7. CLOSURE AND RECLAMATION

7.1 INTRODUCTION

This chapter provides a conceptual Closure and Reclamation Plan for the proposed Harper Creek Project (the Project), consistent with the Project's Application Information Requirements (AIR) issued on October 21, 2011 and meets requirements under the BC *Mines Act* Health, Safety, and Reclamation Code (BC MEMPR 2008).

Closure and reclamation planning for the Project will contribute to successful reclamation of the Project footprint at the end of mine life, and proactive considerations of closure needs will reduce changes in Project design, limit the amount of material re-handling, and minimize the environmental effects of the Project. Mine development and operation will incorporate techniques to minimize surficial disturbance and, where possible, progressively reclaim areas affected during the Construction and Operations phases. Stabilizing and rehabilitating surfaces will reduce the potential for degradation of terrestrial, aquatic, and heritage resources due to extended exposure to climatic factors, reducing closure-related capital costs at the cessation of mining activities.

The environmental management and monitoring systems developed for the Project will ensure, to the extent practical, that these resources are sufficiently protected during mine Construction, Operations, Closure, and Post-Closure. Environmental Management Plans (EMPs) are summarized in Chapter 24 of this Application for an Environmental Assessment Certificate /Environmental Impact Statement (Application/EIS). The monitoring programs will be carried out by a qualified technician. The results from the monitoring programs will be used to improve the environmental management systems, as required.

This chapter is organized as follows:

- Section 7.2 of the chapter describes the regulatory framework related to the Closure phase, including reclamation, citing applicable legislation, standards, and guidelines;
- Section 7.3 identifies closure and reclamation objectives;
- Section 7.4 describes the soil handling plan, provides soil information for the Project Site, and describes soil salvage plans and materials balance;
- Sections 7.5 and 7.6 describe the sequenced conceptual plans for reclaiming individual components of the Project (i.e., open pit; tailings management facility [TMF]; Non-PAG waste rock stockpile, PAG low grade ore stockpile; overburden, and topsoil stockpiles; Plant Site; explosives facility; temporary construction camp; sewage and waste management facilities; and a rail load-out facility located on private land owned by Harper Creek Mining Corporation (HCMC) in Vavenby;
- Section 7.7 describes the end land-use objectives to be reached during the Post-Closure phase of the Project (including topography, drainage, vegetation, and land use);

- Section 7.8 provides conceptual information on the anticipated schedule for Closure phase and reclamation activities;
- Section 7.9 describes potential reclamation research plans that will be undertaken during the Operations phases;
- Section 7.10 outlines HCMC's intentions for Closure and reclamation of the Project in the event of premature closure of mining operations;
- Section 7.11 provides an estimate of Closure phase and reclamation costs.
- Section 7.12 identifies Post-Closure activities, including Post-Closure monitoring programs.

7.2 REGULATORY FRAMEWORK

7.2.1 British Columbia *Mines Act* and Health, Safety and Reclamation Code

The *Mines Act* (1996) and the Health, Safety and Reclamation Code for Mines in British Columbia (the Code; BC MEMPR 2008) require mining operations to carry out a program of environmental protection and reclamation to ensure that, upon termination of mining, land, watercourses, and cultural heritage resources will be returned to a safe and environmentally sound state and to an acceptable end land use. The *Mines Act* (1996) and the Code (BC MEMPR 2008) are administered by the British Columbia Ministry of Energy and Mines (BC MEM). The Chief Inspector of Mines has the ultimate legislative authority for all issues pertaining to the *Mines Act* and the Code.

Proponents of mining projects are required to obtain a permit from the Mines and Mineral Resources Division of the BC MEM prior to commencing any work on a mine site, in accordance with section 10 of the *Mines Act* (1996). Section 10.1 of the *Mines Act* (1996) requires that a permit application must include:

> *…a plan outlining the details of the proposed work and a program for the conservation of cultural heritage resources and for the protection and reclamation of the land, watercourses and cultural heritage resources affected by the mine, including the information, particulars and maps established by the regulations or the code.*

The Chief Inspector may require a financial security as a condition of all *Mines Act* (1996) permits (section 10.4 and 10.5) for all, or part of, outstanding costs associated with mine reclamation and the protection of land, watercourses and cultural resources, including Post-Closure commitments. The security held under the *Mines Act (*1996) can also be used to cover the regulatory requirements of legislation, permits, and approvals of other provincial agencies.

The underlying objective of BC's reclamation security policy is to provide reasonable assurance that the provincial government will not have to contribute to the costs of reclamation and environmental protection if a mining company defaults on its obligations. In the case of a company default, the security should allow government to successfully manage the environmental issues at the Project Site, complete any outstanding reclamation requirements, and continue to monitor and maintain the site for as long as is required. In general, the Mines and Mineral Resources Division reviews reclamation security at a Project Site every five years, or whenever significant changes occur at the

mine. The security can increase or decrease depending upon assessed liability at the time and financial factors such as real return bond yields.

7.3 CLOSURE AND RECLAMATION OBJECTIVES

Part 10 of the Code (BC MEMPR 2008) focuses on reclamation and closure. Section 10.7 identifies reclamation standards. Section 10.7.4 (Land Use) indicates that, "The land surface shall be reclaimed to an end land use approved by the chief inspector that considers previous and potential uses." Section 10.7.5 (Capability) indicates that, "Excluding lands that are not to be reclaimed, the average land capability to be achieved on the remaining lands shall not be less than the average that existed prior to mining, unless the land capability is not consistent with the approved end land use." Section 10.7.6 (Long-term Stability) states that, "Land, watercourses and access roads shall be left in a manner that ensures long-term stability."

HCMC's goal is to develop a conceptual Closure and Reclamation Plan for the Project that will meet the requirements of the Code (BC MEMPR 2008) and that will provide assurance to the provincial government that the site will be left in a condition that will limit any future liability to the people of BC.

The Conceptual Closure and Reclamation plan has three end land use objectives.

1. To return landform structure, heterogeneity, and stability in the Project Site to conditions similar to those existing without the Project.
2. To ensure ground and surface water quality and soil conditions provide the necessary conditions for terrestrial and aquatic life, including fish; and
3. To re-establish productive land use that allows for wildlife habitat.

7.3.1 Provision of Stable Landforms

The design of the Project's permanent mine-related landforms, such as the open pit, the TMF, Project Site roads, and waste rock and overburden stockpiles, has been undertaken to ensure long-term stability during mine Operations, after mine Closure, and after reclamation works are complete.

Stable landforms require a stable foundation. Field investigations were undertaken to enable feasibility-level design of the TMF, stockpiles, and the plant site. Geotechnical site investigations comprised geological mapping of the site infrastructure, as well as drilling of facility foundations. Geotechnical site investigations were carried out in 2011 and 2012 (Appendices 7-A and 7-B; Knight Piésold 2011, 2013a, 2013b). Overburden was assessed at mapping sites and recovered from drill holes.

In summary, geotechnical and hydrogeological investigations have included:

- characterization of geomechanical and hydrogeological conditions for slope design in the open pit;
- characterization of geotechnical and hydrogeological foundation conditions at the proposed plant site, primary crusher, TMF, non-PAG waste rock stockpile, and PAG low-grade ore (LGO) stockpile;

- characterization of geotechnical and hydrogeological foundation conditions for seepage control along the tailings embankments;
- site-wide test pitting and road cut geological mapping to locate borrow areas for construction materials;
- overburden assessment at mapping sites and recovery from drill holes;
- installation of long-term groundwater monitoring wells for environmental baseline studies; and
- installation of long-term groundwater monitoring wells for response testing.

7.3.2 Re-establishment of Productive End Land Use

The pre-development land use and conditions form the basis for setting the end land use and capability objectives. The goal is to return the site to a use consistent with the current land uses, where practical. The landforms resulting from the Project will also be designed, where possible, and reclaimed to accommodate the desired end land use objective.

7.3.2.1 Environmental Setting

The Project components range in elevation from a low of approximately 500 masl in the North Thompson River valley, near Vavenby, where the rail load-out facility will be located to a high of 2,025 masl along the southern-most boundary of the Project Site. Within the Project Site, elevations range from a low of approximately 1,600 masl to a high of 2,000 masl.

There are two Biogeoclimatic (BEC) zones in the Project area: the Engelmann Spruce – Subalpine Fir (ESSF) and the Interior Cedar – Hemlock (ICH). Old-growth forests are common but these have been fragmented by road building and associated forest harvesting. The Harper Creek Project Site is located in the ESSF Biogeoclimatic zone. The dominant tree species include Subalpine fir and Engelmann spruce trees with black huckleberry, false azalea, and oval-leaf blueberry in the shrub layer with variation in the wetter and drier parts of the site (Knight Piésold 2013a). The greater part of the existing access road, transmission line, and rail concentrate load-out occur in the ICH BEC zone.

The Project Site provides habitat for a variety of wildlife species. The most common larger mammals include grizzly bears, moose, mountain caribou, and mule deer as well as smaller furbearers such as wolverine. Western toad has been identified at the Project Site and in particular within the TMF. A detailed description of wildlife and wildlife habitat is provided in Chapter 16. An overview of the terrestrial ecosystems, rare plants and vegetation is provided in Chapter 15.

7.3.2.2 Forestry Use

Commercial forestry has been carried out and continues to be active in the Project Site (see Figure 18.4-5 in Chapter 18 Land and Resource Use). Approximately half of the logging to date occurred prior to 1960. Consequently, the remaining forest is fragmented and has been affected by increasing road density (see Appendix 5-E Traffic Impact Assessment). The Project is located within

the Kamloops Forest District and the industry has experienced recent declines due to the mountain pine beetle infestation and other economic influences. There are currently 12 active cut block tenures in the local study area (LSA). These are held by seven different entities. Softwood timber including spruce, fir, pine, and cedar are predominant forest resources in the North Thompson Valley. Currently, three logging contractors based in Clearwater operate 12 to 14 logging trucks. The Canfor Mill is located in Vavenby. It was shut down in July 2009 to undergo a $27-million facility upgrade. The mill re-opened in September 2011, fitted to handle spruce-pine-fir. Additional operational capacity began in January 2012. Tenure A18688-J191 transects the Project Site. The remaining cutblocks transect the LSA buffer zone surrounding the Project's Construction and Operations access road or power line options. All of these cut blocks are directly accessed along the existing Forest Service Roads (FSRs) that will be used by the proposed Project (Figure 18.4-6; Chapter 18, Land and Resource Use).

7.3.2.3 Recreational Use

There are 26 recreation trails in the area managed by Recreational Sites and Trails BC (BC MFLNRO 2013). Trails that overlap the LSA are known as the Foghorn-Harp Snowmobile Trails (see Figure 18.4-14). The abundance of FSRs in the area provides access for backcountry tourism and recreational opportunities.

The proposed Project is located within the Thompson Fish and Wildlife Region 3, which includes several Wildlife Management Units (WMUs). The LSA overlaps with WMU 340 (0.3%), WMU 341 (4%), and WMU 338 (1.7%). According to provincial government sources, the harvesting value in the region is of moderate value relating to the number of active hunters in the area, but of high value given the variety of unique hunting opportunities in a variety of ecosystems. Hunting primarily conducted for subsistence focuses on mule deer, white-tailed deer, and moose species. The average number of combined resident mule deer and white-tailed deer hunters (in WMUs 337, 338, 341, and 342) is about 255 per year, with a yearly average of 88 harvests. For moose, the average number of resident hunters per year is 77, with a yearly average of 7 harvests. However, game numbers have been reported to be lower in recent years due to habitat changes and high predation rates, mostly by wolves. There are no guide outfitting licences within the LSA to support non-resident hunting.

7.3.2.4 End Land Use Objective

The end land use objective is to provide wildlife habitat. The reclamation approaches will with time, result in the development of complex ecosystems and provide habitat for a variety of species of animals and plants currently occurring in the proposed Project Site. The end land use objective of wildlife habitat will also support the recreational uses (e.g., hunting and snowmobiling) occurring in the area.

7.3.3 Protection of Terrestrial and Aquatic Resources

The environmental management and monitoring systems that will be in place at the start of mine construction are designed to minimize the impacts on terrestrial and aquatic resources. Consistent with best management and adaptive management principles, HCMC will ensure that management and monitoring systems are updated, as required. Project personnel will be specifically

assigned to the various phases of the Project to ensure compliance with applicable permits and HCMC's environmental policies.

7.4 SOIL MANAGEMENT PLAN

According to the Code (BC MEMPR 2008), site reclamation must be carried out in areas used for mining. There are multiple facilities that make up the Project, that range in area from less than 0.4 hectares (ha), such as for a water management pond, to greater than 1,100 ha for the TMF. The total area that will be disturbed by the end of the Operations phase will be approximately 1,900 ha. Following the 28 years of mine life for the Project, the majority of the Project Site will be closed, decommissioned, and/or reclaimed. Some facilities, such as the pit, will not be reclaimed, but will be decommissioned. Soil will only be required for those facilities that will be reclaimed. The general goal of reclamation is to restore, where practical, the equivalent land capability so that end land use objectives can be achieved. To this end, planning will include the conservation of soil materials suitable for reclamation purposes in areas disturbed by mining, where feasible. Reclamation efforts will be directed toward the development of appropriate and functional ecosystems. The objective is to salvage sufficient volumes of soil suitable for reclamation purposes in areas to be reclaimed. These efforts will be supported by appropriate soil material handling and re-vegetation strategies.

The following is a description of the soils in the Project Site in terms of their suitability for reclamation, and the plans for soil salvage and storage until they are required for reclamation.

7.4.1 Soil Assessment

Soil baseline field studies per the Canadian System of Soil Classification were conducted to support the Application/EIS. These were undertaken primarily in 2011 and 2012 but baseline work was also carried out in 2008. The goal of the baseline studies was to map and characterize the soils and their associated parent materials that could be affected directly or indirectly by the Project. The baseline studies included the proposed Project Site, the transmission line, and rail load-out facility. The soils have been summarized in the *Harper Creek Project: Terrain and Soils Baseline Report* (ERM Rescan 2014). The soils have been assessed for suitability for reclamation based on a review of this information.

The soils in the Project Site are developed on a wide range of surficial deposits, which include morainal, colluvial, fluvial, glaciofluvial, glaciolacustrine, weathered bedrock, and organic materials (Figure 7.4-1). The most common surficial material is morainal (Table 7.4-1).

The most common soils mapped in the Project Site are well to moderately well drained Humo-Ferric Podzol and Ferro-Humic Podzol great groups (see Plate 7.4-1), which are highly weathered soils reflective of the wet, cool environment. In the Project Site, these soils are sandy to loamy textured and include compact morainal and loose colluvial materials. The soils developed on morainal materials have an average coarse content of 28%. These materials occur on the valley side slopes and the rolling, upper highland areas such as at the Project Site. They are generally suitable for reclamation purposes except where they are gravelly with greater than 50% coarse fragments by volume.

