occurring within the Project Site, as they are situated within the proposed tailings management facility (TMF) for the Project. The nature of these sites is currently undetermined. The proponent proposes to work in close consultation with the Archaeology Branch and relevant First Nations to determine the most suitable means to mitigate the effects of the Project on these rock cairns, once their nature has been determined.

This plan is dynamic and will be updated based on management reviews and associated costing of the mitigation and monitoring activities relative to the long-term strategy for the Project, regulatory requirements, consultation, and Project operational needs.

24.3.2 Performance Objectives

The objective of the Archaeology and Heritage Management Plan is to establish measures to reduce adverse impacts to known archaeological sites through avoidance or systematic data recovery, and to minimize the potential for impacts to unknown archaeological or paleontological sites.

The plan addresses this by two means.

1. Provision of mitigation measures for the two known archaeological sites: EiQw-2 and EjQW-2.
2. Identification of the chance find procedure for dealing with the currently unknown archaeological and paleontological sites that could be uncovered during the Construction phase.

Archaeological sites are non-renewable resources, very susceptible to disturbance, and are finite in number. They are protected for their historical, cultural, scientific, and educational value to the general public, local communities, and First Nations. Alteration to protected archaeological sites requires a Site

Alteration Permit issued under section 12 of the *Heritage Conservation Act* (HCA; 1996a). Archaeological sites (both recorded and unrecorded) are protected in BC by the HCA (1996a).

If impacts to archaeological sites cannot be avoided additional permits will be required. Any required permits and approvals for mitigations will include an allowance by the Archaeology Branch for Aboriginal input and comments, and approval for impacts to archaeological sites will be at the discretion of the Archaeology Branch.

24.3.3 Environmental Protection Measures

Archaeological Impact Assessments (AIAs) completed for the Project identified two archaeological sites that may be impacted either directly or indirectly by Project activities (Terra 2012). Site Alteration Permits will be required prior to construction for the two archaeological sites that will be impacted by the Project. In order to eliminate or reduce the potential for adverse effects on archaeological and paleontological resources during the Construction phase of the Project, mitigation measures and chance find procedures will be put in place as described below.

24.3.3.1 Mitigation Measures

The two archaeological sites found, EiQw-2 and EjQw-2, may be potentially affected by the Project. A final methodology to determine the function of the rock cairns and the means to manage impacts from the Project will be determined in consultation with the Archaeology Branch and relevant First Nations. The potential effects and standard operating procedures for the two sites are identified in Table 24.3-1. Site-specific management guidelines will be developed through consultation with the Archaeology Branch of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (BC MFLNRO).

Table 24.3-1. Potential Effects and Standard Operating Procedures for Archaeological Sites within the LSA

Archaeological Site	Project Component	Potential Effect	Mitigation Measures
EiQw-2	TMF	Direct	Avoidance or additional work under a HCA section 14 Investigation Permit followed by a section 12 Site Alteration Permit if required.
EjQw-2	TMF	Direct	Avoidance or additional work under a HCA section 14 Investigation Permit followed by a section 12 Site Alteration Permit if required.

24.3.3.2 Chance Find Procedures

The chance find procedure for the Project recognizes that even the most thorough archaeological study may not identify all heritage resources that may be present. It will be implemented through the life cycle of the Project. Relevant Project staff will be familiarized with the procedure and the protocols for managing any chance finds that may occur during Construction and Operations.

The chance find procedure for the Project is outlined below.

1. **In the event that an archaeological or paleontological site is encountered or suspected in the course of work:**
    a. Stop all work in the area.
    b. Do not disturb the site.
    c. Report your discovery to your supervisor.
    d. Isolate and protect the area.
    e. Note the location and leave all discoveries in place.
    f. Prepare an initial Chance Find Form.
    g. An Archaeologist and the Archaeology Branch will be contacted, as required.
2. **In the event that suspected human remains are uncovered during the course of work, follow the Archaeology and Registry Services Branch Operational Procedures for Found Human Remains:**
    a. Stop all work in the area to avoid damaging the site.
    b. Do not disturb any possible human remains that you may encounter.
    c. Report your discovery to your supervisor, who will provide further instructions.
    d. If you are unable to contact a representative of the proponent, and the suspected human remains appear to be current, contact the Royal Canadian Mounted Police.
3. **If suspected human remains are encountered:**
    a. The Coroner's Office and local policing authority are notified and the Coroner's Office determines whether the matter is of contemporary forensic concern.
    b. If the remains are not of forensic concern, the Archaeology Branch will attempt to facilitate disposition of the remains.
    c. If a cultural affiliation for the remains can be determined, the Archaeology Branch will contact an organization representing that cultural group. If the remains are of aboriginal ancestry, the Archaeology Branch will attempt to contact the relevant First Nation(s).
    d. Generally, if remains are still buried and are under no immediate threat of further disturbance, they will not be excavated or removed. If the remains have been partially or completely removed, the Archaeology Branch will facilitate disposition.

24.3.4 Monitoring

No ongoing monitoring is proposed as part of this management plan.

24.3.5 Reporting

Reporting will be conducted on an as-needed basis, should chance finds be encountered.

24.4 EMERGENCY RESPONSE PLAN

24.4.1 Purpose

The purpose of the Emergency Response Plan for the proposed Project is to provide the initial framework for managing emergencies during the various phases of the Project, by outlining the response procedures and preventive measures for achieving effective management of emergency situations.

The preliminary Emergency Response Plan is intended as a precursor to ensuring 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.

An emergency is a situation that immediately 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 Emergency Response Plan does not include the management of accidental spills including those of hazardous materials. These are dealt with separately in the Spill Prevention and Response Plan (Section 24.15).

This Emergency Response Plan addresses three levels of response in an emergency situation: containment, notification, and mobilization. It outlines the common set of practices that enable employees to act in an organized and efficient manner when responding to an emergency situation. The premise of the plan is that employees must first ensure their own safety, and then contain the emergency as quickly as possible. If unable to contain the emergency, a series of escalating responses will be initiated.

24.4.2 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.

A 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.

Insofar as performance objectives are concerned, it is worth noting that emergency response plans are required for all mines in British Columbia, according to the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008), which is empowered under the *Mines Act* (1996b). The Health, Safety and Reclamation Code requires, 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.

24.4.3 Emergency Preparedness Measures

The 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 HCMC will address these requirements in the more detailed Emergency Response Plan developed during the application and permitting process per the *Mines Act* (1996b) and that will evolve as the Project progresses through the Construction, Operations, 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.

This preliminary Emergency Response Plan describes the purpose-designed actions that are envisaged to:

- ensure the safety and well-being of personnel, the environment, and property;
- identify evacuation routes and muster station locations;
- ensure effective communication between personnel and the emergency team;
- ensure that procedures exist to respond to, intervene in, stop, or limit the emergency situation;
- initiate response procedures and follow-up programs for emergencies; and
- ensure when occurrences are investigated, root cause determination and mitigation measures are implemented to prevent reoccurrence.

24.4.3.1 Policy Directive

The Emergency Response Plan will include a clear policy outlining HCMC'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 resources. The Project Emergency Response Plan will be a key element in meeting the policy and priorities. While every effort will be made throughout the life of the Project to prevent emergencies, the Emergency Response Plan will ensure that the Project 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 Emergency Response Plan, 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 Emergency Response Plan and related training.

24.4.3.2 Emergency Response Plan Coordinator and Emergency Response Planning Committee

The Health and Safety Manager for the Project 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 Emergency Response Plan. 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.

24.4.3.3 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 actions 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 fires, explosions, 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 Health, Safety and Reclamation 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 Plan Coordinator will engage supervisors and workers in the identification of hazards and the development of prevention and protection measures.

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.

24.4.3.4 Duties and Responsibilities of Personnel

The job titles of key emergency personnel with their corresponding duties and responsibilities will be comprehensively described in the Emergency Response Plan.

24.4.3.5 Emergency Notification Plan

The Emergency Response Plan 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.

24.4.3.6 Emergency Management Organization for Incident Command

The Emergency Response Plan will establish an Emergency Management Organization under the Incident Command System consistent with the BC Emergency Response Management System, to enhance the ability to integrate with other first responders and agencies involved in an emergency situation. This consistency will allow for reduced communication error, clear definition of roles, and a defined chain of command.

24.4.3.7 Emergency Operations Centre

An emergency operations centre will be established and its location will be carefully selected for ease of access and communication. The location and telephone numbers will be identified in the Emergency Response Plan and posted prominently throughout the Project.

24.4.3.8 Mine Emergency Response Procedures

The Emergency Response Plan will address the three levels of response in an emergency situation, namely 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.

Major events such as pit wall collapse will result in an immediate escalation to Notification Level.

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 contained in the Emergency Response Plan. 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 will contain only those names absolutely required.

Mobilization Level

The mobilization level will take effect when the emergency operations centre has been established and senior management has assumed direction of emergency operations. All key persons will report to the emergency operations centre upon arrival at the Project Site. The Mine Manager or a designate (e.g., the Emergency Response Plan Coordinator) will assume the role of incident commander on arrival.

24.4.3.9 Action Plans

The emergency response procedures will serve as action plans and will be developed in a concise fashion for each potential emergency, to ensure that supervisory and other personnel have an understanding of the duties and responsibilities and are aware of the tasks needed to control the particular situation.

Based on a thorough assessment of the levels of response required, action plans will be written and assigned to those responsible for their execution. The 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, to include BC MEM recommended items;
- list of specialized equipment and where it can be obtained, e.g., lifting bags or hydraulic jacks;
- list of BC MEM contacts and other key provincial personnel contacts and BC government resource agencies;
- BC Provincial Emergency Program;
- list of key Canadian federal contacts;
- list of key community, First Nations, and Treaty Nations contacts; and
- list of special consultants, technical advisors, and contractors.

24.4.3.10 Mine Plan

The Emergency Response Plan 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 surface operations, including the access roads, rail load-out area, and transmission line.

24.4.3.11 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 current mine plan as per Section 24.4.3.10 above.

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

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

24.4.3.13 *Mine Rescue Equipment Inventory*

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

24.4.3.14 *Mutual Aid Agreements*

The Project will investigate the practicality of establishing customized mutual aid agreements with other first responders operating in the region, including other mine rescue teams.

24.4.3.15 *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 Emergency Response Plan 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.

24.4.3.16 *Communication Services*

The Emergency Response Plan 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 staff member to assume coordination of communications. Additional personnel will be assigned as backup support.

The communications coordinator will be responsible for:

- evaluating the envisaged 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 communications systems 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 communications during each shift; and
- establishing a standardized system for recording calls, messages, and information.

24.4.3.17 System for the Dissemination of Information

The Project and HCMC will have a formal plan in place prior to 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 HCMC as responsible for public and media relations. A strategy will be developed for the release of information to the media.

24.4.3.18 Training Plan

The Emergency Response Plan 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.

24.4.3.19 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 emergency operations centre and establishing communications.

24.4.3.20 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 Emergency Response Plan is revised and updated at least annually.

24.4.3.21 Costs

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

24.4.3.22 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 in the open pit at one time is:

- more than 25 per shift, the Mine Manager will ensure that there is one fully trained and equipped mine rescue team; and
- more than 10 per shift, the Mine Manager will ensure that there are four persons trained in mine rescue procedures.

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.

24.4.3.23 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 systems for fire suppression are incorporated into the Project design. Water for firefighting, if required, will be drawn from the fresh/fire water storage tank or from the TMF.

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.

In the event that a fire necessitates the evacuation of the open pit, the design of the haulage roads (30 m width including ditches and berms, maximum gradient 10%) will facilitate the egress of personnel.

If there is a forest fire near the Project Site, management will initiate close monitoring of the fire and seek advice from the BC MFLNRO. 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.

24.4.3.24 Medical Emergencies

Part 3.6.1 of the Health, Safety and Reclamation Code (BC MEMPR 2008) requires that the Mine Manager provides and maintains first aid supplies and services as required by the Workers Compensation Board (WorkSafeBC). During the Operations phase, a first aid station will be maintained and equipped at the warehouse building at the plant site, where the ambulance for the Project will also be located. 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.

In the event of medical or related emergencies, any person who discovers someone injured will implement initial response and identify backup assistance, preferably the appropriately qualified on-site first aid personnel.

The on-site first aid personnel will implement their protocols to address medical emergencies, providing further care, coordinating uninjured personnel to assist in the response and arrange transfer to other health care facilities as necessary.

If the injured require facilities and services beyond that which can be given on site, they will be evacuated to receive further medical treatment. The nearest health care facility is in Clearwater located approximately 50 km by road from the site and accessible by ambulance. The nearest major hospital is in Kamloops, which is a distance of approximately 150 km by road and can be accessed by airborne medical evacuation. A designated helicopter landing area will be identified adjacent to the plant site and at the rail load-out area. A specific procedure will be developed for summoning either a road ambulance or provincial air ambulance, weather dependent.

An accident and injury procedure will be developed that details the actions and record keeping required for minor, serious, and major injuries. In the event of a fatality at a work site, HCMC will exercise discretion for, offer counselling to, and consult with family as well as meet all regulatory requirements for notification and scene preservation.

24.4.3.25 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 HCMC'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 a 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.

24.4.3.26 Snow Avalanche

Geophysical activity that results in snow avalanche is not expected in the area and none of the Project components are likely to be affected by such an occurrence.

24.4.3.27 Extreme Weather Conditions

When prolonged extreme weather conditions such as cold or poor visibility present health and safety concerns, the risk will be assessed and activities will be curtailed or modified, as appropriate. Work activities that are affected by severe winds will be curtailed as appropriate.

24.4.3.28 Power Failure

The Project will be primarily dependent upon electricity delivered by a transmission line from the provincial electricity grid. This will be by means of a new 14-km-long 138-kV transmission line on single wooden monopole towers that will be constructed from the BC Hydro transmission line near Vavenby, crossing the North Thompson River to the Project's main substation located adjacent to the processing plant.

Two diesel generators of 2 MW each will be installed during Construction and will be redeployed as dedicated standby power supply for the operational facilities. Thus, in the event that electricity is interrupted, the Project will have standby diesel power generation of sufficient capacity to operate critical equipment such as pumps and emergency lighting. 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.

24.4.3.29 Mine Access Road Closure

The Project will be serviced by the 24 km mine access road from the Southern Yellowhead Highway (Highway 5). It is possible that sections of the road may be blocked or otherwise impassable at times, due to floods, washouts, landslides, severe weather (heavy snowfall), or forest fires.

An alternative route into the Project exists. If the mine access road becomes impassable the Jones Creek Forest Service Road (FSR) can be used to access the Saskum Plateau FSR and hence the mine access road close to the mine.

During the Construction phase, a road closure would disrupt the delivery of heavy equipment but the alternate route may provide an alternative to allow personnel to be moved in and out of the site. However, if both routes are compromised for more than 24 hours, alternative means of transporting personnel and goods, e.g., by helicopter, will need to be considered.

During the Operations phase, a road closure would disrupt the trucking of concentrate to the rail load-out area. In such circumstances, goods and personnel may be able to use the alternative route. However, if both routes are compromised for more than 24 hours, alternative means of transporting personnel and goods, e.g., by helicopter, will need to be considered.

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

24.4.3.30 Missing or Overdue Persons and Vehicles

To reduce the potential for missing persons, personnel will check in regularly and execute proper remote work practices as outlined in HCMC's or contractors' health and safety plans. Trucks will remain in contact with dispatch while departing from and en route between sites. In the event that a truck does not report, the relevant supervisor will be notified and they will investigate and in turn initiate the appropriate emergency response actions. Additional support for rescue operations will be implemented with site personnel and appropriate regulatory authorities as needed.

24.4.3.31 Automobile and Equipment Accidents

Accidents with vehicles and other equipment will be reported to a supervisor as soon as possible to initiate the appropriate emergency response actions. Priority response, if warranted, will be given to necessities of life. After priority issues are resolved, equipment will be removed from service and will not operate until repairs have been made.

24.4.3.32 Wildlife Encounters and Incursions

Bear safety training will be provided to Project personnel as part of site orientation. Specific personnel will be provided with training to monitor and respond to bear encounters. Other wildlife will be avoided and allowed to move unhindered. Wildlife feeding will not be permitted under any circumstances.

Vehicle collisions with wildlife are a possibility and to minimize collisions, personnel will abide by the prescribed speed limits imposed on Project-related traffic. Wildlife fatalities from traffic incidents or other events will be reported to the Mine Environmental Supervisor who will in turn track such information and make recommendations to prevent further occurrences. Private firearms will be prohibited at all sites.

24.4.3.33 Seismicity

Seismic occurrence training will be provided to Project personnel as part of site orientation. The Government of British Columbia Building Code and the National Building Code will be used for the basis of seismic design of the Project structures.

24.4.3.34 Ground Instability

Incidents relating to ground instability could involve embankment or pit wall collapse, leading to environmental impacts or injuries or damage to equipment or facilities. There will be a focus on incorporating geotechnical knowledge, adequate design and quality installation into all Project facilities. If a situation arises where the risk of geotechnical failure becomes apparent, proactive preventative measures will be taken to address the problem and ensure geotechnical stability is reinstated. In such emergencies, the Mine Manager will be notified so that the necessary response action can be implemented. A qualified professional will inspect the area of suspected failure and will ensure that the area is properly secured and isolated. The incident will be documented and appropriate mitigation and prevention programs developed to limit or minimize subsequent incidents and risks. In the event of an incident, pre-existing preventative measures will be revaluated and updated or adjusted to ensure similar incidents do not occur again.

24.4.3.35 Water or Tailings Management Failure

The risk of failure of the diversion channels, contact water ponds, or tailings pipelines is very low, given that the designs have been carried out by qualified professionals who are particularly experienced with the capabilities of the structures.

Inspections of the diversion channels and contact water ponds will be conducted following extreme precipitation or runoff events. Any spills will be contained by means of available heavy equipment and mitigated as deemed appropriate. Note that a separate Spill Prevention and Response Plan (Section 24.15) has been prepared for the Project, which also addresses water and tailings management failures.

24.4.4 Monitoring

Given the unpredictable nature of emergency events, pre-emptive monitoring is not practical 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 comprise 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 HCMC'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 Emergency 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.

24.4.4.1 Work Planning and Schedule

Work planning and scheduling for Emergency Response Plan activities will largely amount to maintaining a high level of preparedness of both personnel and equipment.

An 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 firefighting teams.

In summary, Emergency Response Plan training sessions will be undertaken in a scheduled manner 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 (e.g., the Mine Rescue Team) - 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.

24.4.5 Reporting

24.4.5.1 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.

At a minimum a written incident report will include the following information, as available:

- date and time of incident;
- location or map coordinates if warranted;
- party responsible for the event;
- type of event;

- status of the event;
- photographic record of the event and mitigation efforts;
- factors affecting the event and mitigation efforts;
- corrective action taken or proposed to mitigate incident;
- whether assistance was required and in what form;
- whether the event posed a hazard to persons or property;
- comments and recommendations;
- name, position, and supervisor of person reporting; and
- name, position, and department of person to whom the incident is reported.

24.4.5.2 Reporting Responsibilities

Designated job titles and corresponding responsibilities of emergency personnel will be listed in the detailed plan developed for specific permitting prior to commencement of each phase of the Project.

24.5 EXPLOSIVES HANDLING PLAN

24.5.1 Purpose

The purpose of the Explosives Handling Plan for the Project is to protect employees and the public from possible deleterious effects on their health and safety from the storage, manufacture, transport, and use of explosives throughout the life of the mine. Similarly, components of the biophysical environment such as water, air, and vegetation, as well as the fish and wildlife that depend on them, must be protected from possible deleterious effects on ecosystem functioning.

The information contained in this plan is at a level of detail appropriate for the Application/EIS submission. It is a living document and will be further developed by the explosives contractor(s) into detailed plans prior to commencement of blasting activity related to various phases of the proposed Project. Blasting procedures will be established as part of HCMC's overall Occupational Health and Safety Management Plan to be developed as required under the *Mines Act* (1996b) and the Explosive Management Plan will be integrated with HCMC's EMS (Section 24.1), including but not limited to the Emergency Response Plan (Section 24.4) and Spill Prevention and Response Plan (Section 24.15).

With the typical production cycle envisaged for the Project, namely drilling, blasting, grade control, loading and hauling, the importance of efficient and safe management of explosives in maintaining the productivity of the mine is clear. A critical component of the Explosives Management Plan is a rigorous handling and storage policy, to be achieved through having systematized and well-defined operating procedures in place.

24.5.2 Performance Objectives

This Explosives Handling Plan is designed to meet four performance objectives, as follows:

- To have a Workplace Hazardous Materials Information System (WHMIS) in place prior to commencement of construction of the Project. The WHMIS will meet the intent of the *Hazardous Products Act* (1985e) and the Controlled Products Regulations (SOR/88-66), and will continue for the life of the Project with adjustments as required to reflect changing types and levels of blasting activities and the knowledge gained over time.
- To maintain an effective inspection procedure that confirms the effectiveness of the explosives storage and manufacturing facility, as well as its handling, transportation and application, that ensures compliance with established systems throughout the life of the Project.
- 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.

The overall approach to blasting and explosives handling for the Project is described as follows.

Prior to commencement of pre-production mining activity, HCMC will award a contract to a major explosives supplier to construct and operate the explosives manufacture, storage and supply facility at the Project Site. HCMC will provide on-site services, diesel fuel and a cleared, leveled and graded site, while the contractor will supply complete facilities including bulk storage or raw materials, explosives storage and magazines, and personnel and equipment.

As part of this arrangement it will be the responsibility of the contractor to obtain the necessary approvals for this specific facility. Bulk explosives will be manufactured by the supplier and delivered to the blast-hole by a dedicated properly labelled delivery vehicle. HCMC will take delivery of the explosives down the hole and the mine blasting crew will be responsible to load and fire the explosive charges. All HCMC blasting crew personnel will hold proper blasting certifications.

Some minor blasting may be required during construction in rock cuts along the access road, the TMF quarry and possibly in foundation excavations such as at the crusher and mill. In such cases, drilling and blasting will be contracted to a licenced drilling and blasting contractor who will supply all of their own supplies, including storage magazines and blasting agents, as well as acquire any necessary permits and licences. Temporary blasting explosives will be stored on site at the same location proposed for the permanent facilities. Blasting requirements are expected to be limited and localized during construction, and will therefore not require a significant quantity of explosives. As a result, bulk explosives are not expected to be required and explosives used will be of the packaged type.

24.5.3 Environmental Protection Measures

Explosives will be required on the Project Site during the Construction and Operations phases in particular. Material Safety Data Sheets (MSDSs) will be required for each of the products that comprise the explosives materials. This management plan addresses the proper and safe handling, storage, and use of explosives, while the Waste Management Plan (Section 24.18) addresses the disposal of explosives products.

Given the current stage in the permitting process for the Project, this Explosives Management Plan is considered a preliminary conceptual-level plan. Additional components in the final plan to be developed by the explosives contractor will include:

- detailed plans of the explosives facility to be located northeast of the TMF, including the various explosive materials and products, and typical quantities within the facility, as well as details of the bulk delivery and application of explosives to active blast site drill holes;
- locations and description of various services and connections to the explosives facility, such as water, fuel, communications, etc.;
- plans of the road access to the explosives facility and control by means of a locked gate; and
- linkages to the Emergency Response Plan (Section 24.4) and Spill Prevention and Response Plan (Section 24.15) that will provide specific information concerning emergency plans for various 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

The explosives contractor will be responsible for the safe management of explosives on the Project Site up to delivery down the blast holes. The Spill Prevention and Response Plan (Section 24.15) and the Emergency Response Plan (Section 24.4) will be developed further and will include details on procedures for dealing with incidents involving explosives.

Construction Measures

Blasting for pre-mining construction activities, e.g., crusher and building foundations and quarrying for the coffer dam, will be carried out by a licenced drilling and blasting contractor who will supply all of their own supplies, including storage magazines and blasting agents. Blasting requirements are expected to be limited and localized during construction, and will therefore not require significant quantities of explosives. As a result, bulk explosives will not be required and explosives used will be of the packaged type. Temporary blasting explosives will be stored on site at the same location proposed for the permanent facilities.

The explosives manufacture and storage facility that will serve for the entire life of the mine will be installed during the Construction phase of the Project and will be licensed by the explosives contractor in accordance with the *Explosives Act* (1985b) and criteria established by Natural Resources Canada's (NRCan) Explosives Regulatory Division.

The explosives manufacture and storage facility will:

- be in the charge of an authorized person who will carry out all required inspections of the facility;
- 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 logbook kept at the facility, 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).

<u>Operational Measures</u>

Bulk ammonium nitrate / fuel oil products will be used during the Construction and Operations phases to break rock for open pit mining activities. Their transportation, storage, and use will be consistent with the array of regulatory requirements mentioned previously.

At the mine, explosives consumption at full production is estimated to be 0.22 kg per tonne of material blasted. Blastholes will be single primed and initiated using non-electric methods. An explosive supply contractor will deliver bulk explosives to the boreholes and the mine blasting crew will work closely with the drilling and blasting engineer.

The transport of the bulk explosives will necessitate the following:

- MSDSs 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.

Blasting procedures will be established as part of HCMC's overall Occupational Health and Safety Management Plan to be developed as required under the *Mines Act* (1996b) and will include such measures as:

- All mine employees will be notified of the time and location of all blasts.
- Smoking or open flame within 15 metres (m) of explosives, detonating devices, and loaded blast holes is strictly prohibited.
- No employee will enter a blast perimeter without first receiving permission from the blaster in charge.
- No equipment will be operated within 8 m of a loaded hole except authorized loading equipment.
- Operation of mobile equipment on a loaded blast pattern without the supervision of the blaster in charge is strictly prohibited. Only equipment associated with explosives is allowed on a blasting pattern.
- No employee will enter a blast pattern perimeter while in the possession of matches, a lighter, or any other source of ignition.
- Blast Time Procedure:
  - blast times will be posted;
  - radio silence will be established during blasting; and
  - communications will be restricted to the Pit Supervisor and blaster until "all clear" given.
- Except for an emergency, the use of the mine radio frequency will be restricted during the countdown to detonation to the Mine Supervisor, blaster, and guards until the blast has been detonated and the "all clear" has been given by the Mine Supervisor.
- Be on the alert for blasting signs when travelling in the pit.
- The unauthorized use or possession of explosives and/or blasting accessories is strictly prohibited.

Closure Measures

Very limited volumes of explosives are expected to be required during the Closure phase of the Project. Management of explosives will continue to be the same as during the Operations phase. When explosives are no longer required, the explosives facility will be deactivated and removed, the sites ripped and capped with available overburden and topsoil, and seeded. There may be an opportunity to develop wetland areas in parts of the explosives facility footprint. The related access roads will be deactivated when they are no longer required for maintenance of the site.

Post-Closure Measures

The reclaimed explosives facility area and access road will be monitored for erosion, geotechnical stability, and re-vegetation success. Any erosion or instability will be addressed and any significant areas of under-performing re-vegetation will be investigated and remedial action taken.

24.5.4 Monitoring

Storage facilities for explosives 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 maintained at the explosives facility.

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 Explosives Manager or appointed designates immediately.

In the event of upset conditions related to explosives the Emergency Response Plan Coordinator described in the Emergency Response Plan in Section 24.4 will launch an investigation of the incident. Together with the Emergency Response Planning Committee, key members of the explosives contractor, HCMC 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 Explosives Handling Plan if the investigation shows that shortcomings pertained.

24.5.4.1 Work Planning and Schedule

Personnel requiring specific training in the management of explosives will be identified by HCMC and will receive such training prior to assuming any related responsibility. All employees will be made aware of the general issues and concerns surrounding the use of explosives as part of their routine health and safety induction and training.

24.5.5 Reporting

24.5.5.1 Reports

Routine reporting according to a schedule of monitoring inspections will be undertaken by the explosive contractor in a structured manner such that the storage and use of explosives can be accurately tracked. Inspections will cover the explosives facility, 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 Explosives Handling Plan will be subjected to review to ensure optimal effectiveness. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and licences.

Where explosives-related emergency or spill incidents occur, these will be reported per the requirements of the Emergency Response Plan (Section 24.4) and Spill Prevention and Response Plan (Section 24.15).

24.5.5.2 Reporting Responsibilities

The explosives contractor manager will be responsible for monitoring and reporting on the management of explosives.

HCMC will be responsible for overall site 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 Explosives Handling Plan.

24.6 FISH AND AQUATIC EFFECTS MONITORING AND MANAGEMENT PLAN

24.6.1 Purpose

The purpose of this plan is to describe the rationale, framework, strategy, and scope of the Fish and Aquatic Effects Monitoring and Management Plan (FAEMP) to be implemented during the Construction, Operations, Closure, and Post-Closure phases of the Project. The FAEMP will be established as a requirement of the provincial permits and federal regulations under which the proposed Project will operate (e.g., *Environmental Management Act* [2003], Metal Mines Effluent Regulations [MMER; SOR/2002-222]). 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 FAEMP will focus on waterbodies proximate to the Project Site and their downstream networks.

This FAEMP:

- refers 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;
- provides a conceptual outline of the program study design, including the incorporation of the Environment Effects Monitoring (EEM) program of the MMER (SOR/2002-222) and applicable standards, guidelines, and regulations; and
- summarizes the reporting requirements for the FAEMP, including those under the MMER.

This FAEMP focuses on the aquatic receiving environment in Harper Creek and its tributaries P Creek and T Creek, and the North Thompson tributaries Baker and Jones creeks. The FAEMP is designed to complement proposed mitigation and management measures presented in the Application/EIS for the following valued components (VCs):

- Surface Water Quantity (Chapter 12);
- Surface Water Quality (Chapter 13);
- Fish and Fish Habitat (Chapter 14); and
- Aquatic Resources (sediment quality, primary and secondary producers; Chapter 14).

24.6.2 Performance Objectives

The goal of the FAEMP is to avoid, minimize or control adverse effects on the aquatic receiving environment. This goal will be achieved by meeting the following objectives:

- implementing a monitoring program that meets federal MMER - EEM program requirements and BC *Environmental Management Act* (2003) Effluent Permit discharge requirements, and that follows the standards contained in the guideline documents below to ensure proper study design, sampling methods, analyses, and QA/QC procedures are carried out:
  - British Columbia Field Sampling Manual (Clark 2003);
  - Water and Air Baseline Monitoring Guidance Document for Mine Proponents (BC MOE 2012);
  - Metal Mining Technical Guidance for Environmental Effects Monitoring (Environment Canada 2012c);
  - Fish Collection Methods and Standards (RIC 1997);
  - 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 MOE 1998);
  - Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia (Price and Errington 1998);

  - Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (Price 2009);
- designing a monitoring program that will confirm the conclusions of the effects assessment, including the anticipated effectiveness of mitigation measures;
- monitoring the response of the target VCs along pathways of interaction between the Project and the aquatic environment, which will allow for early detection of any emerging issues; and
- using the results of the monitoring program to adaptively manage adverse effects on the aquatic environment as needed.

In conjunction with this FAEMP, effects on the aquatic receiving environment are managed through the implementation of a number of other EMPs, including:

- Explosives Handling Plan (Section 24.5);
- Mine Waste and ML/ARD Management Plan (Section 24.9);
- Sediment and Erosion Control Plan (Section 24.11);
- Selenium Management Plan (Section 24.12); and
- Site Water Management Plan (Section 24.13).

24.6.3 Environmental Protection Measures

The Project has the potential to interact with components of the aquatic environment through a number of pathways, such as the alteration of natural drainage networks or the discharge of water from the TMF. The pathways of interactions between the Project and the aquatic environment are discussed in details in the Hydrology, Surface Water Quality, and Fish and Aquatic Resources effects assessments (Chapters 12, 13, and 14, respectively). Mitigation and management of residual adverse effects on these VCs is described in detail in supporting EMPs (as discussed above). Protection measures specific to fish and aquatic resources are described below.

24.6.3.1 Design Criteria

The Project will be designed to minimize interactions with the aquatic environment by ensuring appropriate setback distances from riparian areas are maintained (Site Water Management Plan, Section 24.14). Natural drainage networks will be maintained or restored as much as feasible, stream crossings will be designed to avoid impacts, and riparian areas will be protected with setbacks.

24.6.3.2 Construction and Operations Phases

Mitigation and management measures for avoiding and minimizing the transport of sediments into the aquatic environment, as described in the Sediment and Erosion Control Plan (Section 24.11), will be implemented during appropriate Project phases. The potential for the introduction of nitrogenous nutrients from explosives will be minimized by the application of best management practices for the use, transport, and storage of explosives (Explosives Handling Plan, Section 24.5). Much of the water management infrastructure, such as diversion channels for contact and non-contact water, will be installed during the Construction phase (Site Water Management Plan, Section 24.13). This water management infrastructure will mitigate potential effects from changes in the quantity and quality of water in the receiving environment.

The identification, segregation, and storage of potential sources of metal leaching/acid rock drainage (ML/ARD) will contribute to the mitigation and management of changes in water quality due to the increases in the concentrations of metals or acid rock drainage in the receiving environment. Implementation of the Mine Waste and ML/ARD Management Plan and the Selenium Management Plan (Sections 24.9 and 24.12) will begin prior to Construction phase activities and will continue through the life of the Project.

Potential effects from accidents and malfunctions will be managed by the implementation of best management practices and mitigation measures for the handling and use of explosives, hazardous materials, waste, and fuel (Explosives Handling Plan, Fuel and Hazardous Materials Management Plan, Spill Prevention and Response Plan; Sections 24.5, 24.7, and 24.15, respectively).

24.6.3.3 Closure

Environmental protection measures established during the Construction and Operations phases will be applied during decommissioning and reclamation activities in the Closure phase. Erosion and sediment control measures will be important during the reclamation of infrastructure and the decommissioning of the water management infrastructure (Sediment and Erosion Control Plan, Section 24.11). Potential effects from ML/ARD, including selenium, during the Closure phase will be managed by the operation of the TMF and sub-aqueous storage of potentially acid-generating (PAG) waste rock and tailings (Mine Waste and ML/ARD Management Plan and the Selenium Management Plan, Sections 24.9 and 24.12). The TMF discharge will be managed for water quality according to applicable regulations and permit conditions.

24.6.3.4 Post-Closure

Site reclamation and restoration activities will be completed in the Post-Closure phase, except the facilities related to monitoring and management of the TMF, if necessary. TMF discharge will continue to be managed for water quality according to applicable regulation and permit conditions (Mine Waste and ML/ARD Management Plan, Section 24.9).

24.6.4 Monitoring

Monitoring is a key part of the environmental protection strategy for the Project. The FAEMP will use monitoring to ensure the mitigation and management measures are adequate and to provide the necessary information for adaptive management of unanticipated effects.

The FAEMP will integrate the guidelines and requirements of the BC *Environmental Management Act* (2003) and the federal MMER and its EEM program. An initial FAEMP will be developed in consultation with the BC MOE and Environment Canada, 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 FAEMP will focus on the Project Site and the downstream flow pathways of potential effects in Harper, Jones, and Baker creeks.

The following aquatic components will be considered in the FAEMP:

- surface water quality;
- surface water quantity;
- fish;
- 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);
- fish tissue metal and biological endpoints in sentinel species; and
- site characterization.

The FAEMP will use baseline data previously collected in the area (see baseline settings for the hydrology, water quality, and fish and aquatic resources effects assessments, Sections 12.4, 13.4, and 14.4) and at relevant reference sites and will compare these data to those collected when Project activities commence. Specific MMER components (i.e., effluent toxicity and characterization) will only apply during periods when discharge rates exceed 50 m^3/day and/or the Project discharges deleterious substances as per subsection 36(3) of the *Fisheries Act* (1985c).

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. The monitoring program will include appropriate reference sites to control for natural variation and regional trends. Based on the effects assessment, the sampling sites for the FAEMP are expected to include at least one location in:

- P Creek;
- T Creek;
- Multiple locations on Harper Creek, including after the confluences of P Creek and T Creek, and lower Harper Creek;
- Baker Creek;
- Jones Creek; and
- Dunn Creek (reference site).

The environmental effects analyses will take a before-after-control-impact (BACI) approach according to *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012c). Environmental indicators for each of the aquatic components (e.g., water quality parameters concentrations for surface water quality) will be subjected to BACI analyses. The monitoring program will be designed to provide sufficient spatial and temporal replication for statistical power. The analysis workflow will conform to QA/QC requirements, including evaluation of applicable statistical assumptions, and will be designed to provide transparent and reproducible analyses.

24.6.4.1 Work Planning and Schedule

The monitoring schedule of each aquatic component will take into account the sampling frequencies and methodologies outlined in the MMER (SOR/2002-222) and the BC *Environmental Management Act* (2003) as well as in the *Metal Mining Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2012c), the *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012), and the *British Columbia Field Sampling Manual* (Clark 2003).

Sampling for the FAEMP program may start prior to the Construction phase, if additional baseline sampling is required to provide sufficient replication for BACI analyses. Post-baseline sampling will begin in the Construction phase and will continue throughout Operations into the Closure and Post-Closure phases.

The monitoring program will be adaptively managed and the suitability of the sampling design will be assessed and revised, as necessary, throughout the life of the Project. The sampling frequency will depend on the targeted parameter and the sampling frequencies will follow the requirements outlined in the MMER (SOR/2002-222) and the *Environmental Management Act* Permit.

The monitoring program is expected to include:

- water level and flow measurements;
- effluent monitoring;
- acute toxicity testing;
- water quality monitoring;
- sublethal toxicity testing;
- sediment quality monitoring;
- fish population and benthic invertebrate community studies; and
- fish tissue sampling.

24.6.5 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 reporting of non-compliance events. Reporting on the results of the FAEMP will be the responsibility of the Project's Mine Environmental Supervisor, with delegation as appropriate to Project personnel. Consultants and contractors hired to implement aspects of the FAEMP will be suitably qualified professionals.

The FAEMP will use iterative QA/QC processes to ensure the FAEMP's goals are met. QA/QC measures will be applied to each stage of the monitoring program, including data collection procedures, data entry and analysis, and reporting. The process will be iterative and reassessment of methods and processes will occur for every annual cycle.

Statistical hypothesis testing will be validated using power analysis and any other relevant methods. The annual FAEMP reports will include detailed descriptions of the analytical methods, including the relevant validation and QC procedures.

The iterative QA/QC procedures will continuously improve the effectiveness of the FAEMP to detect Project-related effects in the freshwater environment. These QA/QC processes are important in the overall adaptive management of Project effects, and will support the goals of the Project to minimize, mitigate and/or manage potential adverse effects on the environment while systematically seeking to enhance positive effects.

Two types of reporting are required to fulfill regulatory requirements, outlined below.

24.6.5.1 Annual Aquatic Effects Monitoring Program Report

An annual FAEMP report will fulfill annual requirements under the BC *Environmental Management Act* (2003) Effluent 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 Operations 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 FAEMP 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 (if needed).

