27 Closure and Reclamation

27.1 Introduction

This chapter provides a conceptual closure and reclamation plan for the KSM Project, consistent with the KSM Project Application Information Requirements issued on January 31, 2011. The AIR requires the conceptual plan to be based on the requirements for a permit approving the mine plan and reclamation program pursuant to the *Mines Act.*

Closure and reclamation planning for the KSM Project will contribute to the success of closure and reclamation during mining and at the end of the end of mine life, which will reduce the need to restructure Project components, limit the amount of material re-handling, and reduce 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 construction and operation. Stabilizing and rehabilitating surfaces will reduce the potential for degradation of the 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 possible, that terrestrial, aquatic, heritage, and archaeological resources are sufficiently protected during mine construction, operation, closure, and post-closure. Environmental management plans are summarized in Chapter 26 of the Application/EIS. Concurrent with the initiation of mining, monitoring programs for wildlife, vegetation, and aquatic effects will be implemented to measure any changes in either the terrestrial or aquatic environments. The results from monitoring programs will be used to improve environmental management systems, as appropriate.

This chapter is organized as follows:

- Section 27.2 of the chapter describes the regulatory framework related to closure and reclamation, including applicable legislation, standards, and guidelines.
- Section 27.3 identifies closure and reclamation objectives. Section 27.4 describes the soil handling plan and provides soil information for the Project area, describes soil salvage plans, and materials balance.
- Section 27.5 describes conceptual plans for reclaiming individual components including the Mine Site (open pits, RSFs, diversion tunnels, Mitchell Ore Preparation Complex, truck shop), MTT, PTMA (TMF, process plant, ore stockpiles, laydown areas, landfarm, muck pad), Coulter Creek and Treaty Creek access roads, borrow and quarry sources, mini hydro plants, muck pads and sediment ponds and construction and operations camps.
- Section 27.6 describes the post-closure landscape (including topography, drainage, vegetation and land use).

- Section 27.7 provides conceptual information on the anticipated schedule for closure and reclamation activities.
- Section 27.8 describes plans for reclamation monitoring.
- Section 27.9 identifies reclamation research programs that will be undertaken during operation.
- Section 27.10 outlines the Proponent's intentions for reclamation and closure of the Project in the event of premature closure of mining operations.
- Section 27.11 provides an estimate of closure and reclamation costs.
- Section 27.12 identifies post-closure activities, including post-closure monitoring programs and monitoring costs.

27.2 Regulatory Framework

27.2.1 British Columbia *Mines Act* (1996a) and Health, Safety and Reclamation Code (BC MEMPR 2008)

The BC Mines Act (1996a) and Health, Safety and Reclamation Code for Mines in British Columbia (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* (1996a) and Health, Safety and Reclamation Code (BC MEMPR 2008) are administered by the Ministry of Energy, Mines and Natural Gas (MEMNG), now called the Ministry of Energy and Mines (as of May 2013). The Chief Inspector of Mines has the ultimate legislative authority for all issues pertaining to the *Mines Act* and Health, Safety and Reclamation Code.

Proponents of mining projects are required to obtain a permit from the Ministry of Energy, Mines and Petroleum Resources prior to commencing any work on a mine site, in accordance with Section 10 of the *Mines Act* (1996a). Section 10 of the *Mines Act* 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" (Section 10.1). As a condition of issuing a permit, the chief inspector may require a security for mine reclamation, and to provide for protection of, and mitigation of damage to, watercourses and cultural heritage resources affected by the mine (Section 10.4).

A financial, security is required as a condition of all *Mines Act* 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* can also be used to cover the regulatory requirements of legislation, permits and approvals of other provincial agencies.

The 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 mine site, complete any outstanding reclamation requirements, and continue to monitor and maintain the site for as long as is required (BC MEMPG 2009). In general, MEMNG reviews of reclamation security at a mine 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.

27.2.2 *Fisheries Act* (1985)

In June 2012, the federal government proposed amendments to the *Fisheries Act* (1985). Proposed changes to the *Fisheries Act* (1985) would result in a shift for Fisheries and Oceans Canada (DFO) from a focus on managing effects on all fish habitat, to managing threats to fisheries. These amendments would support the long-term productivity and sustainability of Canada's commercial, recreational, and Aboriginal fisheries. The current *Fisheries Act* (1985) provisions used for the review of Project effects are indiscriminate and require consideration of all projects, on all waters, regardless of the importance of fish species present or of their contribution to fisheries.