Figure 7.4-1

Land Management Unit Mapping - Harper Creek Project Site

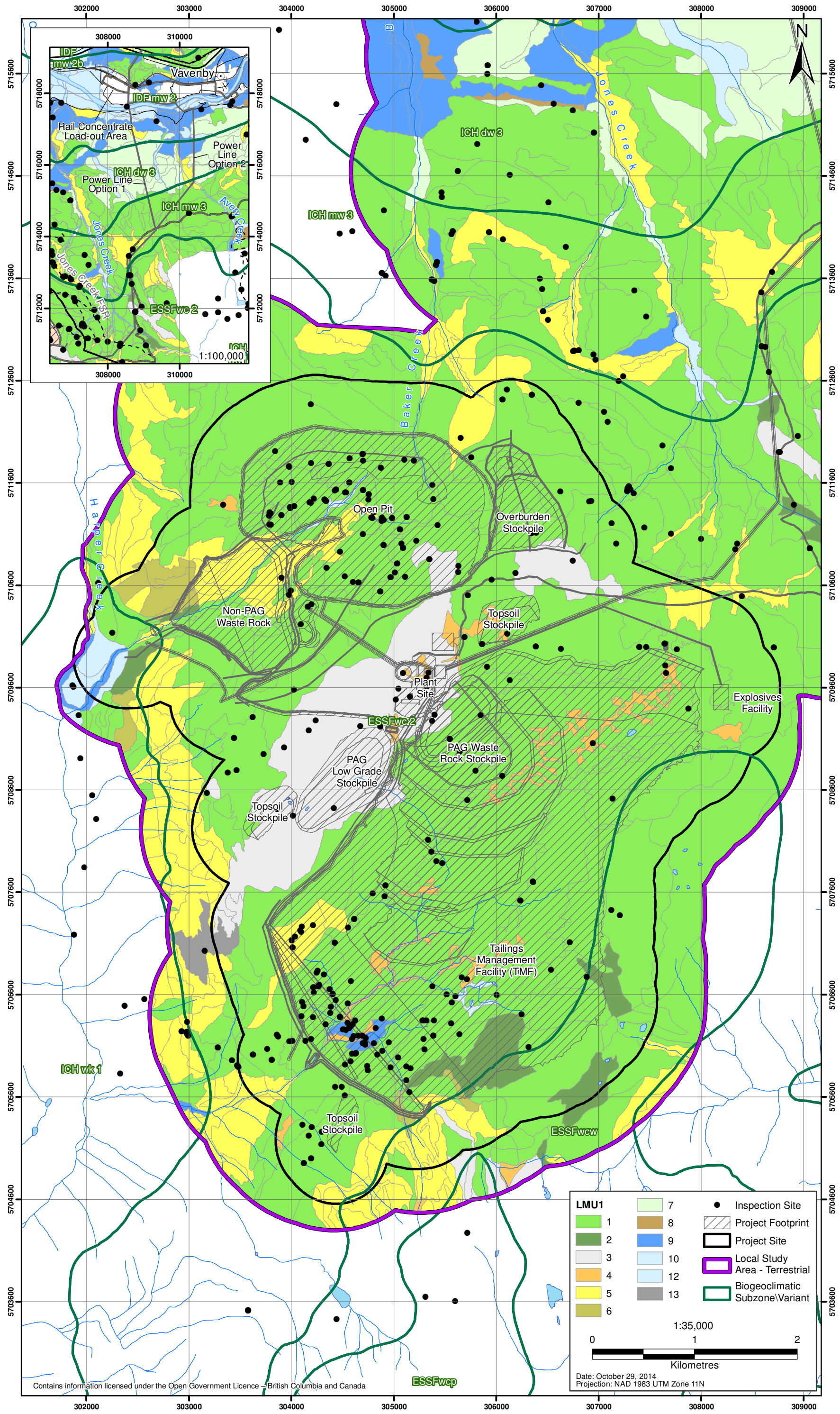


Table 7.4-1. Surficial Materials in the Local Study Area

Land Management Unit	Parent Material	Area (ha)	% of Area
1, 2, 7	Morainal	6,885	62
5, 6	Colluvial	1,155	11
9	Glaciofluvial	1,075	10
11, 12	Fluvial	600	6
3	Weathered rock	580	5
14	Anthropogenic	235	2
4	Organic	200	2
13	Bedrock	110	1
8	Glaciolacustrine	90	1
14	Non-soil	15	<1
15	Water	75	<1
Total		**11,020**	**100**

Gray Luvisols, which are generally fine textured, are developed on gravelly, loamy morainal materials common in the lower elevations and north aspect slopes above the North Thompson River. They are generally suitable for reclamation purposes. Recent, variably gravelly, coarse- to medium-textured, fluvial materials are extensive in the North Thompson River valley bottom plains and terraces. These soils are generally not suited for reclamation purposes as they are very coarse-textured and can be gravelly. Young, weakly developed soils (Orthic Regosols) and Eutric Brunisols (less developed than Podzols) are common in these areas.

Gravelly, sandy glaciofluvial materials occur sporadically within the Project Site at both lower and upper elevations. These soils are generally very coarse-textured and gravelly and have a low suitability for reclamation purposes. Organic soils occur rarely in the Project Site. These are suitable as an organic amendment for mineral soils and improve the organic matter and therefore suitability of the poorer quality soils, such as soils developed on glaciofluvial materials.

Detailed information was collected during the field programs. Soil samples were collected from 32 sites (a total of 54 samples, i.e., some sites with surface and shallow subsurface samples; ERM Rescan 2014). Samples typically represented the surface 15 centimetres (cm; litter and organically enriched surface soils) and a mineral subsoil sample to a depth of 40 cm.

General analytical results of samples of soil (n = 54) and overburden (n = 52) from the Project Site indicate the following:

- soil textures are most often sandy loam but range from silt loam, loam, and loamy sand;
- soil coarse fragment content (particles over 2 millimetres [mm] diameter) averages 28% by volume, though some areas had coarse fragment contents of over 50% by volume;
- soils are non-saline and non-calcareous;

- soil reaction (pH) is generally very strongly acidic to medium acidic (pH ranges 4.4 to 6.7), which is characteristic of the wetter, forested environment;
- overburden is non-saline;
- weathered overburden, near surface (sample range starts within 1.0 m of the surface) is often strongly acidic (median pH 5.4), though ranges to extremely acidic to moderately alkaline; and
- slightly weathered to unweathered overburden (samples from over 1.0 m of the surface) is commonly slightly to moderately calcareous, with a median pH of 7.9 (ranges 6.7 to 9.1, neutral to strongly alkaline).

Based on the analysis of the data collected, the morainal soils have a range of good to fair to poor suitability for reclamation use, primarily depending on texture and coarse fragment content. The colluvial soils may have fair to good suitability for reclamation purposes but may contain a high coarse fragment content in the steeper areas. The glaciofluvial and fluvial soils will have a lower suitability for reclamation use as these soils are inherently coarse-textured and have a low moisture and nutrient holding capacity, which reduce successful plant establishment and growth. The glaciolacustrine soils will have a good suitability for reclamation purposes. The weathered bedrock has low to no suitability for reclamation purposes depending on the coarse fragment content and depth. Soils with coarse fragment content greater than 50% by volume will not be salvaged for reclamation purposes. The organic soils are suitable as an organic amendment. Plates 7.4-1 to 7.4-5 are views of soil development on the surficial materials occurring in the Project Site.

7.4.2 Soils Salvage

The plan is to salvage soils suitable for reclamation where surficial materials will be removed in preparation for the construction of the various facilities. Soils may be salvaged using a variety of equipment (dozers, scrapers, and/or backhoes) under conditions of low soil moisture, typical of the moderately well- or well-drained soils on subdued terrain. Excess soil moisture and/or steeper slope conditions decrease the range of equipment that can be used to achieve adequate separation of surface soil from the subsoil. Backhoes are generally most suited for difficult salvage conditions. Soils will not be salvaged on slopes greater than 50% or 26^{o} due to difficulties using salvage equipment on steep slopes.

Steep slopes that preclude soil salvage generally do not occur in the Project Site (Table 7.4-2; Figure 7.4-2). Soils will not be salvaged over approximately 33 ha in the area of the non-PAG waste rock stockpile due to steep slopes. On the west side of the Project Site, steep slopes occur on colluvial material (Figure 7.4-1). Therefore, no soil salvage will be carried out in this area. As well, soils will not be salvaged where slopes exceed 26^{o}.

Soils will only be salvaged when an area is required for a Project-related activity to reduce exposure of disturbed areas to environmental effects such as erosion. Soils will not be salvaged from the topsoil stockpile footprints. Naturally barren soil will not be considered suitable for reclamation and will not be salvaged.

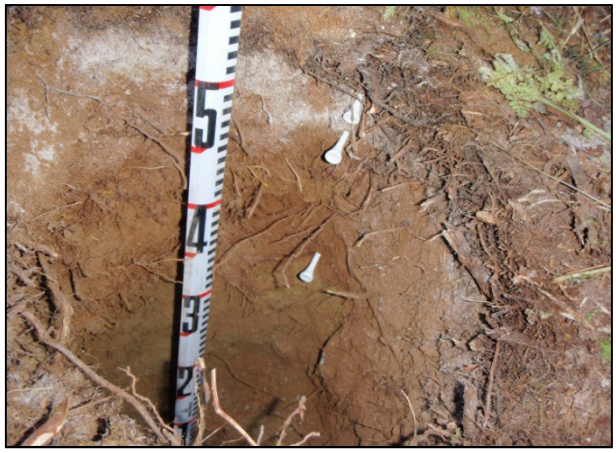


Plate 7.4-1. Soil profile typical of soils developed on morainal material.

Plate 7.4-2. Soil profile typical of soils developed on weathered bedrock.

Plate 7.4-3. Soils developed on colluvial material.

Plate 7.4-4. Soils developed on glaciofluvial material.

Plate 7.4-5. Soils developed on organic material.

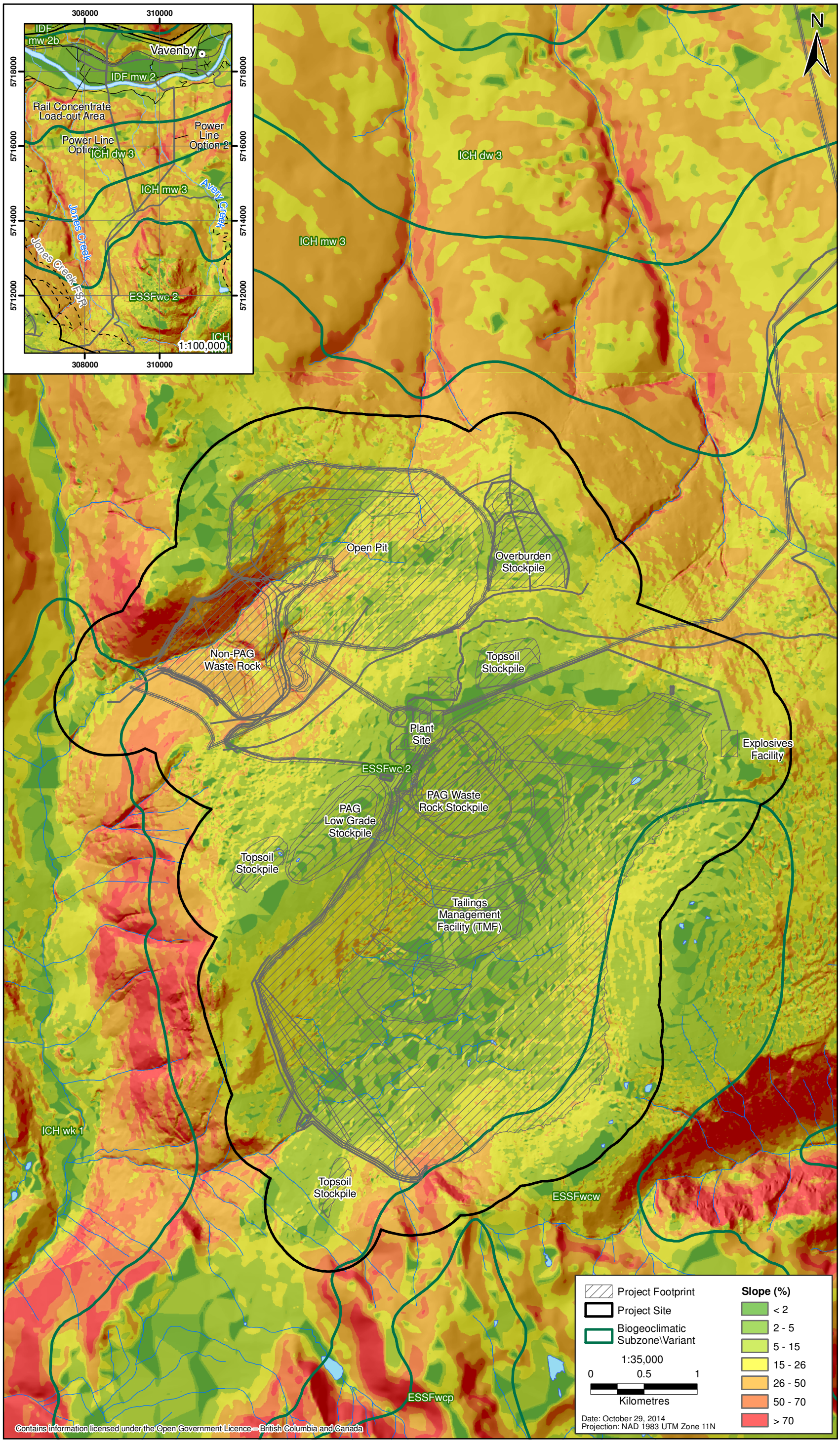
Table 7.4-2. Slopes in the Harper Creek Project Site

Feature	< 26 Degrees		> 26 Degrees		Total
	Area (ha)	Percent	Area (ha)	Percent	
TMF	1,137.8	100	3.6	0	1,141.4
Open pit	310.5	99	4.5	1	315.0
East topsoil stockpile	20.4	100	0.0	0	20.4
West topsoil stockpile	15.5	100	0.0	0	15.5
South topsoil stockpile	8.3	100	0.0	0	8.3
Overburden stockpile	54.2	100	0.0	0	54.2
PAG LGO stockpile	59.8	100	0.0	0	59.8
Non-PAG waste rock stockpile	69.0	68	32.5	32	101.4
Non-PAG LGO stockpile	50.3	100	0.0	0	50.3
Non-PAG waste rock water management pond	1.0	94	0.1	6	1.0
North TMF water management pond	0.3	100	0.0	0	0.3
South TMF water management pond	0.9	100	0.0	0	0.9
Water management pond (PAG LGO stockpile)	0.7	100	0.0	0	0.7
Water management pond (overburden stockpile)	0.5	100	0.0	0	0.5
Explosives facility	3.8	100	0.0	0	3.8
Mine maintenance building	5.7	100	0.0	0	5.7
Processing plant and mill	1.9	100	0.0	0	1.9
Coarse ore stockpile	1.6	100	0.0	0	1.6
Overland conveyor	1.0	99	0.0	1	1.0
Crusher pad	2.2	98	0.0	2	2.2
Plant site	17.4	100	0.0	0	17.4
Rail concentrate load-out facility	0.5	100	0.0	0	0.5
Mine access road	35.6	99	0.3	1	35.9
Project Site roads	43.4	99	0.5	1	43.9
Road access pipe	0.7	95	0.0	5	0.7
Power line - option 1	35.2	98	0.9	2	36.0
Power line - option 2	18.7	96	0.7	4	19.4
Site distribution power line	49.0	97	1.4	3	50.5
Diversion channel	23.8	89	2.8	11	26.7
Reclaim water pipeline	0.4	100	0.0	0	0.4
Tailings delivery pipeline	5.0	96	0.2	4	5.2

Soils will not be salvaged when they are excessively wet, as this will degrade the soil structure. The soils developed on glaciolacustrine materials generally do not occur in the Project Site However, these soils are subject to compaction when wet so extra care will be taken when handling these soils if required.