24.6.5.2 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. 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 monitoring 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.
- Annual reporting of all effluent and water quality monitoring conducted for the year by March 31 of the following year.
- 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.

24.7 FUEL AND HAZARDOUS MATERIALS MANAGEMENT PLAN

24.7.1 Purpose

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

The information contained in this plan is at a level of detail appropriate for the Application/EIS submission. This is a living document and will be further developed into a more detailed and specific plan prior to commencement of each phase of the Project. The management of explosives is addressed separately in the Explosives Handling Plan (Section 24.5), and it should be noted that that the management and disposal of fuel and hazardous materials as waste products is included in the Waste Management Plan (Section 24.18). This Fuel and Hazardous Materials Management Plan deals with their non-waste generating use. Upset conditions in the management of fuel and hazardous materials are dealt with in Section 24.15, Spill Prevention and Response Plan.

Stringent labelling of containers and rigorous storage and handling practices are fundamental principles behind the proper management of fuel and hazardous materials. These principles will be facilitated through having a WHMIS in place prior to commencement of construction of the Project and through the development of site-specific work instructions that will be formulated as appropriate for each phase of the Project.

24.7.2 Performance Objectives

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

1. To have a WHMIS in place prior to commencement of construction of the Project. The WHMIS will meet the intent of the *Hazardous Products Act* (1985e) and the Controlled Products Regulations (SOR/88-66), and will continue for the life of the Project with adjustments as required to reflect changing types and levels of activities and the knowledge gained over time.
2. To maintain an effective inspection procedure that confirms the effectiveness of the equipment intended to transport and store the products and ensures compliance with established systems throughout the life of the Project.

24.7.3 Environmental Protection Measures

Hazardous materials and dangerous goods will be required on the Project Site during construction and throughout the life of the mine as well as during the Post-Closure phase, although to a much lesser extent than during earlier phases. 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. As mentioned, the Waste Management Plan (Section 24.18) addresses the disposal of the products. Table 24.7-1 lists typical dangerous goods and hazardous materials that may be found on the Project Site.

24.7.3.1 Transport

The transport of dangerous goods and hazardous materials will necessitate the following:

- MSDSs will accompany all designated 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.

Table 24.7-1. 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 Project Site in appropriately sized tanks prior to installation of four above-ground 75,000-L tanks with secondary containment	Used throughout; stored at the Project Site in four above-ground 75,000-L tanks with secondary containment	Used throughout; stored at the Project Site in four above-ground 75,000-L tanks with secondary containment; decommissioned during this phase	Used in smaller quantities; stored in 205-L barrels with secondary containment
Gasoline	Used throughout; stored at the Project Site in appropriately sized tank with secondary containment	Used throughout; stored at the Project Site in appropriately sized tank with secondary containment	Used throughout; stored at the Project Site in appropriately sized tank with secondary containment, decommissioned during this phase	Limited use; small quantities stored at the Project Site in 205-L barrels with secondary containment
Lubricating oil	Used throughout; stored at the Project Site in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment	Used in smaller quantities; stored at the remaining fuel storage facilities, in either double-wall tanks or with secondary containment
Lubricants, greases	Used throughout; stored at the Project Site in tubes, pails, and drums with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment	Used throughout; stored at maintenance shops in bulk tanks with secondary containment	Limited use; stored at maintenance shops in bulk tanks with secondary containment
Ethylene glycol	Used throughout; stored at the Project Site in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment	Limited use; stored at maintenance shops in small quantities with secondary containment
Hydraulic fluid	Used throughout; stored at the Project Site in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment	Used throughout; stored at maintenance shops in 205-L barrels with secondary containment	Limited use; stored at maintenance shops in small quantities with secondary containment
Batteries	Used throughout; stored at the Project Site and maintenance shops on pallets	Used throughout; stored at the Project Site and maintenance shops on pallets	Used throughout; stored at the Project Site and maintenance shops on pallets	Limited use; stored at maintenance shops in small quantities on pallets
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 and stored at the maintenance shops; stored in 205-L barrels with secondary containment	Limited use; stored at maintenance shops in small quantities with secondary containment

(continued)

Table 24.7-1. Typical Dangerous Goods and Hazardous Materials on Site by Project Phase (completed)

Product	Phase			
	Construction	Operation	Closure	Post-Closure
Lime	Used at processing plant; stored in bulk (silo)	Used at processing plant; stored in bulk (silo)	Used at processing plant; stored in bulk (silo); decommissioned during this phase	Limited use prior to decommissioning; stored in bulk
Flocculent	Used at processing plant; stored in bulk	Used at processing plant; stored in bulk	Used at processing plant; stored in bulk; decommissioned during this phase	Limited use prior to decommissioning; stored in bulk
Propane	Used at camps and other temporary and permanent facilities for space heating; stored in portable and permanent tanks/cylinders	Used at permanent facilities for space heating; stored in portable and permanent tanks/cylinders	Used at camps and other facilities for space heating; stored in portable and permanent tanks/cylinders; decommissioned during this phase	Limited use prior to decommissioning; stored in portable tanks/cylinders
Domestic products	Used primarily at temporary camp for cleaning	Used primarily at permanent facilities for cleaning	Used primarily at permanent facilities for cleaning; decommissioned during this phase	Limited use prior to decommissioning
Laboratory chemicals	Preservatives for environmental samples; stored in 1-L to 5-L containers	Preservatives for environmental samples, reagents for laboratory analyses; used in assay and met labs, stored in 1-L to 5-L containers	Preservatives for environmental samples; stored in 1-L to 5-L containers	Preservatives for environmental samples; stored in 1-L to 5-L containers
Process Plant reagents	Not required	Will include lime, potassium amyl xanthate (PAX), methyl isobutyl carbinol (MIBC), flocculants, and antiscalant; dry reagents will be stored in bulk bags, liquids in tanks; reagent solutions stored in separate holding tanks and dispensed through metered addition points	Not required	Not required
Wastewater treatment sludge (treatment by-product)	Not required (holding tanks for off-site disposal)	Stored temporarily in an engineered cell or covered structure for short periods, pending being pumped out and shipped off site for disposal	Stored temporarily in an engineered cell or covered structure for short periods, decommissioned during this phase or pumped out and shipped off site for disposal	Not required

24.7.3.2 Measures Related to Design Criteria

An inventory of dangerous goods and hazardous materials is a key element of this management plan. The inventory will list all designated 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 designated chemical is brought to the site, the supplier or contractor will supply an MSDS for the product.

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;
- training of responsible personnel in WHMIS and Transportation of Dangerous Goods;
- 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;
- implementing physical controls and procedures to ensure that no materials escape during routine operation as well as in upset conditions;
- having emergency response plans in place (see Section 24.4, Emergency Response Plan) 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
- keeping records to avoid reoccurring safety and environmental problems.

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 appropriate instrumentation to ensure that spills do not occur 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 fuel, dangerous goods and hazardous substances:

- 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 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 are 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 24.15) 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 spill recovery kit (containing items such as absorbent pads and booms) 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.

24.7.3.3 Measures Related to 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. Management of these products during construction will include:

- 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 the Construction Manager and HCMC;
- provision by the supplier or contractor of a MSDS before any designated chemical is brought on site. 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
- commitment to train employees regarding transportation, storage, and use of dangerous goods and hazardous materials.

During the latter stages of construction, the Construction Manager and HCMC will jointly develop and administer policies and procedures for the commencement of operation, since the transition to the Operations phase will be gradual in many areas.

24.7.3.4 Measures Related to Operation

During Operation, HCMC will refine the policy developed during construction. This Fuel and 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 Mine Safety and Environmental Supervisors. All facilities and activities will be inspected regularly, with 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 better approaches are identified and tested.

24.7.3.5 Measures Related to 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. Inventory control will be managed carefully to minimize surplus materials storage at Closure. Disposal of surplus materials will be guided by the Waste Management Plan (Section 24.18). 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 Mine Environment Manager. Disposal activities will be inspected by a designated person, and inspection reports will be directed to the Mine Manager.

24.7.3.6 Measures Related to Post-Closure

The requirement for dangerous goods and hazardous materials at the Project Site will be reduced during Post-Closure. Diesel fuel will continue to be required by maintenance equipment, and continued operation of maintenance facilities will require small volumes of cleaners, solvents, and assorted hydrocarbons. 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.

24.7.3.7 Management of Hazardous Material Types

Radioactive Equipment Handling and Disposal

Radioactive equipment is used in the mining and mineral processing industry for tasks such as process monitoring (e.g., density gauges) and geotechnical investigations (e.g., soil compaction meters).

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 regulations. HCMC 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 secure storage buildings 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.

<u>Petroleum Products</u>

The materials with the highest risk potential for a spill or accidental release are petroleum products, due to their frequency of use. Prior to the start of construction, the Construction Manager and/or HCMC will provide clear written policies for Construction phase hydrocarbon transportation, storage, and use. 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 the Construction Manager and HCMC. All relevant staff will receive training on the policy before being permitted to transport, store, or use hydrocarbons.

Fuel handling, transportation, and storage facilities and activities will be consistent with the Health, Safety and Reclamation Code for Mines in British Columbia (BCMEMPR 2008) and the Ministry of Water, Land and Air Protection's publication *A Field Guide to Fuel Handling, Transportation and Storage* (BC MWLAP 2002). 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 required to 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 remediation will be considered, contingent on the severity of contamination.

Oils, lubricants, degreasers, solvents, and other petroleum-based products will be delivered to the Project 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. Diesel and gasoline will be delivered to their respective storage tanks on site by commercial, purpose-designed tanker trucks equipped with the necessary fail-safe transfer systems.

Reagents

Reagents to be used in the process will include:

- PAX;
- lime;
- MIBC;
- flocculant; and
- anti-scalant.

Reagent solutions will be stored in separate holding tanks and added to the addition points as required by processes using metering pumps. PAX will be added to the grinding and flotation circuits, lime will be added dry to the SAG mill feed belt, and MIBC will be used as a frother. Fresh water will be used for the preparation of the solid reagents, including PAX, lime, and flocculant to the required solution strength. Each reagent will have its own preparation system, including a bulk handling system and mixing and holding tanks. Provision for additional reagent preparation and use is included in the design.

A lime silo has been designed to store the lime required by the process for at least seven days. Lime will be delivered in bulk and will be off-loaded pneumatically into the silo. The prepared milk of lime will be pumped to the points of addition using a closed loop system. The liquid reagents will not be diluted and will be pumped directly from the bulk containers to the points of addition using metering pumps. The mixing and holding tanks will be equipped with appropriate instrumentation to ensure that spills do not occur during normal operation. Appropriate ventilation, eye-wash stations, safety showers, fire and safety protection, and personal protection equipment will be provided at the reagent preparation areas.

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.

24.7.4 Monitoring

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 by the Mine Safety Supervisor or his/her delegate and such records will be filed with the Mine Manager.

In the event of upset conditions related to hazardous materials or dangerous goods, an on-site staff member tasked with the responsibility of coordinating the Emergency Response Plan described in Section 24.4 will launch an investigation of the incident. Together with an identified Emergency Response Plan team that will include responsible health and safety personnel, a joint incident investigation and root cause analysis will be undertaken. The findings of the investigation will serve to modify the Fuel and 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.

24.7.4.1 Work Planning and Schedule

The Mine Safety Supervisor 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, Operations, 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 fuel and hazardous materials will be identified by HCMC and will receive such training prior to assuming any related responsibility. 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. HCMC will develop a schedule of when monitoring activities will occur, i.e., Project phase, season, frequency, etc.

24.7.5 Reporting

24.7.5.1 Reports

Routine reporting according to a schedule of monitoring inspections will be undertaken in a structured manner such that the storage and use of fuel and 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.

This Fuel and Hazardous Materials Management Plan will be subjected to an annual review to ensure optimal effectiveness, and hazardous materials management performance indicators for specified personnel will also be tracked and reported on annually.

All reports will be reviewed internally by the responsible line manager and the Mine Safety and Environmental Supervisors, in order to identify necessary improvements in the monitoring system. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and licences.

Where emergency or spill incidents occur, these will be reported per the requirements of the Emergency Response Plan (Section 24.4) and Spill Prevention and Response Plan (Section 24.15).

24.7.5.2 Reporting Responsibilities

The Mine Safety Supervisor will ultimately be responsible for monitoring and reporting on the management of hazardous materials and dangerous goods. As the proponent of the proposed Project, HCMC 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 Fuel and Hazardous Materials Management Plan.

24.8 GROUNDWATER MANAGEMENT PLAN

24.8.1 Purpose

The Groundwater Management Plan is established as a tool to monitor and mitigate the predicted effects on groundwater quantity and quality that may result from the Project. The primary purpose of this plan is to provide a framework for monitoring and adaptive management for effects on groundwater. More specific objectives of the Groundwater Management Plan include the following:

- to supplement the surface water quality monitoring program for which downstream receiving water quality guidelines apply;
- to track changes to groundwater levels and quality down-gradient of the mine components;
- to provide an early warning of potential seepage and their sources before they arrive at down-gradient receiving surface water quality locations;
- to establish criteria that trigger adaptive management implementation; and
- to direct the means by which adaptive management may be undertaken.

Localized effects on groundwater quantity and quality have been predicted, as identified in Chapter 11, Groundwater Effects Assessment. The Groundwater Management Plan is established as a means of monitoring and mitigating these potential effects, whereby action is taken to ensure that predicted effects are detected, and adaptive management is undertaken as warranted.

24.8.2 Performance Objectives

The performance objectives are based on groundwater monitoring and sampling conducted at locations established to form a groundwater quality monitoring network. The proposed groundwater monitoring network and schedule is presented in Section 24.8.4. Deviations from performance objectives trigger an adaptive management strategy (described in Section 24.8.5), whereby corrective options are assessed as required. It is understood that groundwater monitoring will be a component of the *Environmental Management Act* Permit and that further detailed discussion on groundwater monitoring will occur at the time of permitting.

The variation and average of groundwater levels observed during the baseline pre-mining monitoring will be used as benchmarks for groundwater quantity (water level changes).

The potential reductions of baseflows in the creeks, as predicted in the effects assessment, will be part of the monitoring component of the Site Water Management Plan (Section 24.13).

Benchmark levels for groundwater quality parameters will be used as performance objectives for groundwater quality monitoring.

A range of benchmark levels will be used, including the following:

- BC Water Quality Guidelines for the Protection of Freshwater Aquatic Life (WQ-FAL; BC MOE 2014a);
- BC Water Quality Guidelines for Drinking Water Supply (WG-DW; BC MOE 2014a); and
- baseline pre-mining conditions at each well (95th percentile).

The specific applicable BC Water Quality Guidelines are presented in Table 24.8-1. WQ-FAL guidelines will be used as a reference for groundwater monitoring sites along flow pathways down-gradient of Project components and predicted to discharge into fish-bearing streams (Harper, P, T, Jones, and Baker creeks). WQ-DW guidelines will be used for drinking water supply wells located along the North Thompson River Valley and at monitoring wells that serve as advance warning for the supply wells.

The measured baseline (pre-mining) groundwater quality at each well and a designated reference well will also be used as a performance objective. Baseline groundwater quality at each existing monitoring site will continue to be measured by collecting quarterly groundwater samples. For proposed new wells, baseline groundwater samples will be collected prior to the onset of activity at the specific Project component for which it is intended to measure effects. Parameter concentrations that exceed the 95th percentile baseline upper limit are considered to exceed the threshold and trigger initiation of adaptive management.

Table 24.8-1. British Columbia Environmental Quality Guidelines Established as Performance Objectives for Groundwater Monitoring

	Guidelines	
Parameter	**Freshwater Aquatic Life [A]**	**Drinking Water [B]**
Hardness (as $CaCO_3$)		
Anions		
Chloride	150	250
Fluoride	Note F	1
Sulfate	Note G	500
Dissolved Nutrients		
Nitrate (as N)	3	10
Nitrite (as N)	Note H	1
Ammonia (as N)	Note V	

(continued)

Table 24.8-1. British Columbia Environmental Quality Guidelines Established as Performance Objectives for Groundwater Monitoring (continued)

Parameter	Guidelines	
	Freshwater Aquatic Life [A]	Drinking Water [B]
Dissolved Metals [Y]		
Aluminum	Note J	0.2
Antimony	0.2 [W]	0.014 [W]
Arsenic	0.005	0.025 [S]
Barium	1 [X]	
Berilium	0.0053 [X]	0.004 [X]
Boron	1.2	5.0
Cadmium	Note T	
Chromium	0.0089 [U,X]	
Cobalt	0.004	
Copper	Note K	0.5
Iron	0.35	
Lead	Note L	0.05
Manganese	Note M	
Mercury	0.00002	0.001
Molybdenum	1	0.25
Nickel	Note N	
Phorsphorus		0.01 [R]
Selenium	0.002	0.01
Silver	Note P	
Thallium	0.0003 [X]	
Uranum	0.3 [W]	
Vanadium	0.006 [W]	
Zinc	Note Q	5

All concentrations presented in units of mg/L

[A] *British Columbia Approved and Working Water Quality Guidelines (BC MOE 2014a) for Freshwater Aquatic Life. Approved guidelines for chronic exposure (30 day average) are listed where both maximum and chronic guidelines exist.*

[B] *British Columbia Approved Water Quality Guidelines (BC MOE 2014a) for Drinking Water.*

[F] *Fluoride - if hardness (as $CaCO_3$) is 10 mg/L the maximum concentration is 0.4 mg/L; otherwise $LC_{50} = -51.73 + 92.57 \log_{10}$ (hardness) × 0.01 mg/L.*

[G] *Sulphate - if hardness is very soft (0-30 mg/L) the guideline is 128 mg/L; if soft to moderately soft (31-75 mg/L) then 218 mg/L; if moderately soft/hard to hard (76180 mg/L) then 309 mg/L; if very hard (181-250 mg/L) then 429 mg/L; if hardness >250 mg/L then the guideline needs to be determined based on site water.*

[H] *Nitrite - if chloride <2 mg/L the guideline is 0.02 mg/L, if chloride 2-4 mg/L then 0.04 mg/L, if chloride 4-6 mg/L then 0.06 mg/L, if chloride 6-8 mg/L then 0.08 mg/L, if chloride 8-10 mg/L then 0.1 mg/L and if chloride >10 mg/L then 0.2 mg/L.*

[J] *Dissolved aluminum - if pH ≥ 6.5 the maximum concentration is 0.1 mg/L and the 30-day mean is 0.05 mg/L; if pH <6.5 the maximum concentration is $e^{(1.209 - 2.426pH + 0.286 K)}$ mg/L where K = $(pH)^2$ and the 30-day mean is $e^{1.6 - 3.327 (median\ pH) + 0.402 K)}$ mg/L where K = $(median\ pH)^2$.*

(continued)

Table 24.8-1. British Columbia Environmental Quality Guidelines Established as Performance Objectives for Groundwater Monitoring (completed)

[K] Copper - if average water hardness (as $CaCO_3$) ≤50 mg/L the 30-day mean is ≤0.002 mg/L; if average water hardness is >50 mg/L the 30-day mean is ≤ 0.00004(mean hardness) mg/L.
[L] Lead - 30-day mean guideline is hardness-dependent: $3.31+e^{1.273Ln(hardness)-4.704}$ / 1,000 mg/L.
[M] Manganese - 30-day mean concentration = 0.0044(hardness)+0.605 mg/L.
[N] Nickel - if hardness (as $CaCO_3$) is 0-60 mg/L the maximum concentration is 0.025 mg/L; if hardness 60-120 mg/L maximum concentration of 0.065 mg/L; if hardness 120-180 mg/L maximum concentration of 0.110 mg/L; if hardness >180 mg/L maximum concentration of 0.150 mg/L.
[P] Silver - if hardness is ≤ 100 mg/L the 30-day mean guideline is 0.00005 mg/L; if hardness > 100 mg/L the 30-day mean guideline is 0.0015 mg/L.
[Q] Zinc - 30-day mean concentration = 7.5 + 0.75(hardness - 90) / 1,000 mg/L.
[R] For lakes used as a source of drinking water.
[S] Interim guideline
[T] Draft Cadmium guideline released June 2014, not approved at time of writing.
30 day mean guideline = 0.02 to $e^{0.762Ln(Hardness)-6.07}$ to 0.172 µg/L
[U] Indicated chromium guideline intended for Cr (III) under ministry review for possible formal approval at time of writing.
[V] Ammonia guideline pH and Temperature-dependent, and intended for surface water temperatures - provided as benchmark only in groundwater assessment.
[W] Working water quality guidelines
[X] Working water quality guideline, under ministry review for possible formal approval at time of writing.
[Y] All metals guidelines are intended for total concentrations, except those for aluminum and iron.

24.8.3 Environmental Protection Measures

Project alternative optimization, design features, and best management practices have served to minimizing effects to groundwater quantity and quality, and to the surface water receiving environment. The functions served by these mitigation measures are described in greater details in Chapter 11 (Section 11.5.2), and include the following:

- Project alternatives, including collecting and conveying the pit dewatering water and the pit lake surplus water to the tailings management facility (TMF) for storage, and siting PAG waste rock and non-PAG low-grade ore (LGO) stockpiles in the TMF catchment basin and sub-aqueous disposal of PAG materials;
- Project design features, including:
  - low-permeability cores, seepage collection drains and pond, and drainage channels incorporated into the TMF embankments,
  - water management pond and drainage channels incorporated into the non-PAG waste rock stockpile, and transferring the collected water in the pond to the TMF for storage,
  - non-contact surface water diversions surrounding a number of Project components, and
  - concurrent reclamation of the waste rock stockpiles, overburden stockpile, as well as the TMF during the Operations and Closure phases of the Project;
- best management practices, including:
  - characterization of ML/ARD potential and segregation of PAG and non-PAG materials in accordance with the Mine Waste and ML/ARD Management Plan (Section 24.10), and

  - inspection of stockpile integrity (drainage and erosion) in accordance with the Mine Waste and ML/ARD Management Plan;
- implementation of an adaptive management approach would serve to further reduce effects to potential receptors of discharging contact groundwater (see Section 11.5.3 in Chapter 11 for predicted residual effects on groundwater quantity and quality).

24.8.4 Monitoring

24.8.4.1 Monitoring Well Network

The proposed groundwater monitoring network, which includes the existing wells and the newly proposed wells (Figure 24.8-1), has been developed based on predictive groundwater flow modelling (refer to the Numerical Groundwater Modelling Report, Appendix 11-B) that formed the bases for the groundwater effects assessments (Chapter 11). The proposed well sites are intended to serve the following purposes:

- monitoring potential changes in groundwater levels down-gradient of project components;
- monitoring groundwater quality down-gradient of project components expected to generate contact groundwater;
- recording background conditions outside the area expected to be influenced by the Project; and
- providing early warning to develop and implement the adaptive management plan.

Rationale for the selection of each individual well location is provided in Table 24.8-2.

Seven new monitoring wells, in addition to the nine existing wells, are proposed along flow pathways predicted to emanate from contact-groundwater-generating Project components, and in the downstream environment. They include the following:

- one new well (MWF-01) and one existing well (MW10-04) down-gradient of the pit lake where seepage is predicted to discharge into Baker Creek, and these wells also serve the purpose to protect the existing water supply wells in the downstream Baker and Jones creeks;
- one existing well (MW12-05S/D) down-gradient of the non-PAG waste rock stockpile, where seepage is predicted to discharge into P Creek and Harper Creek;
- two new wells (MWF-02 and MWF-03) and three existing wells (MW12-01S/D, MW11-03, MW11-04) down-gradient of the PAG LGO stockpile, where seepage is predicted to discharge into P Creek and Harper Creek;
- two new wells (MWF-04 and MWF-05) and one existing well (MW11-23S/D) down-gradient of the TMF Main Embankment, along the seepage pathways predicted to discharge into Lower T Creek and Harper Creek; and
- one new well (MWF-06) and one existing well (MW10-03A/B) down-gradient of the TMF North Embankment, where seepage is predicted to discharge into Jones Creek.

Table 24.8-2. Summary of Proposed and Existing Groundwater Monitoring Wells and Rationale

Well ID	Existing (Y/N)	Active Monitoring Phases				Installation Depth[D]	Location	Rationale for Monitoring
		Construction	Operations	Closure	Post-Closure			
MWF-01	N			X	X	Less than 50 m	Baker Creek catchment up-slope of North Thompson River Valley	Detection of possible seepage emanating from pit lake prior to arrival at the supply wells down-gradient.
MW10-04	Y		Note A	X	X	56-60 m	Baker Creak Catchment down-gradient of open pit	Detection of cross-gradient mixing of seepage leaving the pit lake, providing an early indication of development of a dispersive plume.
MW12-05S/D	Y		X	X	X	Less than 50 m	Down-gradient of non-PAG waste rock stockpile water management pond	Characterization of contact groundwater infiltrating beneath the non-PAG waste rock stockpile and associated seepage recovery system, along flow paths predicted to discharge into P and Harper creeks.
MW12-01S/D	Y		X	X[E]		Less than 50 m	Mid-slope between PAG LGO stockpile and Harper Creek	Monitoring along flow paths predicted to be sourced in the PAG LGO stockpile and discharge into P and Harper creeks.
MW11-03	Y		X	X[E]		23 - 33 m	Short distance down-gradient (west) of PAG LGO stockpile	
MW11-04	Y		X	X[E]		24 - 31 m		
MWF-02	N		X	X[E]		Less than 50 m	Near Harper Creek valley bottom down-gradient (west) of PAG LGO stockpile	
MWF-03	N		X	X[E]		Less than 50 m		
MWF-04	N		X	X	X	Less than 50 m	Adjacent to Harper Creek, near the mouth of T Creek, downstream of TMF	Characterization of contact groundwater discharging into Harper Creek.
MWF-05	N		X	X	X	Less than 50 m	Mid-slope between Harper Creek and the TMF main embankment	Characterization of contact groundwater approaching Harper Creek, providing for mid-path early indication of contact groundwater quality along seepage paths predicted to pass beneath the northern reaches of the main embankment and discharge into Harper Creek.

(continued)

Table 24.8-2. Summary of Proposed and Existing Groundwater Monitoring Wells and Rationale (completed)

Well ID	Existing (Y/N)	Active Monitoring Phases				Installation Depth [D]	Location	Rationale for Monitoring
		Construction	Operations	Closure	Post-Closure			
MW11-23S/D	Y		X	X	X	Less than 50 m	Immediately down-slope of the TMF main embankment water management pond	Confirmation of functionality of main embankment seepage recovery system and detection of potential seepage.
MWF-06	N		X [C]	X	X	Less than 50 m	Down-slope of north embankment water management pond	Characterization of contact groundwater passing beneath the north embankment and associated seepage recovery system, along flow paths predicted to discharge into Jones Creek.
MW10-03A/B	Y		X [C]	X	X	55-59 m	Immediate down-gradient of north embankment water management pond	
MW12-03S/D	Y		X [B]	X	X	Less than 50 m	Ridge southeast of TMF	Monitoring along topographic divide between Harper Creek and Barrière River Watersheds to confirm contact groundwater does not flow from the TMF into the Barrière River catchment.
MW12-04S/D	Y		X [B]	X	X	Less than 50 m	Ridge northwest of TMF	Monitoring along topographic divide between Harper Creek and Barrière River Watersheds to confirm contact groundwater does not flow from the TMF into the Barrière River catchment.
MWF-7S/D	N		X	X	X	Less than 100 m	Highlands South of TMF	Background groundwater quality in bedrock.

[A] *In event of early open pit flooding monitoring will commence at onset of open pit flooding.*
[B] *Monitoring to commence Project year 10, allowing adequate time for baseline water quality characterization prior to pond level approaching ridge-top.*
[C] *monitoring to commence at onset of TMF north embankment construction.*
[D] *Determined based on expected or potential depths of target contact groundwater flow paths.*
[E] *Monitoring may need to continue at Closure or even Post-Closure depending on the water quality monitoring results, after the PAG LGO stockpile is removed at the end of Operations.*

In addition, two existing wells (MW12-03S/D and MW12-04S/D) along the saddle separating the TMF from the Barrière River watershed are planned to be monitored. The groundwater model predicted flow directions towards the east beneath the TMF in the locales of these two wells.

A new reference monitoring well (MWF-7S/D) is proposed south of the Project Site, up-slope of the TMF. No contact groundwater is expected to reach this site, making it a suitable location to conduct background monitoring. Data obtained at the background monitoring well will be used to assess whether any trend observed elsewhere in the monitoring network may be attributed to a natural occurrence.

24.8.4.2 Data Collection and Analysis Methods

Groundwater monitoring and sampling will be conducted in accordance with the guidelines documented in the *British Columbia Field Sampling Manual* (Clark 2003). These guidelines include specific provisions for well purging, sample preservation, and quality control protocol. Monitoring and sampling will be conducted by a trained technician.

The measured water levels will be documented and compared with the observations at the baseline pre-mining conditions. Collected water samples will be analyzed by an environmental laboratory accredited in Canada. Samples will be analyzed for all contaminants of concern, including pH, nutrients, and metals. Results will be compared to the performance objectives specified in Section 24.8.2 and Table 24.8-1. Laboratory results will be archived in a digital database.

Where performance objectives are not met (e.g., a constituent reports above the applicable performance objective) an investigation will be conducted to assess the cause. If repeated measurements indicate that a statistically significant trend toward or above a performance objective, and background monitoring does not indicate a possible natural cause, adaptive management measures will be investigated and initiated if appropriate.

24.8.4.3 Schedule

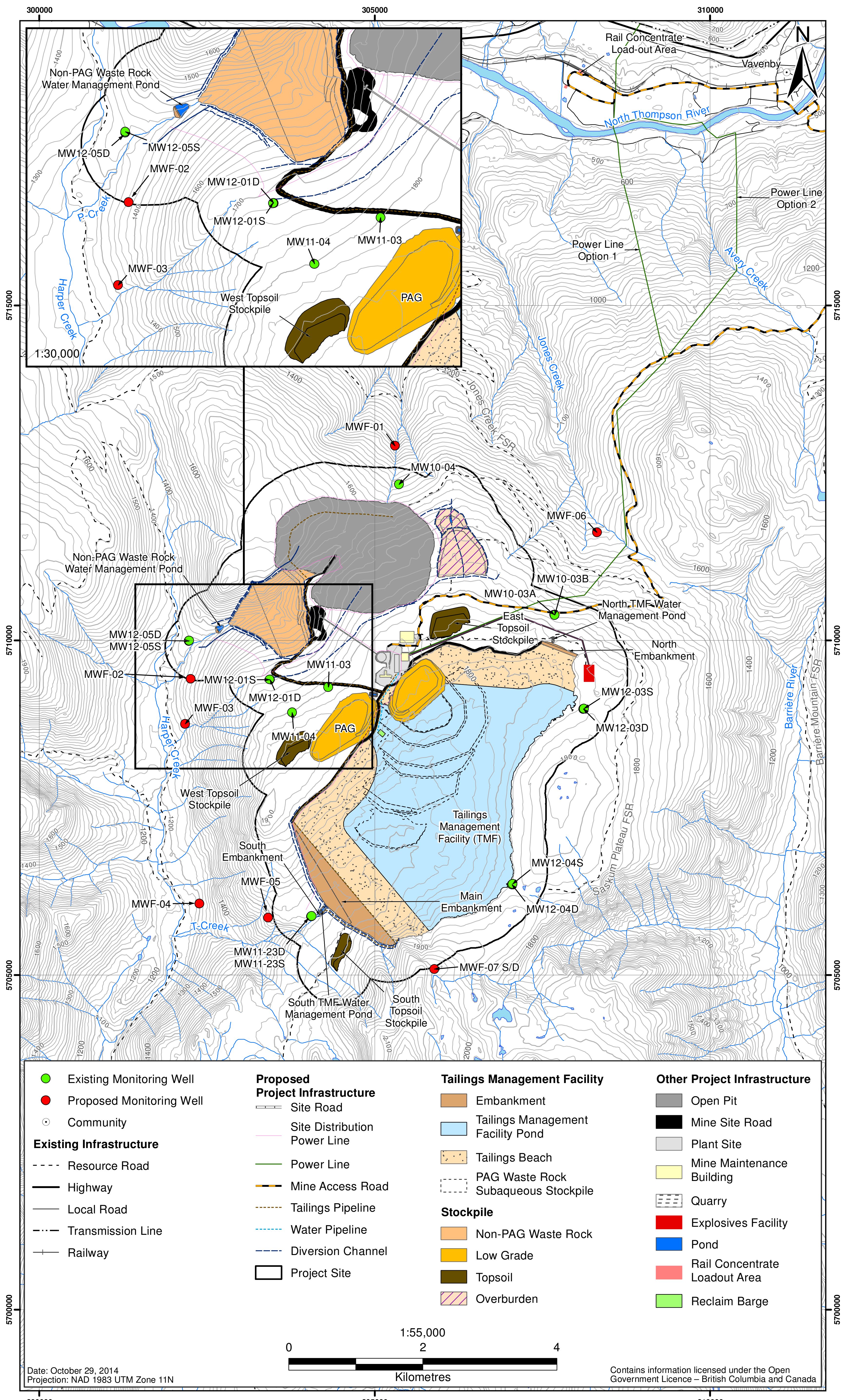
Monitoring will commence at particular wells in advance of up-gradient Project components become active. Specific wells and the Project phases that monitoring will be active are listed in Table 24.8-2. The implementation of the proposed monitoring wells will be on an adaptive basis, which means that the wells located at upper slopes (under each mine component) may be started first and that the wells located at downslopes (e.g., near the receiving creeks) may be started only after effects are detected in the wells on the upper slopes. Functionality of the existing wells will be examined before being utilized.

Monitoring wells will be sampled on a quarterly basis. Monitoring frequency may be increased to monthly or bi-monthly if performance objectives are not being met at a particular well.

During the Post-Closure phase, a progressive reduction in groundwater monitoring will occur, contingent upon meeting performance objectives. Quarterly sampling will be conducted during the first five years of Post-Closure. Bi-annual measurement will be conducted for Years 6 to 10, followed by annual measurements during Years 10 to 50, or as required by regulators.

Figure 24.8-1

Existing and Proposed Groundwater Monitoring Well Locations



24.8.5 Adaptive Management

An adaptive management program for groundwater quality will be initiated under the following conditions:

- where performance objectives are not being met at monitoring wells;
- where a scientifically defensible relation exists between the Project and degradation of groundwater quality; and
- where receiving surface or supply well water quality exceeds permissible levels, or may exceed permissible levels if the detected trend in groundwater quality presents this as a future possibility.

Professional hydrogeologists and/or geotechnical engineers will be consulted, as necessary, to determine the most appropriate adaptive management strategy for a given context. Seepage control mechanisms, such as additional seepage collection dams, pumping wells, or remediation mechanisms such as permeable reactive barriers, are examples of strategies that may be considered to account for unpredicted exceedances of groundwater quality performance objectives.

Increased monitoring frequency and resolution in the vicinity of the performance objective exceedance would be incorporated into the adaptive management program. One or more additional monitoring wells could be installed up-gradient of the receptor of concern. The monitoring frequency along seepage pathways leading to the receptor of concern would be increased to monthly.

As the water levels and flow into the existing water supply wells located in the downstream of the mine are predicted not to be affected, adaptive management plan for groundwater quantity is not expected to be required.

24.8.6 Reporting

Groundwater monitoring results will be provided to regulators annually as part of the Annual Effluent Permit Monitoring Report and *Mines Act* Permit Reclamation Report. These results will include the following:

- all collected data, including dates, locations, laboratory results, and water level measurements;
- methodologies used for data collection and analysis, including quality control and quality assurance measures;
- comparisons between measurements and performance objectives;
- assessment of the relationship between groundwater quality and the data collected at receptors; and
- assessment of the performance of mitigation measures.

24.9 MINE WASTE AND ML/ARD MANAGEMENT PLAN

24.9.1 Purpose

24.9.1.1 Overview

The purpose of this Mine Waste and ML/ARD Management Plan for the proposed Project is to provide the initial framework for managing the possible effects from ML/ARD that may result from the extraction, processing and disposal of waste rock, LGO, overburden, and tailings during the various phases of the Project, by outlining the operating procedures and preventive measures for achieving effective management of potential ML/ARD.

The preliminary Mine Waste and ML/ARD Management Plan is intended as a precursor to ensuring that the potentially deleterious consequences of acid generation can be ameliorated by applying long-term control measures and thus contain and mitigate 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 containing standard operating procedures, method statements, and work instructions for specific permitting prior to commencement of each phase of the Project.

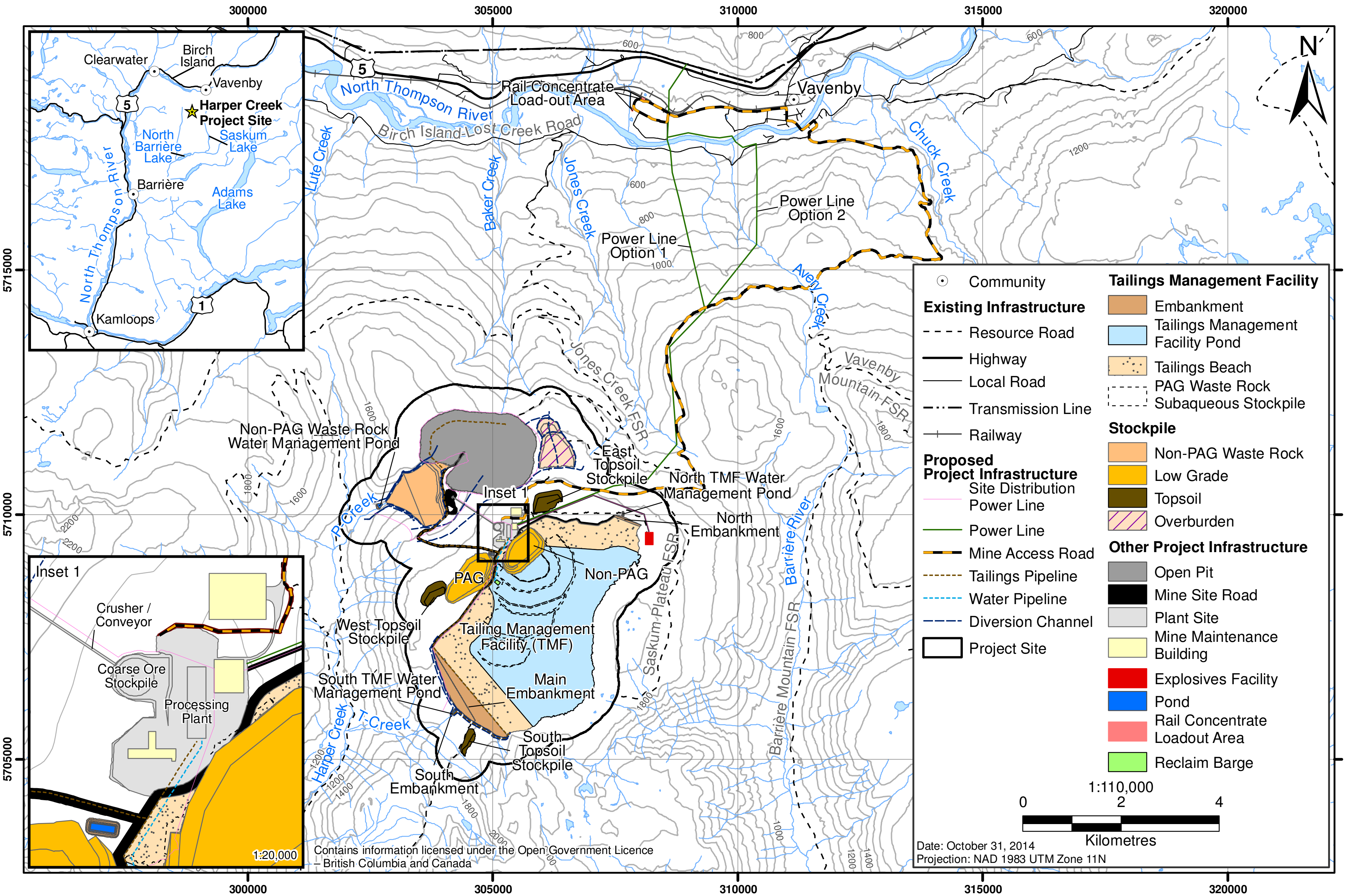
Based on the understanding of the geology of the site, ML/ARD potential was identified as a potential concern, in that a portion of the waste rock produced would likely be acid-generating. Consequently, in preparation of the Application/EIS, HCMC and SRK Consulting characterized the potential for ML/ARD (SRK 2014). This work has shown that certain components of the waste rock, LGO, overburden, and tailings have the potential to pose an ML/ARD generation risk in the absence of appropriate management and mitigation measures.