Currently, DFO is in a transition phase with respect to implementing *Fisheries Act* (1985) legislative changes. Pending enactment of the new legislative provisions, the existing provisions of the *Fisheries Act* (1985) continue to apply. Following the legislative changes, DFO's (1986) Policy for Management of Fish Habitat and its guiding principle of No Net Loss will be changed. However, the details on the timing of policy changes are unknown at the time of production of this plan. Therefore, the current *Fisheries Act* (1985) legislation and policies are discussed below because they have formed the basis for developing the Closure and Reclamation Plan.

The *Fisheries Act* (1985) prohibits the harmful alteration, disruption, or destruction of fish habitat through physical, chemical, or biological means. *The Policy for the Management of Fish Habitat* (DFO 1986) puts forth the principle of "no net loss of productive capacity" of fish habitat. Under Section 35(2) of the *Fisheries Act* (1985), any project or activity that causes harmful alteration, disruption, or destruction requires an authorization from DFO. The *Fisheries Act* (1985) defines fish habitat as "spawning grounds, nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes." Included in this definition are both fish-bearing and non-fish-bearing waterbodies, including the surrounding riparian area and fisheries sensitive zones.

The Metal Mine Effluent Regulations (MMER; SOR/2002-222), enacted in 2002, were developed under Section 36 of the *Fisheries Act* (1985) to regulate the deposit of tailing, and other waste matter produced during mining operations, into natural fish bearing waters. These regulations, administered by Environment Canada, apply to both new and existing mines. If a developer proposes to use a natural fish-bearing waterbody for tailing management, a fish habitat compensation plan must be developed to ensure no net loss of fish habitat results from the use of this waterbody.

27.2.3 *Environmental Management Act* (2003)

The BC *Environmental Management Act* (2003) prohibits the discharge of waste to the environment unless specifically authorized. While there are different types of authorizations under the Act, most mining operations require air emissions, solid refuse and effluent discharge permits (MOE 2013).

A permit authorizes the discharge of wastes from an industry, trade, business, operation or activity to the environment, and sets the terms and conditions under which the discharge may occur so that pollution is prevented. The terms and conditions include limiting the quantity and quality of waste contaminants, monitoring the discharge and the receiving environment, and reporting information to the Ministry. Permits are ongoing authorizations and may be amended, transferred to other dischargers, suspended or cancelled (BC MOE 2013).

Closed mines must obtain a Certificate of Compliance pursuant to Section 53 of the *Environmental Management Act* (2003) and the *Contaminated Sites Regulation* (BC Reg. 375/96). The *Contaminated Sites Regulation* (BC Reg. 375/96) sets the applicable standards for soil, air, and groundwater that must be met to obtain a Certificate of Compliance.

27.2.4 *Water Act (1996b)*

In British Columbia, ownership of water is vested in the Crown as stated in the BC *Water Act* (1996b). The Act is the principal law for managing the diversion and use of provincial water resources. Under the Act, approvals are required for making changes in and about a stream, to authorize constructions of works, the diversion and use of water and water withdrawals.

27.2.5 Riparian Management Area Guidebook (BC MOF and BC MOE 1995)

The *Riparian Management Area Guidebook* (BC MOF and BC MOE 1995) sets out activities on erodible soils in riparian areas. These guidelines are also consistent with the spirit of the *Mines Act* (1996a) and the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEMPR 2008).

27.3 Closure and Reclamation Objectives

Part 10 of the Health, Safety and Reclamation Code (BC MEMPR 2008) focuses on reclamation and closure. Section 10.7 identifies reclamation standards. Section 10.7.4 (Land Use) indicates "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 "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 "Land, watercourses and access roads shall be left in a manner that ensures long-term stability."

The Proponent's goal is to develop a conceptual Closure and Reclamation Plan for the KSM Project that will meet the requirements of the Health, Safety and Reclamation Code for

Mines in British Columbia (BC MEMPR 2008) and that will provide assurance to the Province 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 objectives:

1. to provide stable landforms;
2. to re-establish productive land use; and
3. to protect terrestrial and aquatic resources.

27.3.1 Provision of Stable Landforms

The design of the Project's permanent mine-related landforms, such as the open pits, the Tailing Management Facility (TMF), the Water Storage Dam (WSD) that will impound the Water Storage Facility at the Mine Site, seepage containment dams, and the rock storage facilities (RSFs), 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, RSFs, the plant site, and the Water Storage Facility. Geotechnical site investigations comprised geological mapping of tunnel routes, the Water Storage dam, and the TMF, as well as drilling of facility foundations. Sampling and geotechnical/hydrogeological testing for characterization of foundations, borrow material, and tailing materials continued throughout 2012 (Appendices 4-Q and 4-AB). Investigations of the TMF and Mine Site hydrogeology were carried out. Seismic refraction geophysical surveys were conducted to determine the depth of bedrock at the proposed dam sites. Multi-spectral Analysis of Surface Waves was conducted to estimate the shear wave velocity in the alluvial deposits at the proposed dam sites (Tetra Tech-Wardrop 2012, Appendix 4-C).