Figure 7.4-2

Slope Map – Harper Creek Project Site



Equipment used to handle organic soils may be mounted on wide tracks if necessary to accommodate their low load-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.

Once windrowed, excavators will be used to load the soils onto trucks and move the salvaged soil to the designated storage areas. Special management, including using non-standard equipment (wide-tracked or long-armed equipment), may be used where possible particularly in areas of weakly trafficable soils to avoid excessive disturbance and rut formation.

The depth of mineral soils suitable for salvage (Table 7.4-3) has been estimated based on the field data. The surface 30 cm of soil will be salvaged as these soils generally have good moisture and nutrient holding capacities, high fertility and organic matter content, and have good soil structure. Salvage will include the surface litter and root material further increasing the suitability of the soils for reclamation purposes.

Table 7.4-3. Potential Soil Salvage by Infrastructure Area

Facility	Surficial Material	Area (ha)	Area (m^2)	Potential Soil Salvage Depth (cm)	Volume (m^3)
TMF	Morainal	135	1,350,000	30	405,000
	Colluvial	15	150,000	30	45,000
	Weathered bedrock	5	50,000	25	12,500
	Total	**155**			**462,500**
Open pit	Morainal	276.6	2,765,895	25	691,474
	Colluvial	15.8	157,638	25	39,409
	Total	**292.4**			**730,883**
Plant site	Morainal	3.8	38,078	30	11,423
	Weathered bedrock	15	149,511	25	37,378
	Total	**18.8**			**48,801**
Crusher pad	Morainal	2.2	21,743	25	5,436
	Total	**2.2**			**5,436**
Explosives facility	Morainal	3.8	37,500	30	11,250
	Total	**3.8**			**11,250**
PAG low-grade ore stockpile	Morainal	1.8	17,942	30	5,383
	Weathered bedrock	57.8	577,841	25	144,460
	Total	**59.6**			**149,843**
Coarse ore stockpile	Weathered bedrock	1.2	11,837	30	3,551
	Total	**1.2**			**3,551**

(continued)

Table 7.4-3. Potential Soil Salvage by Infrastructure Area (completed)

Facility	Surficial Material	Area (ha)	Area (m^2)	Potential Soil Salvage Depth (cm)	Volume (m^3)
Non-PAG waste rock stockpile	Morainal	88.3	882,813	25	220,703
	Colluvial	15*	150,000	25	37,500
	Weathered bedrock	0.4	3,670	25	917
	Total	**88.7**			**259,120**
Overburden stockpile	Morainal	52.6	526,210	30	184,174
	Weathered bedrock	14.8	148,150	25	37,038
	Total	**67.4**			**221,212**
South TMF water management pond	Morainal	0.9	8,833	30	2,650
	Total	**0.9**			**2,650**
North TMF water management pond	Morainal	0.3	3,484	30	1,045
	Total	**0.3**			**1045.2**
Non-PAG waste rock water management pond	Morainal	0.2	2,006	25	502
	Colluvial	0.8	8,421	25	2,105
	Total				**2,607**
Water management pond (PAG LGO stockpile)	Weathered bedrock	0.2	1,526	25	382
	Total	**0.2**			**382**
Crusher/conveyor	Morainal	0.8	8,036	25	2,009
	Weathered bedrock	0.2	1,783	25	446
	Total	**1**			**2,455**
Project Site roads	Morainal	31.9	319,064	30	95,719
	Colluvial	2.5	24,525	25	6,131
	Weathered bedrock	8	80,447	25	20,112
	Total	**42.4**			**121,962**
TOTAL					**2,023,696**

No soil will be salvaged along the existing access road or at the rail load-out facility, which have been previously disturbed.

Soils are generally not salvaged from the TMF except where required for stability purposes such as under a dam. As can be seen on Figure 7.4-1, the dominant materials under the TMF dams are morainal with some colluvial, and minor weathered bedrock. The upper 30 cm of soils in the TMF will be salvaged from the dam footprint area. Additional soils may be salvaged in the TMF footprint to provide sufficient soils for reclamation if required. An estimated potential salvage area of 155 ha of the TMF has been identified, from which approximately 462,500 m^3 of mineral soils may be salvaged. Approximately 2,023,696 m^3 of topsoil will be salvaged for reclamation purposes.

The soil volumes calculated for the remaining infrastructure are estimates, as less or greater volumes of soil may be salvaged depending on the nature of the soils encountered at the time of stripping and projected reclamation needs. For example, less soil may be salvaged from an area if the soils are excessively gravelly.

7.4.3 Soil Stockpiling

The soil that is salvaged in the Project Site will be stockpiled in three locations (Figure 7.4-2). The deeper overburden removed for construction of the Project will be kept in a separate stockpile.

The stockpiles will be constructed according to standard management practices. They will not be located within a set distance from a waterway (e.g., 10 m) to reduce the potential of sediment entering the waterways. They will be ditched if required. The stockpiles will be constructed in lifts to add stability and reduce the potential of slumping or failure. No large wood or stumps will be included in the stockpiles, as these materials will decompose and potentially cause instability of the pile. All stumps and large wood that will not be salvaged will be windrowed separately or burned on site.

The stockpiles will sloped accordingly to ensure stability. The stockpiles will be vegetated with a native seed grass suited to the area. The re-vegetation of the stockpiles will reduce the potential for surface erosion and support the stability of the stockpiles. The surface of the stockpiles will be loosely constructed to produce a surface roughness that will reduce the potential of downslope erosion and provide a seed bed for the vegetation. The planned native seed mix includes the following:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

The seed mix is suitable for erosion control and will provide surface coverage. The seed will be certified weed free and applied at 40 kilogram (kg)/ha. The stockpiles will be seeded as soon as possible following their establishment to achieve a good and stable vegetative cover as soon as possible. Seeding will occur in the spring or fall. Straw bales and sediment fencing may be required if some erosion occurs. Eroded areas will be retreated as soon as practical. This may include increasing surface roughness and reseeding as soon as practical.

The stockpiles will be monitored for stability, surface erosion, vegetation establishment, and control of invasive species, and sediment release.

7.4.4 Soils Balance

Approximately 711.6 ha of land will be reclaimed for the Project (Table 7.4-4). The depth of soil required for reclamation varies 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 be required.

Table 7.4-4. Soils Required for Reclamation

Facility	Facility Areas (ha)	Areas Requiring Soil (ha)	Required Depth (m)	Topsoil Volume Required (m^3)	Overburden Volume Required (m^3)	Volume Required (m^3)
TMF dam	75.6	75.6	0.3	226,800		226,800
TMF beach	377.9	377.9	0.3	1,133,700		1,133,700
TMF pond	694	0				
Open pit	315	0				
Plant site	21.1	21.1	0.3	63,300		63,300
Crusher pad	2.2	2.2	0.3	6,600		6,600
Explosives facility	3.8	3.8	0.3	11,400		11,400
PAG low-grade ore stockpile	59.8	59.8	0.3	179,400		179,400
Non-PAG low-grade ore stockpile	1	0				
Coarse ore stockpile (at Reclaim)	1.6	1.6	0.5	4,000	4,000	8,000
Non-PAG waste rock stockpile	106.9	106.9	0.5	267,250	267,250	534,500
Overburden stockpile	57.4	57.4	0.3	172,200		172,200
Construction camp	3.6	3.6	0.3	10,800		10,800
South TMF water management pond	0.9	0				
North TMF water management pond	0.3	0				
Non-PAG waste rock water management pond	1	1	0.3	3,000		3,000
Water management pond (PAG LGO ore stockpile)	0.7	0.7	0.3	2,100		2,100
Water management pond (overburden stockpile)	<0.1	<0.1	0.3	150		150
East topsoil stockpile	20.4	0				
West topsoil stockpile	15.5	0				
South topsoil stockpile	8.3	0				
Overland conveyor	1	0				
Project Site roads	39.5	0				
Mine access road	35.8	0				
Total	**1,843**	**711.6**		**2,052,000**	**271,250**	**2,351,950**

In areas requiring a thicker cover such as on the non-PAG waste rock stockpile, the topsoil cover will be 25 cm thick with an additional thickness provided by the stockpiled overburden. Approximately 1,216,000 m^3 of overburden will be required. The overburden will provide a base for the topsoil and sufficient water holding capacity for the plants.

Based on the calculated amounts of soil that may be available for salvage from the footprint areas (Table 7.4-3) and an estimate of the amount of soil required, 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.

7.5 PROGRESSIVE RECLAMATION

Progressive reclamation will be carried out where practical during the Construction and Operations phases. Progressive reclamation reduces the effects of the environment on the disturbed areas, contributes to the achievement of a sustainable ecosystem sooner, and provides an opportunity to test reclamation strategies. Progressive reclamation will be carried out when a disturbed area is no longer required for operational purposes. The following is a description of the progressive reclamation activities that will be carried out for the Project.

7.5.1 General Construction Disturbance

During Construction, ancillary areas may be required for laydown and working areas. These activities may result in the loss of vegetation and the degradation of the surface soils in high traffic areas.

7.5.1.1 Reclamation

Any areas disturbed during construction in excess of operational needs may be reclaimed as soon as the activities are completed. The soils may be compacted if these areas have been subject to high traffic and the soils may require light ripping and grading to reduce surface ponding and to improve surface drainage. These areas can then be seeded with a suitable native seed mix such as the following:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

The seed can be applied at approximately 40 kg/ha. The seed will be certified weed free. Seeding can be carried out in the spring or late fall.

7.5.2 Temporary Construction Camp

A temporary construction camp will be located on the site near the process plant, to accommodate approximately 600 personnel. The camp will include construction offices, a mine dry, accommodation, a kitchen, a dining room, and recreational facilities. Potable water will be supplied from local wells in areas east of the primary mine components, away from the forecasted

groundwater seepage pathways. Sewage will be gravity fed to holding tanks. The putrescible waste from the offices and camps will be incinerated and the ash along with solid, non-flammable/non-hazardous materials will be disposed of in a site landfill.

7.5.2.1 Closure

This camp will be temporary as no accommodation will be required on site during Operations; the workers will live off site. Therefore, as soon as construction of the mine is completed, the camp will be dismantled. Given the proximity of the construction camp to the mine facilities, this area may continue to be used during Operations as a lay-down area or for other purposes such as equipment assembly. However, if not needed, the area will be progressively reclaimed.

7.5.2.2 Reclamation

The proposed temporary construction camp is located in an area that contains a wetland component (see Figure 7.5-1). Wetlands will be lost for the construction of the TMF. Therefore, reclamation of the construction camp may be an opportunity to replace some of the lost wetland (approximately 3.6 ha), as reflected in Chapter 15, Terrestrial Ecology Effects Assessment and as listed in Table 7.7-1, Section 7.7 Post-Closure).

Part of a naturally depressional area will be excavated to a depth sufficient to allow water to accumulate into the excavated area to create a wetland (Figure 7.5-1). The depressional area will be planted with vegetation including willows, transplanted sedges, and other wetland plants growing in the adjacent wetland areas. With time, leaf and plant litter will accumulate in the bottom of the excavated area and the wetland vegetation from the adjacent area and the planted vegetation will increase in complexity and density resulting in a sustainable wetland.

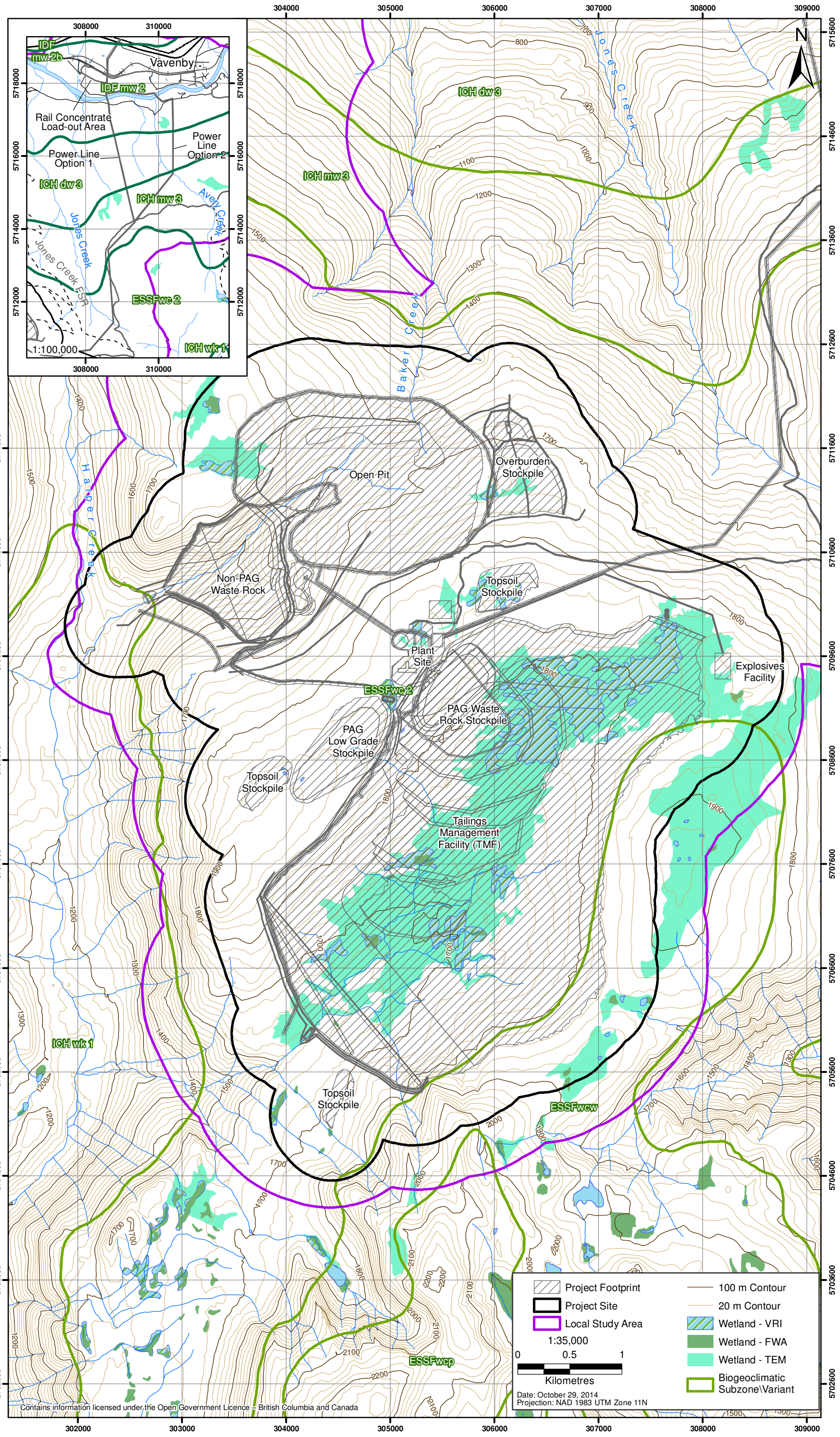
Pocket wetlands may also be created in this area to support western toad habitat, as referred to in Chapter 15, Terrestrial Ecology Effects Assessment. These pocket wetlands are approximately 1 m^2 and 2 m deep. The goal is that they remain wet between April and August to allow the eggs to hatch.