The overall strategy to manage mine waste materials and ML/ARD is for the storage facilities for waste rock, LGO, overburden (including topsoil), and tailings to be located within or peripheral to the open pit and/or the TMF, as required to accommodate the scheduled quantity of each material type. PAG waste rock and overburden will be placed in the upper TMF and be stored in a permanently saturated condition. Non-PAG waste rock will be placed within the valley located to the south west of the proposed open pit, as well as used for TMF embankment construction. Non-PAG overburden not used for road and dam construction will be placed to the east of the pit. Topsoil will be stockpiled in two locations, north and northwest of the TMF. The tailings will be transported to the TMF via two pipelines. Non-PAG rougher tailings will be stored sub-aerially to beaches whereas PAG cleaner tailings will be stored sub-aqueously. Mining operations will cease in the open pit in the latter half of Year 23 and the mine will begin processing LGO stockpiles thereafter. The tailings deposition from processing of the LGO will continue in the open pit, rather than in the TMF. The TMF has been designed to provide for secure and permanent storage of 585 million tonnes (Mt) of tailings and 237 Mt of PAG waste rock from the proposed mining operation. Figure 24.9-1 shows the location of the waste rock, LGO, topsoil, and overburden stockpiles in relation to the open pit, processing plant, and TMF.

Figure 24.9-1

Waste Rock, Low-grade Ore, Topsoil, and Overburden Stockpile Locations

ERM



The summary of the property geology in this paragraph is from a the Technical Report and Feasibility Study for the Project (Merit 2014; Appendix 5-A). The property is located within structurally complex low-grade metamorphic rocks of the Eagle Bay Assemblage which is part of the Kootenay Terrane on the western margin of the Omineca Belt.

This assemblage hosts numerous small polymetallic massive sulphide deposits found mainly within Devonian age felsic volcanic rocks. These deposits formed in an arc volcanic environment in response to eastward subduction of a paleo-Pacific ocean. The host rocks of the mineralization at Harper Creek are a succession consisting of orthogneiss, metasediments, metavolcanics, and metavolcanic clastics. The dominant rock types at the site are phyllites, schist with minimal quartz content, and schist with quartz content and/or quartz eyes. For the purpose of interpretation of the property geology and resource modelling, nine distinctive large-scale lithological packages have been recognized (Merit 2014). Structurally, the packages strike roughly northeast-southwest and dip to the northwest. The Harper Creek Fault divides the site into two domains (east and west) which show some differences in the characteristics of the packages.

This Mine Waste and ML/ARD Management Plan has been compiled from information provided by HCMC, SRK Consulting and ERM. Alastair Tiver, PEng of HCMC and Stephen Day, PGeo of SRK Consulting are acknowledged for their authorship and review of sections of this document.

24.9.1.2 Structure and Purpose

This Mine Waste and ML/ARD Management Plan addresses waste rock, LGO, overburden, tailings, and quarry materials, structured in this plan in terms of:

- their mining method and generation or processing, their geochemical and geotechnical characteristics, as well as the related performance and design objectives for their management (Section 24.9.2);
- the environmental protection measures envisaged for ameliorating the effects of waste rock, LGO, overburden, tailings, and quarry materials from both geochemical and geotechnical perspectives (Section 24.9.3); and
- the details about monitoring and reporting on the management of mine waste and ML/ARD materials (Sections 24.9.4 and 24.9.5).

To ensure that mine waste, and specifically that which gives rise to ML/ARD potential, does not become a long term concern for the site, HCMC has developed this Mine Waste and ML/ARD Management Plan to allow identification of rock with higher potential for ARD to be segregated so that it can be managed to prevent the onset of ARD following completion of mining. Metal leaching, in contrast to ARD, defines the separate issue of leaching of minerals regardless of drainage pH.

At Harper Creek, potentially significant leaching issues have been identified for copper, selenium, and zinc. These three elements are associated with sulphide minerals which in turn are correlated with higher ARD potential. Copper and selenium are associated with the commodity mineral chalcopyrite. As a result, ML potential is managed by economic classification into ore, LGO and waste, and segregation by ARD potential. As far as acid generation is concerned, this plan is therefore focussed on the management of ARD potential. As far as geotechnical effects are concerned, the plan is aimed at the safe and efficient management of the physical attributes of waste rock, LGO, overburden, tailings, and quarry materials.

The submission of the Application/EIS is envisioned to result in the issuance of environmental authorization for the proposed Project. In the case of authorization being issued, an array of permits per the *Mines Act* (1996b) would then need to be applied for. This Mine Waste and ML/ARD Management Plan would be one of several EMPs that would be further developed to comprise the Project's EMS. The implementation of the Mine Waste and ML/ARD Management Plan would be through the development of standard operating procedures, method statements, and other site-specific work instructions.

The overarching purposes of this Mine Waste and ML/ARD Management Plan for the proposed Project's waste rock, LGO, overburden, tailings, and quarry materials are thus to:

- mitigate health, safety, and environmental risks associated with mine waste and ML/ARD;
- ensure compliance with regulatory requirements, or other relevant environmental management guidelines; and
- track environmental performance and evaluate mitigation measures to enable the implementation of adaptive follow-up programs as needed.

24.9.2 Performance Objectives

This Mine Waste and ML/ARD Management Plan has as its primary objective the installation and operation of a mine materials storage and handling system that performs in a safe and efficient manner, while not inhibiting the ecological functionality of the biophysical environment. Implicit in such performance is the prevention or minimization of the potential adverse environmental effects related to waste rock, LGO, overburden, tailings, and quarry materials. These potential effects are primarily chemical (e.g., ML/ARD, and nitrogen residues from blasting) but include physical effects such as dust generation, substrate erosion, release of suspended solids, and removal of land in its natural state.

This Mine Waste and ML/ARD Management Plan provides the initial point of reference for the stable storage and deposition of the tailings and waste rock generated by 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 mine waste 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 Health, Safety and Reclamation Code (BC MEMPR 2008) will thus provide a suite of related performance objectives.

In considering the potential adverse environmental effects caused by mine waste management, the following overarching performance objectives will apply:

- minimizing the water quality effects of mine waste deposition, by ensuring that PAG waste rock and tailings are placed at an adequate depth below the surface of the TMF in a timely and controlled manner;
- minimizing the physical effects of waste rock and overburden storage facilities, and topsoil and LGO stockpiles, by ensuring that dust, erosion, suspended solids, and pollutants resulting from aeolian and fluvial processes are managed in a timely and controlled manner (see also Section 24.2, Air Quality Management Plan, Section 24.11, Sediment and Erosion Control Plan, and Section 24.18, Waste Management Plan); and
- monitoring water quality of the affected catchment, per the technical indicators contained in Section 24.6, Fish and Aquatic Effects Monitoring and Management Plan, as well as Section 24.13, Site Water Management Plan, such that anomalies in these indicators can be responded to by applying appropriate mitigation.

The following sections describe the waste rock, LGO, overburden, tailings, and quarry materials. This is done in terms of their material characteristics, comprising their mining method and generation or processing, their geochemical and geotechnical characteristics, as well as the related performance and design objectives for their management

24.9.2.1 Material Characteristics

Waste Rock

Mining Method and Generation Schedule

The Harper Creek Mine will be a conventional open pit, truck and shovel operation. The targeted production will entail an average material movement of 25 Mt per year over the period of open pit mining. Of this, a total of 543.7 Mt will be waste rock, which includes 39 Mt of overburden.

The equipment fleet will incorporate large scale units which have been well proven in existing operations. In total, the mine will operate one diesel rotary drill, two electric rotary drills, three 42 m^3 electric hydraulic shovels, one 18 m^3 wheel loader, up to 28 mine haul trucks of 227 t capacity, and a fleet of support equipment.

The feasibility study for the Project (Merit 2014), that provides a detailed waste rock production schedule, shows in summary that an amount of 237,349 kilotonne (kt) of PAG waste rock and 265,422 kt of non-PAG waste rock will be generated over the life of the mine. The relative proportions were calculated from acid-base accounting data and the proposed criteria used to define PAG are described below in Section 24.9.3.1, Geochemical Segregation Criteria.

Geochemical Characteristics

Waste rock is defined as rock with copper concentrations less than 0.14% and will be segregated into PAG and non-PAG components (see Section 24.9.3.1). Characteristics of the components are provided in Table 24.9-1, calculated from the exploration database using total sulphur to obtain acid potential (AP) and calcium concentrations to calculate site-specific neutralization potential (NP*) as described in Section 24.9.3.1. Detailed discussion of waste rock characteristics is provided by SRK (2014). PAG rock has distinctively higher sulphur concentrations resulting in higher AP (average 53 kg $CaCO_3$/t) compared to non-PAG rock (average 17 kg $CaCO_3$/t). Copper concentrations are also higher for PAG rock than non-PAG rock.

Table 24.9-1. Geochemical Characteristics of Waste Rock by Acid Rock Drainage Potential

	PAG Waste Rock				Non-PAG Waste Rock			
	NP*	AP	NP*/AP	Cu	NP*	AP	NP*/AP	Cu
Statistic	kg $CaCO_3$/t	kg $CaCO_3$/t		%	kg $CaCO_3$/t	kg $CaCO_3$/t		%
Number of Samples	6,571	6,571	6,571	6,571	5,240	5,240	5,240	5,240
Minimum	1	3.1	0.012	0.001	5.9	0.31	2.0	0.001
5th Percentile	5.9	11	0.12	0.004	20	1.9	2.2	0.002
Median	23	38	0.74	0.03	64	12	4.6	0.01
Mean	35	53	0.66	0.042	81	17	4.9	0.026
95th Percentile	110	150	1.8	0.12	190	50	37	0.11
Maximum	260	310	2.0	0.14	360	130	780	0.14

Geotechnical Characteristics

Waste rock will be placed using conventional methods that allow for the development of the proposed dumps in a manner that minimizes disturbance while providing for the reclamation and closure of these facilities. Details of the site characteristics, geotechnical conditions, waste rock dump stability classification, and stability assessment are contained in the Knight Piésold Ltd. (2014b) report *Mine Waste and Water Management Design Report. Ref. No. VA101-458/11-1*.

Low-grade Ore

Mining Method and Generation Schedule

LGO will be separated from the run of mine mill feed from the open pit truck and shovel operation as described above in Section 24.9.2.1, Waste Rock. During mine operations, approximately 116 Mt of LGO will be stored in temporary stockpiles and processed later in the mine life. Of this figure, approximately 74 Mt is potentially reactive material and will be stockpiled adjacent to the TMF so that surface and seepage run-off are directed into the TMF. Mining operations will cease in the open pit during Year 24 and the mine will begin processing remaining LGO from the site stockpiles. The tailings deposition will continue to occur during this period but the tailings will be directed towards the open pit for long-term storage.

Geochemical Characteristics

LGO is defined based on a lower copper concentration of 0.14% and a variable upper concentration that is higher during the earlier stages of mining (Table 24.9-2). The table indicates that the range of copper concentrations that could report to the LGO stockpiles is 0.14% to 0.24%. LGO will be segregated based on ARD potential using the same methods as waste rock. Geochemical characteristics of LGO according to ARD potential is shown in Table 24.9-3. As with waste rock, sulphide content of PAG LGO is greater than non-PAG LGO, resulting in higher APs for the former. PAG LGO tends to be more sulphidic than PAG waste rock but there is little difference between non-PAG LGO and non-PAG waste rock.

Table 24.9-2. Definition of Ore Grade by Year and Pit Phase According to Copper Concentration

Year	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Phase 1		0.22	0.22	0.20	0.18	0.22									
Phase 2			0.24	0.22	0.18	0.18	0.18	0.18	0.16						0.18
Phase 3					0.20	0.20	0.18	0.18	0.16	0.16	0.18	0.16	0.18	0.18	0.16
Phase 4									0.16	0.16	0.18	0.16	0.16	0.18	0.16
Phase 5												0.16	0.16	0.16	0.16

Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Phase 1														
Phase 2														
Phase 3	0.20	0.20	0.18	0.18	0.16	0.16								
Phase 4	0.18	0.14	0.14	0.14	0.14	0.14	0.16							
Phase 5	0.20	0.14	0.14	0.14	0.14	0.14	0.16	0.16	0.16	0.14				

Source: YMI

Note: Rock above the indicated copper concentration will report to the process plant. Rock with copper concentrations between 0.14% and the indicated concentration will report to a LGO stockpile.

Table 24.9-3. Geochemical Characteristics of Low-grade Ore by Acid Rock Drainage Potential

	PAG Low-grade Ore				Non-PAG Low-grade Ore			
	NP*	AP	NP*/AP	Cu	NP*	AP	NP*/AP	Cu
Statistic	kg $CaCO_3$/t	kg $CaCO_3$/t		%	kg $CaCO_3$/t	kg $CaCO_3$/t		%
Number of Samples	1148	1148	1148	1148	623	623	623	623
Minimum	1	7.2	0.0099	0.14	18	1.3	2.0	0.14
5th Percentile	5.6	17	0.076	0.14	31	5.3	2.1	0.14
Median	24	48	0.58	0.18	62	15	4.1	0.18
Mean	35	64	0.54	0.18	71	18	4.1	0.18
95th Percentile	99	160	1.8	0.23	140	42	12	0.23
Maximum	230	310	2.0	0.24	230	79	50	0.24

Geotechnical Characteristics

LGO separated from the waste rock stream will be placed using conventional methods that allow for the development of the proposed dumps in a manner that minimizes disturbance while providing for the reclamation and closure of these facilities. Details of the site characteristics, geotechnical conditions, waste rock dump stability classification, and stability assessment are contained in the Knight Piésold Ltd. (2014b) report *Mine Waste and Water Management Design Report. Ref. No. VA101-458/11-1*.

Overburden

Mining Method and Generation Schedule

As part of the conventional truck and shovel mining operation, a total of 543.7 Mt of waste will be mined from the open pit. Of this, overburden from the earthworks required to allow access to ore-bearing material amounts to 38.9 Mt. Overburden was one of the material types included in the mine material movement schedule. For the purposes of stockpiling, topsoil was estimated as a subset of overburden. Non-PAG overburden will be used for road and dam construction and the balance will be placed in stockpiles to the east of the open pit. Such use will occur as required to accommodate the scheduled movement of identified material types.

Geochemical Characteristics

Figure 24.9-2 illustrates ARD potential of overburden with reference to in-pit and ex-pit (tailings footprint) locations.

Overburden from the tailings area had acid potentials less than 10 kg $CaCO_3$/t and was classified dominantly as non-PAG. Inside the pit area, two types of overburden were recognized, namely:

- in-pit overburden containing only glacially derived rock fragments and no rock of the type found in the Project areas (“Overburden” in Figure 24.9-2); and
- in-pit overburden containing weathered locally-derived bedrock (“Weather Bedrock” in Figure 24.9-2).

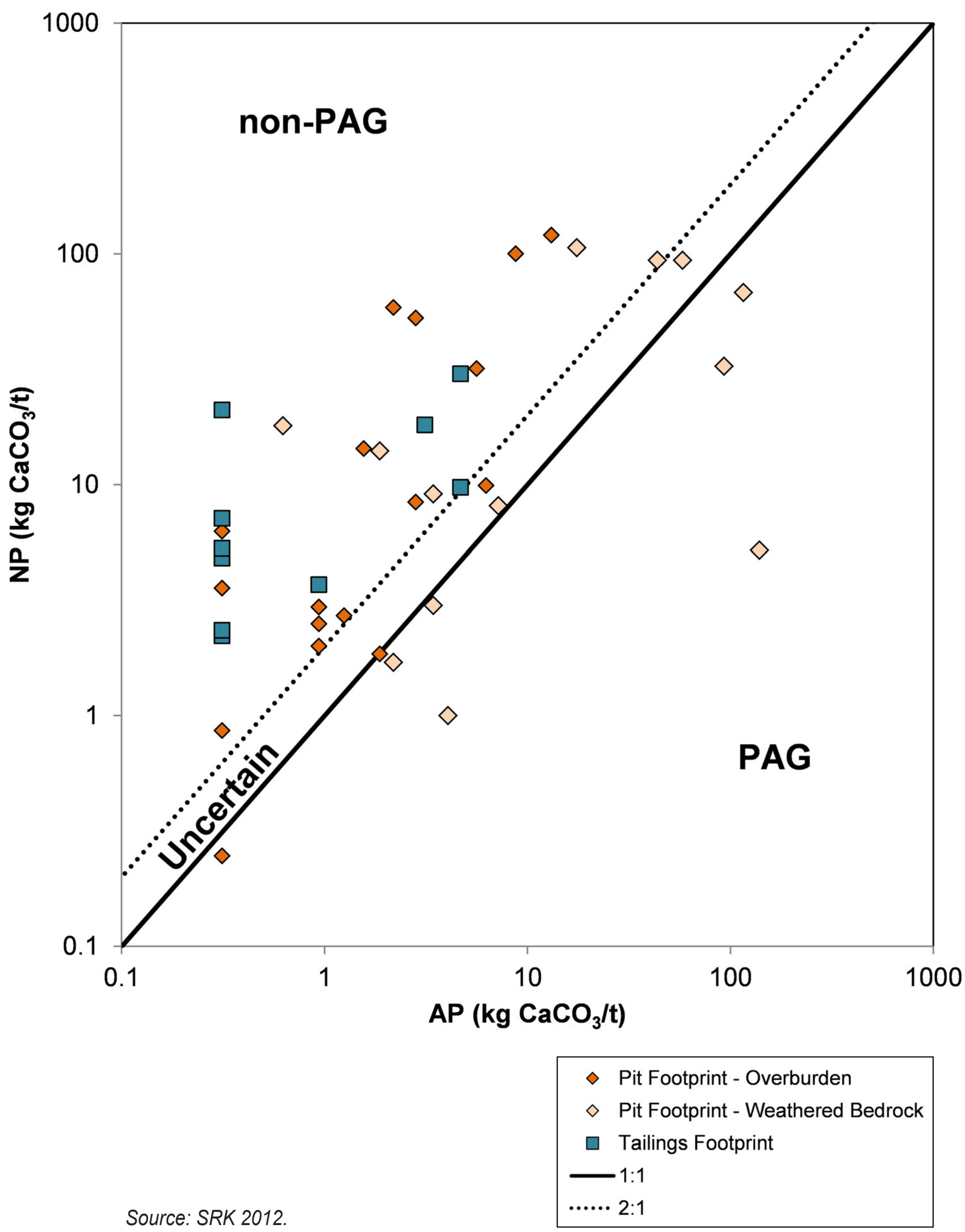
The former was classified mainly as non-PAG due to elevated NP, or had low AP. Some samples had NP/AP less than 2 but APs were less than 10 kg $CaCO_3$/t. The latter showed a wider range of ARD potentials due to variable AP. Three samples with highest AP were classified as PAG.

Geotechnical Characteristics

Overburden from the earthworks required to allow access to ore-bearing material will be placed using conventional methods that allow for the development of the proposed dumps in a manner that minimizes disturbance while providing for the reclamation and closure of these facilities. Details of the site characteristics, geotechnical conditions, waste rock dump stability classification, and stability assessment are contained in the Knight Piésold Ltd. (2014b) report *Mine Waste and Water Management Design Report. Ref. No. VA101-458/11-1*.

Figure 24.9-2

NP vs AP for Overburden Samples from the Pit Area and Tailings Footprint Area



Source: SRK 2012.

Tailings

Process Description

The Concentrator was designed to address the specific requirements to optimize copper recovery from Harper Creek ore. The run-of-mine (ROM) ore will be reduced through three stages of comminution and the copper minerals recovered by flotation, with rougher/scavenger concentrates reground and cleaned to final commercial concentrate grades. The concentrator is designed to process a nominal 70,000 t per day of copper sulphide ore and produce marketable copper concentrate.

The flow of ore will be through crushing, grinding, mechanical rougher/scavenger flotation in tank cell banks and the rougher/scavenger concentrate cleaned through two stage column flotation cleaning to increase the quality of the concentrate. The rougher/scavenger concentrate will be sent through a regrind circuit and reprocessed through the cleaners to increase copper grade to commercial levels. Final concentrate from the second cleaner column will be densified through a thickener and dried in filter presses to achieve a concentrate moisture of approximately 8%. This concentrate will be trucked off site for shipping to smelters.

The final flotation tailings, including the rougher/scavenger flotation tailings and the first cleaner scavenger tailings, will be disposed using the conventional tailing storage method. The process water in the TMF will be recycled to the process plant. Fresh water for process water make-up, gland seal service, mill cooling, and reagent preparation will be obtained from a groundwater well drilled for this purpose, envisaged to be located in the undisturbed area north of the TMF. Abstraction volumes will be scaled to the demand and the necessary regulatory authorisation for such abstraction will be sought.

Geochemical Characteristics

Geochemical characteristics of tailings resulting from metallurgical testwork are shown in Table 24.9-4. Cleaner tailings are classified as PAG whereas rougher tailings are classified as non-PAG. The classification differences occur in the sulphide content, since carbonate content and neutralization potential were similar for both types of tailings.

Geotechnical Characteristics

Two tailings streams will be generated in the process plant and transported to the TMF for conventional slurry tailings storage. The two types of tailings are designated as rougher scavenger (bulk) tailings and cleaner scavenger (cleaner) tailings. The bulk tailings stream consists of approximately 93% of the total tailings stream with cleaner tailings representing the remaining balance of 7%. The bulk tailings slurry concentration was estimated to be 34.5% dry by weight, with a solids density of 2.66 t/m^3. The cleaner tailings slurry concentration was estimated to be 32.7% dry by weight, with a solids density of 3.11 t/m^3. The TMF has been designed to provide sufficient capacity to store approximately 585 Mt of tailings.

Details of the site characteristics, geotechnical and water management considerations for the tailings facility design, seepage collection and reclamation and closure are contained in the Knight Piésold Ltd. (2014b) report *Mine Waste and Water Management Design Report. Ref. No. VA101-458/11-1*.

Table 24.9-4. Static Geochemical Characteristics of Tailings Samples

Sample ID	Type	Paste pH	CO_2 (kg $CaCO_3$/t)	Total S (%)	Sulphate (%)	AP (kg $CaCO_3$/t)	NP (kg $CaCO_3$/t)	NP/AP	Cu (mg/kg)
3321-P2 WSB CL TAILS	Cleaner	8	100	5.9	0.04	180	76	0.41	530
KM 2916-14 Cu 1CT	Cleaner	6.8	130	9.3	0.37	290	80	0.28	2,900
2916-12	Rougher	9.4	110	0.79	<0.01	25	76	3.1	250
2916-13	Rougher	9.5	100	0.72	<0.01	23	78	3.5	250
3321-P2 WSB RO TAILS	Rougher	9.3	96	0.96	0.01	30	76	2.5	220
KM 2916-14 Cu Rotl	Rougher	8.7	110	0.87	<0.01	27	73	2.7	190
2916-12 DUP	Rougher	9.4	96	0.77	<0.01	24	74	3.1	240
2916-13 DUP	Rougher	9.4	110	0.76	<0.01	24	77	3.2	250

Quarry

Mining Method and Generation Schedule

A quarry to supply material for the cofferdam is located in the southeast part of the TMF. Conventional drill, blast and haul quarrying methods will be employed. The cofferdam is required in Year 1, to initiate the construction of the TMF main embankment. The quarry will provide an estimated 400,000 m^3 of material for the core zone of the cofferdam and ultimately the main embankment of the TMF. It will become submerged in the same year as the Stage 1 embankment of the TMF is brought into service.

Geochemical Characteristics

ARD potential of quarry rock is shown in Figure 24.9-3. All samples contained sulphur at or below the detection limit and are therefore classified as non-PAG.

Geotechnical Characteristics

The quarry will provide granitic rock for the construction of the cofferdam. The geotechnical characteristics of granite are particularly suitable for the envisaged purpose as core zone material for the TMF main embankment.

24.9.2.2 Design of Disposal Facilities

Waste Rock

Performance Objectives

The principle design objectives for the waste rock stockpiles are to ensure protection of the regional groundwater and surface water during both Operations and in the long term (after Closure), and to achieve effective reclamation at mine closure. The geotechnical stability of waste rock stockpiles (e.g., suitable angles of repose of slopes) and effective drainage collection (e.g., seepage loss targets) are important design criteria.

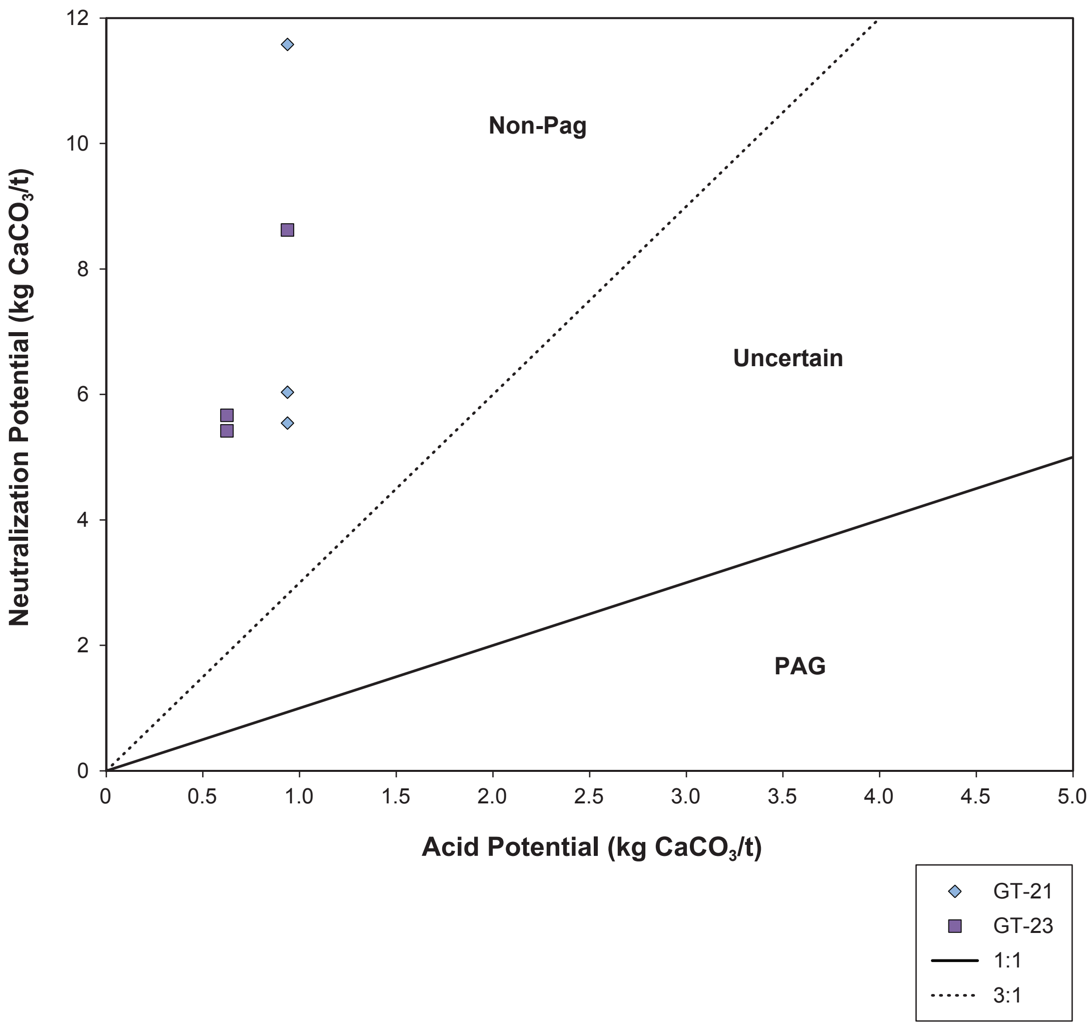
Design Criteria

The design and location of the waste rock stockpiles has taken into account the following requirements:

- situating the waste rock facilities away from sensitive environmental features including fish bearing drainages;
- clustering the facilities to minimize the overall footprint;
- permanent, secure, and total confinement of all solid waste materials within engineered storage facilities;
- control, collection, and removal of free-draining liquids from the waste rock facilities during Operations for recycling as process water to the maximum practical extent;
- prevention of ARD and minimization of metal leaching from reactive waste rock; and
- staged development of the facility over the life of the Project.

Figure 24.9-3

NP vs AP for Quarry Samples



The general arrangement showing the layout of the Project at the maximum extent of all facilities is shown on Figure 24.9-1.

Non-PAG Waste Rock Dump

Material from the non-PAG waste rock stockpile located to the southwest of the open pit will be used to construct the TMF embankments, Project Site roads, and non-PAG LGO platform. Surplus and unsuitable material will remain on the stockpile and be progressively reclaimed during Operations as final slopes and grades are reached.

PAG Waste Rock Dump

Material from the PAG waste rock stockpile located to the northwest of the open pit will be used to construct the upstream zone of the TMF main embankment during the first five years of mine operation. Surplus PAG waste rock will be co-disposed of within the TMF in such a manner that it becomes flooded by the supernatant pond within a year.

Low-grade Ore

Performance Objectives

The principle design objectives for the non-PAG and PAG stockpiles described above in Section 24.9.2.2, Waste Rock, will be employed for the LGO stockpiles, namely the protection of regional water resources, stockpile stability, and effective drainage management.

Design Criteria

The general design criteria described above in Section 24.9.2.2, Waste Rock, will also be employed for the LGO stockpiles. Specific criteria that differentiate between non-PAG and PAG material handling are described in the following paragraphs:

- *Non-PAG LGO stockpile* — An amount of up to 7.5 Mt will be temporarily stockpiled near the primary crusher and processed within the first five years of mine operation. The balance will be stockpiled within the TMF basin on a non-PAG waste rock platform at an elevation above the ultimate extent of the TMF. The remaining non-PAG LGO will be processed during the final four years of Operations.
- *PAG LGO stockpile* — PAG LGO will be stockpiled adjacent to the TMF basin on an engineered sub-grade and processed during the final four years of Operations. This stockpile will be equipped with a surface water and infiltration collection pond, from where the impounded water will be directed to the TMF.

Water Management

As mentioned, surface water and seepage from the LGO stockpiles will be managed by means of collection in purpose-designed impoundments and returned to the closed water cycle in the mining process.

Closure

Some non-PAG LGO will be processed during initial mine operations but the majority of it and the PAG LGO stockpiles will be comprehensively processed during the final four years of the Operations phase. Any remnants of the LGO stockpiles will be subjected to reclamation practices that will accord with acceptable slope dimensions and water management for closure. Similarly, if the LGO stockpiles are not utilised as a consequence of early temporary or permanent mine closure, they will be subjected to the same reclamation practices that accord with closure slope and water management requirements.

Overburden Stockpiles

Performance Objectives

The principle design objectives for the non-PAG and PAG stockpiles described above in Section 24.9.2.2, Waste Rock, will be employed for the overburden, namely the protection of regional water resources, stockpile stability, and effective drainage management.

Design Criteria

The general design criteria described above in Section 24.9.2.2, Waste Rock, will also be employed for the overburden stockpiles. Specific criteria regarding the deployment of overburden material include:

- using the best available overburden material to construct the low-permeability zones of the TMF embankment raises;
- using overburden to construct TMF embankment shell zone when non-PAG waste rock is unavailable; and
- disposing of surplus and unsuitable overburden material in a single on-land waste stockpile to the east of the open pit.

Water Management

Surface water and seepage from the overburden stockpile will be managed by means of collection in purpose-designed impoundments and returned to the closed water cycle in the mining process.

Closure

The overburden stockpile will be progressively reclaimed during Operations as material is deployed as described above and final slopes and grades are reached. The remaining overburden stockpile will be subjected to reclamation practices that will accord with acceptable slope dimensions and water management for closure.

Tailings Dam

Performance Objectives

The TMF will be subjected to the same design objectives as the waste rock stockpiles described above in Section 24.9.2.2, Waste Rock, essentially to ensure protection of the regional groundwater and surface water during both Operations and in the long term (after Closure), and to achieve effective reclamation at mine closure. The geotechnical stability of the embankments of the TMF (e.g., structural integrity) and effective drainage management are important design criteria.

Design Criteria

As with the waste rock stockpiles, the design and location of the TMF has taken into account the requirements described in Section 24.9.2.2, Waste Rock, namely:

- situating the TMF away from sensitive environmental features including fish bearing drainages;
- permanent, secure, and total confinement of all solid waste materials within engineered storage facilities;
- control, collection, and removal of free-draining liquids from the TMF during Operations for recycling as process water to the maximum practical extent;
- prevention of ARD and minimization of metal leaching from reactive tailings; and
- staged development of the TMF over the life of the Project.

More specific to dam safety, the Canadian Dam Association (CDA) Dam Safety Guidelines (2007) were used to determine the dam classification and suggested minimum inflow design flood and earthquake design ground motion for the Project TMF. The TMF was classified by considering the potential incremental consequences of a failure. The dam safety classification for the Project tailings dams is very high. The following suggested design flood and earthquake levels were adopted from the CDA guidelines for the design of the Project:

- inflow design flood – 2/3 between 1/1,000 year and probable maximum flood; and
- earthquake design ground motion – 1/5,000 year return period.

A draft bulletin released by the CDA in 2012, entitled Application of 2007 Dam Safety Guidelines to Mining Dams – Design Considerations, suggests that in closure of the TMF, a mining dam should be designed for the probable maximum flood and the 1/10,000 year return period earthquake design ground motion regardless of dam classification. These design event levels were adopted for closure of the TMF.

Water Management

The following design features have been formulated specifically for the management of water at the TMF:

- cofferdams and sediment ponds to manage water during construction by either routing water around the TMF or directing water to the TMF for collection;
- two zoned water-retaining earth-rockfill dams referred to as the main embankment and north embankment;
- designated PAG waste rock storage areas within the TMF;

- downstream water management ponds for seepage and storm water management;
- collection channels that route water to the TMF and collection ponds;
- diversion channels that route water away from the TMF and collection ponds;
- tailings distribution system;
- tailings beaches;
- reclaim water system; and
- supernatant water pond.

Closure

Having been progressively covered by tailings and the supernatant pond during Operations, the fill platforms of the PAG storage area will be flooded during closure of the TMF. The final stage of the main embankment at closure is designed to reach an elevation of 1836 m, which is approximately 185 m in height at the maximum dam section. It will be capable of securely storing over 585 Mt of process tailings, 237 Mt of PAG waste rock, site contact water, and the inflow design flood with at least 1 m of freeboard for wave run-up. Soil cover and re-vegetation of TMF embankments and tailings beaches will be undertaken as appropriate.

Quarry

Granitic material from the quarry located in the southeast part of the TMF has proved to be non-PAG. Together with the fact that the quarry will become submerged after the first year of mine operation, as the Stage 1 embankment of the TMF is brought into service, it is felt that this facility need not receive further attention in terms of design of storage facilities.

24.9.3 Environmental Protection Measures

The waste rock and LGO are destined for four locations: PAG waste rock will be placed in the TMF, non-PAG waste rock will be placed in the valley to the southwest of the pit, non-PAG and PAG LGO will be stockpiled separately to the southwest of the plant site adjacent to the TMF, and some non-PAG rock will be used for TMF dam construction. ML/ARD prevention planning for the mine includes a strategy for subaqueous storage of waste rock in the TMF during operation, such that waste rock will also become subaqueously stored at that time.

Some overburden will be used for road and dam construction and the balance will be placed in a stockpile located to the east of the open pit for reclamation of dumps at the end of mine life. Approximately 30 Mt will be used for dam and road construction and for creating bases below LGO stockpiles. An additional 72 Mt will be hauled to the TMF for dam raising throughout the mine life.

24.9.3.1 Waste Rock and Low-grade Ore

Geochemical Segregation Criteria

Site Specific Acid Base Accounting Parameters

Waste rock and LGO will be segregated based on ARD potential using NP*/AP where:

- Acid Potential (AP) is determined from:
  - AP (kg $CaCO_3$/t) = S_T(%) × 31.25 where S_T is total sulphur concentration
- Site-specific Neutralization Potential (NP*) is determined from NP (modified method) using:
  - for NP < 100 kg $CaCO_3$/t: NP* (kg $CaCO_3$/t) = NP (kg $CaCO_3$/t)
  - for NP ≥ 100 kg $CaCO_3$/t: NP* (kg $CaCO_3$/t) = NP (kg $CaCO_3$/t) -18

Development of these site specific measures is provided in SRK (2014). An alternative method for calculating for NP* using calcium concentrations (expressed in equivalent units of kg $CaCO_3$/t) determined by a four-acid digestion is:

- Log NP (kg $CaCO_3$/t) = 0.8.log($Ca_{(4\text{-acid})}$, kg $CaCO_3$/t) + 0.49

NP/AP Criterion

Humidity cell data indicate the commonly observed relationship between increasing acid generation rate (as shown by sulphate release) and the ratio of products of carbonate mineral dissolution and sulphate release (Figure 24.9-4). The decreasing ratio as acid generation rate increases is consistent with the transition from simple dissolution of carbonate minerals in the absence of acid generation to dissolution in response to acid generation. The latter yields ratios between one and two whereas the former yields ratios exceeding two. In samples where net acidity is a potential outcome, a ratio between one and two is expected and is equivalent to the critical NP*/AP ratio. The trend indicates a site specific NP*/AP ratio of 1.6.