A Seismic Hazard Assessment was carried out (Appendix 4-J). Overburden was assessed at mapping sites and recovered from drill holes. Index testing of overburden (grain size, Atterberg limits, and moisture content) was carried out as well as triaxial testing of till from the waste dump foundation area for strength and hydraulic conductivity. Pit geotechnical investigations were undertaken (Tetra Tech-Wardrop 2012, Appendix 4-C).

In summary, geotechnical and hydrogeological investigations have included:

- geotechnical drilling and sampling;
- test pit excavations and sampling;
- geophysical surveys;
- borehole televiewer surveys;
- photogrammetric mapping;
- groundwater investigations (including piezometer installations);
- standard penetration tests on overburden materials;

- permeability results from packer testing;
- index tests; and
- geotechnical laboratory tests from drill hole samples (moisture content, liquid limits, plastic limits, friction angle, and cohesion).

Long-term stability of landforms will also be achieved through careful design. The design of RSFs has taken the BC Mines Waste Rock Pile Research Committee dump design guidelines (Piteau Associates 1991) into account. RSF geotechnical stability during construction and closure was analyzed using SLOPE/W© 2007 software (Tetra Tech-Wardrop 2012). The mine rock placement progression will build the RSFs in lifts (initially by bottom-up construction) to consolidate foundations and reduce downslope risks (KCB 2012). Where implemented, top-down placement of waste rock in the RSFs is limited to 400 m maximum lifts, which are comparable to current lift heights implemented at other mines in BC.

The RSFs will be reclaimed. Therefore, final dump configurations are designed with maximum 105 m high terraces at "as dumped" angle of repose, with flat benches between terraces. The overall slope angle will be between 26° and 30° to allow for re-sloping to accommodate reclamation. The upper edge of the RSFs will be rounded off to shed water and to reduce the potential for erosion at the top of slope edges. Reclamation/re-vegetation of the RSFs will reduce the potential for infiltration of precipitation and surface erosion providing more stability.

The TMF will be constructed in three cells, known as the North Cell, the Centre Cell, and the South Cell. The TMF is located within the upper reaches of South Teigen and North Treaty creeks. Design criteria for the dams are based on the Canadian Dam Association Dam Safety Guidelines (CDA 2007). Dams will be constructed with low permeability glacial till cores and compacted cyclone sand shells, using the centerline geometry method. Seepage from the impoundment will be controlled with low permeability zones in the dam and foundation treatment.

The area is moderately seismic and the dams are designed to resist earthquake loads. A site-specific seismic hazard assessment indicates a peak ground acceleration at a 10,000-year return period of 0.14 g. The TMF is designed to store the 30-day probable maximum flood with snowmelt. The TMF is designed to store all inflowing waters during extreme flood events without discharge. TMF dams are designed with sufficient freeboard to store the probable maximum flood resulting from a 30-day probable maximum precipitation storm combined with a 100-year 30-day snowmelt. For dam design purposes, it was assumed that all of the perimeter northeast/northwest diversions and southwest/southeast diversions would be inoperative during this extreme flood event. The probable maximum flood inflow volume is estimated to range from 65 Mm^3 at facility start-up to 53 Mm^3 at the ultimate dam crest elevation (Tetra Tech-Wardrop 2012).

27.3.2 Re-establishment of Productive 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. The current land use information has been obtained from the environmental and socio-economic baseline studies, which were initiated in 2008 and continued into 2012 (Appendix 23-A).

These studies were undertaken in consultation with the KSM Project EA Working Group which includes provincial and federal government agencies, Nisga'a Nation, Tahltan Nation, Gitxsan Nation, Skii km Lax Ha, and the Gitanyow First Nation.

27.3.2.1 Project Setting

The Project is located in the coastal mountains of BC, and includes a diversity of topography and vegetation. The Mine Site is located in a steep, mountainous area that is dominated in the north, east, and south by glaciers, ice fields, and exposed bedrock. The Processing and Tailing Management Area (PTMA) is located in a valley and is separated from the Mine Site by a glacier-covered mountainous area.