Other parts of the site will be re-vegetated with a native grass mix, some shrubs, and tree seedlings suited to the Project Site. The compacted areas will be ripped to 20 cm to provide surface drainage. The prepared areas can then be re-vegetated. The native seed mix could include fescue (western or red), alpine timothy, blue wildrye, mountain brome and Alaskan (sitka) brome.

The seed can be applied at approximately 40 kg/ha. The seed will be certified weed free. Seeding can be carried out in the spring or late fall. Shrubs will also be planted. They may include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow. The willow, blueberry, and huckleberry will provide important wildlife browse. The tree seedlings will include subalpine fir and hybrid white spruce.

Figure 7.5-1

Wetlands in the Harper Creek Project Site



7.5.3 Tailings Management Facility

The TMF has been designed to provide for secure and permanent storage for 585 million tonnes of tailings and 237 million tonnes of PAG waste rock from the proposed mining operation, and extends over 1, 141.4 ha. The TMF is located in a bowl-shaped basin in the upper reaches of T-Creek, a tributary of Harper Creek. The tributary is classified as non-fish habitat in the vicinity of the TMF and is isolated from migratory fish by a natural fish gradient barrier.

The catchment is hydraulically contained by topography on three sides and will be confined by constructing an earthen dam on the southwest side and a smaller dam on the northeast end of the facility.

The outer shell of the dams will be constructed with random fill consisting of overburden and specific waste rock materials from the open pit. The outer dam face will be benched to increase stability and reduce the potential for downslope water erosion. The surfaces will be compacted across the main fill. The upslope side of the dams will be covered with tailings to form a beach, which will extend around three quarters of the pond.

Mining operations will cease in the open pit in the latter half of Year 24 and the mine will begin processing LGO from the site stockpiles thereafter. The tailings from processing of the LGO will be transported to the open pit, rather than the TMF. Reclaim water will continue to be sourced from the TMF supernatant pond for approximately one year, after which process water will be reclaimed from the open pit supernatant pond.

7.5.3.1 Closure

After cessation of the above activities, a portion of the TMF can be reclaimed; however, it will continue to receive water from the surrounding catchment as well as from the open pit during Post-Closure, which will result in excess water in the TMF. This water will be released to T-Creek through a constructed spillway on the east abutment of the larger dam, subject to meeting water quality standards. At this time, water from the south TMF water management pond will also be released to T-Creek if water quality is suitable for release to the downstream receiving environment. Water quality of the facility will be monitored in accordance with the Fish and Aquatic Effects Monitoring Plan (Chapter 24.6).

The tailings and reclaim water pipelines between the process plant and the TMF will be dismantled and re-installed to carry tailings from the process plant to the pit and reclaim water from the pit to the process plant, and upon closure excess water from the pit to the TMF.

Closure of the TMF will commence following drawdown of the TMF during the initial phase of LGO processing when the pond level is at its lowest point. A spillway will be constructed at the east abutment of the main TMF dam with an invert elevation designed to maintain a minimum water cover over the deposited PAG waste rock and tailings in order to maintain permanent subaqueous storage of this material to prevent the onset of acid rock drainage. Lower beach levels nearer to the pond elevation will be inaccessible due to the high water content and fine nature of the material.

7.5.3.2 Reclamation

The outer dam faces will be reclaimed as soon as practical after the dams are constructed to their final crest elevation. In preparation for reclamation, the surface will be lightly ripped to provide surface roughness to hold the soil cover and some surface drainage. The dam surface will also function as subsoil, which will provide additional moisture-holding capacity for the plants growing on the soil cover. A 30-cm-thick layer of soil will be loosely spread over the roughened surface to reduce downslope soil erosion and provide a seed bed for the plant species. The dam faces will be planted with native grasses and shrubs suited to the site to provide wildlife browse and small mammal habitat.

The native grass mix may include the following:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

Shrubs will include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow.

The rougher (non-PAG) tailings will be the final tailings deposited in the TMF. The upper beaches will be reclaimed to the extent safe and practical by placing a 30-cm layer of soil on top of the tailings sands. The soils will be loosely spread to reduce the potential for compaction. The beaches will be planted with a mixture of grasses, legumes, and shrubs on the upper portions similar to those described above.

7.5.4 Non-PAG Low Grade Ore Stockpile

The smaller of the two non-PAG LGO stockpiles (50.3 ha), which is designed as a short term temporary stockpile, will be processed and progressively reclaimed during Operations I (Years 1 – 5). The larger non-PAG LGO stockpile, located south east of the processing plant and within the TMF limit, will be progressively reclaimed during operations. The majority of which will be from Years 24 – 28..

7.5.4.1 Closure

The stockpile base will be ripped and contoured to provide surface drainage and to prepare the site for reclamation. The base material will be re-limed if required before reclamation is carried out.

7.5.4.2 Reclamation

A 30-cm-thick soil cover will be loosely placed on the prepared surfaces of the stockpile footprint. This area will be seeded with a native seed mix, shrubs, and tree seedlings suited to the area. The native seed mix will be similar to the following:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

Shrubs will include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow. The tree seedlings will include subalpine fir and hybrid white spruce.

7.5.5 Overburden Stockpile

7.5.5.1 Closure

Overburden will be removed from the pit area and if suitable used to construct the various facilities at the Project Site, such as for the construction of the TMF. Excess material will be stockpiled east of the pit and once the overburden stripping is completed, the overburden stockpile can be reclaimed.

The overburden stockpile (54.2 ha) will have suitably designed slopes that will allow for re-vegetation of the pile. The overburden material will have poor soil structure. The surface may have a thin surface crust and be slightly cemented due to exposure of the materials to precipitation. Therefore, a dozer or other equipment may be required to break the surface crust. The rough surface will reduce downslope surface erosion and provide small depressions for seedling catchment and establishment.

7.5.5.2 Reclamation

The overburden will have a low fertility. Therefore, approximately 25 cm of topsoil will be loosely spread on the surface. The soils will be re-vegetated using a native seed mix suited to the site. This mix may include:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

The seed can be applied at approximately 40 kg/ha. The seed will be certified weed free. Seeding can be carried out in the spring or late fall.

Shrubs and trees will also be planted on the overburden stockpile. The shrubs may include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow. The willow, blueberry, and huckleberry will provide important wildlife browse. The tree seedlings will include subalpine fir and hybrid white spruce.

7.6 CLOSURE AND RECLAMATION PLANNING

Most closure and reclamation activities will be carried out during the Closure phase, as most of the facilities will be required and remain active until the end of mine life. This section describes the approaches that will be used to close and reclaim the various Project facilities during the Closure phase. A requirement of the *Mines Act* (1996) permit will be the development of a detailed Closure Plan late in the mine life for approval prior to commencement of Closure and reclamation activities, which will provide current information on mine operations at that time. The Project footprint at Year 28 (Closure) is shown in Figure 7.6-1.

7.6.1 Open Pit

7.6.1.1 Closure

Open pit mining of the Harper Creek deposit will occur over a period of 25 years. The overall pit slope angles at the end of the mine life will vary from 35° to 54°, based on wall orientation and stability. A bench face angle of 65° is assumed for interim pit walls and 70° for final pit walls, reducing to 60° where bench faces are parallel to foliation. The pit extends over 315 ha.

Closure of the pit includes backfilling with tailings and water to form a pit lake. Once the pit has reached an elevation between 1,530 and 1,545 m, excess water will be pumped and released to the TMF. The proposed reclaim barge (floating pump station) located in the TMF during Operations Phase 1 will be moved to the pit during Operations Phase 2. The pit dewatering pipeline will use 16- and 20-inch high-density polyethylene (HDPE) piping to convey the water from the pit to the TMF, as necessary, in order to prevent a discharge from the pit to Jones Creek.

The lowest elevation of the pit wall is expected to be an elevation of 1,555 m, which allows for 10 m of freeboard to manage storm inflows. An emergency spillway on the northern edge (lowest point of the pit rim) will be constructed to prepare for potential high precipitation events.

At Closure, the pit will be bermed to stop inadvertent access to high walls. Pumping of water from the pit to the TMF will continue in the Post-Closure phase.

7.6.2 Non-PAG Waste Rock Stockpile

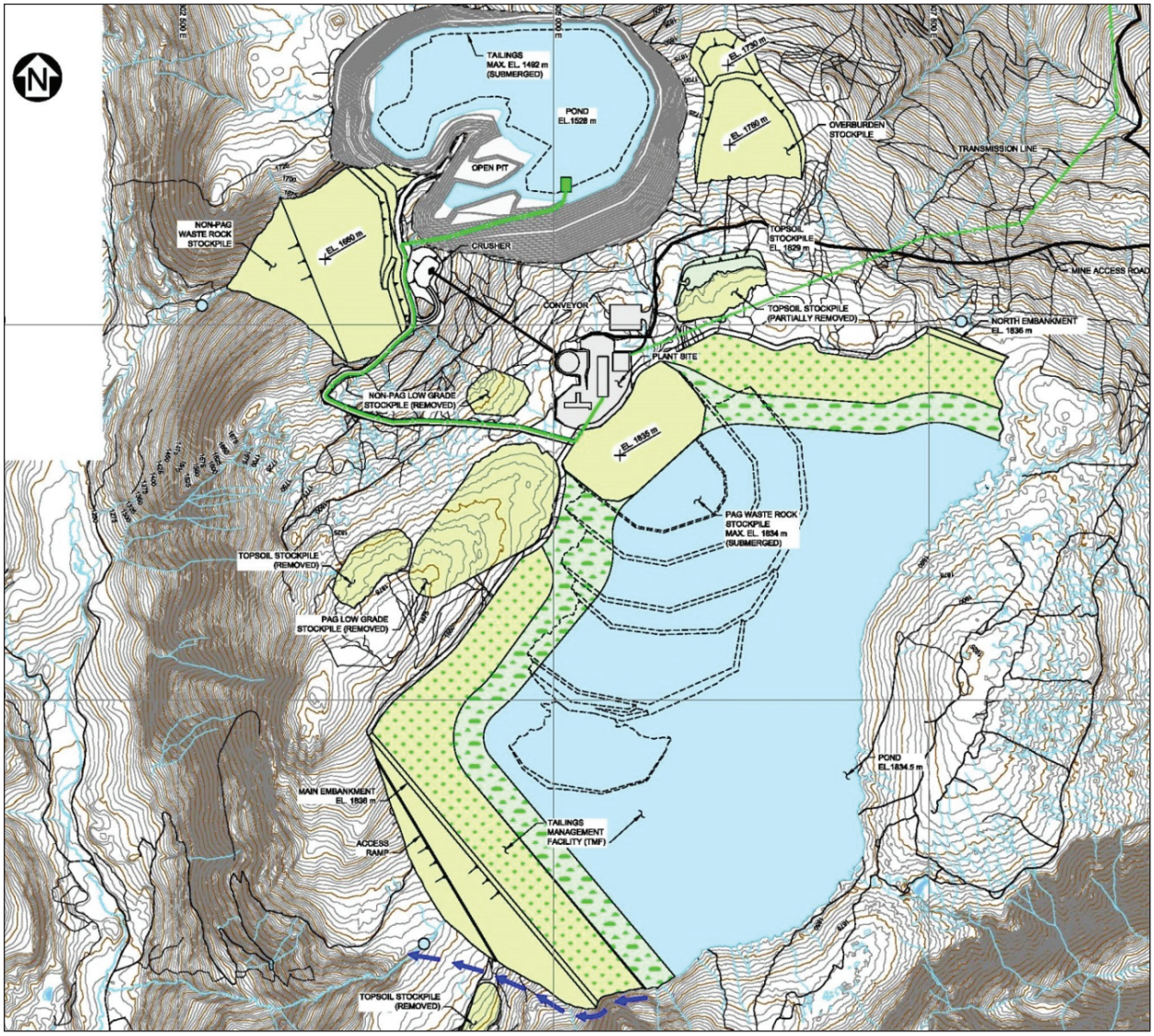
7.6.2.1 Closure

The non-PAG waste rock stockpile (101.4 ha) will have a final slope of 2H:1V, which will allow for reclamation of the pile.

7.6.2.2 Reclamation

The stockpile will be covered with a 25-cm-thick layer of overburden that will be covered with 25 cm of topsoil. This material will be loosely placed to reduce the potential for compaction, to provide surface roughness to reduce downslope water erosion, and to provide depressions for moisture and seed catchment allowing for more successful vegetation establishment. The 50-cm-thick layer will provide sufficient moisture holding capacity for successful re-vegetation establishment and retain enough depth to accommodate some loss of soil in the interstitial spaces in the waste rock pile.

Figure 7.6-1
Project General Arrangement in Year 28 (at Closure)



Source: Knight Piesold 2014

The soil cover will store precipitation and therefore reduce the amount of water entering the waste rock pile. As well, once the vegetation is established, the plants will further take up moisture from the cover, thereby freeing additional storage capacity for precipitation. The leaf surfaces of the plants will also catch precipitation, providing additional evaporative surfaces and further reducing precipitation entering the waste rock pile. The vegetation will also provide stability to the soil cover, thus reducing the potential for surface erosion. The vegetation will provide browse and habitat for small mammals.

The waste rock pile will be seeded with a native seed mix suited to the area such as the following:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

The seed can be applied at approximately 40 kg/ha. The seed will be certified weed free. Seeding can be carried out in the spring or late fall.

Shrubs will also be planted. They may include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow. The willow, blueberry, and huckleberry will provide important wildlife browse.

7.6.3 Low-grade Ore Stockpiles

7.6.3.1 Closure

There will be two LGO stockpiles that will be processed in the final four years of operation (years 24 to 28); one of them contains non-PAG material and one contains PAG material (59.8 ha). The Non-PAG LGO stockpile is located on top of a non-PAG waste rock base in the TMF (Figure 7.6-2). No closure activities are required for the Non-PAG LGO stockpile footprint as it will be flooded at Closure.