However, for operational purposes, PAG rock will be defined by:

- NP*/AP≤2

Non-PAG rock will be defined by:

- NP*/AP>2

Stockpiling Duration and Delay to Onset of ARD

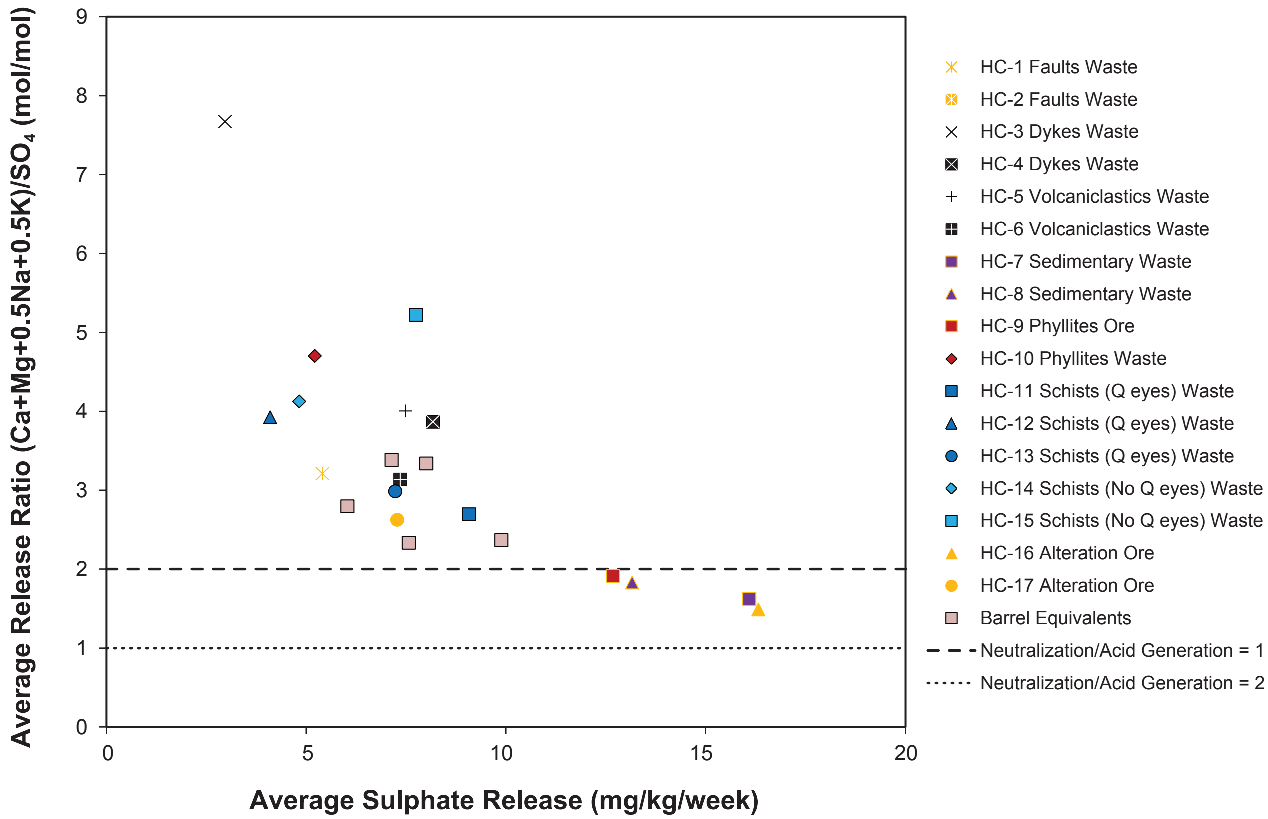
Background

The time or delay to onset of ARD (t_{onset}) depends on both the site-specific availability of reactive neutralization potential (NP*) and the rate at which reactive neutralization potential (R_{NP*}) is depleted:

$$t_{onset} = NP^*/R_{NP^*}$$

Figure 24.9-4

Evaluation of Site-specific NP/AP Criterion Using Humidity Cell Data



However, the rate at which carbonate is depleted is actually a function of the acid generation (sulphide oxidation) rate (R_S). In molar terms, the rate of carbonate depletion to sulphide depletion is the same as the NP/AP criterion for PAG rock ($\{NP^*/AP^*\}_{crit}$).

$$R_{NP^*}/ R_S = \{NP^*/AP^*\}_{crit}$$

Assuming a direct linear relationship between oxidation rate and sulphur content and conservatively a zero order chemical reaction, then:

$$R_S = k.AP^*_0$$

where k is the slope of the line and the rate constant; and AP_0 is the initial sulphur content. The non-zero intercept is not included because if no sulphide is present then the rate of sulphide oxidation is zero.

When these three relationships are combined, the delay to onset is:

$$t_{onset} = \frac{\left(NP^* / AP^* \right)_0}{k.\left(NP^* / AP^* \right)_{crit}}$$

Therefore, the delay to onset is a function of NP*/AP* of the sample, the overall rate of oxidation of sulphide (k) and the effectiveness of neutralization ($\{NP^*/AP^*\}_{crit}$). Longer delays are indicated for rock with higher NP*/AP* values assuming constant values for the two other factors.

Lag Time Calculation for Harper Creek Project

Relationships between initial sulphide content (S_0) and sulphate release are apparent (Figure 24.9-5). Consideration of rock types shows that there are differences in sulphide reactivity.

For schists and phyllites, the regression relationship is (not including the single point with highest sulphide content):

$$\text{Sulphate release (mgS/kg/week)} = 5.4 \times 10^{-5}.S_0 + 1.5 \quad (r = 0.56)$$

For sedimentary rock types, the relationship is (not including the single point with lowest sulphate release):

$$\text{Sulphate release (mgS/kg/week)} = 1.9 \times 10^{-4}.S_0 + 3.9 \quad (r = 0.95)$$

The steeper slope for the sedimentary rock types (1.9×10^{-4} week^{-1}) indicates greater reactivity than the schists and phyllites. The non-zero y-axis intercept implies sulphate release in the absence of sulphide. It is suspected that this reflects residual sulphate flushing which adds to the sulphate generated by sulphide oxidation and therefore that these relationships might slowly shift downwards with time. The slope of the regression lines in each case is k.

Using these values of k, lag time can be estimated separately for each rock type using the site specific criterion for NP/AP (1.6). The result of the calculation is shown in Figure 24.9-6.

Relationship between Sulphide Sulphur Content and Average Sulphate Release from Humidity Cells

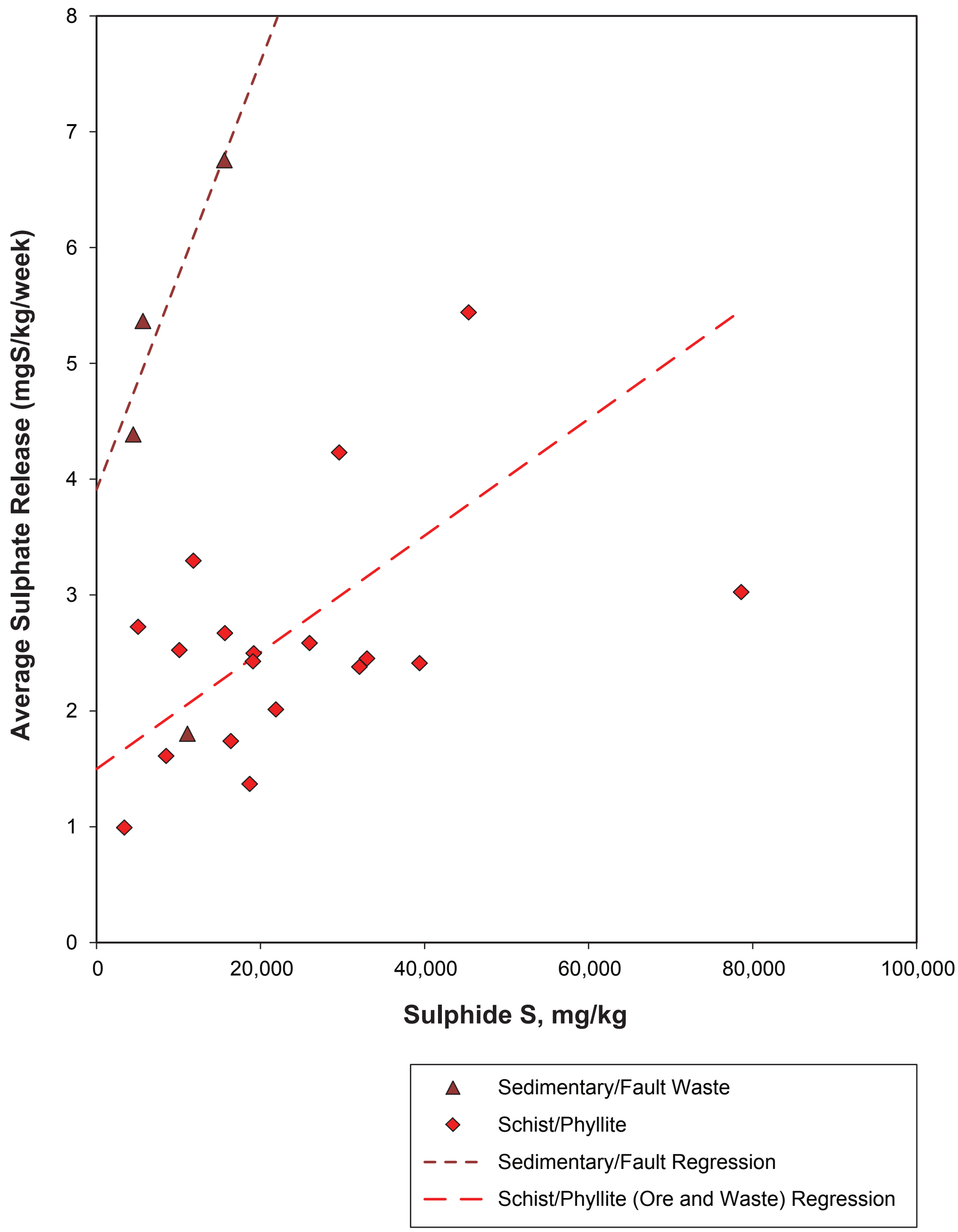
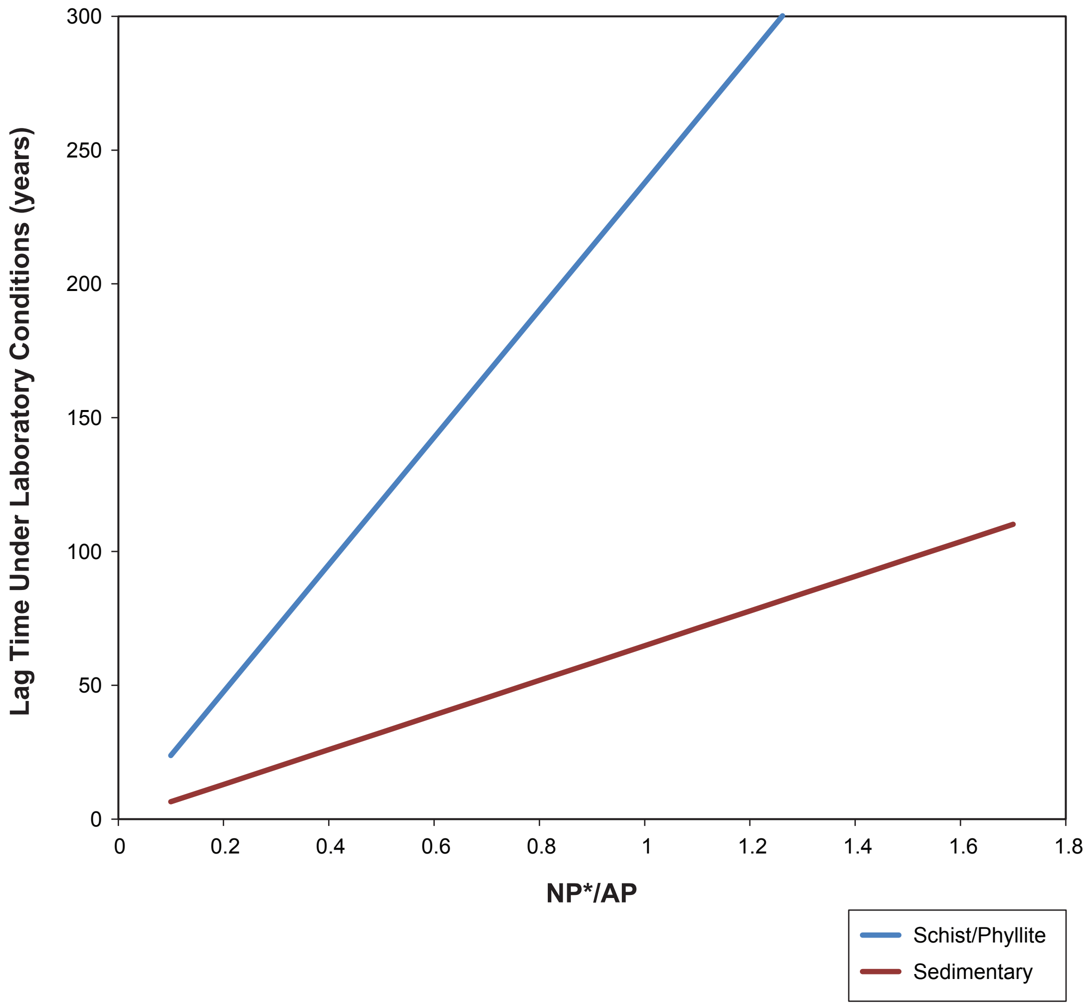


Figure 24.9-6

Calculated Lag Time as a Funtion of Rock Type Group and NP*/AP



The calculation indicates that under laboratory conditions, it will take decades for acidic conditions to develop. Slower onset can be expected under cooler site conditions where sulphide oxidation rates will be lower.

Application to Stockpile Management

PAG LGO stockpiles will be processed or permanently stored underwater before generating acid to prevent the need to manage ARD or result in high dissolved solids loads during processing.

The equations describing delay to onset of ARD (t_{onset}), based in the above equations and assuming a temperature correction for site conditions of 0.3 (SRK 2014), are:

- for sedimentary rock types: t_{onset} (years) = 220 (NP*/AP)
- for phyllites and schists: t_{onset} (years) = 800 (NP*/AP)

These timeframes indicate t_{onset} to exceed decades for most PAG rock at the site which is not expected to be an important constraint to mine operations.

<u>Blast Hole Sampling Density and Analysis</u>

In order to ensure that segregated non-PAG material contains low proportions of PAG rock, blast holes cuttings will be analysed and tested at the on-site laboratory. The planned density of blast hole sampling will be:

- every fifth blast hole.

This frequency will be refined based on operational experience and understanding of variability of ARD potential at the blast scale.

<u>Ore and Waste Modelling</u>

The basis for ore and waste modelling for the Project at a bench scale will be blast hole sampling. In general, samples from individual blast holes will be collected and transported to an onsite laboratory for analysis to determine the copper, gold and silver grades. The results will be transferred to the mine engineering department, where the individual analyses will be referenced back to blast hole locations and the information stored in a blast hole database. In addition to the analytical results for copper, NP*/AP ratios will also be determined and recorded.

Geostatistical analysis of the blast hole results in combination with exploration data will be undertaken to produce a regular three dimensional "grade control" block model with each block having a copper grade assigned to it. Based on a pre-determined set of cut-off grades, individual blocks will be classified as either waste, low grade or ore.

Similarly, with regards to non-PAG and PAG material types, blast hole results in combination with exploration data will be analysed to classify LGO and waste as non-PAG or PAG. Blocks in the "grade control" model will be assigned a flag based on their relative location to the nearest CNP/AP ratio result, thus allowing individual blocks to be identified as either non-PAG or PAG material.

The "grade control" model will form the basis for short term planning within the pit. Routine monthly reconciliation will be undertaken with the mill to assess the effectiveness of ore and waste modelling. In addition, reconciliation against the exploration block model will also be undertaken in order to refine this model and allow more accurate long term modelling of ore and waste.

Definition of Dig Limits

Dig limits will be defined based on five material types:

- ore;
- non-PAG Waste;
- PAG Waste;
- non-PAG Low Grade; and
- PAG Low Grade.

Using the "grade control" model, the mine engineering department will generate dig limits around individual blocks using predetermined cut off grades to define acceptable ore, LGO and waste rock. The dig limits for LGO and waste rock will be further subdivided and classified as either PAG or non-PAG based on the NP*/AP ratio of the individual blocks. For each blast pattern an electronic outline of dig limits will be generated. For ore and low grade sections, a tonnage and grade will be estimated. This information along with the dig limit layout will provide the basis for short term planning and in pit grade control.

Pit Operations

The results obtained would be used by the mine engineering department to classify each sector. Sector classifications would be transmitted to pit operations for implementation.

The transfer of dig limits from the mine engineering department to pit operations will be via mine survey. Mine survey will be provided with coordinate locations for dig limits within an individual blast pattern. These boundaries will be located in the pit by the survey department and marked using a series of stakes. The stakes will be labelled accordingly depending upon the dig limit boundary to allow the shovel operator and shift supervisor to determine the material type either side of a stake. In addition the shovel operator and shift supervisor will be provided with a plan of the blast pattern with all limits marked to allow further definition.

Waste Placement

The shovel operator will confirm with haul truck drivers the characteristics of waste being loaded. Records will be maintained in daily shift reports of the rock hauled and location placed.

Reporting and Confirmatory Sampling

Daily shift reports will be maintained in a database of truck counts which will be compiled into a database to maintain an inventory of material moved. Quantities indicated by truck counts will be compared with volumes indicated by as-built surveys.

Sampling to confirm the efficiency and reliability of the materials handling and management procedures set out under this plan will be carried out on a routine basis. Initially, monthly composite sampling along active non-PAG and PAG waste rock and LGO dumps crests will be conducted. A single composite sample will be collected once a month from samples collected at 25 m intervals along the active dump crest.

As soon as waste rock starts to be generated a study will be performed to determine if preferential fraction of AP and/or NP into blast-generated size fractions will be performed to determine if any adjustments to the waste classification approach are needed. The confirmatory samples collected as described above will be screened to two fractions (<2 mm, representing dump fines, and >2 mm representing the bulk material). The weight of each fraction will be recorded, and the fractions analyzed for NP* and AP.

24.9.3.2 Tailings

Geochemical Criteria

Two types of tailings will be discharged to the tailings impoundment:

- rougher tailings; and
- cleaner tailings.

Rougher tailings will be considered non-PAG if NP*/AP>2 where NP* and AP are determined as specified in Section 24.9.3.1.

Differences in the ARD potential of bulk and beached tailings may be expected if hydraulic enrichment of sulphide minerals occurs as rougher tailings flow down the beach. Beached tailings will need to be non-PAG to ensure that unsaturated tailings adjacent to the dam do not become acidic. In order to determine if there are differences between beached and bulk tailings, both will be sampled and analyzed once monthly during the first year of Operations. If a strong correlation is shown between beach and bulk tailings, the latter will be used as a proxy for the former. If no correlation is apparent, beach tailings will be sampled directly.

Cleaner tailings are classified as PAG.

Sampling Frequency and Analysis

Following intensive sampling during the first year of operation, rougher tailings will be sampled and analysed weekly at the on-site laboratory for total sulphur modified neutralization potential. A grab sample of cleaner tailings will be tested quarterly for inventory purposes.

Contingencies

In the event that ongoing sampling as described above shows that rougher tailings are trending toward classification as PAG, the mill process will be adjusted to improve recovery of sulphide minerals.

Reporting

Ongoing review and trending in NP*/AP will be monitored by the Environmental Department. Trends will be reported to the Mine Manager and Mill Superintendent to implement correction actions as needed.

24.9.3.3 Overburden

Geochemical Segregation Criteria

Two types of overburden will be generated by the Project:

- ex-pit overburden: overburden stripped outside the pit footprint and used for constructing the tailings dam; and
- in-pit overburden: overburden stripped inside the footprint of the pit.

Ex-pit overburden has been determined to be non-PAG and will not need to be managed for ARD potential.

In-pit overburden showed variable ARD potential which is linked to the presence of weathered bedrock in deep overburden, whereas near surface overburden is glacial derived from outside the Project area. Classification of ARD potential will be based on the following visual and chemical characteristics:

- in-pit overburden containing only glacially derived rock fragments and no rock of the type found in the Project areas will be classified as non-PAG and be subject to confirmatory sampling only; and
- in-pit overburden containing any locally derived rock fragments will be characterized and classified using the same methods for waste rock as described in Section 24.9.3.1.

Sampling Density and Analysis

Ex-pit overburden and in-pit overburden that is classified visually as being non-local will not be sampled to determine management requirements.

A site-specific methodology for testing locally derived in-pit overburden will need to be developed as excavation proceeds and variability in ARD potential is better understood. Options could include:

- drilling or test pits ahead of excavation;
- sampling of the active face;
- sampling of stockpiles then re-handled; and
- blanket classification as PAG or non-PAG if PAG and non-PAG components of the overburden cannot be practically segregated.

Confirmatory Sampling

Confirmatory sampling of both types of in-pit overburden will be performed using the same method as waste rock.

24.9.3.4 Quarry Rock

Based in the low ARD potential of quarry rock, no geochemical characterization will be performed as part of this Mine Waste and ML/ARD Management Plan.

24.9.3.5 Pit Walls

Pit walls will be characterized by sampling one in five trim drill holes in final pit walls for ARD potential. Sampling locations will be recorded to allow mapping of pit wall characteristics.

24.9.4 Monitoring

24.9.4.1 Physical Conditions

Waste Rock and Low-grade Ore Storage and Deposition

Volumes of waste rock deposited on land and in the TMF 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 at the TMF and various on land waste rock piles.

A monitoring program will be developed to visually check the condition of waste rock storage facility slopes and surface water control diversion channels during construction and operation. The monitoring program will also include the installation of geotechnical instrumentation for the collection of data to confirm design assumptions, to warn of potential failure or deformation of slopes, and to evaluate stability performance.

The results of the monitoring program will be used to measure the success of the management strategies and to identify where additional mitigation may be necessary. Monitoring will continue for a period of time after mine closure to confirm that reclamation objectives are being achieved and to identify repair or maintenance requirements. Inspection and monitoring may include:

- visual inspection of waste rock storage facility platforms, crests, and slopes to check for signs of cracking, settlement, or bulging;
- visual inspection of the waste rock storage facility toe areas to check for signs of ground heave or seepage;
- installation of slope inclinometers during operation to monitor foundation deformation;
- installation of surface survey monuments during waste rock storage facility construction;
- deployment of wireline extensometers as required; and
- inspection of surface water diversion ditches and channels, to check that their structural integrity remains intact.

The dumping platform at the TMF will require monitoring throughout the period of deposition of PAG waste rock. 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 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 waste rock piles is critical to maintaining their stability. Slope inclinometers and wireline extensometers are appropriate instrumentation for such monitoring and HCMC 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. Haul trucks will also maintain a prescribed minimum distance from the active crest when dumping their loads. This minimum distance will be re-evaluated as operational, site specific experience is gained.

A schedule for routine inspection and instrumentation monitoring will be developed at the time of mine permitting based on the mine construction and operation schedule. Instrumentation trigger levels and response criteria will also be established and included in a Standard Operating Procedure for the waste rock and LGO storage and deposition facilities.

<u>Overburden</u>

Volumes of overburden and topsoil stockpiles deposited on land will be monitored by reference to the records kept as part of the mine plan. The stockpiles will require monitoring throughout the life of a stockpile. Stockpiles will be monitored according to various indicators, which include:

- occurrence of standing water on stockpiles;
- presence of sheet erosion on stockpiles;
- presence of rills and gullies on stockpiles;
- stockpile photographic record;
- surface water diversion ditches and channels, to check their structural condition and to ensure that they are clear of obstruction; and
- metal concentration in stockpiled soil.

When required, corrective management action will be taken promptly.

<u>Tailings</u>

After the initial staging of the starter TMF embankment in Year 1, the annual staging of the TMF dam lifts will allow for each successive year of tailings (as well as PAG waste rock, operational pond volume, and storage of the inflow design flood to provide freeboard for wave run-up). Given that annual dam lifts will occur on an on-going basis for a period of ~22 years, the importance of comprehensive monitoring of the physical conditions pertaining at the TMF is clear.

Volumes of tailing deposited in the TMF 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 performance of the TMF, which will also include visually checking the condition of embankment slopes and surface water control structures. The monitoring program will also include the installation of geotechnical instrumentation for the collection of data to confirm design assumptions, to warn of potential failure or deformation of slopes, and to evaluate stability performance.

The results of the monitoring program will be used to measure the success of the management strategies and to identify where additional mitigation may be necessary. Monitoring will continue for a period of time after mine closure to confirm that reclamation objectives are being achieved and to identify repair or maintenance requirements. Inspection and monitoring may include:

- visual inspection of embankments, crests, and slopes to check for signs of cracking, settlement, or bulging;
- visual inspection of the TMF embankment toe areas to check for signs of ground heave or seepage;
- installation of slope inclinometers during operation to monitor foundation deformation;
- installation of surface survey monuments during TMF construction; and
- deployment of wireline extensometers as required.

Monitoring and responding to any deformation of TMF embankments is critical to maintaining their stability. Slope inclinometers and wireline extensometers are appropriate instrumentation for such monitoring and HCMC will investigate their use or the use of similar instrumentation.

A schedule for routine inspection and instrumentation monitoring will be developed at the time of mine permitting based on the mine construction and operation schedule. Instrumentation trigger levels and response criteria will also be established and included in a Standard Operating Procedure for the waste rock and LGO storage and deposition facilities.

Mine contact water will be collected and water quality monitored at water management ponds located downstream of the TMF main embankment as well as the TMF north embankment. Water quality monitoring is dealt with in more detail in the next section.

24.9.4.2 Geochemistry and Water Quality

Water quality associated with the waste rock, LGO, overburden, and tailings storage and disposal facilities will be monitored in an on-going and routine manner throughout the life of the mine and into the Post-Closure phase.

An on-site laboratory will be used to determine total sulphur concentrations and modified neutralization potential. QA/QC measures, including field and laboratory duplicates and reference samples will be used to evaluate the performance of the laboratory.

Seepage surveys will be performed annually to provide full scale data as validation of the outcomes of the assessment of water quality effects. The toes of each storage facility will be inspected in the early summer following peak freshet conditions. Detected flows will be sampled and analyzed, and flows will be measured.

Ongoing assessments will be performed at the site to refine the management criteria described in this plan. These assessments may include:

- evaluation of the effect of partitioning of carbonates and sulphides into size fractions and the effect on classification;
- further mineralogical assessments to refine the calculation of NP and AP to account for site specific conditions;
- use of different analytical methods for determining NP*;
- refinement of the segregation criteria based on NP*/AP; and
- use of different analytical methods to determine ARD potential.

24.9.4.3 Work Planning and Schedule

The continual operation of the waste rock, LGO, overburden, and tailings storage facilities is critical to the execution of the Project and will be a major component of the mine plan. The planning and scheduling of these Project components and activities is thus a technical engineering competence. To ensure that the planning and scheduling is aligned with the specified environmental performance criteria, the Mine Environmental Supervisor will review the information collected from the mine plan monitoring. Table 24.9-5 summarizes the monitoring commitments envisaged for the Mine Waste and ML/ARD Management Plan.

Table 24.9-5. Summary of Monitoring

Facility	Component	Purpose	Program	Frequency
Waste Rock	All	Classification	1 in 5 blast holes	Continuous
	PAG	Confirm composition	Composite sample from dump crest formed from samples collected every 25 m, analysis to include size fractions	Monthly
	Non-PAG	Confirm composition		Monthly
	All	Contact water chemistry	Toe survey	Annual
Low-grade Ore	All	Classification	1 in 5 blast holes	Continuous
	PAG	Confirm composition	Composite sample from dump crest formed from samples collected every 25 m, analysis to include size fractions	One sample per month
	Non-PAG	Confirm composition		One sample per month
	All	Contact water chemistry	Seepage	Annual
Overburden	Bedrock influenced in-pit	Segregation	To be determined	
	Co-disposed with waste rock	Confirm composition	Included in waste rock program	

(continued)

Table 24.9-5. Summary of Monitoring (completed)

Facility	Component	Purpose	Program	Frequency
Pit Walls	All	Final Pit wall composition	Blast holes from 1 in 5 trim drill holes	Final Pit Walls
Tailings	Rougher (Year 1)	Evaluate bulk and beach correlation	Monthly sampling of beach and bulk tailings	First year
	Rougher	Beach or bulk		Monthly composite
	Cleaner	Inventory characteristics		Quarterly grab

24.9.5 Reporting

24.9.5.1 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, LGO, overburden, and tailings can be accurately tracked. Inspections will cover on-site facilities such as the drainage ditches/channels, deposition areas, and the dumping platform, as well as related documentation such as manifests and logbooks of material transportation and handling. Table 24.9-5 provides an initial monitoring schedule. The frequency of scheduled inspections will be refined as dictated by operational conditions. Components of the monitoring in support of the required reporting, e.g., recording volumes handled, will be continuous while material is being produced.

Since the management of mine waste is essentially a technical engineering matter, reports will be reviewed internally by the responsible line manager and the Mine Manager. The Mine Environmental Supervisor 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 Mine Waste and ML/ARD Management Plan, these will be reported per the requirements of the Emergency Response Plan (Section 24.4) and Spills Prevention and Response Plan (Section 24.15).

24.9.5.2 Reporting Responsibilities

The Project's Mine Manager will carry line responsibility for monitoring and reporting on the management of mine waste and ML/ARD, although this task may be delegated to appropriate technical personnel. HCMC 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 Mine Waste and ML/ARD Management Plan.

24.10 NOISE MANAGEMENT PLAN

24.10.1 Purpose

The purpose of the Noise Management Plan is to outline:

- relevant regulatory requirements and guidance for noise associated with the Project;
- operational measures that will be established to avoid, control, and mitigate potential adverse effects on noise levels associated with all phases of the Project;
- monitoring measures to collect on-site noise data to meet regulatory requirements and enable the implementation of adaptive follow-up programs as needed;
- maintain an effective response mechanism to deal with any issues and complaints, to ensure that all complaints are followed up promptly, and a plan to investigate and address the issues is developed as soon as feasible; and
- reporting practices relevant to the Project.

This plan is designed to be adaptive, effective, and achievable in both the short and long term. The Noise Management Plan is a living document and will be updated as needed based on management reviews, incident investigations, regulatory changes, or other Project-related changes.

24.10.2 Performance Objectives

The objective of the Noise Management Plan is to describe actions that are intended to moderate Project-related noise to acceptable levels. The plan is intended to ensure noise levels meet existing criteria, while taking into account operational requirements. Exposure to noise in the workplace is regulated by WorkSafe BC under Part 7 of the *Occupational Health and Safety Regulation* and by the Ministry of Energy and Mines under Part 2 of the *Health, Safety and Reclamation Code for Mines in British Columbia*. There is currently no federal or provincial legislation that stipulates ambient noise levels for mine development projects in terms of wildlife or other potential environmental impacts.

The AIR (BC EAO 2011) for the Project identified that the Application should address noise effects on humans in accordance with Health Canada's *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (Health Canada 2011). Since this guidance document is in draft form, it was advised by Health Canada that it should not be referenced. Instead, individual references from the document for the various criteria and other more applicable references are used in this plan.

In the absence of specific noise legislation, data and guidelines from the following sources have been referenced:

- World Health Organization *Guidelines for Community Noise* (1999);
- Health Canada's *Useful Information for Environmental Assessments* (Section 6: Noise Effects [2010]);

- US Environmental Protection Agency's *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (US EPA 1974);
- Michaud, Bly, and Keith's (2008) *Using a Change in Percent Highly Annoyed with Noise as a Potential Health Effect Measure for Projects under the Canadian Environmental Assessment Act*;
- US Federal Transit Administration's *Transit Noise and Vibration Impact Assessment* (Harris Miller Miller & Hanson Inc. 2006); and
- Standards Australia (2006) *AS2187.2-2006™ (AS2187.2) – Explosives – Storage and Use Part 2: Use of Explosives* (Appendix J).

Further details are provided in Chapter 10, Noise Effects Assessment.

24.10.3 Environmental Protection Measures for Noise

The following section outlines operational controls that will be implemented during the Construction, Operations, Closure, and Post-Closure phases of the Project. These operational controls were developed in order to minimize noise. The mitigation method approach considers the best available control technology which will eliminate, minimize, control, or reduce adverse effect through the use of technological applications; however, this approach also considers the economic availability of the control technology, depending on the significance of the noise impact.

Noise control during the Construction phase of the Project will be focused on material handling and transportation sources. Noise control during Operations will focus on the open pit and crushing areas (material handling), processing and blasting activities. Noise control during Closure will be focused on the tailings pond closure activities, plant and mine areas. Most of the noise sources during Closure and Post-Closure will be transportation vehicles.

There are three main mitigation strategies for noise control: controlling noise at the source, controlling the noise pathway, and controlling noise at the receptor. These noise mitigation strategies follow a hierarchy of control, with source control the preferred option where reasonable and feasible, and control at the receptor the least favourable option. Controlling noise at the source can be achieved through management actions. There are two approaches applicable to controlling the noise pathway: using barriers and land-use controls. An example of the latter would be attenuating noise by increasing the distance between the source and the receptor. Controlling noise at the receptor is applied when other methods of noise control have been evaluated and implemented and further improvements are still required. If further controls are needed, the most effective options should be evaluated in order to maximize the effectiveness of mitigation. This would be undertaken on an as-needed basis and could include noise mitigation measures such as increasing the thickness of window glazing; reviewing heating, ventilation, and air conditioning systems; and improving the construction of exterior facades.

The majority of noise mitigation proposed focuses on the first of these noise control strategies (controlling noise at the source). The following noise controls will be investigated and implemented as appropriate:

- considering noise ratings when selecting equipment;
- adequately maintaining equipment to minimize noise, including lubrication and replacement of worn parts, especially exhaust systems;
- optimizing the operation of equipment to minimize noise, e.g., reducing vehicle speeds;
- optimizing 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, minimizing the need for mobile equipment to use their backup alarms;
- optimizing site procedures to minimize noise changes, e.g., keeping doors closed;
- housing stationary sources in buildings and conducting loud procedures indoors, where practical;
- turning off equipment when not in use to avoid unnecessary idling of motors;
- fitting diesel-powered vehicles with mufflers meeting manufacturers' recommendations for optimal attenuation, and maintaining these in effective working condition;
- blasting configurations employing sequential detonations with millisecond delays downhole and across rows, as opposed to simultaneous detonation of all holes;
- ensuring blast holes are adequately stemmed for the depth of the hole and stemmed with suitable material;
- identifying enclosures, berms, acoustic screening and shrouding where stationary sources require control;
- ensuring impulse events, such as blasting, will be limited to certain times of the day.

Any sources identified as requiring mitigation will be addressed using the above mitigation or engineered controls as appropriate.

A summary of the various Project phases and relevant management is shown in Table 24.10-1.

Table 24.10-1. Mitigation Schedule

Mitigation	Construction	Operations 1	Operations 2	Closure	Post-Closure
Noise reduction measures	Required	Required	Required	Not considered necessary [a]	Not considered necessary [a]

[a] *The plan will be re-evaluated as required.*

24.10.4 Monitoring

The main activities expected to cause noise impacts include the Project Site camp operations (including vehicles, generators, incinerator), mining, crushing, drilling and transportation activities. The purpose of the monitoring program is to assess the magnitude of noise impacts from Project activities and monitor the effectiveness of mitigation actions. Evaluation of predicted effects will be conducted through facility-specific monitoring. The monitoring, quality control, and reporting procedures detailed in this plan will be used to:

- assess the effectiveness of mitigation and management measures;
- identify Project effects requiring further mitigation efforts;
- address requests/concerns from regulators and stakeholders;
- adapt to changes in the regulations or the Project.

The objective of noise monitoring is to make sure that noise levels propagated from the Project will meet appropriate regulatory criteria and to respond to complaints or concerns raised by regulatory authorities and the public in respect of the effects of ambient noise on human and wildlife receptors.

24.10.4.1 Noise Monitoring Program

Noise monitoring will be performed to assess noise levels in the workplace to conform with WorkSafe BC and *Mines Act* regulations, and as necessary to respond to and address noise complaints and/or concerns from regulatory authorities or the public. In the latter case, monitoring will be conducted at receptor locations and will include, as appropriate, monitoring of ambient noise levels such as: overnight noise, instantaneous noise, and vehicle pass-by noise. Monitoring will be conducted by qualified personnel using CSA, ISO or other approved noise dosimeter or sound level equipment.

When required, the number and siting of monitoring locations will be selected to adequately assess the noise levels experienced at the target receptors. Monitoring equipment would typically be located outdoors, approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., a wall).

Noise monitoring measurements will be performed following International Organization for Standardization standards (ISO 1996-2:2007) which provide guidelines for the measurement of environmental sound and encompass the following aspects:

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

Records of noise-monitoring activities and associated management actions, including operational controls and mitigation, shall be retained and data will be made available to the parties involved and for review by others upon request.

24.10.4.2 Work Planning

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

The Mine Environmental Supervisor will perform routine site inspections which will include aspects covered under the Noise Management Plan. Should noise-related issues be observed, a corrective action notification will be issued to the department responsible that outlines what measures will need to be undertaken within a given timeframe to address the issue.

24.10.4.3 Record Keeping

Record keeping will be conducted by the proponent and, where appropriate, its subcontractors. Data will be entered into suitable electronic databases, quality control and assurance checks completed, and stored with both the subcontractor responsible and with the proponent. Data will be entered in a format and program that allow for comparison over time and storage in a single file format for each type of survey or monitoring activity. Designated personnel will coordinate preparation, review, and distribution, as appropriate, of the data and reports required for regulatory purposes.

24.10.4.4 QA/QC

QA/QC measures will be undertaken at three key stages in monitoring activities: 1) during data gathering; 2) during data entry and analysis; and 3) through reporting and reassessment of methods as part of the evaluation of effectiveness of the plan.

The process of data gathering in the field will be quality controlled through the use of qualified personnel and a system of pre- and post-field checks to ensure that consistent, repeatable data are being gathered. All personnel will have necessary training and accreditation.