Ecosystems in the Project area exhibit both coastal and interior climatic influences and range from high elevation alpine habitats to low elevation forested areas. Sparse/bryoid (10% vegetation [mosses]) is the most extensive vegetation structural stage in the Project area. Herb/dwarf shrub is the next most dominant structural stage with mature forest and shrub/herb (which includes krummholz and avalanche tracks). Young and old forests represent the smallest component. The eastern area is comprised primarily of high elevation forest, the western area and Mitchell-Treaty Twinned Tunnels (MTT) areas are primarily alpine, and the Coulter Creek access road is located primarily in low elevation forest with considerable amounts of high elevation forest and parkland. Old forests are most common in the Upper Unuk watershed, while non-vegetated and sparsely vegetated areas are most common in the Sulphurets and Treaty creek watersheds. Shrub/herb structural stages are most common in the Teigen watershed. Forest cover includes mountain hemlock, western hemlock, subalpine fir, and hybrid white spruce. Reclamation planning will focus on these ecosystems.

Baseline study results from 2008 and 2009 indicate that, during the winter, moose select flat riparian habitat and areas of gentle to moderate slopes that produce abundant shrub forage. The low elevation and gentle topography of much of the PTMA represents suitable moose early and late winter habitat. A proposed moose Ungulate Winter Range has been identified along parts of Treaty Creek. Habitat suitability models indicate that suitable early and late winter habitat is located in the PTMA within the wetlands and riparian areas along Treaty Creek and within the TMF footprint. Moose habitat development will be part of reclamation planning in the PTMA in order to be consistent with current conditions and moose use. Very little suitable moose habitat occurs at the Mine Site, due to the higher elevations.

Habitat suitability mapping was conducted for mountain goats to identify summer and winter habitat. The most suitable year-round habitat occurs along the Snowslide Range, around John Peaks to the west of the Mine Site, and southeast of the TMF. In addition, a mountain goat Ungulate Winter Range (u-6-002) overlaps portions of the PTMA and Mine Site; Ungulate Winter Range polygons occur near the Mine Site and directly east of the TMF at higher elevations. A portion of the RSFs will be reclaimed to mountain goat habitat in consideration of these findings.

Grizzly bears are omnivorous and require different seasonal habitats throughout the year. During the spring, grizzly bears are often found at low elevation sites, such as within riparian

areas, where vegetation is first emerging after the snowpack melts. Grizzly bears may migrate to higher elevations in the summer, following the emergence of new vegetation and berries. Habitat suitability modelling was conducted for grizzly bears during the spring, summer, fall, and winter denning period. High quality habitat for all seasons occurs throughout the PTMA and Mine Site due to the large home ranges and diverse habitat use of grizzly bears. The majority of high quality habitat occurs at lower elevations and river drainages along the Unuk River and within the PTMA rather than at higher elevations at the Mine Site. The area near the proposed TMF and Treaty Creek access road has also been identified as a candidate/proposed grizzly bear wildlife habitat area (WHA 6-282).

Black bears have similar foraging patterns to grizzly bears during the growing season. Black bears exploit different habitat for denning. Therefore, black bear denning habitat suitability was modelled. Black bear dens are typically located in or beneath large diameter trees or wooden structures derived from trees at lower elevations. During baseline studies, black bears were detected along all river drainages, particularly along the Unuk River, Treaty Creek, and Teigen Creek. Large diameter trees suitable for black bear denning were observed along Treaty Creek and at the confluence of Snowbank and Teigen creeks. Much of the disturbed area in both the Mine Site (including the RSFs) and the PTMA will be re-vegetated to result in a forested vegetative cover that will be suitable for bears and other wildlife.

Furbearers are an important economic and cultural resource within the Project area. American marten is the most valuable component of the regional fur harvest. Marten use mature and old growth conifer forest as winter habitat, which is common in the low elevations of the Project area. Large tracts of low-elevation mature forests within all watersheds provide the best forest structure for American marten to access prey populations during the winter. Fisher is also identified as a species of interest. It was assumed that the marten habitat is also suitable winter habitat for fisher. Much of the Project area has been identified as highly suitable winter habitat for marten, with most of the forest habitat occurring within the proposed TMF and low elevation older forests along the Coulter Creek access road. Other furbearers in the area include red squirrel, fisher, grey wolf, mink, and beaver. It is expected that with the general reclamation goal to return the site to a forested cover, these other furbearers will migrate into the reclaimed area as the vegetation becomes more established.

During baseline studies in 2008 and 2009, 93 bird species were detected: 8 raptor species, 25 wetland bird species, and 60 forest/alpine bird species. Raptors include hawks, falcons, owls, and other birds of prey species. Wetland birds include ducks, geese, shorebirds, and other species associated with waterbodies. Forest/alpine birds include songbirds, hummingbirds, woodpeckers, and game birds.

During the 2009 baseline studies, three western toad breeding sites were observed, all of which were observed north of the PTMA at low elevations in shallow open water with an open canopy and warm water temperatures. No breeding sites were observed within the Project footprint.