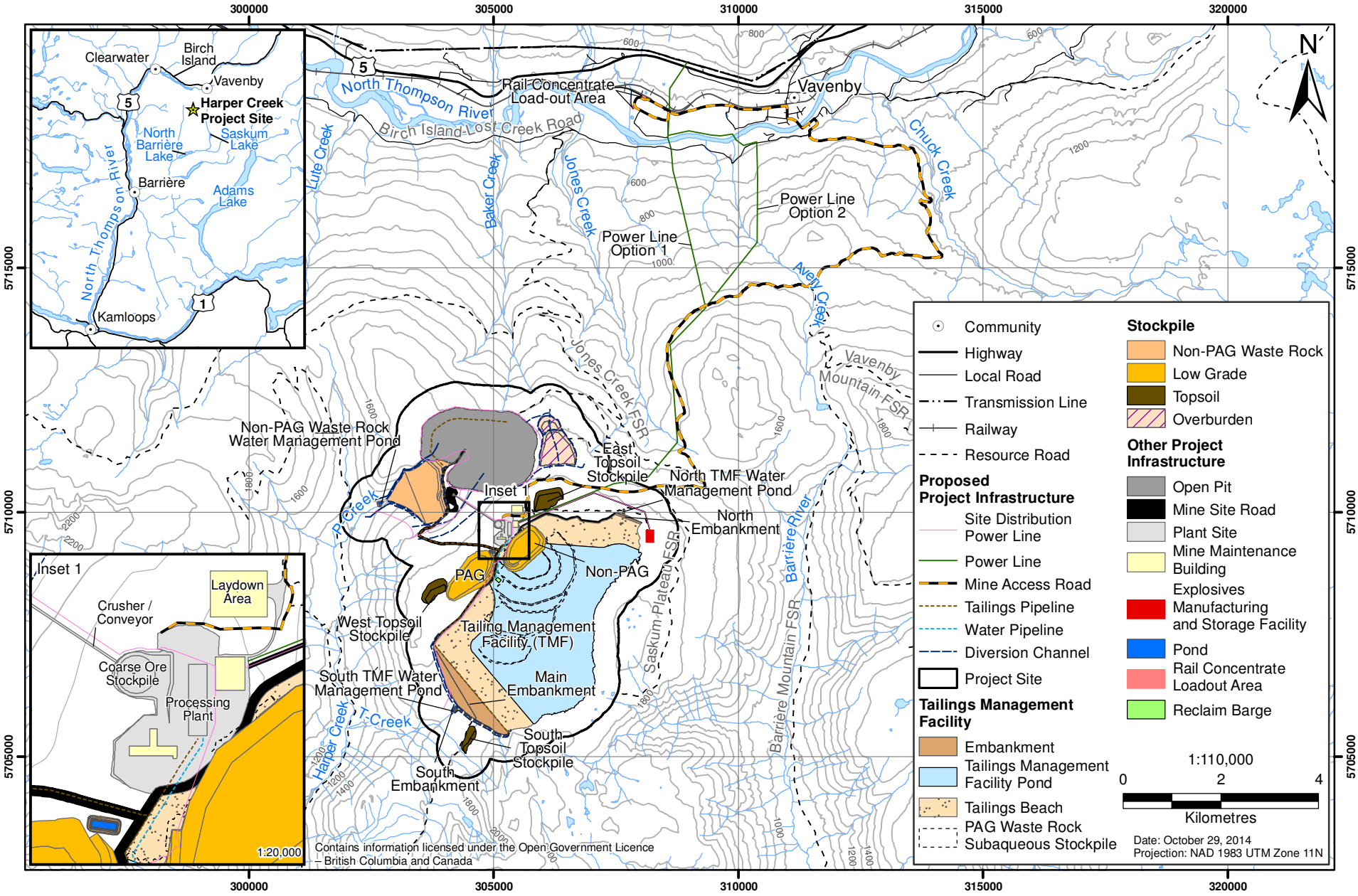
The footprint of the PAG LGO stockpile will be located on a compacted base. The footprint area will be limed to reduce the effects of the remaining PAG ore particles and dust. The base will be ripped and contoured to provide surface drainage in preparation for reclamation. The base material will be re-limed if required before reclamation is carried out.

7.6.3.2 Reclamation

A 30-cm-thick soil cover will be loosely placed on the prepared surfaces of the two LGO stockpile footprints located outside of the TMF. These areas will be seeded with a native seed mix, shrubs, and tree seedlings suited to the area. The native seed mix will be similar to the following:

- fescue (western or red);
- alpine timothy;

Figure 7.6-2
Operations 1 Infrastructure (Year 23)



- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.

Shrubs will include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow. The willow, blueberry, and huckleberry will provide important wildlife browse. The tree seedlings will include subalpine fir and hybrid white spruce.

7.6.4 Topsoil Stockpiles

7.6.4.1 Closure

There will be three main topsoil stockpiles located in the Project Site. The topsoil will be used for reclamation and the footprint will be reclaimed.

7.6.4.2 Reclamation

The east topsoil stockpile site (20.4 ha) located at the north end of the TMF is partially occupied by a wetland (Figure 7.6-3). This wetland will be lost due to construction of the TMF. Therefore, reclamation of this stockpile footprint may be an opportunity to replace some of the lost wetland, as reflected in Chapter 15, Terrestrial Ecology Effects Assessment.

Following recovery of the existing topsoil layer, the existing depressional area will be re-excavated to allow water to accumulate into the excavated area to create a wetland. Approximately 10.2 ha of wetland will be created in the east topsoil stockpile area.

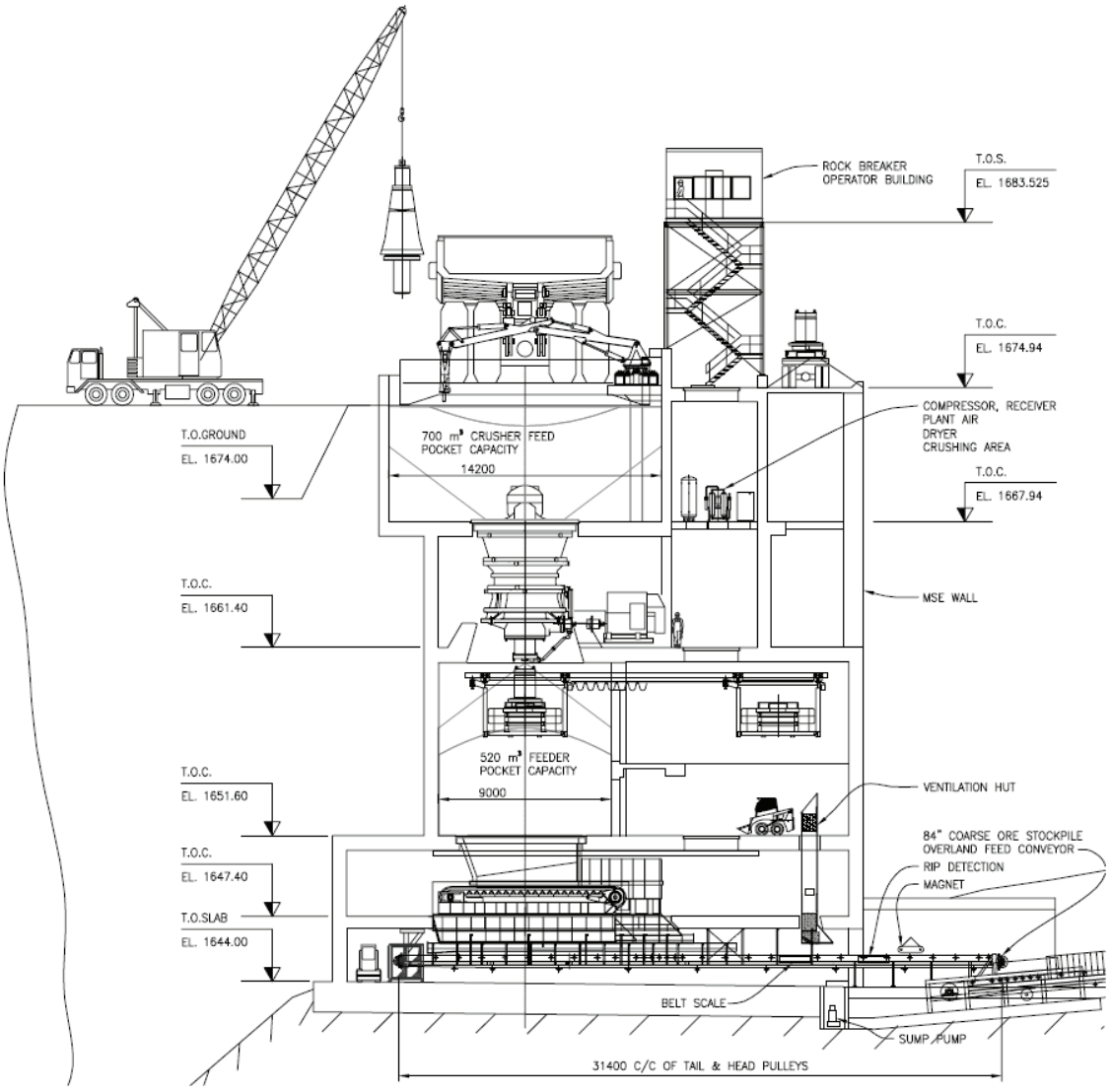
The depressional area will be planted with vegetation including willows, transplanted sedges, and other wetland plants growing in the adjacent wetland areas. With time, leaf and plant litter will accumulate in the bottom of the excavated area and the wetland vegetation from the adjacent area and the planted vegetation will increase in complexity and density to result in a sustainable wetland.

Pocket wetlands created in association with the east stockpile area would support toad habitat, as reflected in Chapter 15, Terrestrial Ecology Effects Assessment. These pocket wetlands would need to be approximately 1 m^2 and 2 m deep and remain wet between April and August to allow the eggs to hatch.

Approximately 10.2 ha of this area will be re-vegetated with a native grass mix, some shrubs, and tree seedling suited to the Project Site to result in a forested ecosystem.

The native seed mix could include:

- fescue (western or red);
- alpine timothy;
- blue wildrye;
- mountain brome; and
- Alaska (Sitka) brome.



Source: Allnorth Consultants Limited, 2011.

The seed can be applied at approximately 40 kg/ha. The seed will be certified weed free. Seeding can be carried out in the spring or late fall.

Shrubs will also be planted. They may include false azalea, *Vaccinium* spp. (blueberry and huckleberry), and willow. The willow, blueberry, and huckleberry will provide important wildlife browse. The tree seedlings will include subalpine fir and hybrid white spruce.

The other two stockpiles areas (total of 23.8 ha) will also be planted with grasses, shrubs, and tree seedlings to develop into a forest ecosystem.

7.6.5 Water Management and Process Plant Ponds

There are seven water management ponds planned for the site. Five of these ponds are designed to manage water from various facilities, including: the PAG LGO stockpile, the temporary non-PAG LGO stockpile, the non-PAG waste rock stockpile, and the north and south TMF dams.

In addition, a water settlement pond is designed to collect water from the heavy vehicle wash and a large process plant pond provides water for processing and milling.

7.6.5.1 Closure

The water management pond for the PAG LGO stockpile (0.7 ha) will be backfilled and reclaimed at Closure as the LGO will be processed and the stockpile footprint will be reclaimed. The pond will be backfilled with the berm material around the pond, which is the native material generated when the pond was excavated. To close the pond, the liner will be perforated so that the pond base will drain. Once the pond is backfilled, it will be reclaimed.

The water management ponds will be closed when water quality meets acceptable water quality standards. The reclamation of the waste rock pile will reduce precipitation entering the pile and as the material is non-PAG, the water quality should improve with time. This pond will also be closed by compromising the liner, by backfilling with berm material, and reclaiming the surface.

Both of the water ponds at the plant site (process plant and heavy vehicle wash bay ponds) will be backfilled and the areas reclaimed during closure (see Section 7.6.9 for more information).

7.6.5.2 Reclamation

For reclamation, a 30-cm layer of soil will be loosely spread over the surface of the backfilled ponds. The areas will then be vegetated with the native seed mixes, shrubs, and tree seedlings as described previously.

7.6.6 Primary Crusher

The primary crusher facility (see Figure 7.6-3) will be located near the pit. The crusher facility will include:

- the crusher;

- a mobile crane;
- a rock breaker operator building;
- a ventilation hut;
- a compressor;
- an electrical room;
- a transformer; and
- conveyors.

7.6.6.1 Closure

At Closure, the crusher will be dismantled and taken off site for disposal or sold. The electrical system will be dismantled and taken off site for recycling or disposal. The oils and lubricants in motors, transformers, sump pumps, and any other equipment will be drained and prepared for off-site disposal in a regulated facility. Once drained of oils and lubricants, the equipment will be taken off site for disposal/recycling. All other structures will be dismantled including the rock breaker operator building, the ventilation hut, and the electrical room. The concrete building foundations will remain. All other materials will be disposed of in a regulated facility. Any wood waste will be burned on site in accordance with the Open Burning Smoke Control Regulation (BC Reg. 4/2010) or disposed of in a landfill.

The conveyor system will be dismantled for reuse or recycling. The belts will be cut and taken off site for recycling or disposed of in a permitted landfill. Once all equipment has been removed the site will then be reclaimed.

7.6.6.2 Reclamation

The crusher pad (2.2 ha) will be limed, if required. The site will be severely compacted and therefore will be ripped and contoured. A 30-cm soil layer will be loosely spread over the surface. The area will then be re-vegetated with the native seed mix, shrubs, and tree seedlings described previously for reclamation purposes.

7.6.7 Overland Conveyor

The overland conveyor from the primary crusher to the coarse ore stockpile at the plant site will be partially located in a trench and partially supported in the air to allow for aerial deposition onto the coarse ore stockpile at the plant site.

7.6.7.1 Closure

During Closure, the conveyor dismantled for reuse or recycling. The belt will be taken off site for recycling or disposed of in a permitted landfill. The frame and supports will be taken off site for recycling. This will include dismantling the drive and take-up tower. Any excavations caused by dismantling the conveyor will be backfilled with the native soil from the excavations which will be bermed along the conveyor trench.

7.6.7.2 Reclamation

A 30-cm soil cover will be applied where necessary and the backfilled trench will be seeded with the native seed mix used for reclamation of the site, as previously described. Any adjacent disturbed areas will also be reseeded with the native seed mix.

7.6.8 Reclaim Facility and Coarse Ore Stockpile

The reclaim facility (Figure 7.6-4) is located below the coarse ore stockpile (1.6 ha) at the plant site. The reclaim system moves the crushed rock from below the stockpile to the mill for further crushing. This infrastructure consists of several components:

- an underground conveyor;
- an escape and ventilation hut;
- three feeder shoots with ancillary equipment (e.g., hoists);
- a SAG mill ball feeder bin; and
- an aboveground conveyor.