24.10.4.5 Adaptive Management

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

Indications of the need for corrective actions and additional control measures may include:

- monitoring data showing noise levels greater than applicable guidelines;
- monitoring data showing an increasing trend in noise levels;
- issues raised by on-site staff, regulators, or local communities.

In situations where noise monitoring results are identified as exceeding the specified criteria applicable to the Project, the following actions will be undertaken:

- The Mine Environmental Supervisor must be notified as soon as practicable of any exceedance identified during attended or unattended noise monitoring.
- The Mine Environmental Supervisor will investigate the results of the noise monitoring to determine the potential causes of the exceedance.
- If no recognizable causes can be identified, further investigations may be undertaken to identify the cause, e.g., specific weather or atmospheric conditions.
- Where the cause is identified, additional controls will be implemented or the operational method will be altered.
- Additional monitoring may be required as a follow-up to determine the effectiveness of any corrective actions implemented.
- Any corrective action will be recorded and reported to the Mine Environmental Supervisor, who will keep a record of all significant proactive and reactive actions.

Upon receipt of a complaint, preliminary investigations should 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 Mine Environmental Supervisor deems the complaint likely to be valid.

This plan is a living document and will be updated as required to reflect changing conditions and regulatory requirements.

The cycle of mitigation activities, monitoring and evaluation, and new mitigation activities if required, will provide adaptive management of noise issues identified and arising as a result of the Project.

24.10.5 Reporting

Ambient noise monitoring will be undertaken as necessary in response to regulatory requests and/or public concerns. An appropriate measurement report for each monitoring session will be developed. The measurement report contents may include, as appropriate, such information as:

- 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 occurred; as well as temperature, barometric pressure, humidity, and the location of the weather instrumentation;
- a description of the residual sound;
- 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;
- photographs of the microphones as set up;
- noise monitoring results and comparison to performance criteria;
- noise-related complaints and management/mitigation measures undertaken;
- management/mitigation measures undertaken in the event of any confirmed exceedance of noise performance criteria; and
- review of the performance of noise management/mitigation measures and the monitoring program.

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

This Noise Management Plan will be reviewed annually and, if necessary, revised.

24.11 Sediment and Erosion Control Plan

24.11.1 Purpose

The purpose of this Sediment and Erosion Control Plan is to minimize the degradation and loss of soils due to erosion throughout the life of the Project, and to prevent damage to other ecological values as a consequence of soil erosion. This is essentially accomplished through both minimizing soil disturbance and by following best practices when disturbance is required.

Mine development activities may result in soil erosion in portions of the Project footprint, if not effectively mitigated. A Sediment and Erosion Control Plan presents the objectives of soil erosion management, and the 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 site-specific conditions. The plan therefore provides a suite of management tools that can be employed to effectively manage soil erosion and degradation that are purpose-designed for the particular conditions encountered on the Project Site.

24.11.2 Performance Objectives

The following performance objectives are implicit in achieving the plan's purpose:

- conserving soil quantity and quality in areas that are subject to erosion (e.g., areas with fine textured soils, areas cleared of vegetation, disturbed areas located on slopes, and stockpiles);
- minimizing natural drainage disruption along access and site 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.

24.11.3 Environmental Protection Measures

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 the high surface area of clay particles). Due to the occurrence of steep slopes, terrain instability and thin veneers over bedrock, erosion prevention and sedimentation control will be important during all phases of the Project, i.e., Construction, Operation, Closure, and Post-Closure.

24.11.3.1 General

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

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

Vegetation cover plays a vital role in erosion control. Thus, soil and associated vegetation disturbance will in principle be minimized to the extent practical in both areal extent and duration. Generally, all areas where vegetation has been removed will be re-vegetated using an appropriate re-vegetation strategy (seed mix and/or planting) as soon as activity in the area has permanently ceased and seasonal conditions permit. If required, additional means of soil surface stabilization (e.g., mulch or soil binder) may be used to hold the soil in place while the vegetation establishes itself. Disturbed, non-soil areas such as bedrock, coarse rubble and gravel bars will generally not be treated but assessed for potential erodibility and only attended to if required.

Typical erosion prevention and sediment control strategies may include, as appropriate:

- controlling and directing runoff from disturbed areas by grading slopes and ditching;
- re-establishing a vegetative cover on disturbed areas;
- 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 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, the installation of:

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

24.11.3.2 Construction

Erosion prevention and sediment control measures will be applied in conjunction with the Site Water Management Plan (Section 24.13) to address sediment control during Project Construction. One of the most important aspects relevant to sediment control will be development sequencing, particularly at the Project Site. For example, the contact water pond should be constructed before the contact water ditches, and erosion prevention and sediment control measures should be used during the construction of both. Construction runoff interception ditches and sediment control structures should be in place where needed before ground disturbance activities are to occur. The water diversion structures would serve to keep non-contact water out of the primary development area.

Where disturbance of wet areas is required, measures such as drainage ditches, settling ponds, sediment fences, and erosion cloth will be used as appropriate to minimize sediment mobilization and loss. Both the baseline soils mapping 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. Storm water runoff and sediment control measures, including isolation of work areas from surface waters and the use of temporary diversion methods (i.e., ditches, dam-and-pump) will be implemented as appropriate. Personnel competent in these measures will direct undertaking of the task.

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 need for erosion protection.

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. Where required, travel corridors will be clearly demarcated and vehicle travel will be restricted to these areas.

Access 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 Project Site and access roads will be required throughout the life of mine. Deactivated or disused roads will be reclaimed in accordance with the Project's closure and reclamation strategy.

24.11.3.3 Operation

Sediment control ponds will be situated downstream of the TMF embankment, PAG LGO stockpile and non-PAG waste rock stockpile. The ponds will provide a collection point for surface runoff and all water collected will be pumped to the TMF supernatant pond for long-term storage and use as reclaim water for process purposes.

Erosion prevention and sediment control measures for the non-contact water diversion structures will be applied throughout the life of mine. These will comprise water diversion channels upstream of the open pit, overburden stockpile, east topsoil stockpile, and non-PAG waste rock stockpile, as well as a diversion along the southeast side of the TMF facility.

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

24.11.4 Monitoring

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. In addition to monitoring conducted by HCMC staff and contractors, workers will be encouraged to communicate to their supervisors any incidental 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 monitored at the beginning and end of the runoff 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 the substrate has stabilised and 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 Project Site 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.

24.11.4.1 Work Planning and Schedule

The sediment and erosion monitoring work plan and schedule is tied to the various mine development phases and features. To ensure that the planning and scheduling of these mine features is aligned with the sediment and erosion mitigation measures and monitoring performance criteria, the Mine Environmental Supervisor will coordinate the scheduling of inspection activities. Any sites determined to require ongoing monitoring will be identified and monitored, as required.

It is envisaged that the water management structures and systems (e.g., diversion ditches, collection ponds), as well as site and road drainage systems, would be inspected routinely during maintenance activity and water quality monitoring, to verify their functionality and confirm that positive drainage is being maintained.

24.11.5 Reporting

A communications strategy will be established on the Project Site to report on the effectiveness of the Sediment and Erosion Control Plan to the Mine Environmental Supervisor. In the event of a significant sediment and erosion control failure, notifications will be given immediately to the relevant 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.

Formal inspection reports, when required, will include as appropriate:

- a description of the sediment release or erosion type and its intensity;
- the 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.

The Mine Environmental Supervisor or his/her delegate (i.e., appropriately trained personnel) will oversee the erosion monitoring program, maintain inspection reports, and provide guidance and direction on appropriate action and mitigation measures to be undertaken.

24.12 SELENIUM MANAGEMENT PLAN

24.12.1 Introduction

Selenium (Se) is a naturally occurring element, and background concentrations in the environment may be highly variable across sites. Determinants of natural, background concentrations are mainly geology and geochemistry: the presence of Se-bearing minerals and the physico-chemical processes that mobilize Se, such as weathering, erosion, and leaching of subsurface strata. Large-scale surface disturbance, such as construction and operation of a mine, may expose Se-bearing rock to oxygen and water, thereby increasing the potential for mobilizing naturally occurring Se.

Selenium became an emerging issue in the mining sector in the 1990s when routine monitoring detected elevated concentrations of Se in the Elk River, which is located in the southeast coal block of BC (Heinz et al. 1990; Lemly 1996; Hoffman and Heinz 1998; L. E. McDonald and Strosher 1998; Hamilton 2004). A government-industry task force, including five coal mines, guided an investigation to determine the scale of effects of elevated Se in the Elk Valley and to recommend mitigation measures (Canton et al. 2008). The investigation found that Se was causing developmental deformities in fish (Kennedy et al. 2000; Rudolph, Andreller, and Kennedy 2008) and a modest depression of productivity in some birds (Harding and Paton 2003; SciWrite Environmental Services Ltd. 2004, 2005).

Historically, Se was not particularly considered a metal of potential concern for metal mining projects (unlike coal mining); however, experience at the now-closed Kemess Mine (copper and gold) showed that Se can be a potential concern at metal mines, resulting in elevated concentrations of Se in both water and fish tissue (B. G. McDonald et al. 2010). Other projects in BC have also recently identified Se as an element of potential concern (e.g., the Kerr-Sulphurets-Mitchell (KSM) Project, a proposed gold-copper-molybdenum mine in northwestern BC; Rescan 2013).

Selenium has been identified as an element of potential water quality concern for the Project by the water quality predictive model (Appendix 13-C). The proponent has developed this Selenium Management Plan to address and mitigate the potential for effects of increased Se concentrations on the environment that may be caused by the Project.

Speciation and chemical form are important factors that influence the bioavailability and uptake of Se by biota. Selenium has four oxidation states: Se(VI) [selenate], Se(IV) [selenite], Se(0) [elemental Se], and Se(-II) [selenide]. The most common forms of Se in the aquatic environment when oxygen is present include the oxyanions of selenate and selenite, with elemental Se and selenides predominating in oxygen deficient (anaerobic) environments (Maher et al. 2009). Methylation is the primary transformation process of Se into organic forms of Se.

Selenium is an essential element for vertebrates and is required for good health; however, as with most other elements, it becomes toxic at high doses. Organisms have varied dose-response behaviours due to species-specific sensitivities and a range of confounding physical, chemical, and biological environmental factors. Such factors include Se speciation, exposure profiles that change over time (e.g., annually or seasonally), habitat use, variations in diet or metabolism, changes in water composition, the bioavailability of Se, elevated concentrations of other contaminants of concern, and fish or bird movement in and out of sites of contamination (Ohlendorf 2002, 2003; Adams et al. 2003; DeForest et al. 2012).

Primary producers (e.g., periphyton, phytoplankton, and macrophytes) may take up Se directly from water. However, research suggests that the major pathway of Se bioaccumulation in organisms at higher trophic levels is via uptake through diet, not through the water column (Orr, Guigure, and Russel 2006; Chapman et al. 2009; Orr et al. 2012). Thus, the food chain is one of the primary methods in which Se moves through both aquatic and terrestrial environments. High levels of Se can cause adverse effects to reproduction, such as mortality or deformities in developing embryos, reduced survival of fry, reduced hatchability of fertile eggs, and reduced fledging success of nestlings, therefore, egg-laying vertebrates, such as fish and aquatic-dependent birds, are typically the most sensitive receptors (Janz et al. 2009; Ohlendorf et al. 2011; Ohlendorf and Heinz 2011; DeForest et al. 2012).

Selenium typically bioaccumulates to a greater degree in lentic (still water) systems than lotic (flowing water) systems because of longer residence time of water, greater organic content of sediments, more active and abundant bacterial communities in these environments, and greater conversion into organic forms of Se (Maier, Ogle, and Knight 1988; Minnow Environmental Inc. 2004; Brix et al. 2005; Hillwalker, Jepson, and Anderson 2006; Orr, Guigure, and Russel 2006; Lorax Environmental Services Ltd. 2009; Martin et al. 2009; Martin et al. 2011). Organoselenium compounds are the most bioavailable; selenite is more bioavailable than selenate, and elemental Se (inorganic Se) is not readily taken up by aquatic organisms due to its stability in the environment.

The areas downstream of the Project identified as being at risk of elevated Se levels (i.e., T Creek and Harper Creek) are predominantly low-order, lotic (stream) environments, and are thus at lower risk for bioaccumulation of Se through the food chain.

24.12.2 Purpose

The Selenium Management Plan (SeMP) has been proposed as a follow-up program in the Fish and Aquatic Resources Effects Assessment (Chapter 14) to ensure ongoing monitoring and adaptive management of selenium in the aquatic environment, address uncertainties in the effects assessment for fish and aquatic resources, and to verify the accuracy of the conclusions of the effects assessment. The purpose of the SeMP is to identify, characterize, and address potential environmental risks that elevated Se may pose to the aquatic environment surrounding the Project.

Based on issues raised by First Nations and Working Group members, the following information will be included in the SeMP:

- description of baseline Se concentrations within the local, regional, and downstream environments;
- predictions of Se in water downstream of Project components;
- the potential for Se bioaccumulation in the aquatic ecosystem downstream of the Project; and
- monitoring and management practices that will be applied during all phases of the Project to prevent and manage potential environmental effects of Se.

The framework of the SeMP is designed to meet best practices for environmental and technical performance objectives for the Project, in addition to ensuring statutory requirements are considered and addressed. The framework of the SeMP is supported by four aspects: prediction, prevention, mitigation, and monitoring, that together form an effective strategy to achieve environmental protection. Potential risks due to elevated Se will be adaptively managed based on the results of the proposed monitoring program to ensure that risks are mitigated before adverse effects occur in the aquatic environment.

24.12.3 Legislation and Standards

Both statutory and policy-based approaches are used to regulate mining activities in BC, and in Canada. Statutory requirements (i.e., legislation, regulation, and codes of practice) are legal requirements that if breached, may result in enforcement action. Policies, guidelines, and best practices are voluntary-based mechanisms that guide industry performance and encourage continuous improvement; however, there is no rule of law associated with these approaches.

Currently, the MMER (SOR/2002-222), as prescribed under the *Fisheries Act* (1985c), identifies maximum allowable end-of-pipe concentrations for eight parameters. Selenium, which is not currently regulated under the MMER for end-of-pipe discharge limits, has been proposed for inclusion in an upcoming update; however, discharge limits have not been publicly discussed.

Provincially, effluent discharges are regulated under the *Environmental Management Act* (2003) and the associated Waste Discharge Regulation (BC Reg. 320/2004), which were introduced in 2004 and are intended to protect the environment and human health from changes in water quality that may result from effluent discharges. Mining effluent discharge permits issued by the BC MOE Environmental Protection Division identify Pollution Control Objectives for end-of-pipe discharges, similar to the MMER.

24.12.3.1 Policy and Guidelines

The *Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price and Errington 1998) provide policy direction and a set of guiding principles to be considered during the environmental assessment planning phase of a mine. Three key objectives of this policy are to minimize environmental harm, ensure the long-term productive use of land, and protect the provincial government from liabilities associated with mining operations and reclamation requirements.

Other relevant guidelines include environmental guidelines developed by the BC MOE, and federally by the Canadian Council of Ministers of the Environment (CCME 2013a) or Health Canada (2012). These guidelines are intended to provide guidance on concentrations of parameters in the natural environment that are considered safe and would be expected to protect the various uses of water (e.g., aquatic life, wildlife, drinking water, recreation, agriculture, and livestock). New provincial Se guidelines were approved in May 2014 (Beatty and Russo 2014) and are summarized in Table 24.12-1.

Table 24.12-1. Receiving Environment Selenium Guidelines

Media or Biota	BC Guideline[a]	Federal Guideline[b]
Water quality (aquatic life)	2 µg/L (30-day mean); 1 µg/L (alert concentration)	1 µg/L (chronic)
Water quality (wildlife)	2 µg/L (30-day mean)	N/A
Drinking water quality	10 µg/L	10 µg/L[c]
Sediment quality	2 µg/g dw (alert concentration)	N/A
Dietary intake for aquatic life (invertebrate tissue)	4 µg/g dw (interim)	N/A
Fish tissue (whole body)	4 µg/g dw	N/A
Fish tissue (muscle/muscle plug)	4 µg/g dw	N/A
Fish tissue (egg/ovary)	11 µg/g dw	N/A
Fish tissue screening values for human consumption	7.3 µg/g dw for high fish intake (220 g/day)	N/A
	14.5 µg/g dw for moderate fish intake (110 g/day)	N/A
	75.0 µg/g dw for average fish intake (21.5 g/day)	N/A
Bird tissue (egg/ovary)	6 µg/g dw	N/A

Notes: N/A = not available; dw = dry weight
µg/L = micrograms per litre (= parts per billion); µg/g = micrograms per gram (= parts per million)
[a] Source: Beatty and Russo (2014)
[b] Source: CCME (2013a)
[c] Source: Health Canada (2012)

24.12.4 Baseline Studies

Baseline studies were conducted for the Project between 2008 and 2014. The purpose of the baseline studies were to characterize the existing environment, including metal concentrations in various media, as well as habitat and species distributions for aquatic resources, fish, and wildlife throughout the Project study areas. Selenium concentrations have been measured in multiple environmental media including water, sediment, and tissue (benthic invertebrates and fish). Baseline data is briefly summarized in the following sections, with reference to additional information in the Application/EIS.

24.12.4.1 Water

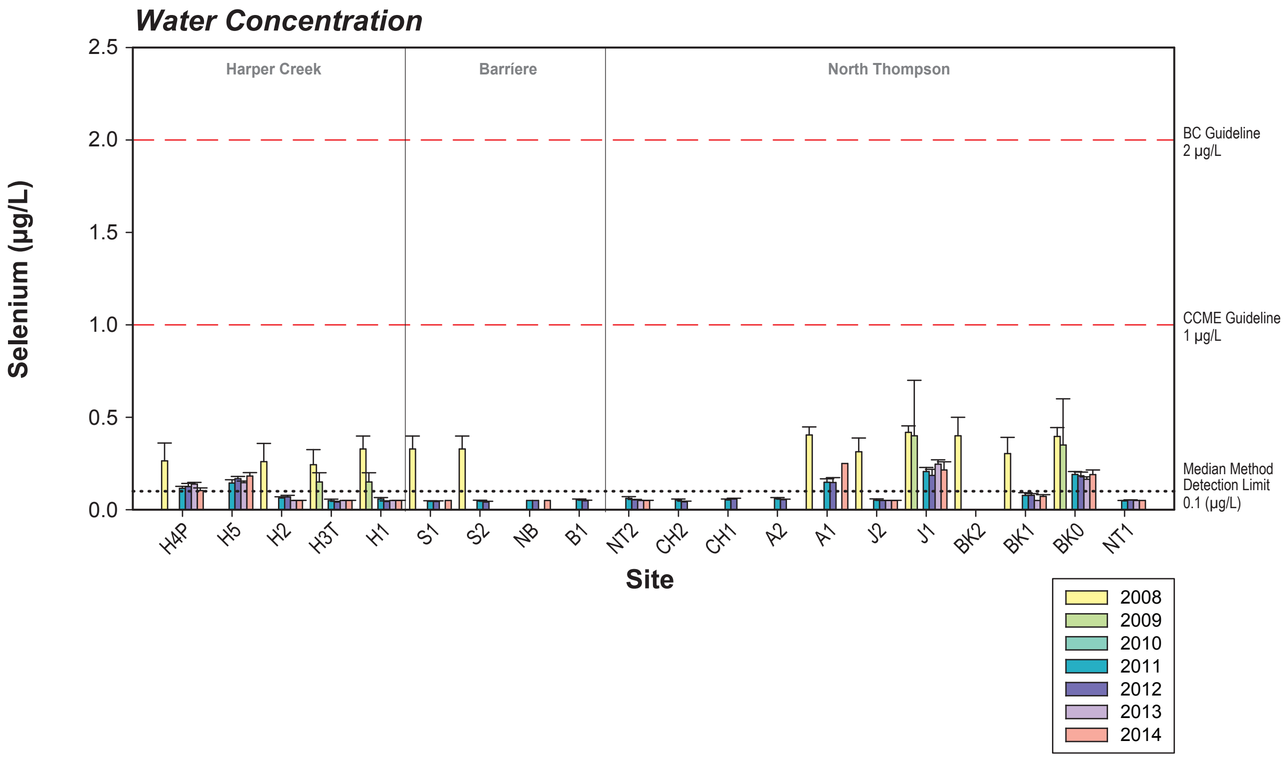
Baseline water quality data is summarized in Chapter 13 of the Application/EIS and associated appendices (Appendices 13-A and 13-B). A map of sampling site locations can be found in the Application/EIS, Chapter 13, Figure 13.4-1.

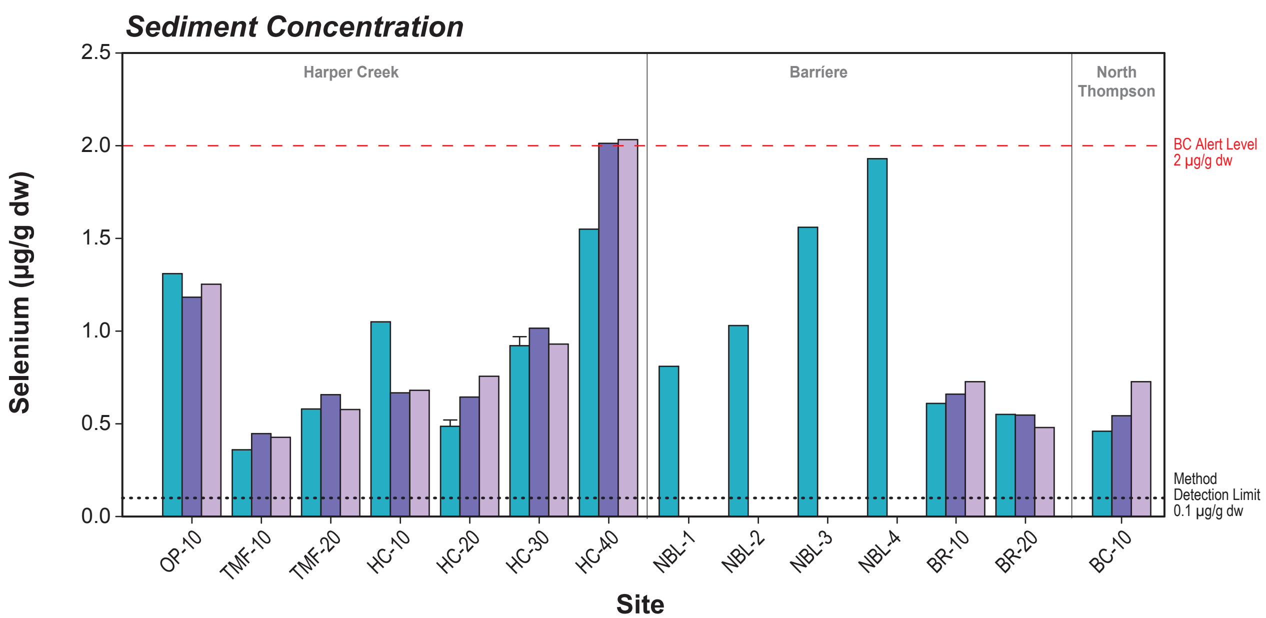
Baseline water quality at the Project was collected at 20 sites between 2007 and 2014, with, monthly and quarterly sampling events. Selenium concentrations in rivers and creeks within the water quality regional study area (RSA) are shown in Figure 24.12-1 and can be summarized as follows:

- Harper Creek Area:
  - The highest total Se concentrations were measured in the north part of Harper Creek at site H5 in April 2011 (0.30 µg/L), April 2012 (0.281 µg/L), March 2014 (0.250 µg/L), and April 2014 (0.260 µg/L).

Figure 24.12-1

Selenium Concentrations in Water and Sediment, Harper Creek Project, 2008 to 2014





Note: Error bars represent standard error of the mean.
Dotted line represents the method detection limit; values below the detection limit were plotted as half the detection limit.

  - Total Se concentrations in the Harper Creek area were below the Canadian Council of Ministers of the Environment (CCME; 2013b) guideline for protection of aquatic life (1 µg/L) and the BC MOE guideline for aquatic life (2 µg/L; 30-day mean).

- North Thompson River Area:
  - The highest total Se concentrations were measured in Jones Creek (site J1) in July 2009 (0.70 µg/L) and February 2014 (0.41 µg/L), and Baker Creek (site BK0) in July 2009 (0.60 µg/L) and October 2008 (0.40 µg/L).
  - Total Se concentrations in the North Thompson River area were below the CCME (2013b) guideline for protection of aquatic life (1 µg/L) and the BC MOE guideline for aquatic life (2 µg/L; 30-day mean).
- Barrière River Area:
  - The highest total Se concentrations were measured in Barrière River (site B1) in May 2011 (0.10 µg/L), February 2012 (0.06 µg/L), and March 2012 (0.05 µg/L).

Total Se concentrations in the Barrière River area were below the CCME (2013b) guideline for protection of aquatic life (1 µg/L) and the BC MOE guideline for aquatic life (2 µg/L; 30-day mean).

24.12.4.2 Sediment

Sediment baseline monitoring is summarized in Chapter 14.3.3 and in Appendix 14-A, Fish and Aquatic Habitat Baseline. Sediment samples were collected at ten creek or river sample sites in September 2011, 2012, and 2013, and at four lake samples sites in October 2011 along a transect in North Barrière Lake (NBL-1, NBL-2, NBL-3, and NBL-4; Appendix 14-A). Baseline creek and rivers sampling sites included: T Creek (TMF-10, TMF-20), P Creek (OP-10), Harper Creek (HC-10, HC-20, HC-30, and HC-40), Barrière River (BR-10, and BR-20), and Baker Creek (BC-10).

Selenium concentrations in sediment were compared to the BC MOE alert concentration for Se (2 µg/g dw; Beatty and Russo 2014) since there is insufficient data for the BC MOE to provide a full guideline at this time. The CCME does not provide a Se sediment quality guideline for the protection of aquatic life in fresh water (CCME 2013b). All sites sampled had sediment Se concentrations below the BC MOE alert concentration except in upper Harper Creek at site HC-40 in 2012 and 2013, which had mean sediment Se concentrations slightly higher than the guideline at 2.01 and 2.03 µg/g dw, respectively (Figure 24.12-1).

24.12.4.3 Periphyton and Benthic Invertebrates

Taxa abundance, diversity, community composition, and biomass of periphyton and benthic invertebrates were determined at several sites within the Aquatic Environment RSA in baseline studies from 2011 to 2013 (Section 14.4.3.3 and Appendix 14-A, Fish and Aquatic Habitat Baseline). Baseline tissue metal concentrations in aquatic resources are provided in the Application/EIS in Appendix 14-B, and are summarized here in Table 24.12-2. A map of sampling site locations can be found in Chapter 14 (Figure 14.4-1).

Table 24.12-2. Selenium Concentrations in Benthic Invertebrate Tissue, Harper Creek Project, 2014

	Selenium Concentration in Benthic Invertebrate Tissue (µg/g dw)				
Sampling Location	Number of Replicates	Mean	Minimum	Maximum	SEM
Harper Creek (HC-10)	8	0.27	0.17	0.36	0.02
North Barrière Lake (NB site)	8	0.14	0.09	0.21	0.02
Dunn Creek (DC site, reference)	7	0.48	0.23	0.79	0.07

Notes: µg/g = micrograms per gram (= parts per million); dw = dry weight, SEM = standard error of the mean

Benthic invertebrate tissue metal Se concentrations were collected in Harper Creek (HC-10 site) and North Barrière Lake (NB site) in June 2014, with seven or eight replicate samples at each site (Appendix 14-B). The BC water quality guidelines provide an interim dietary Se guideline for invertebrate tissue residue of 4 µg Se/g dw (see Table 24.13-1; Beatty and Russo 2014). Selenium concentrations from all replicates from both HC-10 (maximum Se concentration = 1.94 µg Se/g dw) and NB site (maximum Se concentration = 0.79 µg Se/g dw) were below the BC tissue residue guideline of 4 µg Se/g dw (Table 24.12-1; Appendix 14-B).

24.12.4.4 Fish

Baseline fish and fish habitat are described in Chapter 14 of the Application/EIS and associated appendices, including raw tissue metal data (Appendix 14-A and 14-B).

Freshwater fish species presence and distribution in the Project area has been assessed on site since 2011 (Chapter 14 and Appendix, 14-A), in combination with a literature review, to determine the fish presence within the North Thompson drainages and Barrière Drainages (including Harper Creek). The literature search was based on the Fisheries Information Summary System, Ecological Reports Catalogue databases, and other previous governmental or consultancy reports containing fish diversity and distribution on the Project (Chapter 14 and Appendix, 14-A).

<u>Barrière River and Fennel Creek</u>

Migratory fish species identified in the Barrière River include Pink Salmon (*Oncorhynchus gorbuscha*), Chinook Salmon (*O. tshawytscha*), Sockeye Salmon (*O. nerka*), and Coho Salmon (*O. kisutch*), as well as non-salmonid fish species of Torrent Sculpin (*Cottus rhotheus*) and Longnose Dace (*Rhinichthys cataractae*). Non-migratory species identified include Rainbow Trout (*O. mykiss*), Bull Trout (*Salvelinus confluentus*), and Mountain Whitefish (*Prosopium willamsoni*).

No fish tissue metal data are available for fish within Barrière River and Fennel Creek.

<u>North Barrière and Saskum Lakes</u>

Based on literature reviews, Rainbow Trout, Bull Trout, Brook Trout, Mountain Whitefish Sockeye/ Kokanee Salmon, and Coho Salmon have historically been present within North Barrière and Saskum lakes. However, during baselines studies only Rainbow Trout, Bull Trout and Brook Trout have been observed in these waters (Chapter 14 and Appendix 14-A). Among non-salmonids, Torrent Sculpin in both lakes and Longnose Dace in North Barrière Lake have also been observed. No fish tissue metal data have been collected from fish within Saskum Lake.

Tissue metal data for eight Rainbow Trout were collected in 2014 from fish within North Barrière Lake (Table 24.12-3 and Appendix 14-B). Rainbow Trout muscle tissue Se concentrations collected in 2014 ranged from 0.86 to 1.35 µg/g dw and were well below the BC tissue residue guideline for fish (4 µg/g dw; Beatty and Russo 2014).

Table 24.12-3. Selenium Concentrations in Fish Muscle Tissue, Harper Creek Project, 2011 to 2014

Fish Species	Sampling Location	Sampling Year	Number of Samples	Muscle Tissue Selenium Concentration (µg/g dw)				
				Minimum	95th Percentile	Maximum	Mean	SEM
Bull Trout	P Creek	2011	5	0.784	1.10	1.78	1.27	0.168
	P Creek	2012	5	1.86	2.86	3.00	2.27	0.196
	T Creek	2011	5	1.71	2.38	2.42	2.10	0.117
	T Creek	2012	5	0.897	1.78	1.94	1.21	0.87
Rainbow Trout	Baker Creek	2011	4*	1.04	3.06	3.19	2.20	0.442
	Baker Creek	2012	5	1.73	2.27	2.28	2.10	0.101
	Lute Creek	2011	5	1.23	3.02	3.22	2.08	0.337
	Lute Creek	2012	5	3.01	3.75	3.83	3.40	0.131
	Jones Creek	2011	5	1.79	2.12	2.15	1.91	0.0691
	Jones Creek	2012	5	2.17	2.48	2.48	2.34	0.0611
	North Barrière Lake	2014	8	0.864	1.29	1.35	1.07	0.0520

Notes:
µg/g = micrograms per gram (= parts per million); dw = dry weight; SEM = standard error of the mean
Fish tissue concentrations that were reported as wet weight (C_{ww}) were converted to dry weight (C_{dw}) using the equation: $C_{dw} = C_{ww}/((100 - \%\ moisture)/100)$
** Selenium concentrations were measured for five fish; however, one of the samples had unusually high percent moisture content and therefore was removed from the analysis.*

Harper Creek

Within the lower section of Harper Creek, salmonids including Rainbow Trout, Bull Trout, Mountain Whitefish, and Coho Salmon have been observed. Non-salmonid species residing in these waters include Longnose Dace and Torrent Sculpin.

The only fish observed in the upper section of Harper Creek are resident and adfluvial (fish that migrate from lakes to streams and rivers to spawn) Bull Trout. This is mainly due to the presence of a series of waterfalls located at km 18.5 of Harper Creek. Only Bull Trout can access the upper section of Harper creek when water flows are adequate and the falls are seasonally passible.

T Creek and P Creek

No fish are present in T Creek above 336 m upstream of the confluence with Harper Creek due to a 1.8 m waterfall and high gradient cascades. Similarly, due to a 3 m bedrock fall and a series of waterfalls and high gradient cascades in P Creek, no fish are present above 469 m upstream of the confluence with Harper Creek.

Bull Trout (muscle) tissue metal data have been collected from the lower reaches of T Creek and P Creek above the confluence with Harper Creek; Chapter 14, Appendix 14-A). Summary statistics of dry weight fish tissue Se concentrations are presented in Table 24.12-3.

Bull Trout muscle Se concentrations ranged from 0.784 µg/g dw to 3.00 µg/g dw at P Creek and 0.897 µg/g dw to 2.42 µg/g dw at T Creek. All Bull Trout tissue Se concentrations were below the BC tissue residue guideline for fish (whole body, 4 µg/g dw; Beatty and Russo 2014).

North Thompson Drainages

Within the North Thompson drainage, Rainbow Trout have been observed at all of the fish sampling locations. Bull Trout were observed in the lower section of Baker Creek, while Coho Salmon have been observed in lower sections of Baker and Jones creeks, as well as in Lute Creek. Among non-salmonid species, Longnose Dace and Torrent Sculpin populations were observed in Jones Creek.

Rainbow Trout tissue (muscle) metal data have been collected from Baker Creek, Lute Creek, and Jones Creek (Chapter 14, Appendix 14-A).

Fish tissue Se data are presented in Table 24.12-3. No Rainbow Trout tissue metal concentrations were above the BC tissue residue guideline for fish (4 µg/g dw; Beatty and Russo 2014).

24.12.4.5 Birds

Baseline information on bird habitat was described in the Application/EIS in Chapter 16 (Section 16.4) and in the Vegetation and Wildlife Baseline Report (Appendix 15-A). A total of 67 bird species were observed during breeding bird surveys conducted in 2008 and 2011 (Chapter 16 and Appendix 15-A).

The focus of the SeMP is on birds that are water-dependent such as birds that rely on waterbodies as habitat features for forging, breeding, and staging. Wetland birds include waterfowl and wading birds such as ducks, geese, swans, loons, and grebes; shorebirds such as Spotted Sandpiper (*Actitis macularia*); and birds that breed in marshes (e.g., Northern Waterthrush, *Parkesia noveboracensis*) or along streams (e.g., Harlequin duck, *Histrionicus histrionicus*). Some of these species were observed incidentally during baseline bird surveys (Appendix 8 of Appendix 15-A).

Measurement of bird egg Se concentrations was not part of the Project's baseline sampling program and monitoring of bird egg Se concentrations has not been included pursuant to the SeMP at this time for reasons as discussed further in Section 24.12.8.

24.12.5 Predictive Studies

24.12.5.1 Water Quality Model

Knight Piésold Ltd. developed water quality predictions for the Project using GoldSim (Knight Piésold Ltd. 2014a; Appendix 13-C), including predictions of water concentrations of Se. The water quality model for the Project was developed using a mass balance calculation approach in GoldSim to model the volume and flow of water and the concentrations and transport of chemical species as a function of time. The GoldSim water quality model incorporated water management, Project design, and baseline geochemistry, hydrology, and surface water quality inputs to characterize the potential change in surface water quality due to release of effluent and seepage loss during all Project phases.

Geochemical source terms for 25 different Project components were developed as inputs to the water quality model for water quality parameters, including Se. Source terms were developed from site-specific laboratory and field testwork, scaling factors, mineral solubility (e.g., selenium solubility was assumed to be linked to gypsum solubility), and data from geologically analogous mine sites (SRK 2014; Appendix 6-A). The expected case source terms represent the inputs that are considered to be the most likely outcome. The expected case is considered to be a conservative model because it does not consider natural attenuation in groundwater seepage or in surface waters (KP 2014; Appendix 13-C).

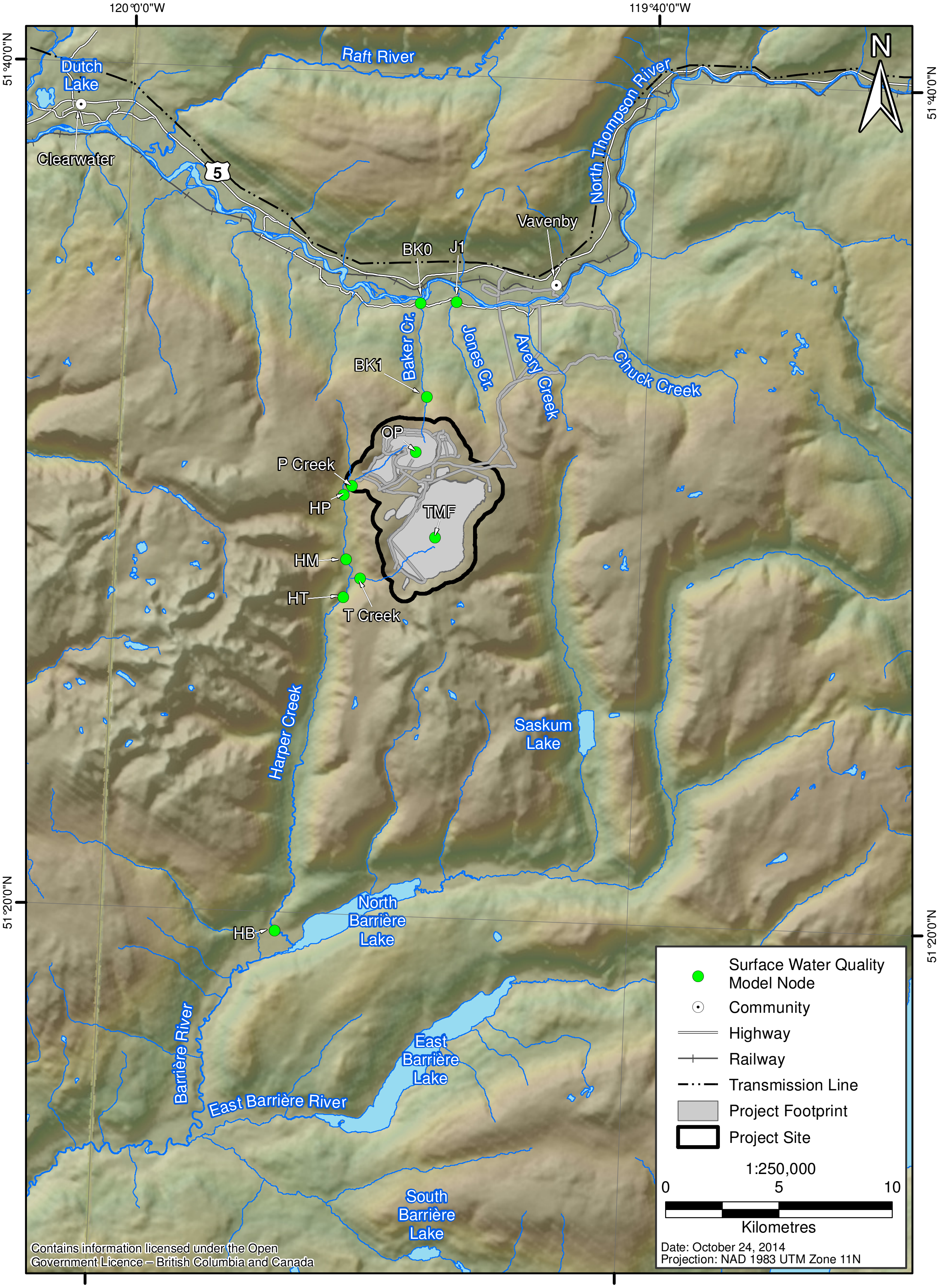
The water quality model is based on monthly time steps and contains both contact and non-contact water that reports to T, P, Harper, Baker and Jones creeks, either directly or via a tributary. Full details of the model approach, assumptions, and sensitivity analyses are provided in Appendix 13-C (Knight Piésold Ltd. 2014a) and summarized in Chapter 13 (Section 13.5.1). Figure 24.12-2 shows the locations of the surface water quality modelling nodes.