27.3.2.2 Recreational, Guide Outfitting, and Trap Lines

There are no formal hiking trails, snowmobile routes, or other recreational sites in the Project area. Commercial recreation tenures for heli-skiing, river rafting, backcountry expeditions, fishing, and angling are present in the Project area.

Three trapline licences occur in the Project area, and one guide outfitting licence covers all of the proposed facilities for the Project. This licence is extensive and covers the area north and south of the Project area, as well as the area east of Highway 37 (Appendix 23-A).

27.3.2.3 End Land Use Objective

The end land use objective is based on the information provided in Sections 27.3.2.1 and 27.3.2.2. That is, primarily to provide for wildlife habitat for the described wildlife species, including bears, mountain goats, and moose. It is proposed that the reclamation approaches will result in the development of complex ecosystems with time and will provide habitat for the species of animals and plants currently occurring around the proposed KSM Project area. Reclamation will include the development of wetlands with their characteristic vegetation and use by wildlife such as moose, western toads, American martens, and fishers. With time, and with the development of complex ecosystems, suitable habitat for the other wildlife species found in the Project area will develop. Reclaimed areas could be used by guide outfitters and for traplines in the future, where safety concerns are not an issue. Lost fish habitat will be compensated through new habitat being created as part of the Fish Habitat Compensation Plan (Appendix 15-Q).

27.3.3 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 ensure the protection of terrestrial and aquatic resources. Consistent with best management and adaptive management principles, the Proponent will ensure that management and monitoring systems are updated, as required. Environmental Monitors will be assigned to the various phases of the Project to ensure compliance with applicable permits and the Proponent's environmental policies.

27.4 Soil Handling Plan

Site reclamation must be carried out in areas used for mining (Health, Safety and Reclamation Code for Mines in British Columbia [BC MEMPR 2008]). The general goal of reclamation is to restore, where possible, 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, and these areas will be re-vegetated, where feasible. The landforms resulting from the Project will also be designed, where possible, and reclaimed to accommodate the desired end land use objective. Reclamation efforts will be directed toward the development of appropriate and functional ecosystems. These efforts will be supported by appropriate soil material handling and re-vegetation strategies.

27.4.1 Soil Assessment

The Health, Safety and Reclamation Code for Mines in British Columbia (Section 10.7.8; BC MEMPR 2008) states that all surficial soil materials removed for mining purposes shall be saved for use in reclamation programs unless these objectives can be otherwise achieved. According to Section 10.7.5 of the Code, the goal is that the average land capability of the reclaimed area shall not be less that the average that existed prior to mining. To achieve this, soils need to be assessed for their suitability for reclamation, and must be salvaged, stored, conserved, and used according to their nature, source, volume, access, and intended final use location. The objective is to retain sufficient volumes of soil suitable for reclamation purposes in areas to be reclaimed. The following is a description of the soils in the Project area in terms of their suitability for reclamation, and the plans for soil salvage and storage until they are required for reclamation.

The soils in the KSM Project area have been mapped and field-checked (Appendix 8-A). Soils are developed on a wide range of surficial deposits, which include morainal, colluvial, fluvial, glacio-fluvial, and organic materials (Table 27.4-1). Typical soils occurring in the Project area include those classified as Brunisols, which are less weathered soils (Plate 27.4-1); podzols, which are leached soils with low fertility (Plate 27.4-2); regosols, which are poorly developed; gleysols, which are poorly-drained (Plate 27.4-3); and organic soils, which occur in wet areas and are commonly called peat soils. Soils range from poorly decomposed (fibrisols), to moderately decomposed (mesisols; Plate 27.4-4), to well decomposed (humisols).

Table 27.4-1. Surficial Materials in the Project Area

Surficial Materials	Project Area	
	ha	%
Colluvial	9,627	19%
Colluvial-Morainal	2,438	5%
Fluvial	1,971	4%
Fluvial-Colluvial	71	0%
Glacio-Fluvial	556	1%
Ice	8,296	17%
Morainal	12,518	25%
Non soils	10,310	21%
Organic	367	1%
Bedrock	2,980	6%
Water	350	1%
Total	**49,484**	**100%**

Because part of the Project area occurs above 2,300 masl, valley glaciers fill the upper portions of the larger valleys (Plate 27-4.5) and bedrock outcrops are commonly found in apex to upper slope positions at high elevation (Appendix 8-A), soils are not available for reclamation in all parts of the Project area. As well, particularly in the Mine Site (Plate 27-4-2), the Project area is characterized by steep topography with loose talus resulting from rockslides and slumps.



Plate 27.4-1. Weakly developed soils (Orthic Dystric Brunisol).