7.6.8.1 Closure

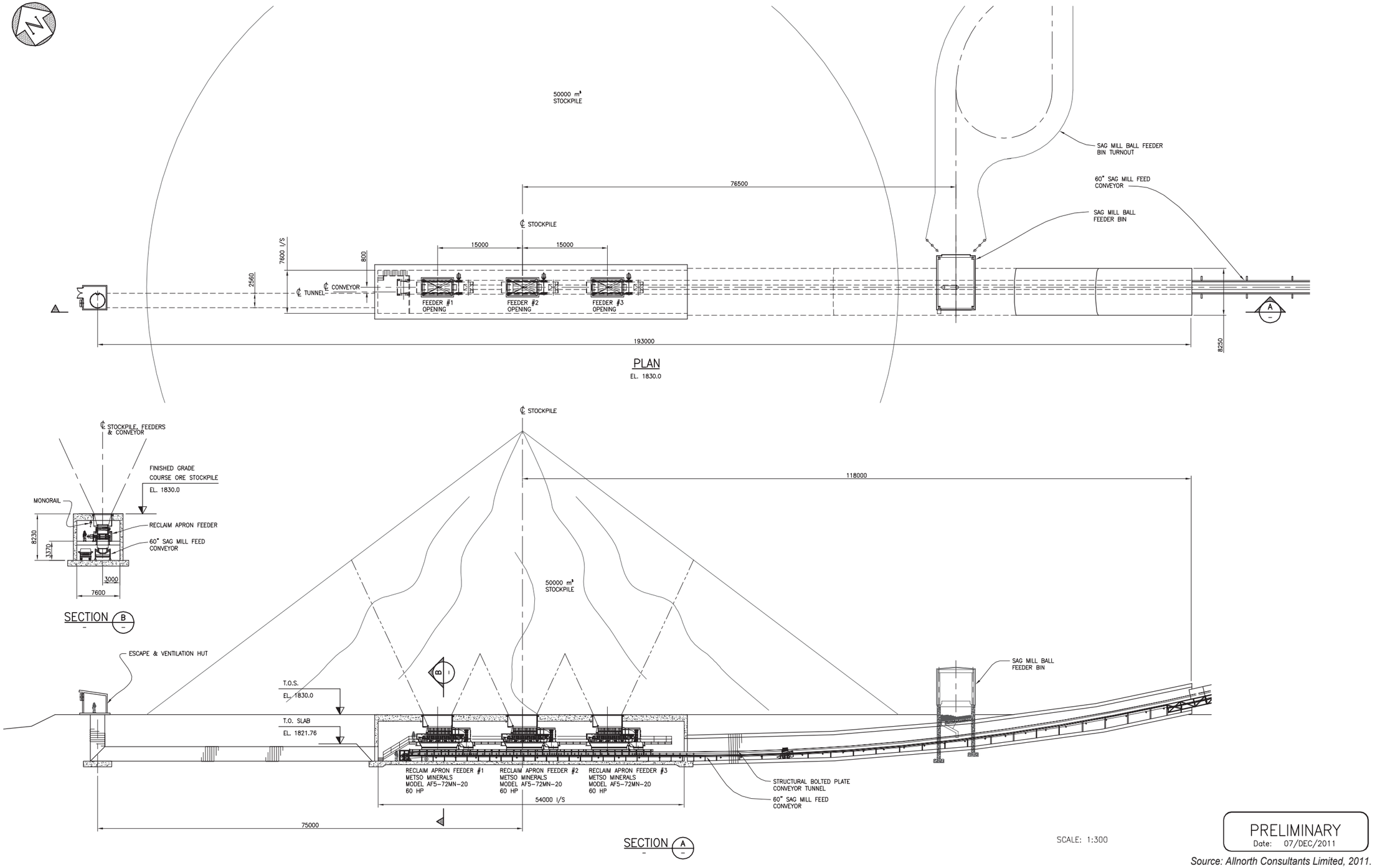
At Closure, all electrical systems will be disconnected. Oils and lubricants will be removed from all motors, condensers, and any other equipment and taken off site for disposal in a regulated facility. All small equipment and supplies will be taken off site for reuse, recycling, or disposal. The escape and ventilation hut and the SAG mill ball feeder bin will be dismantled and taken off site for recycling or disposed of in a permitted landfill. Any wood waste will be burned in accordance with the Open Burning Smoke Control Regulation (BC Reg. 4/2010) or disposed of in a landfill. The below-ground conveyor and its infrastructure and all secured equipment not suitable for recycling will remain underground.

The aboveground portion of the conveyor will be dismantled. The belt will be taken off site for reuse or disposal. The conveyor infrastructure will be dismantled and taken off site for recycling or reuse.

Each feeder shoot opening will have a dimension of 1.8 m by 6.1 m. The frame of the feeder shoots, which will be at ground level, will be left in place. The openings will be closed by backfilling This area will then be backfilled with a minimum of 1 m of overburden to create a small hill over and around the conveyor opening at ground level. Once the openings have been closed the stockpile footprint area, will be reclaimed.

Figure 7.6-4

Coarse Ore Stockpile and Reclaim General Arrangement



Source: Allnorth Consultants Limited, 2011.

7.6.8.2 Reclamation

The ground under the stockpile will be highly compacted. The ground will be ripped and contoured. The soils will be tested for acidity and metals. Soil with elevated metals above applicable levels will be removed to the TMF or open pit, The ground will be limed if required. A 30-cm soil cover will be loosely spread over the surface mounding to 1 m over the concrete structure with an additional 30 cm over the overburden-covered conveyor opening. The soils will be re-vegetated with the native seed mix, shrubs, and tree seedlings, as described in previous sections.

7.6.9 Plant Site

The plant site (Figure 7.6-5) consists of several components, including the following:

- process plant and mill (1.9 ha);
- substation;
- truck shop and parking area;
- warehouse;
- fuel tank farm;
- process water pond;
- sewage treatment plant;
- tailings lines (5 ha);
- reclaim pipeline (0.4 ha); and
- laydown area and landfarm.

At Closure, all of these infrastructure components will be closed as described below.

7.6.9.1 Closure

Process Plant

The process plant will consist of the following operations and equipment:

- primary grinding circuit, including a SAG mill, two ball mills and hydrocyclones;
- copper rougher and scavenger flotation circuit;
- copper cleaner flotation circuit;
- rougher and scavenger concentrate regrinding;
- copper concentrate thickening and filtration circuit;
- assay and metallurgical laboratory; and
- reagent storage.

There is also a loading area. At Closure, all of the equipment will be dismantled and taken off site to be sold or recycled/disposed. Lubricants and oils will be drained from all motors, pumps, condensers, and any other equipment and taken off site for recycling or disposed in a permitted landfill.

Chemical reagents used in the process will include:

- potassium amyl xanthate (PAX);
- lime;
- methyl isobutyl carbinol (MIBC);
- flocculant; and
- anti-scalant.

Reagent solutions will be stored in separate holding tanks. Reagent inventories will be depleted in anticipation of Closure. Tanks will be cleaned and taken off site to be sold or recycled. Reagents will be taken off site to be returned to the supplier or disposed of according to regulatory requirements.

The electrical wiring in the building, insulation, etc. will be removed. Once the building has been emptied, it will be dismantled and the demolition materials will be taken off site for reuse or recycling or disposed of in a permitted landfill. The concrete foundation will be broken up and left in place. Any construction wood will be disposed of in a landfill.

Substation

The substation will be dismantled at Closure. All oils and lubricants will be removed from the equipment and will be taken off site to be disposed of in a regulated facility. The transformers will be drained of oils and will be taken off site for resale or recycling. The equipment will be removed from the site to be sold or recycled. Any below-ground wires and cables will be removed.

Warehouse and Truck Shop

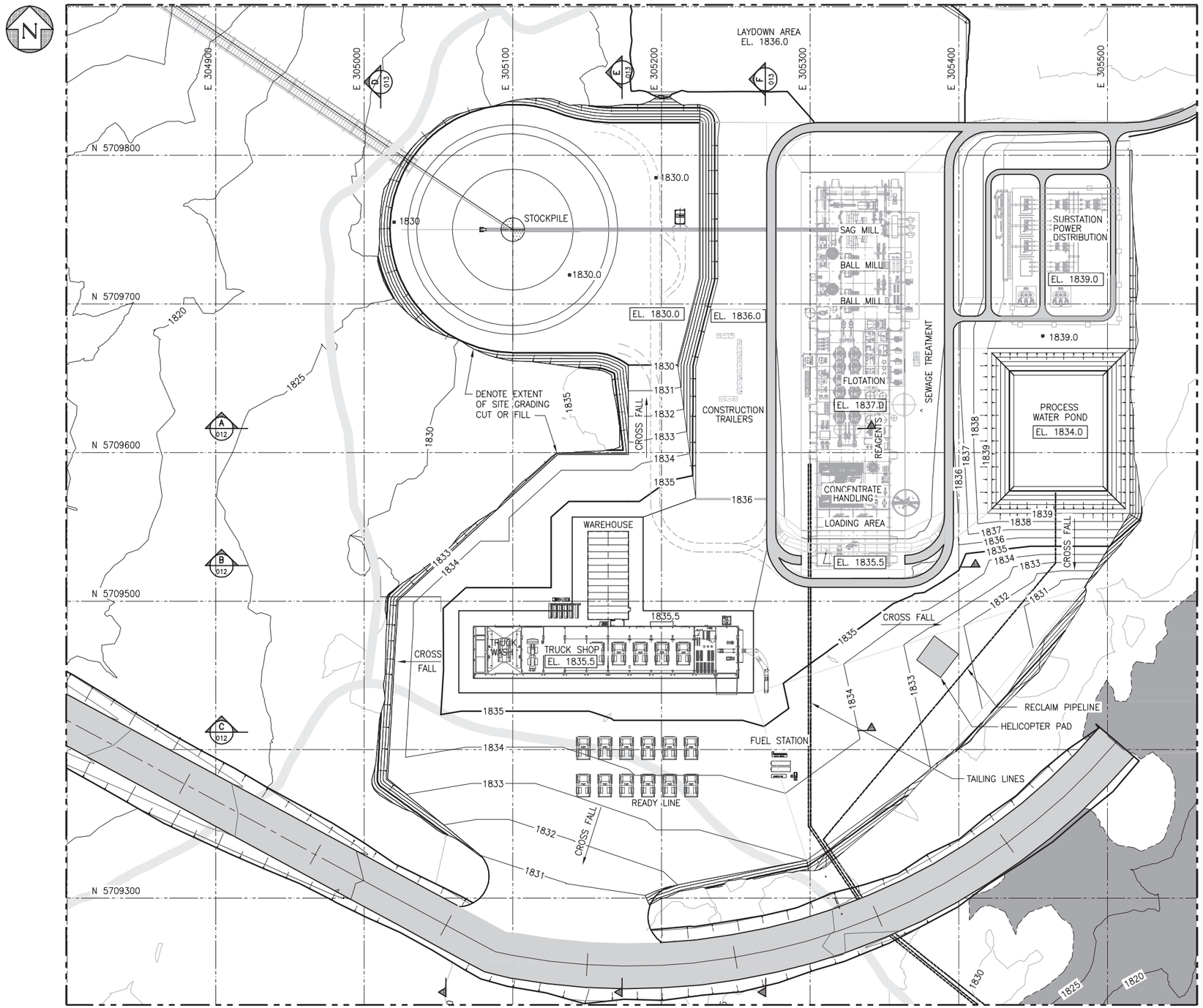
The truck shop will be a stand-alone pre-engineered steel building with insulated roof and walls. The building will have a footprint of about 7,000 m^2 and will include six bays for heavy equipment, two welding bays, a wash bay complete with pressure washer and pond, shop warehouse, light vehicle shop, mine wet/dry, 50-/15-t bridge crane and engineering offices.

A warehouse will be contained within a stressed fabric building near the truck maintenance shop and connected via a passageway. It will be approximately 59 m by 27 m and will be used for storage of parts and materials needed for mine and plant operations.

At Closure, all tools and small equipment will be taken off site for reuse/resale. Oil, grease, and lubricants will be drained from the equipment and placed with other waste oils for removal from the site and recycling at a designated facility. The potable water system will be drained, dismantled, and taken off site for resale or disposal. Wiring and cables will be removed from the building and taken to a designated facility off site. The crane will be taken off site for resale or reuse once it is no longer needed on site. Wood materials such as benches or supports will be disposed of in a landfill. The interior metal structures such as shelving will be dismantled and taken off site for resale or metal recycling. The pressure washer will be taken off site for reuse or disposal.

Figure 7.6-5

Harper Creek Plant Site



PLANT SITE – PLAN

SCALE 1:1750

NOTES:

1. COORDINATES ARE RELATIVE TO UTM NAD83 ZONE 10N
2. LIDAR MAP TOPOGRAPHY SUPPLIED BY KNIGHT PIESOLD LTD.
3. ELEVATIONS ARE IN METRES.

PRELIMINARY
Date: 07/DEC/2011

Source: Allnorth Consultants Limited, 2011.

The metal structure, including the walls and roof, will be dismantled and taken off site for metal recycling. Any insulation or other non-burnable waste will be disposed of in a designated landfill. The concrete flooring will be broken up and left in place. Any exposed rebar will be taken off site for metal recycling.

Fuel Storage

Diesel fuel for the mining, process, and ancillary facilities will be supplied from a diesel fuel storage facility, consisting of four aboveground 75,000-litre-capacity diesel fuel storage tanks suitable for four days of on-site usage, together with the necessary loading and dispensing equipment. The facility will be located near the truck shop and will include a gasoline storage tank. Fuel tanks will be installed in suitable lined containments at site.

Fuel inventories will be depleted in anticipation of Closure. At Closure, any fuel remaining in the tanks will be removed off site for recycling or use by others. The tanks will be cleaned. The tanks and attached equipment will be removed off site for reuse or will be recycled. The gravel over HDPE liners will be removed and stored in an adjacent area. Any spilled fuels on the liners will be mopped with fuel absorbent pads and the pads will be incinerated. The liners will be taken off site for disposal and the gravel will then be re-spread over the surface. Any materials affected by hydrocarbon spillage will be excavated and treated at the on-site landfarm or removed off site for treatment at an appropriate facility. As activity on site is anticipated to continue Post-Closure, some fuel storage capacity is expected to be maintained. A decision on capacity requirements will be made at the time of Closure.

Process Water Pond

The process water pond will be closed when processing is completed. Process water will be drained and disposed of in the TMF and the pond will be backfilled with the bermed material. The liner will be breached to allow the pond to drain and to ensure water does not accumulate in the base of the pond. Sediment in the bottom of the pond will be tested for metals. If the sediment is high in metals, it will be taken to the TMF for disposal. If the sediment is not removed it will be tested for acidity and will be limed if required before the pond is backfilled.

Sewage Treatment Plant

The sewage treatment plant will be dismantled and taken off site. Any pipes associated with the plant will be removed and taken off site.

Miscellaneous Structures

The site landfill will be located in an area of suitable substrate and will be subjected to the required permit approvals. The landfill will be established during the Construction phase and will be maintained during the Operations phase, at a reduced level of service. At Closure the landfill will be covered and re-vegetated in accordance with the permit requirements.

Any other small structures in the plant site area used for temporary or small storage will also be emptied of materials and dismantled. The demolition materials will be taken off site for recycling or disposed in a permitted landfill.

Pipelines

The tailings will be transported from the plant to the TMF by aboveground pipelines. The bulk tailings pipeline will consist of 32- to 36-inch piping. The cleaner tailings pipeline will consist of 14-inch DR17 HDPE pipe. Reclaim water will be carried by aboveground pipes from the TMF to the process water pond. The reclaim water pipeline will consist of 30-inch DR11 HDPE and a 30-inch carbon steel pipe. At Closure, the pipelines and their infrastructure will be dismantled and taken off site for reuse or disposal except for pipelines necessary for Post-Closure, such as for transporting water from the open pit to the TMF.