The water quality model developed by Knight Piésold Ltd. (2014a) predicted in the Expected Case or the Unrecovered Seepage Sensitivity Analysis Case that the concentration of Se in water will be greater than the BC water quality guidelines of 2 µg/L (0.002 mg/L) for the protection of aquatic life in:

- P Creek at the P Creek modelling node during the Operations 1 and 2 phases;
- T Creek at the T Creek modelling node during the Operations, Closure, and Post-Closure phases;
- Upper Harper Creek at the HP modelling node (Harper Creek, downstream of the confluence with P Creek) during the Operations phase;
- Upper Harper Creek at the HM modelling node (Harper Creek, between P and T creeks) during the Operations phase;
- Upper Harper Creek at the HT modelling node (Harper Creek, downstream of the confluence with T Creek) during the Operations, Closure, and Post-Closure phases; and
- Lower Harper Creek at the HB modelling node (Harper Creek, upstream of the confluence with North Barrière Lake) during the Closure and Post-Closure phases.

Figure 24.12-2

Surface Water Quality Effects Assessment Model Nodes



The potential for effects due to Se (and other parameters that could affect water quality) was assessed in the Application/EIS for water quality (Chapter 13), fish and aquatic resources (Chapter 14), wildlife (Chapter 16), and human health (Chapter 21).

Since the predicted concentration of Se is greater than BC water quality guidelines, alternative environmental targets are required for the Harper Creek receiving environment. These targets are intended to be protective and identify the threshold for Se concentrations in water that are not expected to result in population-level impacts to sensitive receptors, such as egg-lying vertebrates (i.e., fish or birds). The BC water quality guideline (aquatic life, 30-day mean) for Se (i.e., 2 μg/L) will be applied at other sites for the Project (e.g., Jones Creek, Baker Creek) as development of an alternative target is not required for these sites.

24.12.5.2 Bioaccumulation Models

There are a number of local factors that can influence the degree to which Se is taken up into the food chain; ideally, bioaccumulation models should be site-specific. Predictive bioaccumulation models have been used at mining projects throughout BC to define the relationship between Se concentrations in water and fish tissue or fish eggs.

Bioaccumulation models can be used to back-calculate "safe" Se concentrations in water based on tissue-based toxicity thresholds. The environmental targets for Se would then be unlikely to cause adverse effects in sensitive aquatic species.

Fish

Project-specific Bioaccumulation Models

Development of a bioaccumulation model was attempted for the Project using tissue Se concentrations for fish sampled from lotic environments within the LSA (i.e., Bull Trout from P and T creeks in 2011 and 2012; Rainbow Trout from Lute Creek, Baker Creek, and Jones Creek in 2011 and 2012; Table 24.12-3). The Rainbow Trout sampled in North Barrière Lake in 2014 (Appendix 14-B) were not included in the model as they are from a lentic environment. Different fish species may accumulate Se at different rates and to varying degrees; thus, the fish species were considered separately in the development of bioaccumulation models.

The fish bioaccumulation models for the Project used data from water quality sampling sites which corresponded to fish muscle tissue metal samples (i.e., same site or nearby sampling locations). Dietary uptake is the primary route of Se exposure to fish and longer-term mean water concentrations provided a better match for Se tissue residues than short-term measurements (e.g., single, concurrent samples). At each site, the total Se water concentrations used in the models were based on the annual average of samples collected in the year prior to fish sampling.

Five Rainbow Trout were collected at or near each of the corresponding water quality sites in Baker Creek (BK0), Jones Creek (J1), and Lute Creek (NT1) per year. One Rainbow Trout sampled from Baker Creek in 2011 had unusually high tissue moisture content and was excluded from further analysis. Five Bull Trout muscle samples were collected in P and T creeks in each sampling year.

Mean fish muscle Se concentrations were plotted for each site (x-axis) against the mean total Se concentration in water (y-axis).

Figure 24.12-3 shows the bioaccumulation models (based on linear regression) developed for Rainbow Trout and Bull Trout using the mean annual total Se water concentrations and mean Se fish muscle tissue residues. The bioaccumulation model using untransformed Rainbow Trout tissue Se residues (Figure 24.12-2) had the best fit (i.e., R^2 of 0.344) compared to other types of relationship (e.g., non-linear or log transformed). However, the linear regression line is negative (i.e., has the opposite slope to what is expected) and the relationship was not significant (p-value = 0.22). Therefore, the model is not suitable to define Se tissue concentrations as a function of total Se water concentrations.

The linear regression bioaccumulation model had a better fit for Bull Trout than for Rainbow Trout (Figure 24.12-2), but the relationship between water and whole body Se concentrations was also not significant (i.e., $R^2 = 0.0917$ and p-value > 0.05).

Additional data may improve the fit of both fish species bioaccumulation models. However, one of the limitations for developing a Project-specific bioaccumulation model using baseline data is that the range of Se concentrations that are naturally present in water (and fish tissue) is quite small. This means that, even if a regression relationship could be defined, natural concentrations of Se will be below the range of concentrations that are predicted during the Operations, Closure, and Post-Closure phases. This will limit the ability of the bioaccumulation model to predict future fish tissue residues when the water concentrations are higher than baseline conditions since the model has significant uncertainty outside of the range of Se water concentrations used in developing the model.

Non-Project-specific Bioaccumulation Model

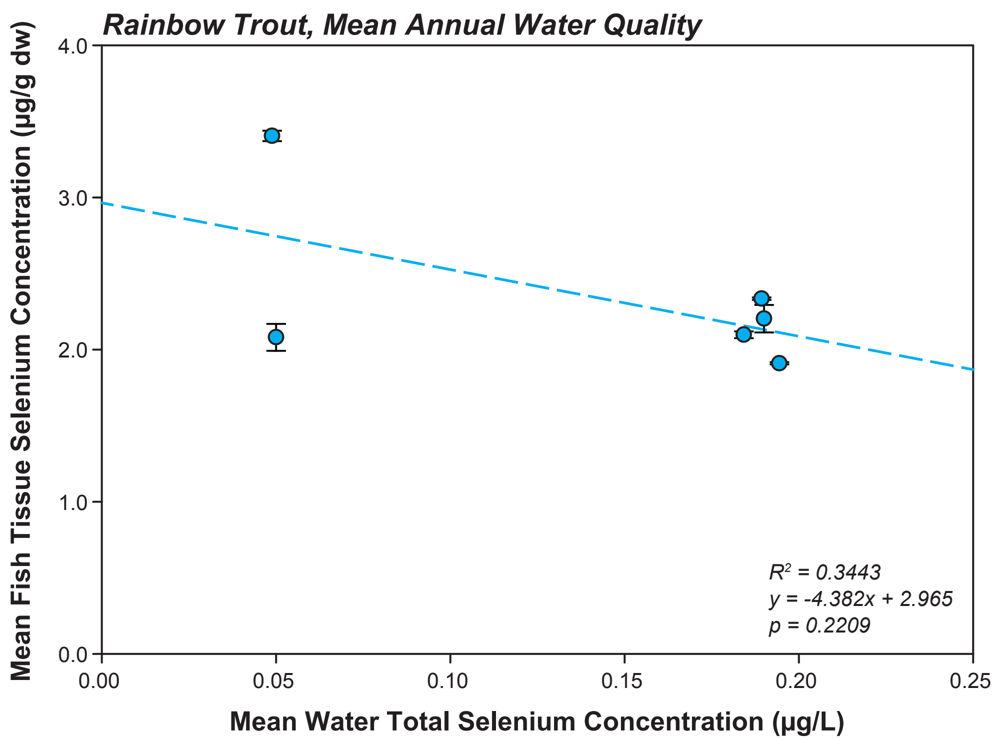
The Project-specific bioaccumulation models for Rainbow Trout and Bull Trout were based on limited sets of matched fish muscle tissue and water Se measurements from the Baker, Jones, Lute, P, and T creeks. The relationship between Se concentrations in water and Rainbow Trout and Bull Trout tissue were not significant (poor R^2 values and p-values > 0.05). Therefore, neither of the bioaccumulation models are suitable models for deriving potential environmental targets for Se for the Project at this time.

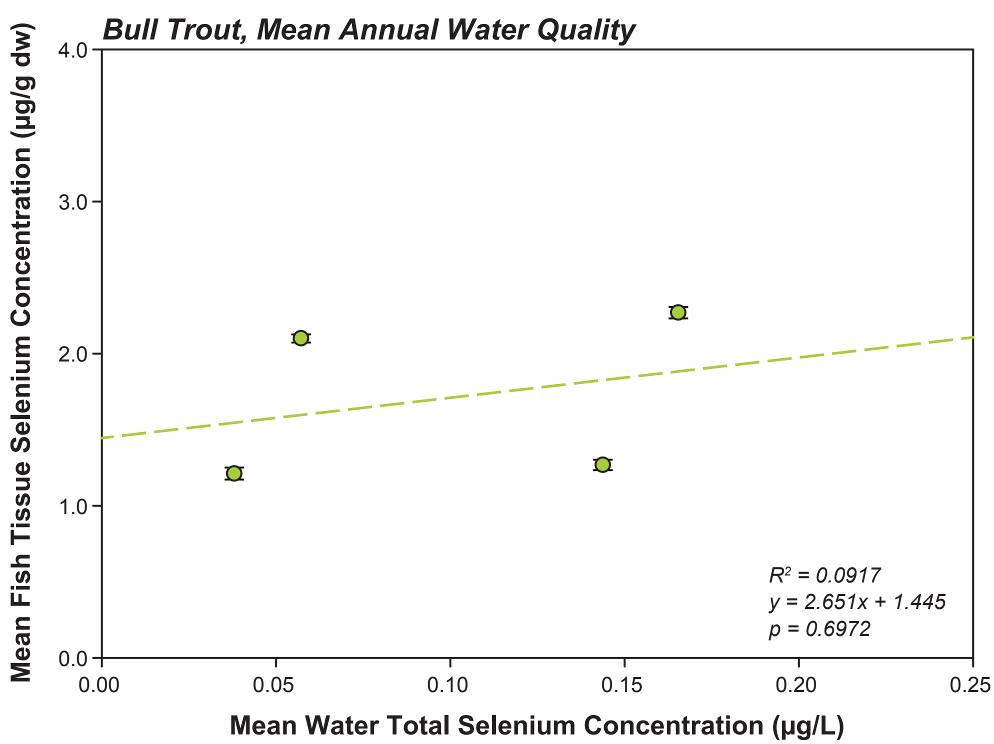
Since a site-specific bioaccumulation model could not be developed, as an interim approach the publicly-available Quintette bioaccumulation factor (BAF) model was adopted for use at the Project. This model is based on Slimy Sculpin, which tend to accumulate Se to a higher level, both in whole body and egg tissue, in comparison to other fish species (Golder Associates Ltd. 2010; Teck Coal Ltd. 2012; Beatty and Russo 2014). Thus, the Slimy Sculpin model is a conservative estimate of the potential for Se bioaccumulation in populations of other fish species that have lower BAFs, including Bull Trout and other salmonids species.

The Quintette BAF model is based on a more comprehensive data set of 324 matched water and fish tissue Se measurements from the Murray River watershed (Golder Associates Ltd. 2012a). The Quintette BAF model was developed based on Se concentrations in water between 0.10 and 10 µg/L (Golder Associates Ltd. 2012a), providing a wider range of total Se water concentrations than is currently available for the Project.

Figure 24.12-3

Bioaccumulation Models for Selenium in Rainbow Trout and Bull Trout





The model also includes a relationship between Se concentrations in egg tissue and whole body Se concentrations. This is important because the egg is the most relevant tissue for determining toxicity thresholds in fish. Studies have found that effects in developing embryos or early developmental stages are best correlated to the concentration of Se in the egg (Brix et al. 2005; Beatty and Russo 2014). Using a model that allows back-calculation of Se water concentrations from Se concentrations in the egg increases the likelihood that the calculated environmental target will be protective of fish. Selenium concentrations in egg are not available for the Project at this time, so site-specific relationships between fish muscle and egg cannot be developed.

The Quintette BAF model correlating the whole body Se fish tissue concentration (Se_{WB}) and annual mean total water Se concentration (Se_{Wat}) is (Golder Associates Ltd. 2012a):

$$\log_{10} Se_{WB} = 0.147 \times \log_{10} Se_{Wat} + 0.768 \quad \text{[Equation 1]}$$

The Quintette BAF model also relates the Se concentrations in fish tissue to eggs:

$$Se_{egg} = 1.907 * Se_{WB} + 4.356 \quad \text{[Equation 2]}$$

Equations 1 and 2 of this BAF model were used to estimate a "safe" environmental target for Se, which is the concentration of Se in water where effects to sensitive receptors would not be expected to occur.

Birds

The Spotted Sandpiper is a riverine bird species that occurs in the Project area (observed during breeding bird surveys; Appendix 15-A) and is often used as a Se indicator species for lotic systems.

Baseline studies for the Project did not include the collection of bird eggs for metal residue analysis. Thus, a publicly-available Se bioaccumulation model for birds developed for the Quintette Mine was used instead. Baseline studies for the Quintette Mine included the collection of Spotted Sandpiper eggs along the Murray River, and in surrounding tributaries and wetlands (Golder Associates Ltd. 2012b). The Quintette Mine field data were used along with data from other studies (Harding, Graham, and Paton 2005; Minnow Environmental Inc., Interior Reforestation Co. Ltd., and Paine, Ledge and Associates 2007) to develop a Spotted Sandpiper Se bioaccumulation model, which is similar to other models developed for birds (Brix et al. 2005). This model was developed by plotting the annual mean water concentration of Se (Se_{Wat}) in µg/L on the x-axis and the mean egg Se (MES) concentration in µg/g dw on the y-axis. The fitted model equation was ($R2 = 0.87$; $p < 0.001$; Teck Coal Ltd. 2012):

$$\log_{10}(MES) = 0.478 \quad \text{when } Se_{Wat} \leq 0.5\ \mu g/L \quad \text{[Equation 3]}$$

$$\log_{10}(MES) = 0.269 * \log_{10}(Se_{Wat}) + 0.559 \quad \text{when } Se_{Wat} > 0.5\ \mu g/L \quad \text{[Equation 4]}$$

This relationship implies that, at low water concentrations of Se (i.e., less than 0.5 µg/L; Equation 3) the concentration of Se in bird eggs is independent of the water concentration. As the concentration of Se in water increases, the concentration of Se in the egg also increases as shown in the second part of the regression relationship (when Se_{Wat} is greater than 0.5 µg/L; Equation 4).

Assumptions and Uncertainties

Selenium bioaccumulation through the food chain is known to be site-specific and dependent on a number of factors (Section 24.12.1). There are a number of uncertainties associated with Se bioaccumulation through the aquatic food chain and adopting a bioaccumulation model developed for another project or region in BC; these uncertainties are considered in the following sections.

Type of Aquatic Habitat

The risk of Se bioaccumulation through the aquatic food chain is higher in lentic environments (e.g., wetlands or lakes) compared to lotic environments (e.g., creeks or streams; see Section 24.12.1). For the Project, the aquatic environments downstream of the mine components are primarily lotic, so would be at lower risk of Se bioaccumulation.

The bioaccumulation models adopted from the Murray River area are also based on aquatic food chains in lotic environments, so are reasonably comparable with the type of environments present downstream of the Project Site. However, the water chemistry is likely to be different between the regions, in part because there are operating (coal) mines and other industrial activities in the Murray River area that could influence water chemistry. The benefit of this is that there is a wider range of concentrations of Se in water in the Murray River area, which improves the bioaccumulation model. However, the drawback is that there may be other parameters in water that can influence the bioaccumulation or toxicity of Se (e.g., sulphate, phosphate, copper, arsenic, iron, and mercury; Beatty and Russo 2014). Concentrations of these parameters may be different in the Murray River than in the Harper Creek area, which can influence the applicability of the bioaccumulation models outside of the Murray River area.

Species Sensitivity

Different species have been found to have different sensitivities to Se. This may be due to inter-species differences in toxicokinetics or toxicodynamics (e.g., uptake, tissue distribution, metabolism, activity of Se at specific receptor sites within the body, and excretion). For some species, no toxicity information is available and extrapolations or estimates of toxicity thresholds must be made based on data available for similar species (e.g., Bull Trout and Dolly Varden).

The bioaccumulation model for fish adopted from the Murray River area is based on Slimy Sculpin; this species has been noted to bioaccumulate Se to a greater degree than other fish species (Golder Associates Ltd. 2010; Teck Coal Ltd. 2012; Beatty and Russo 2014). Use of this model is likely to over-estimate the amount of uptake of Se by other fish species, providing a more conservative basis for comparison to toxicity thresholds. The environmental target for fish was also based on the toxicity threshold for the most sensitive fish, to ensure that the back-calculated water concentration was protective of the most sensitive species.

Benthic Invertebrate Community Composition

Selenium uptake by organisms at higher trophic levels (e.g., fish and birds) is predominantly through the food chain. The amount of bioaccumulation in the aquatic food chain is heavily dependent on the composition and community structure of the food chain, which can be quite variable within and between regions of the province.

Classification was used to assess the similarity of sampled Harper Creek benthic invertebrate communities to those of other areas where Se bioaccumulation models have been used. Stream benthic invertebrate community data were compiled from publicly available data obtained from Canadian Aquatic Biomonitoring Network (CABIN) database for projects or areas in which Se has been identified as a concern including:

- the Harper Creek Project;
- the KSM Project (Seabridge Gold Inc.);
- the Murray River Project (HD Mining Ltd.); and
- the Elk River area, upstream and downstream of the Elk Valley Coalfields (BC MOE).

Due to the use of different sampling devices (i.e., Hess, surber, or kick net) and different mesh sizes (i.e., 250 µm vs. 400 µm) between Projects, family abundances were standardized as percentages of the whole community for analysis. Thus, this analysis takes into account the structure of the communities and not the overall density. As per CABIN protocols, terrestrial and small invertebrates not sufficiently sampled with the utilized mesh sizes were excluded from analysis (Environment Canada 2012b). Median family percentage values were calculated for each site and year from replicate samples, which were then used to calculate Bray-Curtis dissimilarity values. Bray-Curtis dissimilarity values were used to construct a dendrogram of stream benthic invertebrate communities from BC which indicates how similar Harper Creek communities are to other regions (Figure 24.12-4).

Harper Creek benthic invertebrate communities generally formed a distinct cluster from other BC projects, indicating that Harper Creek communities were more similar to one another than to other project communities (Figure 24.12-4). Among project locations, most Harper Creek sites had communities more similar to those in the Murray River area, except at BC-10 (2011 and 2012) and HC-20 and HC-30 (2011 to 2013) which were more similar to Elk River area communities (WIG02 to WIG05). The bioaccumulation models for fish and birds adopted as an interim measure for the Project were based on data collected in the Murray River area; since there is some similarity in benthic community structure between the Harper Creek and Murray River areas, it is not unreasonable to use the bioaccumulation models until a Project-specific model can be developed.

24.12.6 Performance Objectives

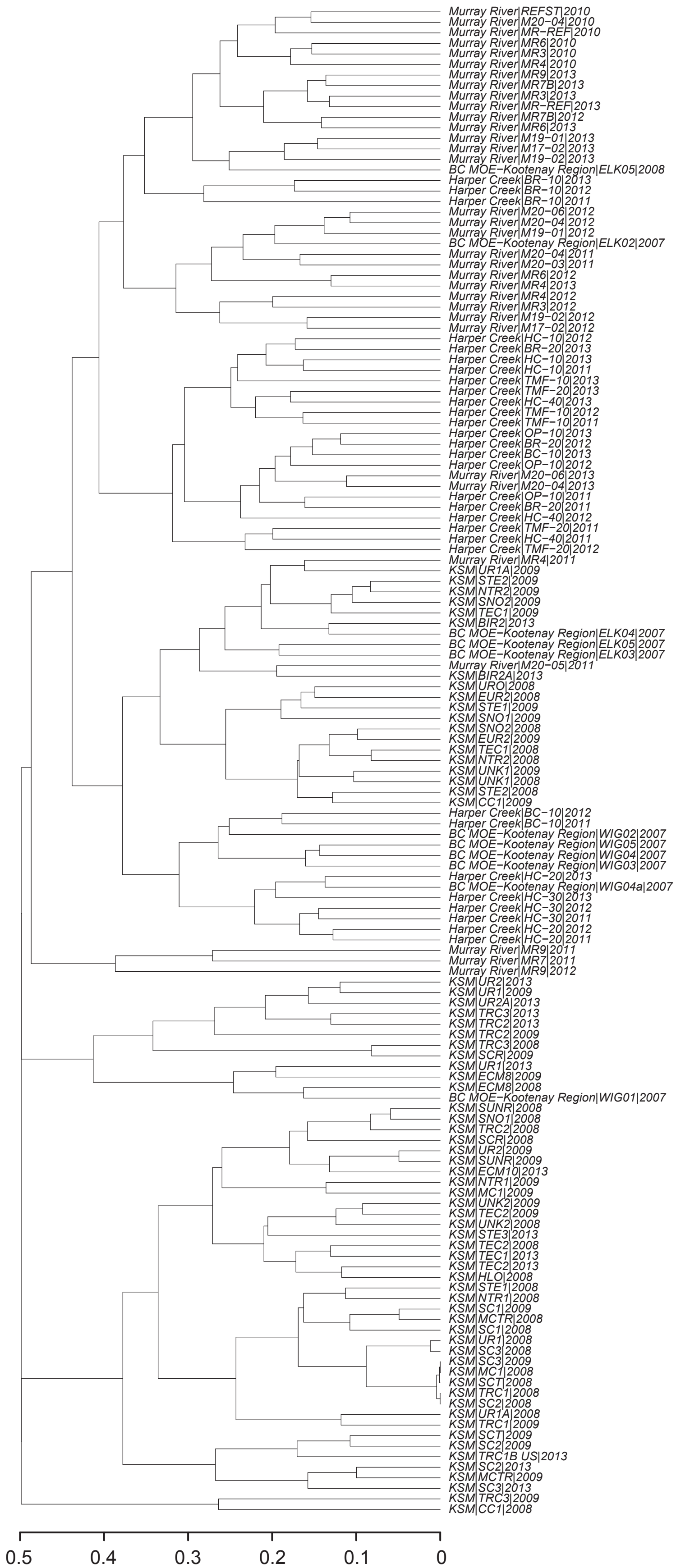
24.12.6.1 Calculation of Potential Environmental Targets based on Protection of Fish

Similar to the approach used for Quintette (Teck Coal Ltd. 2012) and Roman Mine (Golder Associates Ltd. 2011), an environmental target was derived by rearranging Equation 1 and 2 and back-calculating water concentrations from tissue-based effects benchmarks (see Section 24.12.5.2 for equations).

Bull Trout are the only fish species identified in the lower 336 m of T Creek and upper Harper Creek during baseline studies. There is no data currently available relating the concentration of Se in muscle, whole body, or egg with the potential for toxicity in Bull Trout. The toxicity threshold for Dolly Varden, a closely related species of the same genus, was found to be 54 µg/g dw in the egg (B. G. McDonald et al. 2010). Other fish species, including some that were identified in lower Harper Creek during baseline studies, are more sensitive to Se, with effects occurring at concentrations between 20 and 30 µg/g dw in the egg (Chapman et al. 2009; Janz et al. 2009; DeForest et al. 2012; Beatty and Russo 2014).

Figure 24.12-4

Benthic Invertebrate Bray−Curtis Dendrogram of British Columbia Streams



DeForest et al. (2012) compiled relevant toxicity data for species including Rainbow Trout, Brook Trout, Dolly Varden, and other species. The egg Se toxicity threshold was based on data for 12 Canadian freshwater fish species, analyzed using a species-sensitivity distribution (SSD) approach. They found that the 5th percentile concentrations for the SSD was 20 µg/g dw in the egg, which they recommend as a toxicity threshold (i.e., no significant effects would be expected at concentrations of less than 20 µg/g dw in the egg), which is similar to the no-observed-effects-concentration (NOEC, 20 µg/g dw) reported for Brook Trout and lower than the EC_{10} (concentration at which effects occur in 10% of the population, 20.8 µg/g dw) reported for Brown Trout.

Based on this information, 20 µg/g dw was used as the maximum acceptable egg concentration in the back-calculation of an environmental target that would not be expected to result in toxicity in fish populations. This toxicity threshold is conservative since it takes into account the most sensitive fish species, and it is possible that Bull Trout have a greater tolerance to Se (e.g., similar to closely related Dolly Varden, where the EC_{10} concentration is 54 µg/g dw in the egg).

The environmental target back-calculated using Equations 1 and 2, based on the toxicity threshold 20 µg/g dw in the egg, is approximately **10 µg Se/L**. By using the toxicity threshold for the most sensitive species as a benchmark, species with lower sensitivity to Se toxicity are also protected. This environmental target for Se in water is within the range of concentrations in which significant bioaccumulation in fish in lotic environment is unlikely to occur (Brix et al. 2005).

24.12.6.2 Calculation of Potential Environmental Targets based on Protection of Birds

Using the bioaccumulation model developed for the Quintette Mine, thresholds for Se in water were developed by back-calculation based on toxicity thresholds that would be expected to be protective of bird species reliant on aquatic environments. Toxicity thresholds for birds, for both lentic and lotic environments, range from approximately 7 to greater than 20 µg/g dw, based on the concentration of Se in the egg (Janz et al. 2009; Ohlendorf and Heinz 2011; Beatty and Russo 2014).

Harding, Graham, and Paton (2005) related aqueous Se concentrations to effects on Spotted Sandpiper and found a slightly reduced hatchability at the highest measured mean egg Se concentration of 7.3 µg/g dw. However, subsequent studies and data analysis suggested that Spotted Sandpiper may be able to regulate their body burdens of Se, such that the rate of bioaccumulation decreases as the concentration of Se in water increases (i.e., the relationship is polynomial rather than linear) and plateaus at concentrations at or near the toxicity threshold (Rescan 2013). This is similar to the findings of studies on Red-winged Blackbirds, where the rate of bioaccumulation decreases and the regression relationship between Se in water and Se in egg plateaus near the toxicity threshold (Golder Associates Ltd. 2007; SciWrite Environmental Services Ltd. 2007; Harding 2008). Additional data will be required to confirm this for Spotted Sandpiper, since there is limited data available for Se concentrations in bird eggs at higher water concentrations.

To be conservative, the toxicity threshold (rounded down to 7.0 µg/g dw) reported by Harding, Graham, and Paton (2005) was used to back-calculate an environmental target for Se that would be protective of birds. Using Equation 4 from the previous section (Section 24.12.5.2) and a MES concentration of 7 µg/g dw, back-calculation yields a target water concentration of Se of **11.5 µg/L**.

This concentration of Se in water would be expected to be protective of sensitive bird species dependent on the aquatic food chain.

24.12.6.3 Preliminary Environmental Targets for Selenium in Receiving Waters for the Harper Creek Project

The preliminary environmental targets for selenium in receiving waters for the Project are shown in Table 24.12-4. Based on Sections 24.12.6.1 and 24.12.6.2, the preliminary environmental target concentration for Se in receiving water is **10 µg/L**, which is the more conservative, lower value that is protective of both fish and birds. This environmental target is considered preliminary since it was developed using bioaccumulation models from other projects in BC and will be refined over time as Project-specific information comes available. Once Project-specific data and bioaccumulation models are available (see Section 24.12.8) a Science Based Environmental Benchmark (SBEB) for selenium will be formally developed for the Project. The SBEB will be developed based on guidance provided by the BC MOE (BC MOE 2013b), with additional guidance currently under development.

Table 24.12-4. Environmental Targets for Selenium in Receiving Waters for the Harper Creek Project

Type of Target	Water Concentration	Purpose of Target
Environmental Target (Preliminary)	10 µg/L	Maximum concentration of selenium in receiving water that is protective of fish and birds in lotic environments
Trigger Concentration	7.5 µg/L	Concentration of selenium in receiving water that acts as a trigger for additional monitoring and initiates consideration of adaptive management options

In addition to the preliminary environmental target of 10 µg/L, a trigger concentration is defined as 7.5 µg/L (i.e., 75% of the environmental target). This trigger concentration is intended to increase monitoring levels and prompt the proponent to begin considering adaptive management options before the environmental target concentration is reached.

24.12.7 Environmental Protection Measures

The proposed mitigation and management measures are actions to prevent, avoid, minimize, or restore effects to surface water quality within the spatial and temporal boundaries of the Project. The strategy of this SeMP is aligned with the goals outlined in the *Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price and Errington 1998), which are to: achieve long-term protection of the receiving environment and minimize the "alienation" of resources from productive use. Progressive mitigation measures will be implemented where potential effects to the receiving environment are first prevented, then controlled, and finally minimized (reduced) to the extent practical.

Mitigation and management measures to eliminate or reduce Project effects include design and planning, engineered structures, best management practices, compliance with regulatory requirements, and monitoring and adaptive management. The Project is designed to minimize the impacts of metal leaching and/or acid rock drainage (Section 24.9, Mine Waste and ML/ARD Management Plan), which will, in turn, minimize the amount of Se that enters the aquatic environment.

Adaptive management of Se in the aquatic environment will be a continuous, iterative process in which potential concerns are identified (e.g., through monitoring) and corrective actions are taken to eliminate or decrease potential effects. Monitoring is proposed as part of this plan (Section 24.17.8) and under the Fish and Aquatic Effects Monitoring and Management Plan (Section 24.6). Environmental or biota monitoring is intended to identify changes to the aquatic environment or organisms residing in the aquatic environment. If monitoring indicates that Se is accumulating in the aquatic environment to concentrations that have the potential to adversely impact aquatic life, additional mitigation measures (i.e., corrective actions) will be considered.

Additional mitigation measures that could be considered, if necessary, to adaptively manage Se loading to the aquatic environment include one or more of the following:

- additional investigation of the sources of Se (beyond geochemistry characterization studies already conducted) and refinement of predictive models (e.g., water quality models, food chain models);
- changes to Project materials handling or water management practices (e.g., structure redesign or re-engineering to minimize seepage or enhance seepage collection efficiency, or additional seepage collection measures);
- alteration of the TMF discharge regime in Closure and Post-Closure phases from passive release of water to active (controlled) release of water (e.g., seasonal discharge, staging of discharge to match the natural hydrograph);
- installation of fish barriers (e.g., T Creek and P Creek) to decrease access of aquatic organisms to areas where Se concentrations in water may be elevated relative to receiving waters; or
- ecological risk assessment to determine whether or not adverse effects are occurring in the aquatic environment as a result of Se.

Other mitigation measures not described here may also be considered, since considerable work in this area is ongoing. Technology and scientific knowledge will improve over the years and new mitigation strategies may be available during the time in which they are required (e.g., once discharge from the TMF begins).

24.12.8 Monitoring

The objectives of the monitoring program under the SeMP are to:

- collect data to support development of site-specific bioaccumulation models;
- verify the predictions of the water quality model and the conclusions reached in the effects assessment;
- detect changes in the aquatic environment before there is the potential for effects to occur; and
- allow for the proactive implementation of adaptive management and mitigation strategies, before adverse effects can occur in aquatic biota.

Precise sampling locations will be determined in consultation with appropriate regulatory agencies during the permitting phase of the Project. Since the water quality model (Expected Case and Unrecovered Seepage Sensitivity Analysis) predicts Se to be elevated in P, T, and Harper creeks, the monitoring program is focused on these locations. Therefore, sampling locations for Se monitoring are expected to be selected at one or more locations in:

- P Creek;
- T Creek;
- Harper Creek:
  - upstream of the confluence with P Creek,
  - mid-Harper Creek between P Creek and T Creek,
  - downstream of the confluence with T Creek,
  - upstream from the confluence with North Barrière Lake; and
- one or more reference sites that are not expected to be influenced by activities of the Project or other projects in the area (current or foreseeable future developments).

Wherever possible, the sampling locations selected as part of the SeMP monitoring program will coincide with the sampling locations selected for other purposes (e.g., compliance monitoring under the MMER and the *Environmental Management Act* [2003] Effluent Permits). This ensures the most efficiency and minimizes the redundancies in sampling programs.

The proposed monitoring program is based on the guidance provided in Section 3.0 of the *Companion Document to: Ambient Water Quality Guidelines for Selenium Update* (BC MOE 2014b). The environmental media or biota to be monitored and the frequency of sampling will vary depending on the concentration of Se measured in water. To the extent possible, all samples required at a site should be collected concurrently and sampling sites for multiple media or biota sampling should be co-located. Table 24.12-5 outlines the media or biota proposed for sampling at each site and the frequency of sampling. The actual frequency and media or biota to be sampled at each site will be determined in consultation with appropriate regulatory agencies.

Bird egg sampling has not been included as part of the monitoring plan at this time. This is because it is considered unlikely that a sufficiently sized population of a suitable aquatic bird species, such as the Spotted Sandpiper, is using the relatively small affected area in the Harper Creek watershed for breeding in sufficient numbers to support such sampling. However, if bird egg sampling is recommended at a later date based on the results of the other monitoring undertaken pursuant to this Plan, then it is recommended that an aquatic bird breeding survey be done in this area to determine whether or not there is evidence of breeding aquatic birds using these waterways. If an aquatic species of bird is found to be present and breeding in the area in sufficient numbers, then monitoring of bird eggs may be considered for incorporation into the monitoring plan following consultation with FLNRO, likely at the same frequency as fish eggs.

Table 24.12-5. Proposed Selenium Monitoring Program

Environmental Media or Biota	Parameters to be Analyzed	Frequency of Sampling		
		When Receiving Water [Se] is < 2 µg/L	When Receiving Water [Se] is ≥ 2 µg/L but < 7.5 µg/L	When Receiving Water [Se] is ≥ 7.5 µg/L
Water	Physical parameters, dissolved anions, organic carbon, total and dissolved metals	Monthly or otherwise as required by permit or other authorization	Monthly	Twice per month
Sediment (63 µm fraction)	Particle size, total metals, moisture content, total organic carbon	Once every 5 years [b]	Once every 2 years	Annually [c]
Periphyton or Aquatic Plant	Tissue metal analysis, moisture content			
Benthic Invertebrates				
Fish Tissue (whole body) [a]				
Fish Egg [a]				

Notes:
[Se] means concentration of total selenium
[a] *Fish tissues/eggs will only be sampled provided that necessary permits can be obtained and adequate numbers of fish or eggs can be located and sampled without affecting the local population status.*
[b] *Frequency assumes that [Se] are below applicable guidelines for sediment, benthic invertebrates, fish tissue or fish egg (see Table 24.12-1 for guidelines). If [Se] are greater than the applicable guidelines, frequency of sampling for sediment and biota should be increased to once every 2 years.*
[c] *Additional parameters, indicators, or studies may be added to the monitoring program if the preliminary environmental target of 10 µg/L is exceeded such as periphyton or benthic invertebrate taxonomy, fish population studies, and laboratory- or field-based toxicity studies. Additional parameters, indicators, or studies to be added will be determined in consultation with the appropriate regulatory authorities.*

Data collected under the monitoring program will be used to develop and/or refine Project-specific bioaccumulation models, which will in turn be used to develop Project-specific SBEBs. The monitoring program under the SeMP should be re-evaluated and adjusted periodically (e.g., every three to five years) in order to ensure that the sampling locations, types, and frequencies are sufficient to meet the objectives of the overall SeMP. Any changes to the monitoring program will be made in consultation with appropriate regulatory agencies.

24.12.9 Reporting

Details of the monitoring and reporting required under the SeMP will be combined with other regulatory monitoring and reporting requirements (e.g., under the *Environmental Management Act* [2003] Effluent Permits). The SeMP is a "living document" and components of the plan may be revised over the life of the Project, based on the results of previous monitoring, adaptive management, regulatory changes and/or scientific and technological advances. Any modifications made to the overall plan will be communicated to regulatory authorities where applicable.

24.13 SITE WATER MANAGEMENT PLAN

24.13.1 Purpose

The purpose of the Site Water Management Plan is to provide an operational guide for management of surface water quantity throughout the life of the Project. This plan focuses on actions for avoidance, mitigation and control, as well as a water management monitoring program. By incorporating principles of adaptive management, this Site Water Management Plan provides a framework for ongoing review and improvement of management practices. The plan addresses the following goals:

- protect water-related resources and avoid harmful impacts on fish and wildlife habitat;
- provide sufficient water to support the mill operations and maintain storage of PAG materials in a subaqueous state; and
- manage water in a manner that will ensure that any discharges are in compliance with MMER and applicable water quality guidelines are being met in the receiving environment.

The Site Water Management Plan is intended to be used in conjunction with the Fish and Aquatic Effects Monitoring and Management Plan (Section 24.6), the Mine Waste and ML/ARD Management Plan (Section 24.9), the Sediment and Erosion Control Plan (Section 24.11), and the Selenium Management Plan (Section 24.12), in addition to any other applicable plans. Water management infrastructure and the water balance model are presented in Knight Piésold Ltd. (2014b) and in Appendix 12-B.

24.13.2 Performance Objectives

The Site Water Management Plan provides guidance for achieving the following performance objectives during all phases of the Project:

- comply with regulatory commitments, guidelines, and objectives;
- implement environmental protection measures in a timely, effective, and cost-efficient manner;
- integrate water management activities with other management and monitoring programs;
- reduce, eliminate, or mitigate erosion and sediment yield, flow blockage, and environmental effects of extreme weather events;
- intercept and divert non-contact water (freshwater) away from work areas;
- collect and store contact water in the tailings management facility (TMF);
- maintain an adequate supply of water for mine operations;
- maintain PAG materials stored in the TMF in a subaqueous state; and
- minimize use of freshwater.