Plate 27.4-2. Well-developed soils (Orthic Humo-Ferric Podzol).



Plate 27.4-3. Poorly-drained soils (Orthic Humic Gleysol).



Plate 27.4-4. Organic soil.



Plate 27.4-5. Glacier-filled valley, south of the Sulphurets deposit.

Surficial materials, therefore, occur in varying thickness, depending on the topography and on the surficial processes by which they developed. On steeper slopes, soils may occur as a thin veneer over bedrock, or they may occur between bedrock outcrops. The lowlands and valley bottoms within the study area consist of subdued relief, with glacially rounded and elongated outcrops, and thick, intervening morainal, glacio-fluvial, and fluvial deposits. The region has been the site of more than one glaciation, following which the land surface has continued to be modified by the action of gravity, wind, water, and ice, resulting in large areas of colluvial deposits. Wetlands and soils with organic caps have developed in depressional and seepage areas.

The suitability of soils for reclamation depend primarily on coarse fragment content and texture. Soils that are coarse-textured (loamy sand to sand) or that have a coarse fragment content greater than 50% are not suitable for reclamation purposes because they have insufficient soil moisture holding capacity.

Morainal materials are the dominant surficial material in the KSM Project area (Table 27.4-1), and are generally suitable for reclamation purposes. They can be medium textured and non-gravelly or slightly gravelly (Appendix 8-A). In steeper areas, they may be more gravelly reducing their suitability as reclamation materials. Where the deposits are thick, the deeper, less fertile subsoil may be useful as a base for the topsoil or as topsoil, where there is a shortage of soil, particularly in the Mine Site. The colluvial materials may or may not have high coarse fragment content (greater than 50%) and, therefore, their suitability will need to be assessed during salvage operations. The glacio-fluvial materials are generally coarse-textured and gravelly at depth, and therefore, droughty. These materials are not suitable for reclamation purposes, except, perhaps, for the top few centimetres of the soil column. Fluvial materials are generally coarse-textured and, therefore, are generally not suited for use as reclamation materials.

The organic soils are poorly drained and highly saturated. Salvaged organic material can dry out, becoming hydrophobic (water-repellent), and therefore not suitable as reclamation material. However, these materials can be mixed with less suitable material, which will prevent them from drying out. Mixing of organic soils with less suitable materials will contribute to the organic matter content of the soil material and, therefore, extend the supply of reclamation material.

In summary, the salvageable material suitable for reclamation purposes will include:

- **soil (mineral) –** includes the organic/nutrient-enriched humus (forest litter) and the upper developed (weathered) mineral material to the depth of plentiful rooting (typically includes the A and upper B horizons); it is variable in thickness but it is assumed to be between 0.3 and 0.5 m thick for the local forest soils (commonly referred to as surface soil);
- **soils (organic) –** limited in extent to wet depressions or very poorly drained toe slopes and composed of organic material; these soils are sometimes referred to as peat; and
- **overburden –** includes the un-weathered soil parent material (subsoil). The goal will be to salvage deeper till in areas when the surface soils are being salvaged to obtain sufficient materials for reclamation, particularly in the areas of the RSFs, the TMF, and the various dams constructed for the Project because these facilities will require a large volume of soils for reclamation purposes.

Based on soil mapping carried out for the Project (Appendix 8-A), the soils have been given a rating for salvage potential and reclamation suitability from high to unsuitable based on limitations of soil texture and coarse fragment content and ease of salvage (Table 27.4-2; Figures 27.4-1 to 27.4-3). Soils that are rated high are considered to be the most suitable soils in the Project area for reclamation. The soils that are gravelly (with greater than 50% coarse fragments) and coarse-textured (loamy sand to sand) are not considered suitable for reclamation purposes. These automatically include the active fluvial materials and the glacio-fluvial materials. The soils that occur between bedrock outcrops are not considered salvageable.

27.4.2 Soil Salvage

Prior to mine development, soil will be salvaged from the footprint areas where soil is suitable for reclamation purposes (Figures 27.4-1, 27.4-2, and 27.4-3). Soils will only be salvaged from footprint areas. The Mine Site is located in a mountainous area with steep (Plate 27.4-6), narrow valleys. Although there may be pockets of soils that are suitable for reclamation, they may not be accessible due to the steepness of the slopes. Soils will generally not be salvaged on slopes steeper than 26° (50%) due to practical limitations on equipment accessibility and operator safety.