7.6.9.2 Reclamation

Once all facilities, equipment, and miscellaneous material have been removed, the plant site will be reclaimed. The plant site ground area will be compacted and the surface will have areas of gravel and broken concrete from the building foundations. The compacted ground, including the gravelled areas, will be ripped and contoured to improve surface drainage. Once the site is prepared, approximately 30 cm of soils will be loosely spread over the surface, including over the broken concrete.

The plant site area will then be re-vegetated with the native grass species, shrubs, and tree seedlings previously described to reclaim the other parts of the Project Site. With time, the vegetation community will become more complex as native plants growing in the adjacent areas gradually move into the reclaimed areas.

Some surface disturbance may occur while dismantling the pipelines. Some re-grading may be required where this occurs. Once this is completed, the disturbed areas will be re-vegetated with the native seed mix as described above.

7.6.10 Water Management Pipelines

The water management pipelines will send surface runoff and infiltration from the stockpiles to be recycled using dedicated pump stations. The water management pipelines will be the following nominal diameters, materials, and lengths:

- non-PAG waste rock stockpile – 20-inch diameter HDPE DR11 and 4,200-m long;
- non-PAG LGO stockpile – 12-inch diameter HDPE DR11 and 2,100-m long; and
- PAG LGO stockpile – 12-inch diameter HDPE DR11 and 650-m long.

7.6.10.1 Closure

Once the LGO stockpiles have been removed and the sites reclaimed, the pipelines will not be required. Therefore, these pipelines and their support infrastructure will be dismantled and the pipes and support infrastructure will be taken off site for reuse or recycling or they will be used where required on site such as for pit dewatering, if suitable.

The pumps will be drained of oils and lubricants and taken off site for disposal or used for another purpose on site.

7.6.10.2 Reclamation

Some surface disturbance may occur while dismantling the pipelines. Where this occurs, some re-grading may be required. Once this is completed, the disturbed areas will be re-vegetated with the native seed mix as described previously.

7.6.11 Explosives Manufacturing Facility

An explosives manufacturing facility will be set up on site. This will require a bulk ammonium nitrate emulsion plant. Ammonium nitrate fuel oil will be used in the process. The ammonium nitrate prill will be unloaded pneumatically into the storage silo adjacent to the main building. From there it will be transferred into stainless-steel heating tanks in the manufacturing plant to produce ammonium nitrate solution (ANS). Off-loaded ANS will be unloaded into a storage tank.

Diesel fuel will be used in the manufacture of the emulsion-based explosive. It will be stored in a diesel fuel storage tank and will likely be re-supplied by tanker truck from the central fuel farm of the mine.

A surfactant is required in the process. The material will be trucked to site in B-train tankers and pneumatically unloaded into a 35,000-litre storage tank located inside the manufacturing plant. Sodium nitrate and ethylene glycol are required for the emulsion production process and will be stored in a separate building in the compound.

The manufacturing process will also require clean water, to be sourced from the site water distribution system. The truck storage / wash bay facility in the compound will have a sump and evaporation system for collecting wash water and wastes. The resulting residue will either be recycled into the manufacturing process or disposed of on site. A sump in the building will collect any water for eventual emulsion/oil/water separation and disposal.

Boosters and detonators will be stored in two separate magazines, located away from the explosives plant.

7.6.11.1 Closure

At Closure, all surfactant, oils, fuels, and chemicals will be drained from equipment and will be taken off site and disposed of in a regulated facility. The diesel storage tanks will be drained and cleaned. The tanks and outside attachments such as pumps, hoses, and outside valves will be taken off site for reuse or recycling. All storage silos and storage tanks will be emptied, cleaned, dismantled, and taken off site. All other equipment, including heating tanks and pipes, will be disconnected and taken off site. Other materials/equipment such as the boosters and detonators will be taken off site according to regulations. Wiring and transformers will be removed from the site and will be reused or recycled. The buildings will be removed and the demolition materials will be taken off site for disposal or recycling. The concrete foundations will be broken up and the concrete rubble will be left in place.

All contaminated soils that are not treated at the on-site landfarm will be taken off site for disposal at a regulated facility. The gate and fence around the explosives manufacturing compound will be dismantled and sent off site for recycling or reuse or used on site.

7.6.11.2 Reclamation

Similar to the topsoil stockpile area, some wetland (3.8 ha) may be developed in the depressional areas of the site. A large wetland (Figure 7.5-1) extends north from the TMF and it may be feasible to develop additional wetland in the explosives site area to connect with this wetland, as referred to in Chapter 15, Terrestrial Ecology Effects Assessment. This would require some excavation of the site.

Some parts of the site will not be conducive to wetland development. In these areas, the site will be re-vegetated with the native seed, shrubs, and tree seedlings. Prior to reclamation, the site will need to be prepared. The areas around the buildings and surrounding parking areas will be compacted as a result of the use of the site. In preparation for reclamation, the surface will be ripped and contoured to increase drainage. Approximately 30 cm of soil will be loosely spread over the area as ripped ground surface will provide additional rooting depth and soil water storage capacity for vegetation establishment and growth. Approximately 30 cm of soils will be loosely spread over the broken concrete area and the site will be re-vegetated.

7.6.12 Rail Load-out Facility

HCMC intends to build a rail load-out facility (0.5 ha) for the Project at the abandoned sawmill property on private land, which was previously disturbed and is currently considered to be an industrial area. The rail load-out facility is connected to McCorvie Road, an existing road suitable for the intended truck traffic. The off-site storage and shipment facility for the copper concentrate will consist of a 36 m by 38 m building with a raised dumping area for concentrate trucks and bunker walls to contain the concentrate.

When the site is no longer required; the building will be dismantled or sold. If it is dismantled, all materials will be removed from the site and disposed of at a regulated facility.

7.6.13 Power Line

Power will be required on site during the Post-Closure phase. As a result, the power line will continue to be maintained and will not be de-commissioned, although the power supply voltage may be reduced.

7.6.14 Mine Access Road

The main access road to the Project Site is a short 24 km length, existing Forest Service Road. Some upgrades to this road will be required for stability purposes, particularly around tight bends, over stream crossings, and steep hills. Mitigation and management of the access road during the Construction phase will be implemented through a number of Environmental Management Plans, including through the Traffic and Access Management Plan (Section 24.16), the Sediment and Erosion Control Plan (Section 24.11), and the Spill Prevention and Response Plan (Section 24.15). As a secondary user of the road, HCMC will negotiate maintenance costs with other users. A small (2.5 km)

section of new road will be constructed from the intersection of the Saskum Plateau FSR and the Vavenby-Saskum FSR to the Project Site. During the Closure and Post-Closure phases, the access road will be needed to transport materials and provide access to the Project Site for mine personnel.

7.6.15 Summary of Closure Activities

To summarize the Closure activities, all buildings and structures including the rail load-out facility will be removed and 868 ha (44%) of the Project Site will be reclaimed. This includes the footprints of the PAG LGO stockpile, the non-PAG waste rock stockpile, plant site, and overburden and topsoil stockpiles. The pit will be filled with water and excess water will be pumped to the TMF. The TMF dam faces and beaches will be reclaimed.

The site roads and the power line will be required for ongoing monitoring of the TMF, the pit lake, and reclaimed areas of the Project Site.

7.7 POST-CLOSURE PHASE

As described above, the Post-Closure objectives for the Project are to return the Project footprint and impacted areas to conditions similar to those existing prior to the Project, including productivity, landscape heterogeneity, and land use. This includes ensuring constructed landforms are stable (see Chapter 5, Section 5.4 Terrain and Landforms), that the quality of groundwater (Chapter 11) and surface water (Chapter 13) and soil (Appendix 5-B Terrain and Soils Baseline Report) provide adequate habitat conditions to support aquatic resources (Chapter 14), terrestrial ecology (Chapter 15) and wildlife (Chapter 16), and that regional land use (Chapter 18) activities allowed under the Kamloops Land Resource Management Plan (LRMP) e.g., commercial forestry, may continue to occur in the area of the Project.

To effectively develop a wildlife habitat reclamation strategy for the Project during both Closure and Post-Closure, performance objectives for creating wildlife habitat (e.g., target wildlife species, plant and soil conditions) are identified.

As already described, wildlife habitat will be restored by re-vegetating selected areas with native species suited to the Project Site that will provide browse and shelter for ungulates. Monitoring and an adaptive management approach will be used to determine if habitat reclamation objectives are being met.

7.7.1 Post-Closure End Land Use Objectives

The Closure and Reclamation Plan will result in areas vegetated with native grasses, shrubs, and trees to create a partially forested ecosystem that will support summer ungulate range for feeding, rearing, and shelter, specifically for moose and mule deer. This includes wetlands and the creation of Western toad habitat in specific locations on the site. The complexity of the vegetation will increase with time and result in a sustainable ecosystem, which would be expected to also support other species such as furbearers.

As previously described, the Project Site is located in the Engelmann Spruce-Subalpine Fir (ESSF) Biogeoclimatic zone. The dominant tree species include subalpine fir and Engelmann spruce trees with black huckleberry, false azalea, and oval-leaf blueberry in the shrub layer, with variation in the wetter and drier parts of the site (Knight Piésold 2013a). The vegetation at Post-Closure is based on the species that are currently on the site and the planting of these species will result in a faster return

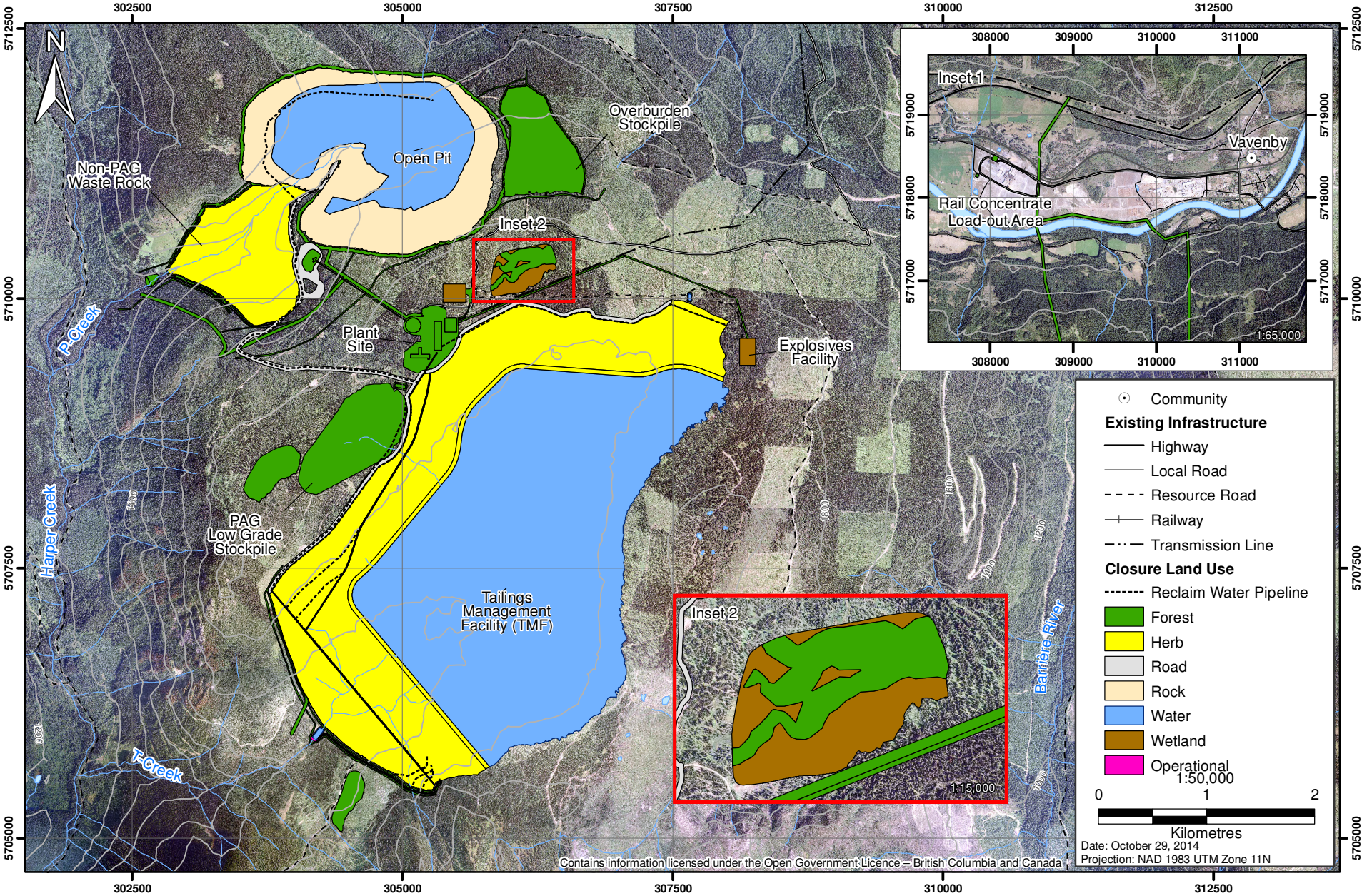
of the site to its previous condition. As the vegetation becomes more mature, the ecosystem complexity will increase because of the effects of wind and wildlife entering the reclaimed areas and carrying seeds from the adjacent areas. As well, as the organic matter in the soil increases due to vegetation establishment and maturity, some plant species will dominate in some areas and others in different areas. As the trees become taller, they will provide more shade and affect soil moisture and moderate microclimate temperatures, which will allow for a more complex ecosystem.

The development of wildlife habitat will also provide the opportunity for hunting, trapping, and recreational activities, by Aboriginal groups and the public. The Post-Closure landscape for each Project component has been determined by the nature of the existing landforms and site conditions (Table 7.7-1; Figure 7.7-1).

Table 7.7-1. Post-Closure Landscape

Project Component Description	Project		Land Use
	ha	%	
Open Pit Rock Area	161.0	8	Rock
Pit Lake	154.1	8	Water
TMF Dam Faces	75.6	4	Grass/shrubs
TMF Beach	377.9	19	Grass/shrubs
TMF Pond	694.0	35	Water
Non-PAG waste rock stockpile footprint	106.9	5	Grass/shrubs
PAG LGO stockpile footprint	59.8	3	Forest
Overburden stockpile footprint	57.4	3	Forest
West and South Topsoil stockpile footprints	23.8	1	Forest
East Topsoil stockpile footprint	10.2	1	Forest
East Topsoil stockpile footprint	10.2	1	Wetland
Plant Site footprint	21.1	1	Forest
Coarse Ore Stockpile (Reclaim) footprint	1.6	< 1	Forest
Crusher Pad	2.2	< 1	Forest
Explosives Facility	3.8	< 1	Wetland
Temporary Construction Camp	3.6	< 1	Wetland
Project Site roads	43.0	2	Road
Site distribution power line	30.2	2	Forest
Pipeline	1.1	< 1	Forest
Diversion Channels	20.9	1	Forest
South and North TMF Water Management Ponds	1.2	< 1	Water
Non-PAG Waste Rock stockpile, PAG LGO stockpile, and Overburden Water Management Ponds	1.7	< 1	Forest
Mine Access Road	35.8	2	Road
Connector Road to Explosives Facility	4.4	< 1	Forest
Power Line	54.5	3	Grass/shrubs
Rail concentrate load-out facility	0.5	< 1	Private land: industrial
Total	**1,956.5**	**100**	

Figure 7.7-1
Harper Creek Post-Closure



The general end land use is to return the site to an open forested ecosystem for use as wildlife habitat. Reclaimed waste rock and tailings areas will be planted with grasses and shrubs to protect the soil cover from windthrow disturbance. The reclaimed waste rock pile will result in approximately 107 ha of grass and shrub area and the TMF dam and beaches will result in approximately 452 ha of grass and shrub area. The overburden pile will be vegetated with grasses, shrubs, and tree seedlings that will ultimately develop into a forest cover.