Specific management measures that will be implemented to achieve these performance objectives are summarized in Table 24.13-1. These management measures, which are categorized into two environmental protection types, namely Project design and adaptive management, are described in Section 24.13.3.

24.13.3 Environmental Protection Measures

Effective water management requires environmental protection measures within an integrated adaptive approach. These measures are broadly applicable to all activities on the site. Here, they are categorized into two groups: 1) design criteria, and 2) adaptive management.

Table 24.13-1. Water Management Performance Objectives and Corresponding Management Measures

Environmental Protection Type	Performance Objectives	Management Measure	Other Applicable Management Plans
Project Design	• Intercept and divert non-contact water (freshwater) away from work areas; • collect and store contact water in the TMF; • maintain an adequate supply of water for mine operations; • maintain PAG materials in the TMF in a subaqueous state; and • minimize use of freshwater.	Non-contact water diversion channels will be constructed upstream of the open pit, east topsoil stockpile, and non-PAG waste rock stockpile. Contact water will be stored in the TMF during Operations. Water management ponds, sized to store the 1-in-50-year 24-hour precipitation event, will be situated downstream of the TMF embankment, PAG LGO stockpile and non-PAG waste rock stockpile. Pumping systems will be designed to maintain the water management pond levels during the snowmelt and rainfall freshet, and to restore water levels to normal operating conditions following a flood event. Open pit dewatering, sized to manage the 1-in-10-year 24-hour precipitation event and an additional 20% surge capacity, will divert the water to the TMF. This will be completed using a staged surface water in-pit pumping system. The coffer dam, to be used for construction of the TMF embankment, provides storage capacity for four months of statistically wet conditions for the Project Site area, in addition to the runoff from the 1 in 10-year 24-hour precipitation event with freeboard allowance.	Mine Waste and ML/ARD Management Plan (Section 24.9), Sediment and Erosion Control Plan (Section 24.11), and Selenium Management Plan (Section 24.12)

(continued)

Table 23.14-1. Water Management Performance Objectives and Corresponding Management Measures (completed)

Environmental Protection Type	Performance Objectives	Management Measure	Other Applicable Management Plans
Adaptive management	• Comply with regulatory commitments, guidelines, and objectives; • implement environmental protection measures in a timely, effective, and cost-efficient manner; • integrate water management activities with other management and monitoring programs; and • reduce, eliminate, or mitigate erosion and sediment yield, flow blockage, and environmental effects due to extreme weather events.	Scheduling and staging will be implemented for all site-specific work plans prior to beginning work. Applicable site personnel will be familiarized with the purpose and content of the Site Water Management Plan, and with their responsibilities in its implementation. Communication will be maintained among site manager/supervisors, environmental personnel, and contractors. The Water Management Plan is a living document and will be modified to adapt to changing work plans and site conditions. 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 Sediment and Erosion Control Plan (Section 24.11). Site access roads will be constructed and maintained in accordance with the *Forest Road Engineering Guidebook* (BC MOF 2002). Equipment and materials for water management/erosion and sediment control will be maintained in locations that are easily identifiable and accessible. Snow will be piled in areas where snow melt can be managed effectively.	Fish and Aquatic Effects Monitoring and Management Plan (Section 24.6), Mine Waste and ML/ARD Management Plan (Section 24.9), Sediment and Erosion Control Plan (Section 24.11), and Selenium Management Plan (Section 24.12)

24.13.3.1 Design Criteria

Design elements of the water management plans are discussed in Knight Piésold Ltd. (2014b). Environmental protection measures associated with these elements are described here. Water management information in this section is based on the Project Description (Section 5.11) unless otherwise specified.

Design criteria ensure sufficient water is available to support the process water requirements, while mitigating environmental effects to downstream receiving waters. Water will be controlled in a manner that minimizes erosion in areas disturbed by construction activities and prevents the release of sediment-laden water to the receiving environment. This includes the collection and diversion of surface water runoff, sediment control ponds, and pump-back systems.

Diversion Ditches

The Project Site is in an area of high annual precipitation with a mean annual precipitation of approximately 1,050 mm at an elevation of 1,680 m. The TMF is anticipated to have a surplus of water over the life of the Project. Freshwater diversions have been designed to reduce this surplus status, and to minimize the use and management of non-contact water for as long as practical. These diversions include open channels upstream of the open pit, east topsoil stockpile, overburden stockpile, and non-PAG waste rock stockpile (Figure 24.13-1).

Tailings Management Facility

The water balance indicates that the TMF is in surplus conditions during all years of Operations. A water discharge from the TMF during Operations was not considered to be the preferred alternative as part of the Project design, due to downstream water quality considerations. As a result, all water will be stored in the TMF during Operations. Reclaim water for mill operations is sourced from the TMF during Operations 1 and the first 18 months of Operations 2 when Low Grade tailings are being directed to the open pit. During the remainder of Operations 2, reclaim water will be pumped from the open pit, and the TMF pond receives natural runoff until it reaches the design spillway elevation and begins discharging to T Creek during Closure. During Closure, water will be pumped from the open pit pond and directed to the TMF such that the water level within the open pit will remain about 25 m below the minimum crest elevation of the open pit.

Seepage Collection and Water Management Ponds

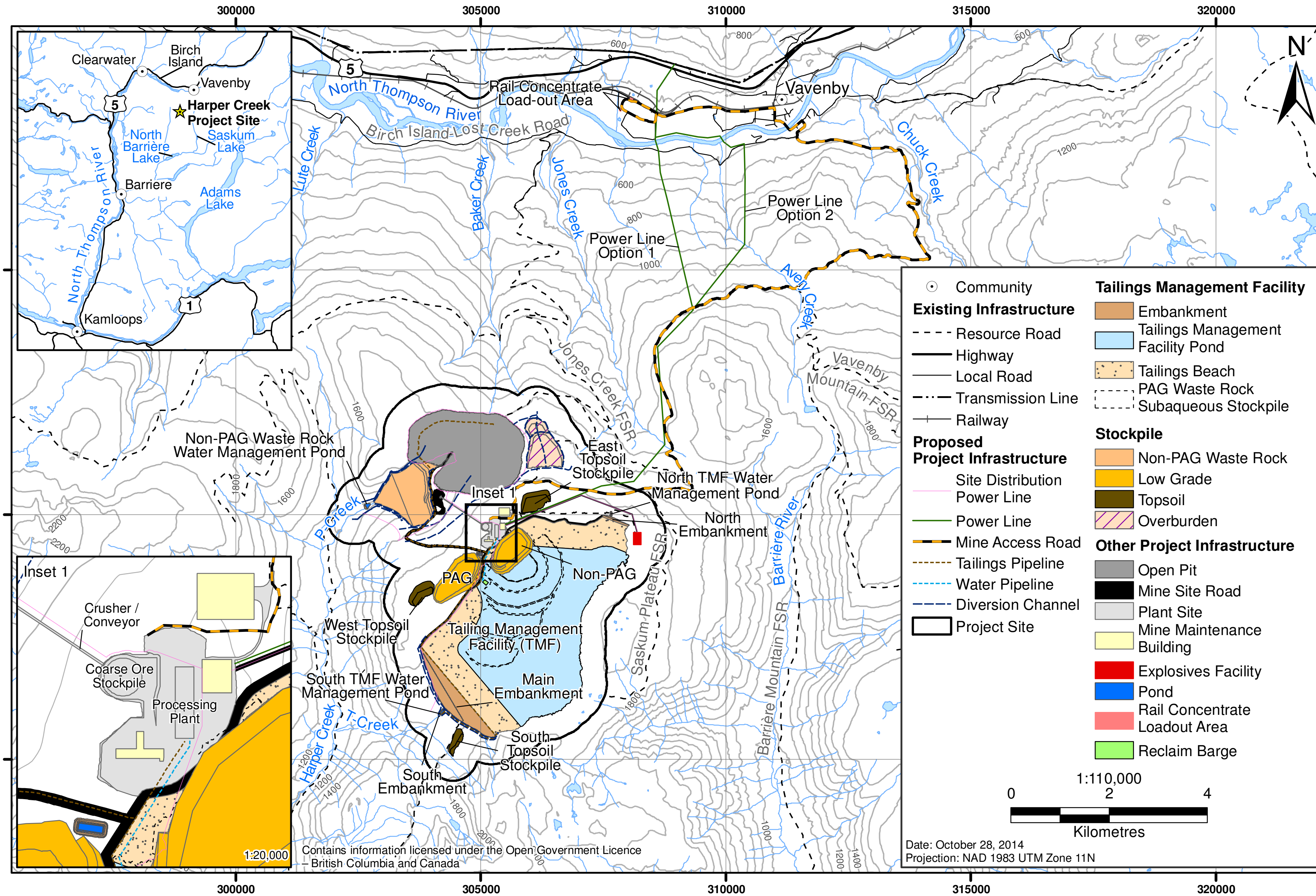
Water management (sediment control) ponds will be situated downstream of the TMF embankment, PAG LGO stockpile and non-PAG waste rock stockpile (Figure 24.13-1). The ponds will provide a collection point for surface runoff and infiltration from the stockpiles as a result of precipitation in these catchment areas, and for seepage through the embankment. All water collected will be pumped to the TMF supernatant pond for long-term storage and use as reclaim water for process purposes.

Water management ponds have been sized to store runoff from the 1-in-50-year 24-hour precipitation event, as well an allowance for freeboard. Runoff collection ditches will be used during Construction and Operations to intercept and divert runoff to these water management ponds. Appropriate sediment control measures will be used to ensure discharges are in compliance with applicable water quality guidelines. Runoff collection ditches may be either temporary or permanent structures. Pumping systems will be designed to maintain an operational pond level during the snowmelt and rainfall freshet, and to restore water levels to normal operating conditions following flood events.

Water Management Pipelines and Pumping Systems

The pipelines and pumping systems for the water management ponds were designed to convey mean monthly runoff during the snowmelt and rainfall freshet, i.e., the month of June. The pumping systems are capable of conveying the June monthly flow without storage.

Figure 24.13-1
Project Infrastructure



Open pit dewatering will be completed using a staged surface water in-pit pumping system. The water collected in the open pit dewatering system will be delivered to the TMF. The open-pit dewatering pipeline and pump system was sized to manage the 1-in-10-year 24-hour precipitation event, groundwater seepage, average annual inflows, and an additional 20% surge capacity. The dewatering plan in the pit allows ten days for dewatering for the design event. Mining activities in the open pit can be relocated if necessary to accommodate accumulated pit water.

Cofferdam

The coffer dam, to be used for construction of the TMF embankment, provides storage capacity for four months (September through December) of statistically wet conditions for the Project Site area, in addition to the runoff from the 1-in-10-year 24-hour precipitation event, with freeboard allowance. Pumping systems for the cofferdam will be available to restore the cofferdam water levels to normal operating conditions within seven days following a flood event.

24.13.3.2 Adaptive Management

Adaptive management is a process of continually improving management practices by learning from the outcomes of operational practices (e.g., Bunnell et al. 2009, BC MOF 2014). To be effectively implemented, adaptive management 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. Best management practices (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 so that additional measures can be quickly implemented if needed.

Communication is essential to successful application of the water management plan. Applicable personnel working at the site, including cross-shifts, should be advised and trained about the plan's goals and purpose, and their responsibilities in order to implement the plan successfully. Personnel should be informed of changes in a timely manner. Appropriate training and field supervision are important elements of the water management plan. Personnel should understand why water management measures are needed and how to implement them correctly.

Sedimentation Inspections

Embankment condition, evidence of sediment transport into watercourses, and flow blockage will be assessed along water diversion channels, drainage ditches, ponds, and waterway crossings (see Sediment and Erosion Control Plan, Section 24.11). The waterbodies adjacent to construction sites will be visually inspected for introduced sediment. Regular inspection of areas releasing sediment will be carried out until sediment is no longer released.

Site access roads will be constructed, upgraded, and maintained according to the *Forest Road Engineering Guidebook* (BC MOF 2002) and maintained to ensure low landslide risk and continuous, efficient, controlled water drainage.

Site Resources

Equipment and materials for water management should be maintained in locations that are easily identifiable and accessible. These 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 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. Shutdowns of ground-disturbing activities may be required during periods of very high rainfall (e.g., greater than 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 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 areas where snow melt can be managed effectively.

24.13.4 Monitoring

A Water Management Monitoring Program will be implemented with a focus on inspection and maintenance of structures related to water management, and 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;
- identify and promptly address areas where maintenance, upgrades, modifications, or additional mitigation measures are necessary; and
- measure actual water use on site (intake, recycling, discharge).

Additional mitigation and management measures relevant to the Site Water Management Plan are provided in the following environmental monitoring and management plans:

- Section 24.6, Fish and Aquatic Effects Monitoring and Management Plan;
- Section 24.9, Mine Waste and ML/ARD Management Plan;
- Section 24.11, Sediment and Erosion Control Plan; and
- Section 24.12, the Selenium Management Plan.

The Mine Environmental Supervisor or other designated person will be responsible for overseeing the water management monitoring program, maintaining inspection and maintenance records, ensuring water monitoring reporting, and providing guidance on any changes needed to the program.

Trained technical staff will be employed at the Project. They 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 Mine Environmental Supervisor or other designated person, the technical staff will have the responsibility of confirming that water management measures are properly implemented, and, if not, for giving appropriate direction to ensure that they are.

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.

24.13.4.1 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 the Mine Environmental Supervisor or other designated person at a frequency dictated by site conditions and activity level. In frozen conditions, formal inspection frequency may be reduced. Inspections of water management structures and systems will be conducted within 24 hours of any extreme rainfall event, typically in the order 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 structural failure and consequent sediment transport. Maintenance will also include routine removal of accumulated sediment from ditches and retention structures.

Water management monitoring variables are outlined in Table 24.13-2. Monitoring frequency will be dictated by site conditions and activity level and may be increased as required based on the results of the other relevant monitoring programs[1]. Inspection criteria may be modified on a site-by-site basis or as conditions require.

24.13.5 Reporting

The Project's Mine Environmental Supervisor will be responsible for reporting on observations and monitoring results to the Mine Manager (Table 24.13-3). 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.

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[1] Frequency may be decreased during winter when ground is frozen.

Table 24.13-2. Water Management Monitoring Variables and Expected Outcomes

Monitoring Variable	Outcomes
Water level and flow measurement	To be used in other management and monitoring plans
Performance of water management structures and systems (e.g., diversion ditches, site collection pond)	Functioning as required and after high rainfall/ runoff[1] events
Site and road drainages[2]	Positive drainage maintained at all times; no ponding
Supply of water management/erosion prevention and sediment control materials	Sufficient on-site supply is always available

[1] Combined 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).
[2] For more information, see the Sediment and Erosion Control Plan (Section 24.11).

Table 24.13-3. Water Management Reporting Requirements and Responsibilities

Report Type	Reporting Responsibilities	Submitted to
Site inspection and maintenance logs	Technical Staff	Mine Environmental Supervisor
Water management materials inventories	Technical Staff	Mine Environmental Supervisor
Annual report as required by permits	Mine Environmental Supervisor	Mine Manager, regulatory authorities
Environmental incident report	Initial notification by attending manager	Mine Environmental Supervisor

A log of all site inspections, recording the date and pertinent observations, will be established. The log form will typically include such information as the work site, time, date, weather conditions, current site activity, list of water management practices or structures, and, as appropriate, a date-stamped photograph.

Environmental incidents will be communicated by the individual who detects an incident to their supervisor who will report to the Mine Environmental Supervisor or designated person.

24.14 Soil Salvage and Storage Plan

24.14.1 Purpose

The purpose of the Soil Salvage and Storage Plan is to conserve soil quantity and promote ecosystem functionality by minimizing the loss of soil characteristics, namely fertility, permeability, water holding capacity, and biotic diversity. This will be accomplished by minimizing soil disturbance, and avoiding soil loss and degradation by following best practices when disturbance is required. This plan addresses the latter.

Baseline studies of the Project Site indicate that it is primarily located in an area of significant soil leaching. Local soils include shallow till, colluvium and weathered bedrock that range from strong to medium acidity, and of course to medium texture (sandy loams). Approximately one-third of the area of the Project Site is occupied by lithic soils, while a minor portion is occupied by organic (peaty) soils.

Although of varying suitability and extent, soils available for use in mine reclamation for the Project will be retained and preserved, as described in this plan. Soil salvage is anticipated for areas that will be either excavated or subject to cut and fill operations. Salvaged soils, and possibly suitable overburden from the Project Site, will be used during mine reclamation to facilitate the restoration of functioning ecosystems. To achieve this goal, these materials will need to be salvaged, handled, transported, and stored in a manner that does not result in excessive loss of their suitability and future productivity.

24.14.2 Performance Objectives

The objectives of the Soil Salvage and Storage Plan are to retain and preserve suitable soil that can be made available for use in mine reclamation. These objectives include:

- preserving adequate volumes of soil and suitable overburden for use in reclamation activities that will be undertaken during the Construction, Operations, and Closure phases of the Project as described in Chapter 7, Closure and Reclamation;
- minimizing sediment release by salvaging soil under appropriate weather and soil moisture conditions;
- minimizing soil loss during storage by vegetating the stockpiles or applying other means of protection from fluvial or aeolian erosion;
- retaining native fertility of soils during storage by preventing mixing with lower quality material or invasive plant species; and
- preventing soil erosion during soil handling operations (salvage operations, to and from stockpiles, and during replacement).

24.14.3 Environmental Protection Measures

24.14.3.1 Design Criteria

Environmental protection measures are specific actions and practices that mitigate possible environmental damage. These measures are typically incorporated into the criteria that inform the engineering design of a project. For soil salvage and storage for the Project, the overall approach to such measures will include the following:

- undertaking the operation in an adequately planned and supervised manner, following a predetermined plan for soil salvage and storage;
- salvaging and storing humic materials with 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 application in final reclamation;
- avoiding prolonged exposure of bare soil to the elements, i.e., where practical, soil salvage will immediately follow vegetation clearing;

- limiting soil salvage when soils are too wet or too dry, where practical, since working in these conditions can degrade soil quality; and
- where practical, separating coarse mineral fragments from the soil, e.g., large boulders thus improving the quality of the soil for use in future reclamation efforts and enabling equipment operators to effectively shape the soil stockpile.

Where storage of suitable soil and overburden from Project footprint areas is to occur, it will adhere to the following guidance:

- stockpiles will be designed to be geotechnically stable;
- stockpiles will be located on stable substrate, 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, i.e., 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;
- where deemed necessary stockpiles will be surrounded by runoff diversion and collection ditches and shaped in a way that will promote controlled, 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;
- overburden stockpiles may require fertilizer for vegetation establishment but no further maintenance is planned unless erosion and/or excessive establishment of invasive species are reported;
- stockpiles will be accessible and will be marked on mine plans ; and
- information on stockpile quantity and quality will be recorded.

Progressive soil replacement and reclamation can increase the effectiveness of erosion control measures and reduce closure-related capital costs at the cessation of mining activities. Where practical, 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 7).

Mixing surface and subsurface soils during salvaging operations (admixing) will be avoided, where practical, as excessive mixing of surficial organic and mineral horizons with deeper soils 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, while 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 practical 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 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 general work areas so they will not be disturbed by Project activities.

24.14.3.2 Construction

Progressive reclamation will be carried out during the Construction and Operations phases of the Project when a disturbed area is no longer required for operational purposes. The bulk of soil salvage and storage will occur during the Construction phase of the Project. There is an estimated 2,023,696 m^3 of potentially salvageable soil available from areas due to be occupied by Project infrastructure and the bulk of this is made up of the open pit and the TMF dam footprint areas which together comprise 1,193,383 m^3 of potentially salvageable soil. Project infrastructure, i.e., the spatial extent of the entire development footprint, will occupy 1,938 ha.

The design criteria detailed in Section 24.14.3.1 will primarily apply to the Construction phase of the Project. Soils may be salvaged using a variety of equipment (dozers, scrapers, and/or backhoes) under conditions of low soil moisture, and will not be salvaged on slopes greater than 50% or 26^{o} due to difficulties using salvage equipment on steep slopes. Equipment used to handle organic soils may be mounted on wide tracks if necessary to accommodate their low bearing strength. Backhoes equipped with clean-out buckets are usually best suited for this application as they allow the operator to view the clean separation of the organic material from the underlying mineral material.

Soil that is salvaged from Project infrastructure areas will be stockpiled in three dedicated locations around the perimeter of the TMF and the deeper overburden from substrate stripping at the open pit will be kept in a separate stockpile to the east of the open pit. The management of soil stockpiles, i.e., their optimum means of storage, is described in the design criteria in Section 24.14.3.1.

24.14.3.3 Operations

Given the progressive reclamation approach that will be applied throughout the life of the Project, some soil from salvaged stockpiles will be utilised during the Operations phase.

24.14.3.4 Closure

The bulk of the salvaged soil kept in storage stockpiles will be used during the decommissioning and reclamation activities undertaken in the Closure phase of the Project.

Approximately 711.6 ha of land will be reclaimed for the Project and although the depth of soil required for reclamation will vary according to the site conditions of the areas to be reclaimed, the general plan is to apply a 30 cm thick soil cover where soils are required for reclamation. Approximately 1,891,750 m^3 of topsoil will thus be required. In areas potentially requiring a thicker cover, such as on the non-PAG waste rock stockpile, an initial thickness, where necessary, will be provided from stockpiled overburden, as a base for the topsoil and to ensure sufficient water holding capacity for plant growth. Approximately 1,216,000 m^3 of the stockpiled overburden will be required throughout the site for this purpose.

With reference to Section 7.4.4, Soils Balance, in Chapter 5, Closure and Reclamation Plan, the calculated amounts of soil that may be available for salvage from the footprint areas and an estimate of the amount of soil required, suggest that there may be a small surplus of approximately 5,000 m^3 of topsoil. However, some adjustment may occur if the soils in the planned salvage areas are less suitable for reclamation purposes than predicted. Any surplus soils will be used for the reclamation of disturbed areas where additional soil may be required, such as in working and laydown areas, gravelled areas that require additional soil, and other disturbed areas.

24.14.3.5 Post-Closure

There should not be any need for stockpiled soil to be managed during the Post-Closure phase of the Project.

24.14.4 Monitoring

With the salvage and placement of stored topsoil occurring in a controlled and scheduled manner as described in this plan, monitoring of the performance of the undertaking will largely amount to on-going evaluation of the integrity of the stockpiles from stability and surface erosion perspectives.

An adaptive management approach to the salvage and stockpiling of topsoil will be important, since reclamation activities will occur during multiple phases of the Project, as described in Section 24.14.3.2. Parts of stockpiles may therefore remain active for longer periods and thus require additional vigilance in their management.

Monitoring of salvaged and stockpiled soils will form part of HCMC's environmental program and will be complemented by the Project's Sediment and Erosion Control Plan (Section 24.11). Active stockpile sites will be regularly checked for evidence of erosion or slumping, particularly after high rainfall events, until such time as vegetation or other surface control measures have become established and stability and erosion of the substrate are of lesser concern. The frequency of such inspections of works can then be reduced accordingly.

The results of the monitoring program will be used to measure the success of the management strategies and to identify where additional or amended mitigation is necessary. Monitoring results may thus trigger an appropriate adaptive management response.

24.14.4.1 Work Planning and Schedule

To ensure that the planning and scheduling of soil salvage and storage activities is aligned with excavation and cut and fill activities, the Mine Environmental Supervisor will coordinate the scheduling of inspection activities. Any sites determined to require ongoing monitoring will be identified and monitored, as required. It is envisaged that topsoil stockpiles would routinely be inspected by the environmental department to verify their structural integrity and confirm that positive drainage is being maintained.

24.14.5 Reporting

Oversight of soil salvaging and stockpiling operations, inspection reports, implementation, and associated reporting related to this plan will be the responsibility of the Mine Environmental Supervisor or delegate.

Reporting will be included in the annual reclamation report as required by the *Mines Act* (1996b) and 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 BC MEM and will allow for the verification of the effectiveness of the outcomes of the Soil Salvage and Storage Plan.

24.15 SPILL PREVENTION AND RESPONSE PLAN

24.15.1 Purpose

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

This plan will prepare site personnel for response to an accidental spill emergency and will comprise a component of the EMS for the Project, as described in Section 24.1. Note that the information contained in this plan is at a level of detail appropriate for the Application/EIS submission. This plan is a living document that it will be updated and further developed for each phase of the Project.

24.15.2 Performance Objectives

The primary objective of the Spill Prevention and Response Plan is the avoidance of accidental spills in the first place. A management strategy 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 is detailed in the Fuel and Hazardous Materials Management Plan (Section 24.7).

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 and that it will be further refined 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 24.4), the Fuel and Hazardous Materials Management Plan (Section 24.7), and the Waste Management Plan (Section 24.18). An integrated approach will thus be adopted in the application of the various components of environmental management and reporting for the Project.

24.15.3 Environmental Protection Measures

24.15.3.1 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 for all fuels and dangerous or hazardous products storage facilties, with protective barriers where there is potential for impact from vehicles,
  - secondary containment with capacity to accommodate 110% of the largest vessel in the storage area, and
  - separate storage and sump systems for storage areas of incompatible products;
- documented operational procedures and site-specific work instructions 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;
- preventative maintenance of vehicles, equipment, storage containers, etc.;
- regular housekeeping and inspections of facilities to ensure 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.

24.15.3.2 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 applied on an ongoing basis to identify potential high-risk areas and ensure procedures are in place to address these situations.

An analysis of the risks of selected spill types is provided in Table 24.15-1. The list is not comprehensive, but addresses the materials of greatest concern.

Table 24.15-1. Analysis of Risks per Selected Spill Type

Area of Concern	Cause of Spill	Potential Effect	Potentially Impacted Area	Preventive Measures	Available Response Resources
Moderate and High Risk of Occurrence					
Tailing spill	Tailings pipeline failure	Low	Absorbed into soil; uncontrolled entry into Tailings Management Facility	Instrumentation; 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; stringent handling procedures	Site spill kits; 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	Site spill kits; call for assistance
Low Risk of Occurrence					
Large diesel spill	In situ pipeline rupture in or adjacent to open pit workings	Moderate	Absorbed into surface substrate; enter local creeks; human health	Instrumentation; preventive maintenance; visual inspections	Use mining equipment and available trucks to contain and clean up; pumps; 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; Site spill kits; call for assistance

24.15.3.3 Materials-specific Actions

Tailings

Two tailings pipelines will run from the process plant to the TMF, namely for the bulk and cleaner tailings. The bulk tailings stream will consist of approximately 93% of the total tailings stream with cleaner tailings representing the remaining 7%. A tailings pipeline leak or failure would likely result in the discharge being contained within the TMF. While highly unlikely, such a spill may be considered an upset condition and 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; and
- containment channels around sections of the pipeline where practicable.

Petroleum Products

Petroleum products will be stored and used at a number of Project locations. Spills may occur in the following locations:

- on the Project Site at the fuel storage area and anywhere mobile equipment is in use, including the open pit and haul roads, primary crusher, plant site including mill building, truck shop and warehouse, laydown area, construction camp, explosives facility, TMF, and internal roads;
- along the Project access road; and
- at the Rail Load-out Facility.

Site fuel storage 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 (BC MWLAP 2002) *Field Guide to Fuel Handling, Transportation and Storage*. All fuel storage vessels will be double walled or include appropriately lined secondary containment with a sump, and oil/water separators. Tanks and sumps will have high-level alarms. Fuel storage and transfer locations will be equipped with appropriate spill kits.

Fuel transfer procedures will include best management practices to ensure no overtopping of tanks or spillage. In addition, inventories will be tracked as a check on any possible losses. 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. Results of inspections will be kept on file.

All personnel will be instructed to report any spills or accidents to their supervisor immediately. Spills will be reported to the appropriate authorities in accordance with the Spill Reporting Regulation (BC Reg. 263/90). Employees and contractors responsible for transporting or storing petroleum products 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 Fuel and Hazardous Materials Management Plan (Section 24.7) will be followed to minimize the risk of spills of those products. They 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 spilled product and conveniently located material safety data sheets and spill kits will facilitate safe and timely cleanup.

24.15.3.4 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 appropriate in advance of all Project phases. It will be updated and integrated into the Project's Emergency Response Plan (Section 24.5) before construction starts.

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.

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

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 promptly, including government agencies and nearby communities and other potentially affected stakeholders.

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 (see Section 24.4, Emergency

Response Plan), 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 Response

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

- the spill material and source of the spill will be identified;
- 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;
- the responsible Health and Safety representative and the Mine Environmental Supervisor and will be notified;
- if safe to do so:
  - measures will be taken to stop the flow,
  - 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 Health and Safety representative and the Mine Environmental Supervisor 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 water bodies. 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 Mine Environmental Supervisor in coordination with Health and Safety personnel and with external consultants and regulatory authorities, if required.

Statutory Reporting

The Spill Reporting Regulation (BC Reg. 263/90) 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. Table 24.15-2 reflects the reportable quantities, as defined.

Table 24.15-2. Reportable Quantities under the Spill Reporting Regulation

Substance Spilled	Examples	Reportable Spill Quantity
Explosives (Class 1)	Ammonium nitrate/fuel oil, stick powder, emulsions	Any
Flammable gases (Class 2, Div 1), other than natural gas	Propane	10 kg
Non-flammable gases (Class 2, Div 2)	Halon	10 kg
Poisonous gases (Class 2, Div 3)	Aerosols, ammonia, chlorine	5 kg
Corrosive gases (Class 2, Div 4)	Ammonia, chlorine	5 kg
Flammable liquids (Class 3)	Brake or hydraulic fluid, diesel fuel, ethylene glycol, gasoline, paints, solvents	100 L
Waste asbestos	Asbestos	50 kg
Flammable solids (Class 4)	Metal alkyds, aluminium metal	25 kg
Oxidizing substances (Class 5, Div1)	Ammonium nitrate	50 kg
Organic compounds (Class 5, Div 2)	Organic peroxides	1 kg
Poisons (Class 6)	Arsenic, mercury	5 kg
Infectious organisms	Raw sewage	Any
Radioactive materials (Class 7)	Instrumentation in processing	All discharges or a radiation level exceeding 10 mSv/h at package surface and 200 uSv/h at 1 m from the package surface
Products of Class 8	Acids, battery acid, caustic	5 kg
Miscellaneous products (Class 9, Div 1)	Lead, ammonium hydroxide with not more than 10% ammonia	50 kg
Miscellaneous products (Class 9, Div 2)	PCBs, lead compounds, DDT	1 kg
Miscellaneous products (Class 9,Div 3)		5 kg
Waste oil	Waste oil	100 L
Waste containing a pest control product	Pesticides	5 kg
A substance not covered by items in the above categories that can cause pollution		200 kg
Natural gas	Natural gas	10 kg if there is a breakage in a pipeline or fitting operated above 100 psi that results in a sudden and uncontrolled release of natural gas

Sources: Environmental Management Act *(2003), Spill Reporting Regulation (BC Reg 263/90);*
Transportation of Dangerous Goods Act *(1992b), and Transportation of Dangerous Goods Regulations (SOR/2001-286).*

Spill Kits

A key component of spill response is having appropriate equipment and materials readily available to contain and abate a spill in a timely manner. HCMC will maintain an inventory of equipment suitable for spill response, such as earth moving equipment (dozers, graders, backhoes, etc.) and pumps, and will compile spill kits designated for specific areas, with contents selected to manage the potential materials, volumes, and environmental sensitivities of each area. Typical spill kit contents will include oil absorbent pads and 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 will be easily transferable to trailer or truck for rapid deployment to a spill scene or to allow for helicopter delivery. They will be inspected on a regular basis to confirm that they are complete and functional. HCMC will maintain a list of suppliers of specialized spill response services and materials that can be contacted to provide support at short notice.

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 lining 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 blocking inlet and/or outlet;
- using absorbents (e.g., oil pads) for hydrocarbon spills;
- using granular absorbents where appropriate; and
- using emergency response kit.

Specific spill cleanup and disposal procedures will be developed for:

- a tailings spill outside the TMF catchment;
- a fuel spill;
- a reagent spill;
- a concentrate spill; and
- an explosive 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 HCMC's overall Emergency Response Plan (Section 24.4).

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 24.4.3.16 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.

24.15.4 Monitoring

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 24.15.3.1 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 key members of HCMC'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.

24.15.4.1 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.

24.15.5 Reporting

24.15.5.1 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. 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. External reporting will be made to relevant government agencies as required by regulations and licences.

With reference to the statutory reporting of spills in particular, a Spill Report will be completed for all qualifying spills on the Project, as described in Section 24.15.3.4 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.

24.15.5.2 Reporting Responsibilities

The Mine Manager will carry ultimate responsible 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 Emergency Response Plan Coordinator will be a key member of HCMC'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.

24.16 TRAFFIC AND ACCESS MANAGEMENT PLAN

24.16.1 Purpose

The purpose of the Traffic and Access Management Plan for the Project is to ensure that the main access road into the mine site is designed, operated and maintained in such a manner that the safety of road users is maximized and that adverse effects on the environment and wildlife are minimized.

A safe and reliable means of delivering personnel, materials and equipment to the Project Site, and hauling concentrate from the mine to the rail load-out facility, will be required to support the Project. In general, the proposed operational access to the site from Highway 5 is via the Vavenby Bridge Road through Vavenby and across the North Thompson River to the Birch Island-Lost Creek Road (BILCR). From there, access is via an existing network of FSRs including the Vavenby Mountain, Saskum Plateau, and Vavenby-Saskum FSRs. In order to improve access for both construction and mining, the FSRs will be upgraded as required and a new 2.5 km section of road will be constructed on the mine site from the intersection of the Vavenby Mountain and Saskum Plateau FSRs to the plant site area.

24.16.2 Performance Objectives

This Traffic and Access Management Plan is designed to achieve the following performance objectives:

- to upgrade, operate and maintain the Project Site access road so that it is safe for designated uses;
- to minimize wildlife mortality from vehicle collisions related to Project Site access road;
- to ensure that all authorized road users follow stipulated procedures;
- to comply with the Mines Act by controlling access to the Project Site; and
- to minimize adverse effects on fish and fish habitat by complying with guidance for the operation, maintenance, and deactivation of the Project and access roads, particularly at river crossings.

24.16.3 Environmental Protection Measures

24.16.3.1 Design Criteria

The Project Site access road will be upgraded, operated, and maintained with user safety and environmental stability in mind. The access road will be used year round during all phases of the Project to deliver and remove supplies and materials, and to ship concentrates to the rail load-out facility. The supplies will include diesel fuel, mill consumables, mining consumables , and sundry equipment and supplies.

Two-way radios will be used for site communications and a radio control process will be implemented to manage traffic movement as required.

24.16.3.2 Construction

During the upgrading of the existing FSRs that will serve as the Project access road, control over vehicle access by non-Project road users will be exercised, after consultation with the existing tenure holder and BC FLNRO, as required. Additional gates will be installed on other FSRs that enter the Project area, for example Harper Creek FSR and Jones Creek FSR, in order to comply with Mines Act requirements for restricting public access to the active mine area. The locations of the additional gates will be assessed during the Construction Phase.

During the course of construction, oversized loads will require an alternative access across the North Thompson River as the Vavenby Bridge has not been designed to cater for such loads safely. This proposed route crosses the North Thompson River at the BILCR Bridge which has been design for heavier loads.

A gatehouse will be installed during the construction phase at the entrance to the Project site to control and record the access of people to restricted working areas.

Traffic along the Project access road will include trucks hauling fuel and other hazardous materials. 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 23.16) will address accidental spills and road users (HCMC personnel as well as contractors) are expected to be knowledgeable in relevant spill-response techniques and protocols. Spill kits should be available on vehicles transporting dangerous goods or hazardous materials, and mobile spill response kits will be available at the Project plant site.

As far as the protection of fish and fish habitat is concerned, relevant measures referred to in the *Fish-stream Crossing Guidebook* (BC FLNRO, BC MOE, and DFO 2012) will be applied, such as curtailing sediment-release from nearby roadworks and preventing deleterious substances from entering streams.

24.16.3.3 Operation

Access control as described above, i.e. additional gates on other FSRs, and the main access control gatehouse at the Project site, will become permanent features and maintained throughout the operations phase. Similarly, the spill response protection measures described for the construction phase above will be maintained and rigorously applied during the operations phase of the Project.

The Project will not use KP Road to access the rail load-out facility, and it will remain gated. This will avoid difficult traffic conditions at the intersection of KP Road and Highway #5. Appropriate signage on Project site and access roads will also be installed.

24.16.3.4 Closure

Access control to the Project site by means of gates on the main access road and certain FSRs as described for the operations phase above, will be maintained as required during the closure phase. Closure traffic will be similar to construction phase traffic in that it will comprise the transportation of large pieces of equipment and bulk materials, in this case for resale, recycling or disposal off-site. However, the number of vehicle trips will diminish considerably since concentrate will no longer be hauled to the rail load-out facility.

The Project's Spill Prevention and Response Plan (Section 23.16) will also remain in force while closure activities are taking place.

The closure phase will see the demolition and removal of the gatehouse facility, and the decommissioning and rehabilitation of most of the mine site roads. The Project access road will remain intact as an FSR and to provide access to the site Post-Closure.

24.16.3.5 Post-Closure

Access control to the closed mine site will be maintained into the Post-Closure phase, but only until an acceptable level of closure and rehabilitation has been reached and the presence of personnel diminishes to an infrequent level. The envisaged Post-Closure landscape for the site does not include fences and gates.

24.16.4 Monitoring

Monitoring will be implemented to track the effectiveness of the proposed environmental protection measures for traffic and access to the Project site. These will include:

- tracking of road safety incidents to determine trends and to identify areas requiring further mitigation; and
- tracking of unauthorized use of access roads.

24.16.4.1 Work Planning and Schedule

The performance objectives and measures related to access management will be relayed to all Project personnel that have a direct or indirect influence on such management during site orientation and job training. Communication of such training will be recorded.

A notional indication of a monitoring schedule for traffic and access management includes the following:

- routine inspection of all gates leading into the Project, to monitor the measures listed in the previous section and initiate corrective actions as required; and
- routine review of all recorded traffic and access incidents and initiate corrective actions where trends or anomalies are apparent.

24.16.5 Reporting

24.16.5.1 Reports

Routine reporting will be undertaken in a structured manner such that the management of access related incidents and mitigation measures can be accurately tracked.

All reports will be reviewed internally by the responsible line manager, the Mine Environmental Supervisor, Health and Safety Supervisor and the Mine Manager, in order to identify necessary improvements in the monitoring system. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and licences.