As can be seen in Table 27.4-3, approximately 65% of the area that will be occupied by the RSFs has slopes greater than 50%. Therefore, soil will be salvaged from approximately 35% of the RSF footprint (Figure 27.4-4 and 27.4-5). Some of the remaining soils will not be suitable for soil salvage, such as fluvial and glacio-fluvial materials that are coarse-textured. A qualified person will be present on site to guide the equipment operator regarding the soils that should be salvaged. As noted above, the RSFs will be constructed from the bottom up such that the soils will be salvaged in the early phases of construction of the RSFs.

Table 27.4-2. Soil Reclamation and Salvage Ratings

Map Unit	Description	Reclamation/ Salvage Rating	Limitations	Salvage Depth
M1	Morainal; slopes 0 to 26%; rapidly to imperfectly drained brunisols, pockets of gleysols, organic, and regosols.	High	Gravelly	> 30 cm
M2	Morainal; slopes 26 to 50%; rapidly-to-moderately-drained brunisols and podzols, pockets of well-drained regosols, and imperfectly to poorly drained gleysols.	Moderate to low	Gravelly	> 30 cm
M3	Morainal veneers over bedrock; slopes range 26 to 50%; well-to-imperfectly-drained brunisols and podzols, pockets of Non-soil.	Low	Gravelly; Bedrock	30cm
M4	Morainal; slopes 50 to 70%; rapidly-drained brunisols, pockets of regosols and podzols.	Unsuitable	Steep	0 cm
M5	Morainal veneers over bedrock; slopes 50 to 70%; well-drained brunisols and podzols; pockets of Non-soil.	Unsuitable	Steep	0 cm
CM1	Colluvial and morainal; slopes 26 to 50%; well-drained podzols, pockets of well-drained brunisols.	Moderate to low	Gravelly	> 30 cm
CM2	Colluvial and morainal; slopes 50% to 70%; well-drained podzols, pockets of well-drained brunisols.	Unsuitable	Steep	0 cm
C1	Colluvial; slopes 0 to 26%; well-drained brunisols and podzols, pockets of imperfectly-drained gleysols and organic soils.	High	Gravelly	> 30 cm
C2	Colluvial veneers over bedrock; slopes 0 to 26%; well-drained brunisols and podzols, pockets of poorly-drained organic soils, gleysols, and exposed bedrock.	Low	Gravelly; Bedrock	30 cm
C3	Colluvial; slopes 26 to 50%; rapidly-to-moderately-drained brunisols and podzols.	Moderate to low	Gravelly	> 30 cm
C4	Colluvial veneers over bedrock; slopes 26 to 50%; rapidly-to-moderately-drained brunisols and podzols, pockets of exposed bedrock.	Low	Gravelly; Bedrock	30 cm
C5	Colluvial; slopes 50 to 70%; rapidly-to-well-drained brunisols and podzols, pockets of gleysols.	Unsuitable	Steep	0 cm

(continued)

Table 27.4-2. Soil Reclamation and Salvage Ratings (completed)

Map Unit	Description	Reclamation/ Salvage Rating	Limitations	Salvage Depth
C6	Colluvial veneers over bedrock; slopes 50 to 70%; rapidly-drained to well-drained brunisols and podzols, pockets of exposed bedrock.	Unsuitable	Steep	0 cm
CM3	Colluvial and morainal; slopes > 70%; well-drained brunisols, podzols, pockets of exposed bedrock, regosols and non-soils.	Unsuitable	Steep	0 cm
F1	Fluvial material in active fluvial zones; rapidly-drained to well-drained regosols and brunisols, pockets of poorly-drained gleysols.	Unsuitable	Coarse	0 cm
F2	Fluvial material in non-active fluvial zones; terraced landscape; slopes 0 to 26%; well-drained podzols, pockets of well-drained brunisols.	Low	Coarse; Gravelly	30 cm
FG	Glacio-fluvial; benches and with side slopes (26 to > 70% slopes); rapidly-drained podzols.	Unsuitable	Coarse; Gravelly	0 cm
FC	Fluvial and colluvial complex; variable slopes; rapidly-to-well-drained regosols and brunisols.	Unsuitable	Coarse; Gravelly	0 cm
O	Organic; very poorly drained Organic soils, pockets of imperfectly-drained gleysols and well-drained brunisols.	Moderate	Organic	> 30 cm



Plate 27.4-6. Steep slope (74%) near the south boundary of the Kerr deposit.

The soils in the TMF footprint will be salvaged, particularly in the footprints of the dams.

There are numerous areas designated for borrow pits, log landings, and waste areas along the Coulter Creek access road, especially where the road follows the Sulphurets Creek Valley (see Figures 27.5-28, 27.5-29, and 27.5-30). These areas will be cleared and grubbed. The upper 50 cm of soil, where it occurs, will be salvaged in preparation for borrow and storage areas. A portion of the waste will include soils salvaged in preparation of the road bed.