7.7.1.1 TMF Wetland Complex during Post-Closure

Approximately 17.6 ha of wetland will be constructed on the site. This will occur in the east topsoil stockpile footprint, and at the construction camp and explosive facility areas. The closed diversion channels, pipeline routes, and conveyor corridors will be planted with the native grass mix, as described above. With time, the adjacent vegetation will become established in the reclaimed linear areas. These areas will ultimately become forested.

7.7.2 Summary

In summary, approximately 868 ha of the Project Site will be reclaimed to forest, grasses and shrubs, and wetlands representing roughly 44% of the land area disturbed for the Project. Approximately 290 ha or 15% of the land disturbed for the Project will be reclaimed to forest cover Post-Closure (Table 7.7-2). Approximately 30% will be reclaimed to a grass/shrub landscape.

Table 7.7-2. Summary of Post-Closure Landscape

Post-Closure Landscape	Area (ha)	Percent
Forest	289.5	15
Grass/shrubs	560.5	29
Wetland	17.6	1
Road	78.8	4
Water	849.2	43
Rock	161.0	8
Total	**1,956.6**	

Approximately 75 ha will remain as roads including the existing access road. The Project Site roads are required for Post-Closure monitoring. The pit edge will represent approximately 161 ha of rock and the pit lake and the TMF pond area will occupy approximately 849 ha.

7.8 CLOSURE AND RECLAMATION SCHEDULE

The reclamation schedule will include progressive reclamation, where practical, as this will reduce the potential effects of the Project on the environment. The Project design allows for substantial reclamation activities to occur during the final five years of Operations (reclamation of tailings beaches, the tailings dam embankments, and topsoil stockpiles, as an example), leaving the PAG LGO stockpile footprint, non-PAG waste rock stockpile and Plant Site infrastructure to be reclaimed during the Closure phase. Progressive closure and reclamation activities will commence about

five years into mining operations for the smaller non-PAG LGO ore stockpile, and the temporary construction camp area if not needed for operations. The activities have been split into concurrent reclamation (years 5 to 28) and final reclamation (years 29 to 35). A general description of reclamation activities that will occur in each phase is provided in Table 7.8-1.

Table 7.8-1. Closure and Reclamation Schedule for the Harper Creek Project

Phase	Length of Phase (Years)	Location	Description and Sequence of Reclamation Activities
I Open Pit	4	Project Site	Open pit mining and initial extraction
			Reclamation research initiated on areas progressively reclaimed
II Open Pit	2 - 8	Project Site	East south expansion of the open pit and progressive reclamation
III Open Pit	4 - 16	Project Site	West/north expansion of the pit
IV Open Pit	8 - 21	Project Site	Southern up-dip expansion of the open pit
V Open Pit	11 - 24	Project Site	Northern down-dip expansion of the open pit
Stockpile Recovery	24 - 28	Stockpiles	Closure and reclamation of the TMF, stockpiles and structures
Closure/Final Reclamation	29 - 35	Project Site	Removal of equipment and structures
			Dismantling of surface structures (e.g., conveyor)
			Removal of aboveground pipelines
			Backfilling of water management ponds (overburden, process plant, heavy bay)
			Removal of diversion ditches
			Ripping of compacted areas; breaking concrete foundations of mill site; spreading of soil and seeding in reclaimed areas
			Removal of batch plant
		PAG LGO stockpile; non-PAG waste rock stockpile; coarse ore stockpile	Reclamation of footprint areas
Post-Closure	50		Post-Closure monitoring

7.9 RESEARCH PROGRAMS

Progressive reclamation, which is planned for the Project, will provide an opportunity to test and assess the various planned reclamation approaches. There are a range of soil types and site conditions across the Project Site. Early re-vegetation and soil placement is planned during the Operations phase for some components as sites become available for reclamation. The early re-vegetation will allow for the assessment of the suitability of the native species selected for the various site conditions and soils. Species that are less successful can be replaced with different species to develop the most successful outcome. The tests can include seeding application rates and methods, planting density of shrubs and trees, and the effects of inter-planting density and

competition. Such programs require good record keeping and reporting practices so that approaches with varying levels of success are documented for later review and planning. Research program planning will occur during the detailed permitting phase of the Project.

7.10 TEMPORARY MINE SHUTDOWN AND MINE CLOSURE

The Closure and Reclamation Plan covers on-site Project facilities. Temporary closure activities will be dependent on the stage of operation. Care and maintenance activities can include ongoing security of the site gates and the site in general related to trespassing. If the site has been operating for some years, there will be safety issues related to the open pit and the TMF. The stocks of explosives and detonators may require removal during temporary shutdown. For extended periods, equipment such as pumps and generators may need special lubricants and flushing of lines depending on the equipment.

Low grade ore stockpiles will be developed during the early stages of project operations to facilitate increased processing of high grade ore. These stockpiles will be processed at a later stage of the Project. In the event of early temporary mine closure, the LGO stockpiles will be regularly examined for dust generation. Those areas observed to be generating unacceptable levels of dust will be treated with a dust suppressant or covered with erosion control cloth or other similar material. In the event of permanent mine closure, the non-PAG LGO will be reclaimed in place and the PAG LGO will be rehandled and placed under water in the TMF or pit.

An uncovered crushed ore stockpile will be utilized by the mill. In the event of early temporary mine closure, the pile will be left in its current state. In the event of permanent mine closure, the pile will tested and if non-PAG will be re-sloped to a 2H:1V slope, covered with 40 cm of stockpiled soil, and re-vegetated with the native seed mix as previously described, or if PAG, will be rehandled to the TMF for storage under water.

Ongoing monitoring of water quality, as well as the structural stability of stockpiles, the TMF, and the pit will be required. As well, areas subject to surface erosion and slumping, which may indicate potential instability, will require ongoing monitoring.

7.11 CLOSURE COSTING

Preliminary closure and reclamation costs have been estimated for the Project at $16,377,490 (not including monitoring costs). This estimate includes closure of on-site/off-site facilities and reclamation. Approximately $6,213,150 has been estimated to dismantle structures such as the mill, crusher, the water process pond, the conveyors, infrastructure related to the coarse ore stockpile, and various other buildings and structures, with no allowance for salvage value offsetting closure costs (Table 7.11-1).

Table 7.11-1. Closure Cost Estimate

Infrastructure Areas	Labour and Equipment Costs
Mill	$2,483,400
Mine Maintenance/Truck shop	$981,450
Warehouse	$176,000
Coarse Ore Stockpile Infrastructure	$707,100
Crusher and Conveyor	$1,124,500
Other Infrastructure/Equipment	$740,700
Total	**$6,213,150**

The reclamation costs for other mine components and other minor costs have been estimated at $10,164,340 (Table 7.11-2). This includes costs for site preparation, soil spreading, and re-vegetation for areas such as the coarse ore and PAG LGO stockpile footprints, facility footprints, the TMF dam faces and beaches, as well as the waste rock and overburden stockpiles. The labour costs for closing the feeder shoots and escape and ventilation openings are included in Table 7.11-1 as part of the coarse ore stockpile infrastructure; the cost of concrete and supplies for these components is included in Table 7.11-2.

Table 7.11-2. Reclamation and Materials Cost Estimate

Infrastructure Areas	Site Preparation, Reclamation, Materials
Tailings Management Facility	$6,802,500
Non-PAG Waste Rock Stockpile	$1,603,500
Overburden Stockpile	$746,200
Plant Site	$513,900
Coarse Ore Stockpile (Reclamation)	$54,080
Coarse Ore Stockpile (Seal Materials)	$37,200
Crusher Pad	$56,760
Construction Camp	$86,400
Explosives Facility	$91,200
Topsoil Stockpiles	$132,600
Other Areas	$40,000
Total	**$10,164,340**

The closure costs have used standard rates for heavy equipment operation and standard approaches and unit costs have been used for reclamation. These are high-level costs in that they will be affected by the cost of materials and equipment brought to the site, the efficiencies of the personnel carrying out the work, and changes in the amount of disturbance or new approaches to mining and reclamation over the years. The costs are based on the current mine plan. The preliminary costs indicate what is expected at the end of the life of the mine based on 2014 dollars. More detailed closure and reclamation costing will be developed as required under the Mines Act in conjunction with permitting.

7.12 POST-CLOSURE MONITORING AND REPORTING

Monitoring is required under section 10.7.30 of the Code (BC MEMPR 2008) to demonstrate that reclamation and environmental protection objectives including land use, productivity, water quality, and stability of structures are being achieved. As well, the *Mines Act* (1996) permit to be issued authorizing the construction, operation, and closure of the Harper Creek Mine and the *Environmental Management Act* (2003) permit to be issued authorizing the discharge of effluent from the TMF will both set out site-specific monitoring and reporting requirements for the Project. The results of the monitoring programs will be included in annual reports on reclamation and environmental monitoring (per section 10.1.4 of the Code; BC MEMPR 2008). Monitoring will be carried out during the Closure and Post-Closure phases. The monitoring will be carried out by an environmental technician who will be on site during the non-snow periods. The following is a brief description of the Closure and Post-Closure monitoring plans proposed for the Project.

7.12.1 Reclamation

Reclaimed areas will be monitored annually for the first three years following reclamation or until the vegetation is well established to ensure reclamation is successful. Bare areas may indicate that the soils are compacted. Treatment may include roughening the surface to reduce surface compaction before reseeding. As well, fertilizer may be required to promote plant establishment where vegetation is sparse. Slope instability may require grading and re-vegetation. Further information can be found in Section 24.11 Sediment and Erosion Control Plan.

The grass mix typically used will include a range of native species suited to the area. This will compensate for variation across the site such that plants will be established despite differences in microclimate, aspect, soil texture, soil fertility, and soil drainage. The species may be changed, however, to reflect the site conditions. For example, plants on coarse-textured soils may be affected by insufficient moisture and may indicate that areas need to be reseeded with more drought-resistant species.

Native shrubs and tree seedlings will be planted in most areas to accelerate the development of a forested ecosystem and wildlife habitat. Plants will be checked for excessive browsing and wildlife use and sightings will be recorded. The plants may need protection from browsing by wildlife. Early monitoring will therefore be required to ensure that plants are established and flourish to a suitable level to allow for the development of more complex vegetative communities. This will occur over time through the influence of wildlife use, as well as natural seed dispersal from adjacent areas. Reclaimed sites will also be checked for noxious weeds. The locations of any areas requiring retreatment will be recorded to allow for future monitoring.

Potential uptake of metals by vegetation is a function of metal content in soils. The soils collected for reclamation will be mixed during the construction of the stockpiles. Any dust with elevated metal levels from Operations activities on the stockpiled soils will be automatically mixed with the deeper and greater part of the soil volume in the soil stockpiles when the soils are required for reclamation. Therefore, metal contamination of reclaimed areas is not predicted to occur. However, soils in representative areas such as in the crusher area and the plant site will be checked for metals as soon as

the areas are reclaimed. Additional details of the monitoring program can be found in the Vegetation Management Plan (Section 24.17).

7.12.2 Wetland Habitat

Created wetlands (approximately 17.6 ha) and the establishment of wetland vegetation will be monitored to document the success of reclamation efforts. The sites will be photographed and a record will be kept on the plant species and their growth. The presence/absence of insects and signs of wildlife use will be recorded.

The pocket wetlands will be monitored for the presence of water between April and August and toad numbers and the presence/absence of eggs will be recorded as the pocket wetlands are intended as a mitigation to reduce Project effects on Western toads.

7.12.3 Surface Water Quality

Surface water quality will be monitored at sites with the potential to incur effects attributable to Project infrastructure, such as seepage and discharge from the TMF. Surface water quality monitoring is outlined in the Fish and Aquatic Effects Monitoring Plan (Section 24.6). All water samples will be analyzed for the physical parameters required by the Metal Mining Effluent Regulations (MMER; SOR/2002-222); in addition to the environmental effects monitoring requirements specified in the *Environmental Management Act* effluent permit conditions. 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). Water quality sampling will include a number of physio-chemical parameters, including anions, nutrients, total organic carbon, total and dissolved metals, turbidity, and TSS.

7.12.4 Groundwater Monitoring

The groundwater monitoring network has been developed based on the predictive groundwater flow modelling (Appendix 11-B) that formed the basis for the Groundwater Effects Assessment (Chapter 11). Monitoring during the Operations, Closure and Post-Closure will be undertaken in accordance with the Groundwater Management Plan included as Section 24.8, which identifies the individual well locations and the rationale for their selection.

During the Post-Closure phase, a progressive reduction in groundwater monitoring will occur, subject to permit and regulatory requirement and contingent upon meeting performance objectives or as otherwise required by regulators.

7.12.5 Geotechnical Stability

The TMF dams will continue to be monitored for stability during Closure and Post-Closure in accordance with the *Mines Act* (1996) and *Mines Act* permit issued to HCMC, as well as the various guidelines, including the Canadian Dam Association's *Dam Safety Guidelines* (CDA 2007). An Operations, Maintenance, and Surveillance Manual will be prepared in accordance with the CDA Guidelines outlining a detailed program for instrumentation, monitoring and inspections of the TMF

dams. Inspections will be conducted by the design engineer, as well as by independent dam safety reviews at the frequency required by the CDA Guidelines at a minimum (see Chapter 5 Section 5.7.1.5 and 5.8.2 for more information on TMF dam construction methods and guidelines).

The reclaimed waste rock and overburden stockpiles will be monitored for slope stability. Typical geotechnical monitoring includes the following, as described in the *Mine Rock and Overburden Piles Investigation and Design Manual: Interim Guidelines* (Piteau Associates 1991):

- type of monitoring;
- frequency;
- allowable movement thresholds;
- movement/failure reporting;
- special inspections/reviews;
- incidence of instability; and
- runout.

7.12.6 Pit and Tailings Management Facility Water Management Stability

The water management of the pit and TMF will be regularly monitored during the Closure and Post-Closure phases. The emergency spillway of the pit will be monitored as well as the water level and quality in the pit. Water levels and water quality, and spillway performance will also be regularly monitored in the TMF, especially during critical times such as at spring thaw when ice and high snow melt can affect outlets. Pumps and the reclaim barge in the open pit will be checked and serviced in advance of seasonal pumping requirements.

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