24.16.5.2 Reporting Responsibilities

The Health and Safety Supervisor and Mine Environmental Supervisor will be responsible for the monitoring and reporting on access management related incidents and mitigation measures as per their areas of responsibility. Appropriately qualified personnel will be employed throughout the life of the Project to supervise, direct, monitor, and implement the line management actions required by this Traffic and Access Management Plan.

24.17 VEGETATION MANAGEMENT PLAN

24.17.1 Purpose

The purpose of the Vegetation Management Plan (VMP) is to:

- identify mitigation to reduce effects to VCs;
- minimize vegetation loss, disturbance, and loss or alteration of ecological function;
- minimize impacts to listed species at risk pursuant to the *Species at Risk Act* (2002b);
- avoid the introduction and subsequent spread of invasive plant species;
- ensure compliance with regulatory requirements; and
- track environmental performance and evaluate mitigation measures to enable the implementation of adaptive follow-up programs as needed.

This VMP includes measures to avoid impacts on vegetation VCs (rare plants, ECAR, wetlands, and old-growth forests) through detailed design and planning prior to Construction, and measures to minimize and mitigate unavoidable effects identified in Chapter 15. This plan has been developed to complement related plans in the Application such as: Spill Prevention and Response Plan (Section 24.15), Sediment and Erosion Control Plan (Section 24.11), Soil Salvage and Storage Plan (Section 24.14), Site Water Management Plan (Section 24.13), and Air Quality Management Plan (Section 24.2). The plan is designed to be adaptive, effective, and achievable in its implementation in both the short and long-term with monitoring programs forming an essential part of the plan.

24.17.2 Performance Objectives

The objectives of the VMP are to maintain and promote healthy vegetation and ecosystems, as well as to assist in the reclamation of any disturbed sites. To reduce adverse Project effects, three general categories of mitigation will be applied: 1) impact avoidance; 2) impact reduction and technical mitigation; and 3) reclamation.

The objective of avoidance measures is to remove the potential for direct or indirect impacts to the VCs as a result of the Project. This can be achieved through modification of construction and operations methods. Impact avoidance is only possible in certain locations where physical avoidance of VCs is feasible.

The objective of impact reduction and technical mitigation is to reduce the magnitude and severity of Project related effects on the VCs through the targeted modification of construction and operations methods. Impact reduction is restricted to those areas where total avoidance is not feasible.

The objective of reclamation is to restore the landscape to its pre-disturbance condition in order to reduce the magnitude, duration and extent of habitat loss. Specific end land use objectives for the Project are provided in Chapter 7 (Closure and Reclamation).

24.17.2.1 Regulatory requirements

Acts and guidelines that exist that are relevant to this VMP include:

- BC *Mines Act* (1996b);
- BC *Weed Control Act* (1996e);
- *Species at Risk Act* (2002b);
- BC *Environmental Management Act* (2003);
- BC *Integrated Pest Management Act* (BC Hydro 2003);
- BC *Forest and Range Practices Act* (2002a);
- *Canadian Environmental Assessment Act*, 2012 (2012);
- *Fisheries Act* (1985c);
- *Migratory Birds Convention Act* (1994);
- Canada *Wildlife Act* (1985a);
- BC *Wildlife Act* (1996f);
- Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia (Biolinx Environmental Research Ltd and E. Wind Consulting 2003) ;
- Standards and Best Practices for Instream Works (BC MWLAP 2004); and
- Develop with Care (BC MOE 2014c).

24.17.3 Environmental Management Measures

The VMP will be initiated prior to Construction, and carried-out through to Post-Closure. However, the environmental measures applied will vary depending on the Project phase. The majority of the general environmental protection measures will be implemented in Construction and Operations phases, as described below. Activities during the Closure and Post-Closure phase will focus on the reclamation of mine facilities, re-creation of habitat including reclamation of wetlands and deactivation of mine roads, as described in Chapter 7 (Closure and Reclamation). Three types of mitigation are discussed: impact avoidance, impact reduction and technical mitigation, and reclamation.

24.17.3.1 Impact Avoidance

As a part of Project design to date effects on VCs have been avoided through Project design changes as described in Chapter 15, including alteration of footprints to reduce effects to rare plant populations, old-growth forest and wetlands. Additional impact avoidance mitigation proposed for the Project during the final design and Construction phase includes:

- Consideration of known VC occurrences and high-suitability habitat areas adjacent to the development footprint during the final design and Construction phase. Where feasible and practical, Project facilities will be placed so as to avoid direct impacts to these occurrences and habitats.
- Known VC occurrences adjacent to construction and development areas will be clearly flagged in the field and marked on site plans to prevent incidental disturbance from Project activities; signage will be added where appropriate to indicate the boundaries of exclusion areas.
- Construction and operating personnel will be provided with orientation to identify exclusion areas and explanation of the importance of avoiding disturbance in these areas.

24.17.3.2 Impact Reduction and Technical Mitigation

Steps to limit disturbance include limiting activities to already disturbed areas, limiting the amount of vegetation cleared, reducing impacts to soil, and avoiding unnecessary mechanical damage to adjacent trees to reduce the risk of attack by insects or pathogens.

<u>Limit Disturbance to Rare Plants and Ecosystems</u>

Mitigation measures for rare plants and ecosystems include:

- including locations of sensitive areas and exclusion zones on site plans;
- marking of vegetation clearance boundaries in the field to minimize unnecessary disturbance beyond the development area, where practical;
- construction areas will be limited to the narrowest operationally viable width through known areas of rare plant occurrences and ecosystems;
- placement of temporary facilities and additional footprints will be avoided beyond development areas, whereverpractical; and

- buffers around sensitive areas will be applied to limit disturbance outside development areas, where practical.

During Construction and Operations, Project activities will be undertaken while referencing guidance outlined in *Standards and Best Practices for Instream Works* (BC MWLAP 2004) including:

- prevention of the introduction of substances, sediment, debris, or material that could adversely affect a stream;
- removal of temporary materials or structures following completion of Construction;
- design stream crossings to protect against erosion and avoid areas of poor bank stability; and
- ensure uncured or partly cured concrete and similar deleterious substances do not enter waterbodies.

All activities that involve potentially harmful or toxic substances such as oil, fuel, antifreeze, and concrete will consider the provincial best management practice guidebook *Develop with Care* (BC MOE 2014c) and follow approved work practices such as:

- avoid refuelling or servicing equipment within 30 m of surface water;
- prior to initiating construction activities in proximity to any waterbody, the hydraulic, fuel, and lubrication systems of all equipment will be checked to ensure systems are in good condition and free of leaks; and
- biodegradable hydraulic fluids will be considered for machines used for instream works.

Mitigating Dust

The potential for effects of fugitive dust from Construction and Operations on vegetation, including ECARs, wetlands, and rare plant occurrences located adjacent to development areas, will be minimized through the application of mitigation measures as detailed in the Air Quality Management Plan (Section 24.2). If unanticipated impacts on adjacent ECARs, wetlands, and rare plants are detected, adaptive management measures will be implemented as detailed in the plan to further reduce fugitive dust.

Mitigating Altered Hydrology

Construction activities will be designed and carried out in a manner that minimizes impacts to the hydrology of adjacent wetlands (those not directly altered or removed by the Project), particularly where known rare plant occurrences are present. Adequate culverts will be placed under access roads and sedimentation barriers will be used as required. Wetlands along the Project Site power line will be clear-spanned (i.e., no poles erected within the wetland) and vehicles (tracked or wheeled) will avoid wetland areas under the Project Site power line. Further details regarding site water management are provided in the Site Water Management Plan (Section 24.13).

Development of an Invasive Plant Species Management Plan

An invasive plant species management plan will be developed during the permitting process. The objectives of this plan will be to prevent the establishment of invasive plant species, to control and stop the spread of invasive species that do become established, and to maintain healthy, viable, native vegetation communities.

Vegetation Management in the Power Line Right of Way

Vegetation under the power line right of way (ROW) will be maintained in a shrub/herb state to avoid encroaching on the power line's limits of approach. Maintenance will include regular mechanical clearing either using machines (mowers) or by hand (slashing).

Managing Forest Edges

HCMC will conduct windthrow mitigation measures in areas with high windthrow risk. Operational activities will cleanup ongoing windthrow to avoid beetle outbreaks or hazardous fuel conditions.

Re-vegetating Disturbed Areas

The Closure and Reclamation Plan (Chapter 7) outlines the measures to be implemented for the re-vegetation of disturbed areas. Progressive reclamation will be undertaken to achieve the end land use objectives and the associated monitoring for reclamation is described in that chapter. The Soil Salvage and Handling Plan (Section 24.14) identifies the measures to ensure that adequate suitable soil is available for re-vegetation of disturbed areas.

Re-vegetating Listed Ecosystems

One Blue-listed mesic forested site, western red cedar - paper birch / oak fern (*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*) occurs within the LSA, some of which will be lost during construction. Mesic forest growth can be encouraged by maintaining moderately well-drained soils wherever possible, however reclamation of this ecosystem to pre-disturbance conditions is unlikely.

Two wetland-associated Blue-listed forested communities will be affected by Project Construction: lodgepole pine / dwarf blueberry / peat-mosses (*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.) and tufted club-rush / golden star-moss (*Trichophorum cespitosum / Campylium stellatum*). These ecosystems have characteristics similar to that of a wetland and mitigation measures outlined for wetlands (in the following section) will be used. Reclamation planning will consider the potential for re-establishing this type of ecosystem on poorly drained soils on cooler slopes (north facing).

Wetland Reclamation and Enhancement

On-site reclamation and ecosystem re-establishment is the preferred mitigation method for ecosystem loss related to the Project. The goal of creating pocket wetlands on site is to maintain wetland function as it relates to creating clean water sources for wildlife. Approximately 20 ha of wetlands will be created in the Project Site during reclamation; the majority will be created at the topsoil stockpile north of the TMF, as described in Chapter 7 (Closure and Reclamation).

24.17.3.3 Additional Surveys

Additional surveys for Howell's Quillwort and ECAR will be completed in the Northern Monashee Wet Cold Engelmann Spruce – Subalpine Fir variant (ESSFwc2), within the RSA to determine the extent of other occurrences in order to provide a regional perspective on the known occurrences within the Project area.

24.17.4 Monitoring

Monitoring will evaluate the effectiveness of the VMP and establish if efforts to reduce adverse effects from Project Construction are successful. Monitoring of mitigation and management activities described in associated plans in this chapter and Chapter 7 (Closure and Reclamation) will inform adaptive management measures, to ensure continuous improvement of management activities and successful implementation of mitigation measures.

Monitoring goals include: documenting actual effects of the Project on vegetation and ecosystems; ensuring that proposed mitigation measures are implemented and are having the desired outcome; and identifying areas where adaptive management is required. Monitoring may include:

- amount of area disturbed;
- amount of area re-vegetated, and the level of success of the re-vegetation efforts;
- amount of area affected by invasive plants and species type;
- invasive plant species control measures and success; and
- results of reclamation research.

Monitoring will be conducted in the growing season (May to October) during Construction, Operations, and Closure phases including the effectiveness of re-vegetation and invasive species control, and to identify opportunities for improvements through adaptive management. Effectiveness of re-vegetation will include Project Site surveys that will identify areas where healthy plant communities have been maintained and where further re-vegetation is required as per the Closure and Reclamation plan (Chapter 7).

The regional impact of Project Construction on rare plants and ECAR is uncertain, due to the lack of available information on the distribution and abundance of rare plants and ECAR in the region. HCMC will undertake additional surveys in the ESSFwc2 to determine the extent of additional rare plant occurrences and ECAR in similar habitats within the RSA.

Monitoring invasive species presence, spread, and the effectiveness of treatment will occur throughout Construction and Operations. The BC Ministry of Forest and Range's *Invasive Plant Pest Management Plan for the Southern Interior of British Columbia* (BC MOFR 2010) can be used as a guide for data collection, monitoring, and reporting.

Adaptive management strategies will employed as necessary to minimize adverse effects of the Project on vegetation and wetlands.

24.17.5 Reporting

The results of the monitoring programs will be included in annual reclamation report (per section 10.1.4 of the Code; BC Ministry of Energy and Mines 2008). The monitoring report will include:

- summaries of areas disturbed by development activities;
- summaries of areas reclaimed;
- results of reclamation research;
- results of invasive plants surveys;
- summaries of all mitigation carried out over the past year;
- methodologies used;
- monitoring results and discussion;
- evaluation of the effectiveness of the VMP; and
- a detailed photographic inventory.

These annual reports will be used to track the success of the management plans put in place, as well as to guide future projects on how best to be managed.

The Project's Mine Environmental Supervisor will ultimately be responsible for the development, implementation, and monitoring of the VMP. Senior and technical environmental staff and/or consultants may be employed throughout the Construction and Operations phases to supervise, direct, monitor, and implement the management strategies.

24.18 WASTE MANAGEMENT PLAN

24.18.1 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 with the Environmental Policy that the proponent, HCMC, has in place.

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 the approach adopted by HCMC to waste management and outlines strategies that will be used to process the various waste streams to ensure maximum 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. While this plan includes hazardous materials, their non-waste generating use is dealt with in Section 24.7, Fuel and Hazardous Materials Management Plan, and upset conditions in their management are dealt with in Section 24.15, Spill Prevention and Response Plan.

Note that the information contained in this plan is at a level of detail appropriate for the submission of an Application/EIS. This is a living document that will be further developed into a more detailed and specific plan prior to commencement of the various phases of the Project.

24.18.2 Performance Objectives

The performance objectives that underpin 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;
- every waste collection or disposal area has designated and secure areas or containers for disposal of specific waste types;
- appropriate spill kits are available wherever there is a potential for a spill; and
- responsible site workers are trained in spill prevention and spill response.

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.

24.18.3 Environmental Protection Measures

24.18.3.1 Waste Reduction, Reuse, Recycling, and Recovery

This Waste Management Plan focuses on the wise use of resources, which includes the four basic principles of waste management, namely to reduce, reuse, recycle, and recover. Where practical, the potential for each of these methods will be investigated before disposing of waste materials.

<u>Reduction</u>

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. Typical examples of waste reduction measures include:

- product review, selection, and substitution - recyclable/reusable and non-hazardous materials will be 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

Materials brought to the Project Site should be used to the extent practical, and where applicable, reused on the site. Typical 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.

Recycling

A recycling program will be incorporated at the Project for optimum management of waste streams. The program will recycle as many products as practical on site (e.g., salvageable lumber and scrap metal, paper, cardboard, and salvageable parts from vehicles).

Other recyclable materials will be shipped off site to a recycling facility. Typical waste products to be shipped off site for recycling would include:

- used oil filters (oil removed, crushed, and recycled separately);
- lead-acid and alkaline batteries;
- plastic petroleum pails;
- oil-based paints; and
- empty drums.

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.

24.18.3.2 Waste Types

The types of waste that will typically be generated during the Construction, Operations, Closure, and Post-Closure phases of the Project are listed in Table 24.18-1. 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 Section 24.7, Fuel and Hazardous Materials Management Plan.

Table 24.18-1. Typical Domestic, Industrial, Chemical and Hazardous Waste Likely to be Generated at the Harper Creek 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	X
	Building materials and bulk debris	X	X	X	
	Cement	X	X	X	
	Conveyor belts		X	X	
	Fluorescent light ballasts	X	X	X	
	Glass	X	X	X	
	Incinerator ash	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	

Notes: C = Construction, O = Operations, Cl = Closure, PC = Post-Closure

24.18.3.3 Waste Collection and Management Facilities

<u>Construction</u>

A temporary construction camp will be established to accommodate 100 persons during the initial stage of Construction, with further staged expansion to accommodate a peak force of 600 persons sometime in the second year of Construction. This camp will include construction offices, a mine dry, accommodation, a kitchen and dining room, and recreational facilities.

Sewage will be gravity fed to holding tanks that will be periodically emptied by local community services. The putrescible waste from the offices and accommodation will be incinerated and the ash along with solid, non-flammable/non-hazardous materials will be disposed of in a site landfill. Food waste is a prime wildlife attractant and will therefore be incinerated in a timely manner, thus leaving little trace of attractants for wildlife.

The site landfill will be located in an area of suitable substrate to accommodate such a facility. It will be subjected to the required permit approvals and maintained throughout the Operations phase.

Clearly labelled containers will be provided at the construction camp for the different types of materials (e.g., hazardous waste, reusable, and recyclable materials) that need to be disposed of off site. Hazardous waste in particular will be securely stored until it can be transferred to an appropriate off-site disposal facility. The waste materials from the camp will be hauled for processing at a waste disposal or recycling facility off site. The on-site waste management facilities will be subjected to controls that will ensure that they do not serve as attractants for wildlife.

<u>Operations</u>

Waste collection and disposal facilities will not change dramatically as the Project progresses from the Construction to Operations phases. Project waste management facilities will include waste collection areas for recyclable and hazardous wastes. It is planned to install a portable sewage treatment plant (rotating biological contactors or other similar unit) to handle both black and grey water waste. The resultant wastewater, treated to an acceptable quality standard, will be released into the environment via a tile field. Sludge will be removed as required for efficient operation of the plant, and disposed of at on off-site facility.

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 reuse, recycling or removal from the site.

The waste collection areas and sewage effluent/sludge disposal systems will have waste containment and runoff control structures that will prevent escape of untreated waste to the surface or groundwater systems. 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 on-site HCMC staff member who has responsibility for environmental management as a component of their role, henceforth referred to as Mine Environmental Supervisor. The Mine Environmental Supervisor will report to the Mine Manager in this regard. 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.

A salvage yard or laydown area will be set aside for the storage of equipment parts, vehicles, pieces of plant and metal components that are no longer serviceable but not yet depleted or expendable and may be used as spare parts or for general reuse.

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. The waste collection areas will be designed to adequately and safely store a sufficient quantity of waste over a prescribed time limit. Where necessary, the waste collection areas will be covered and/or fenced to prevent attraction of wildlife and to provide protection from the weather. Additionally, hazardous waste disposal facilities will be adequately designed to contain spills.

A waste collection area will typically consist of three parts:

1. Reuse/Recycle Area — This area will contain the items that can be reused or recycled on the site. Non-hazardous 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 reuse/recycle area of the waste collection area. This method will allow personnel to search the reuse/recycle use 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 appropriate facility.
2. 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, oily rags, absorbent pads, hydraulic fluid, and any other hazardous chemicals, will be stored in a bermed containment area labelled according to the WHMIS derived from the *Hazardous Products Act* (1985e) regulations, and the regulations under the *Transportation of Dangerous Goods Act* (1992b). Hazardous waste will not be permitted to accumulate to excessive volumes, but will be shipped off site to avoid crowding.
3. Removal Area — This area will contain waste that will be disposed of at the Project landfill or at an off-site facility. Waste will include domestic and industrial waste that is not hazardous or recyclable.

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 waste and hazardous 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.

24.18.3.4 Procedures for Managing Specific Waste

The waste collection areas 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 24.18-2 shows the typical waste types to be expected at the Project, their treatment strategies, and handling/disposal methods.

Table 24.18-2. Waste Types, Treatment, and Disposal

Type	Treatment	Disposal
Hazardous Waste		
Petroleum Waste Stream		
Used oil	Off-site recycling	Oil storage tank at vehicle maintenance shop
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
Chemical Waste Stream		
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/paint tins	Disposal in landfill	Waste collection areas
Paints	Reuse/off-site recycling	Waste collection areas
Laboratory chemical waste	Disposal in approved facility	Waste collection areas
Process plant reagents	Return to supplier/disposal in approved facility	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		
Inert Solid Waste		
Paper and corrugated cardboard	Reuse/incineration/off-site recycling/landfill	Incinerators/waste collection areas
Plastics	Reuse/recycle/disposal off-site	Waste collection areas
Tires and conveyor belts	Reuse/recycle/disposal off-site	Waste collection areas/tire recycling facilities
Vehicles	Reuse/recycle	Waste collection areas

(continued)

Table 24.18-2. Waste Types, Treatment, and Disposal (completed)

Type	Treatment	Disposal
Scrap metal	Off-site recycling	Waste collection areas
Waste lumber	Recycling/disposal	Waste collection areas/incinerators
Electrical equipment	Recycle	Waste collection areas
<u>*Solid Domestic Waste*</u>		
Food waste	Incineration/landfill	Incinerator/landfill
General camp waste	Incineration/landfill	Incinerator/landfill
<u>*Sewage*</u>		
Sewage	Sewage treatment plants	Project Site tile field
Sewage sludge	Disposal in approved facility	Disposal in approved facility

24.18.3.5 Hazardous Waste

Hazardous waste produced at the Project Sites 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 *Environmental Management Act* (2003) 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 Section 24.7, Fuel and Hazardous Materials Management Plan, 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.

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, where the necessary documentation will be issued.

<u>Petroleum Waste Stream</u>

Petroleum products will be used widely at the Project, including diesel fuel, lubricants and gasoline. There is a potential for these products to enter the waste stream and used oil and solvents, and oily rags and absorbent pads will also be generated. The handling, storage, and spill contingency actions for petroleum products are outlined in Section 24.7, Fuel and Hazardous Materials Management Plan, and Section 24.15, Spill Prevention and Response Plan.

Used Oil

Oil will be used for vehicles, plant and equipment 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 areas with secondary containment areas. Used oil generated during the Construction phase will be collected in barrels in secondary containment areas at the construction camp. The used oil will be reused where possible, such as for fuelling the construction camp incinerator, or disposed of through a waste oil burner when appropriate, otherwise shipped off site to a licensed disposal facility for recycling.

Oil and Fuel Filters

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.

Hydraulic Fluid

Hydraulic fluid that is not reused will be stored in marked drums in secondary containment in the vehicle maintenance areas 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 a negative 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 in 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 adjacent to the vehicle maintenance areas or in 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 high pressure systems will be used as practical 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 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 practical in place of aerosol cans to reduce the amount of waste produced. Aerosol cans that are misdirected into the waste stream can pose a safety concern. Therefore separate waste containers for aerosol can collection will be placed around the mine facilities, and cleaning staff will be alerted to separate aerosol cans that make it into the waste stream. Empty aerosol cans will be disposed of in the landfill.

Paints

When paint cans are completely emptied and dried they will be disposed of in the landfill. Residual paint from latex-based paints will be dried before disposal in the 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 may be generated at the on-site first aid areas where personnel trained to the appropriate levels of first aid competency will be available. This waste will be properly contained in biohazard containers in the first aid areas under the supervision of the first aid staff. The blood- and tissue-contaminated materials, together with other biohazardous waste, will be shipped off site to an approved disposal facility.

24.18.3.6 Non-hazardous Waste

Non-hazardous waste will be produced widely at the Project. 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, and general packaging. Paper waste will be reduced in a number of ways, such as reducing the use of paper, reusing, and recycling. Minimizing the use of paper may 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 may be achieved by such approaches as using shredded paper as packaging material and reusing paper from the recycling bins for notepads. Recycling may be achieved by placing paper recycling boxes in all the buildings where paper will be used. The recycling boxes will be emptied into a crate in the waste collection areas to be shipped off site to a paper recycling facility.

Corrugated Cardboard

Corrugated cardboard waste will be generated mainly from packaging of materials. Cardboard will be collected along with the paper for recycling and will be stored in a crate in a dry location in the waste collection areas to be shipped off site to a paper recycling facility.

Plastics

Plastic waste will mainly be generated from 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 but non-useful plastic types will be collected at waste collection areas for off-site recycling.

Plastics that contained non-hazardous materials and that cannot be recycled 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 will be re-treaded and repaired as many times as safe and feasible. When they are no longer safe to use, they will be reused for different purposes such as for storing material in the parts laydown area, or as impact barriers at road intersections. The tires that are not reused in some way will be sent to a recycling facility, returned to the vendor or disposed of in an approved manner.

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 a recycling facility or disposed of in an approved manner.

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 the site landfill.

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 or disposed of in an approved manner.

Waste Lumber

Waste lumber will be generated during Construction and throughout the Project life from building and maintenance 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. Unuseable pressure-treated lumber will be removed by a licenced waste management company 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 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 with 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. Note that food waste will only be produced on site in volume during the Construction phase, since no accommodation or catering will be provided during the Operations phase.

- <u>Food Waste</u> — Putrescible food waste and packaging from food materials will be incinerated during the Construction phase in a timely manner to minimize the attraction of wildlife. The ash from the incinerator will be transported to the landfill.
- <u>General Camp Waste</u> — 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 during the Construction phase, or disposed of in the site landfill.

Sewage Sludge

Sewage sludge from the rotating biological treatment unit in use during Operations will be disposed of by removal to an off-site facility.

24.18.3.7 Transporting Waste

Reputable 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, and revise the contractual conditions if warranted.

24.18.3.8 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 7, Closure and Reclamation, covers the closure, reclamation, and decommissioning of the Project in detail.

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 waste management facilities at the Project Site, such as the waste collection areas, will be retained to support continuing site maintenance and inspection activities until no longer required, at which time they will be dismantled and removed. Scrap metal will be recycled or 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.

24.18.4 Monitoring

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 by tracking waste type, volume, method of disposal, and location. Tracking of the waste streams by each department will show where changes can be made to further improve the waste management system over the life of the Project.

A monitoring program is thus required to alert management when enforcement is necessary to ensure compliance with the plan and procedures. The Mine Environmental Supervisor or his/her delegate will be responsible for carrying out a monitoring program that will:

- 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.

24.18.4.1 Work Planning and Schedule

The Mine Environmental Supervisor will disseminate the performance objectives and measures related to waste management to all Project personnel that have a direct or indirect influence on such management during the Construction, Operations, Closure, and Post-Closure phases. 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 routinely to the Mine Manager.

Personnel requiring specific training in the management of waste will be identified by HCMC and will receive such training prior to assuming any related responsibility. 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.

Monitoring will be on-going and the frequency of scheduled inspections will be dictated by the relevant policies, plans, and procedures. Monitoring and inspection program findings will be used to alert management when enforcement is necessary to ensure compliance with the plan and procedures.

24.18.5 Reporting

24.18.5.1 Reports

Routine reporting according to a schedule of monitoring inspections will be undertaken in a structured manner such that the management of waste can be accurately tracked. Inspections will cover on-site facilities such as waste collection areas, the landfill, incinerator, and sewage plant, as well as related documentation such as inventories, manifests, and logbooks. As mentioned, the frequency of scheduled inspections will be dictated by the relevant policies, plans, and procedures.

All reports will be reviewed internally by the responsible line manager and the Mine Environmental Supervisor, in order to identify necessary improvements in the monitoring system. Where required, reports will be forwarded to relevant government agencies as stipulated by regulations and licences.

Where emergency or spill incidents occur as a result of upset conditions or non-compliance with this Waste Management Plan, these will be reported per the requirements of Section 24.4, Emergency Response Plan and Section 24.15, Spill Prevention and Response Plan.

24.18.5.2 Reporting Responsibilities

The on-site Mine Environmental Supervisor will be responsible for monitoring and reporting on the management of waste. The Mine Manager will carry line responsibility for ensuring that the performance objectives and protection measures are achieved, and the Mine Environmental Supervisor will report to the Mine Manager in this regard. 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.

24.19 WILDLIFE MANAGEMENT PLAN

24.19.1 Purpose

This Wildlife Management Plan (WMP) has been developed to minimize impacts of the Project on wildlife and wildlife habitat. The WMP is designed to be adaptive, effective, and achievable in both the short- and long-term. Adaptive management should be implemented when an identified threshold is reached or if unanticipated effects are observed. Thresholds for adaptive management are not fixed, they depend on the amount of information available about those VCs, and variability in the data collected. The WMP will be implemented during all Project phases to avoid or minimize impacts to wildlife and to provide direction on additional measures to reduce Project-related effects.

The purpose of the WMP is to:

- protect species at risk pursuant to federal and provincial legislation;
- ensure compliance with regulatory requirements;
- track environmental performance and assess the effectiveness of mitigation measures to enable the development of adaptive follow-up programs as needed; and/or
- verify some of the predictions made during the environmental assessment.

The WMP will be implemented at the start of Construction and will remain in place until the completion of mine Closure and reclamation activities. This plan outlines the mitigation measures that will be used for all wildlife VCs.

24.19.1.1 Regulatory Requirements

Specific federal and provincial legislation, standards, and best practices guidelines that apply to wildlife and wildlife habitat are identified and briefly summarized below. These standards and best practices are guidelines that encourage development to occur in ways that will avoid, limit, or mitigate negative effects. Legislation relevant to this WMP includes:

- the *Species At Risk Act* (2002b), which is intended to "prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened;"
- the *Migratory Birds Convention Act* (1994), which concerns the conservation and protection of migratory birds, prohibits the unauthorized killing, capture, possession, purchasing, selling, or exchanging of migratory birds or their nests. It also prohibits the unauthorized introduction of harmful substances into areas frequented by migratory birds;
- the BC *Wildlife Act* (1996f), which controls the hunting, trapping, possession, purchase, and sale of wildlife as well as allows for the creation of special areas for wildlife management and preservation, within which special prohibitions apply. Section 34 of the *Wildlife Act* protects most vertebrate animals from direct harm and harassment and specifically protects birds, eggs, and occupied nests from possession, molestation, injury, or destruction;

- the BC *Water Act* (1996d), which describes standards for any proposed work in or about streams. The proposed work must include provisions to protect fish and wildlife and must adhere to regulations under part 7 of the BC Water Act Regulation. Under section 44 (3) of the Water Regulation, a change may also be made in and about a stream by a person who holds a permit under section 10 of the *Mines Act* (1996b), without obtaining an Approval or Notification, if the person complies with:
  - Part 11 of the Health, Safety and Reclamation Code for Mines in British Columbia (BC MEMPR 2008),
  - all conditions in the permit respecting changes in and about a stream; and
- the *Forest and Range Practices Act* (2002a), which outlines provisions for Ungulate Winter Ranges (UWRs) for the management of important ungulate habitat, and provisions for Wildlife Habitat Areas (WHAs) to protect important habitat for Identified Wildlife. General wildlife measures do not apply to exploration, development, or production activities authorized for the purpose of subsurface resource exploration, development, or production under the *Mines Act* (1996b).

Examples of best practices and standards that may be used on this Project include:

- Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia (Ovaska et al. 2004);
- Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia (Demarchi, Bently, and Sopuck 2005);
- Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia (BC MOE 2014c);
- Standards and Best Practices for Instream Works (BC MWLAP 2004).

24.19.2 Performance Objectives

The objectives of this WMP are to:

- minimize impacts to wildlife habitat and populations;
- verify the predictions made during the environmental assessment;
- track and evaluate mitigation measures to enable the implementation of adaptive follow-up programs as needed;
- ensure compliance with regulatory requirements; and
- protect species as risk.

24.19.3 Environmental Management Measures

This WMP identifies general environmental protection measures that apply to all wildlife VCs, as well as specific wildlife protection measures to mitigate effects on certain species of wildlife identified as VCs in the effects assessment. The majority of general management and mitigation measures for wildlife have been incorporated into other EMPs within this chapter.

24.19.3.1 General Environmental Protection Measures

The majority of the general environmental protection measures will be implemented in Construction and Operations phases, as described below. Activities during the Closure and Post-Closure phase will focus on the reclamation of mine facilities, re-creation of wildlife habitat including reclamation of wetlands and deactivation of mine roads, as described in Chapter 7 (Closure and Reclamation).

Waste and Wildlife Attractant Management

A Mine Waste and ML/ARD Management Plan (Section 24.9), a Waste Management Plan (Section 24.18), and a Spill Prevention and Response Plan (Section 24.15) will be initiated during Project Construction and continued throughout all Project phases.

Wildlife specific management and mitigation strategies include the following:

- if adverse effects on wildlife are observed associated with use of the TMF or pit areas, adaptive management will be initiated to discourage wildlife from accessing these facilities;
- a logbook will be kept to record observations of toads, deer, moose, caribou, bears, wolverine, and other wildlife in and around Project facilities and activities (including access roads);
- if areas of high wildlife interaction with vehicle traffic or other Project activities are observed, mitigation measures will be employed as appropriate to reduce the potential effects on wildlife due to traffic and other Project activities. Mitigation could include reduced speed limits in that area, reflectors around corners, diversion structures or other methods to reduce the risk of vehicle collisions or other encounters with wildlife.

Sensory Disturbance Management

A Noise Management Plan (Section 24.10) has been developed with the objective to ensure noise levels during all phases of the Project are acceptably low for human receptors, as per human health guidelines (Health Canada 2010), which will ensure noise levels are acceptably low for wildlife receptors as well.

Water Quality and Dust Management

Mitigation measures to protect air quality and water quality will help to decrease the potential risk of adverse effects to wildlife. Mitigation measures to protect air quality are described in the Air Quality Management Plan (Section 24.2). Water quality mitigation and management are described in various management plans including: the Mine Waste and ML/ARD Management Plan (Section 24.9), the Groundwater Management Plan (Section 24.8), the Sediment and Erosion Control Plan (Section 24.11), and the Site Water Management Plan (Section 24.13). A Selenium Management Plan (Section 24.12) will be implemented to decrease the potential for effects to potential ecological receptors.

Human Activity Management

To minimize the potential effect of increased human presence and activity on wildlife and their habitat, the following mitigation will be implemented:

- adherence to safe speed limits to reduce wildlife mortality;
- personnel will be prohibited from hunting or carrying firearms in the Project area;
- Project related activity near identified critical wildlife habitat during sensitive periods will be avoided, where practical; and
- a wildlife component will be included in employee indoctrination and training to ensure their awareness and understanding of the rationale for the recommended wildlife mitigation measures and procedures.

24.19.3.2 Specific Wildlife Protection Measures

Western Toads

Vegetation clearing activities will be avoided in identified breeding ponds from May through August, unless pre-clearing surveys are conducted. If tadpoles or toadlets are observed, these sites will be adaptively managed (e.g., buffer zones or relocation).

Based on current information, the residual effect of western toad habitat loss is considered not significant (moderate) – the effect is not considered significant because it is expected that the amount of habitat lost due to the footprint is an overestimate (see Section 15.4.3.3). To address this uncertainty, HCMC will survey wetland habitat and western toad breeding ponds within the footprint of the TMF and the pit prior to construction activities being conducted. The approximate area of confirmed wetland breeding sites will then be used to ensure an appropriate amount of wetland habitat is created during reclamation or with the creation of "pocket wetlands" during the Construction and/or Operation phases.

Other measures to be implemented include:

- pocket wetlands for toads will be created, as discussed in the Closure and Reclamation Plan (Chapter 7);
- monitoring of pocket wetlands for western toad habitat will be also be undertaken to track the effectiveness of reclamation and support an adaptive management approach; and
- if western toad migrations are observed, mitigation measures will be employed as appropriate to reduce potential traffic mortality.

Migratory Birds

The *Migratory Birds Convention Act* (1994) protects migratory birds, their nests and their eggs from possession, molestation or destruction, protecting the nests of migratory birds while they or their eggs are in the nest. To ensure compliance with the *Migratory Birds Convention Act*, active migratory bird nests will not be disturbed or destroyed during site clearing for infrastructure. Vegetation clearing activities will be scheduled outside of the general breeding bird period (early May to mid-August), unless pre-clearing surveys for nests are conducted. If active nests are observed, these sites will be adaptively managed (e.g., buffer zones or contact the appropriate government agency if the nests should be moved).

Raptors

The BC *Wildlife Act* (1996f) protects raptors, their eggs and active nests from possession, molestation or destruction, and protects the nests of eagles, Ospreys, falcons and raptors year-round. Work will be conducted in compliance with the *Wildlife Act*. If raptor nests are encountered, species-specific buffers will be established around the nest following recommended best management (Demarchi, Bently, and Sopuck 2005), or the appropriate regulators will be consulted regarding potential relocation of nests.

Bats

Buildings will not be demolished during the bat roosting season (May through September) unless pre-clearing surveys confirm that the buildings are not occupied by bats. Surveys will only be conducted in buildings that are scheduled to be moved during the sensitive timing window (May to September), particularly at lower elevations (e.g., old Weyerhaeuser Mill).

Grizzly bears

Bear awareness training will be provided to all Project personnel. Observations of nuisance bears will be reported to the Project Mine Environmental Supervisor, and to the local provincial Conservation Officer when necessary. Work sites should be kept clean and free of waste, including safe and secure storage of food, food waste, and human waste.

24.19.4 Monitoring

On-site monitoring for the Project (e.g., incidental observation, mortality events, and interactions with Project infrastructure) will occur on a regular basis throughout the Construction and Operations phases of the Project. Results from monitoring will identify potential opportunities for adaptive management.

Monitoring of pocket wetlands for western toad habitat will be also be undertaken to track the effectiveness of reclamation and support an adaptive management approach.

The effectiveness of mitigation measures will be monitored by recording:

- incidental observations of wildlife VCs on site (including date, location, species, condition, and behaviour of wildlife observed);
- effectiveness of adaptive management measures, if implemented (including date, location, and type of adaptive management);
- observations of incidents and mortality events, if they occur (including date, location, species, number); and

- interactions of wildlife with Project infrastructure (e.g., waste, TMF, buildings, etc.).

24.19.5 Reporting

The Project's Mine Environmental Supervisor, or his/her delegate (i.e., appropriately trained personnel), will ultimately be responsible for the development, implementation, and monitoring of the WMP. Senior and technical environmental staff, as well as consultants, may be employed throughout the Construction and Operations phases to supervise, direct, monitor, and implement the management strategies.

Individual reports will be prepared by mine staff or specialized consultants on an as needed basis to address specific or general environmental protection measures taken in respect of certain species of wildlife identified as VCs in the effects assessment or in respect of wildlife species generally.

Examples of the type of information that could be incorporated into these reports may include the following:

- summaries of all mitigation tasks carried out over the past year;
- methodologies (e.g., a description of the analyses that were performed, detection limits used, and QA/QC procedures);
- monitoring results and discussion;
- evaluation of the effectiveness of the WMP; and
- assessment of the effectiveness of additional adaptive mitigation measures taken.

REFERENCES

1985a. *Canada Wildlife Act*, RSC. C. C. W-9.

1985b. *Explosives Act*, RSC. C. E-17.

1985c. *Fisheries Act,* RSC. C. F-14.

1985d. *Hazardous Materials Information Review Act,* RSC. C. 24

1985e. *Hazardous Products Act,* RSC. C. H-3.

1992a. *Canadian Environmental Assessment Act,* SC. C. 37.

1992b. *Transportation of Dangerous Goods Act,* 1992, SC. C. 34.

1994. *Migratory Birds Convention Act*, SC. C. C. 22.

1996a. *Heritage Conservation Act,* RSCB, C. 187.

1996b. *Mines Act,* RSBC. C. 293.

1996c. *Motor Vehicle Act*, RSBC. C. 318.

1996d. *Water Act*, RSBC. C. 483.

1996e. *Weed Control Act*, RSBC. C. 487.

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