The general plan is to salvage morainal, colluvial, and organic soils in the Project area. The organic soils have low structural stability and bearing strength, and are difficult to handle. Therefore, organic soils must be stripped prior to construction of any works, since they are poor foundation materials. Organic soils (greater than 0.4 m thick) or mineral soils with a peaty phase (greater than 15 cm to less than 40 cm of surface organic material) are more common within the TMF footprint. These materials will be salvaged primarily from the TMF dam footprints.

27.4.2.1 Salvage Sequence and Methods

Soil salvage is associated with pre-stripping activities and, as such, will generally be conducted in the pre-production years.

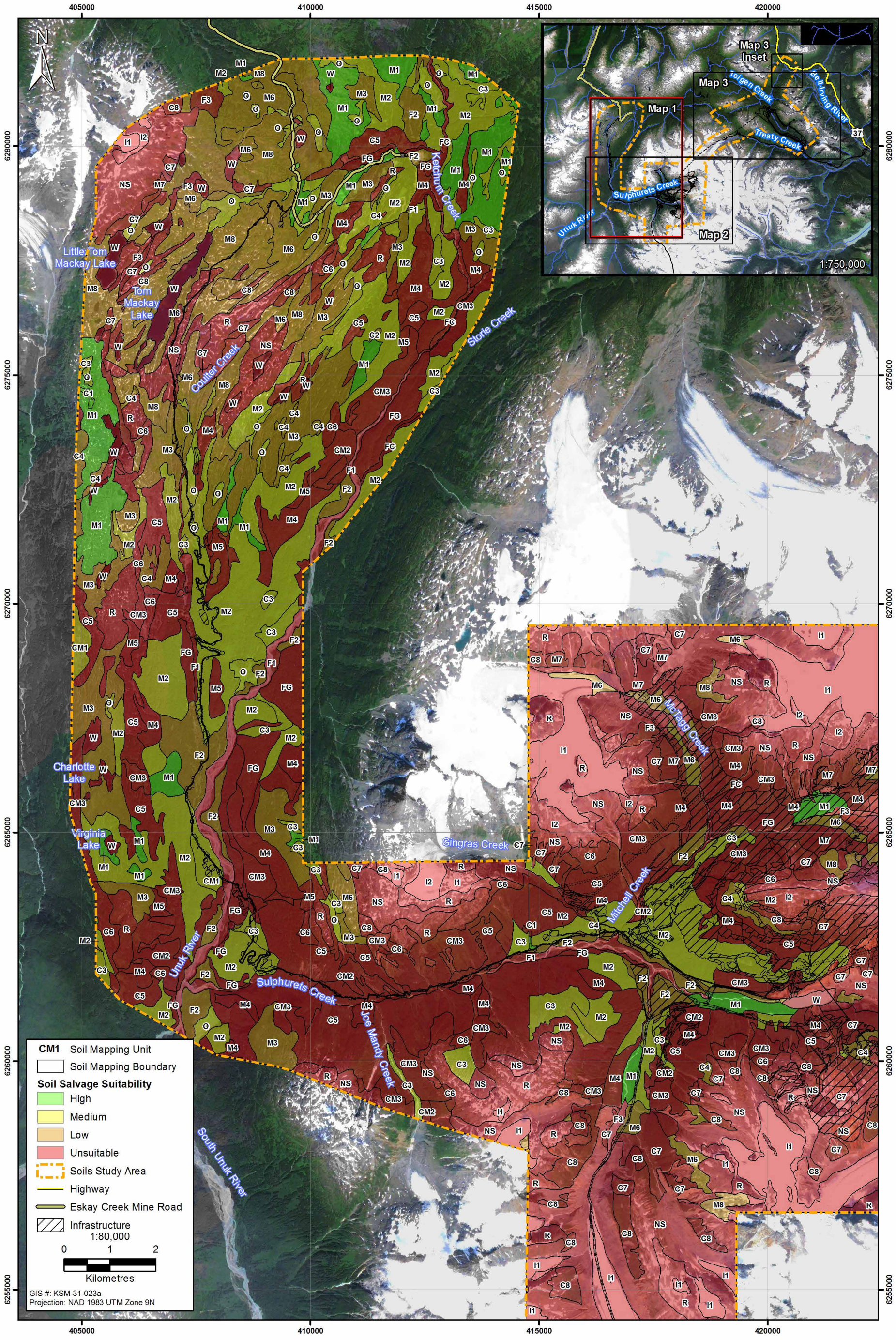

Figure 27.4-1

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KSM Project Soil Salvage Map 1

Figure 27.4-1

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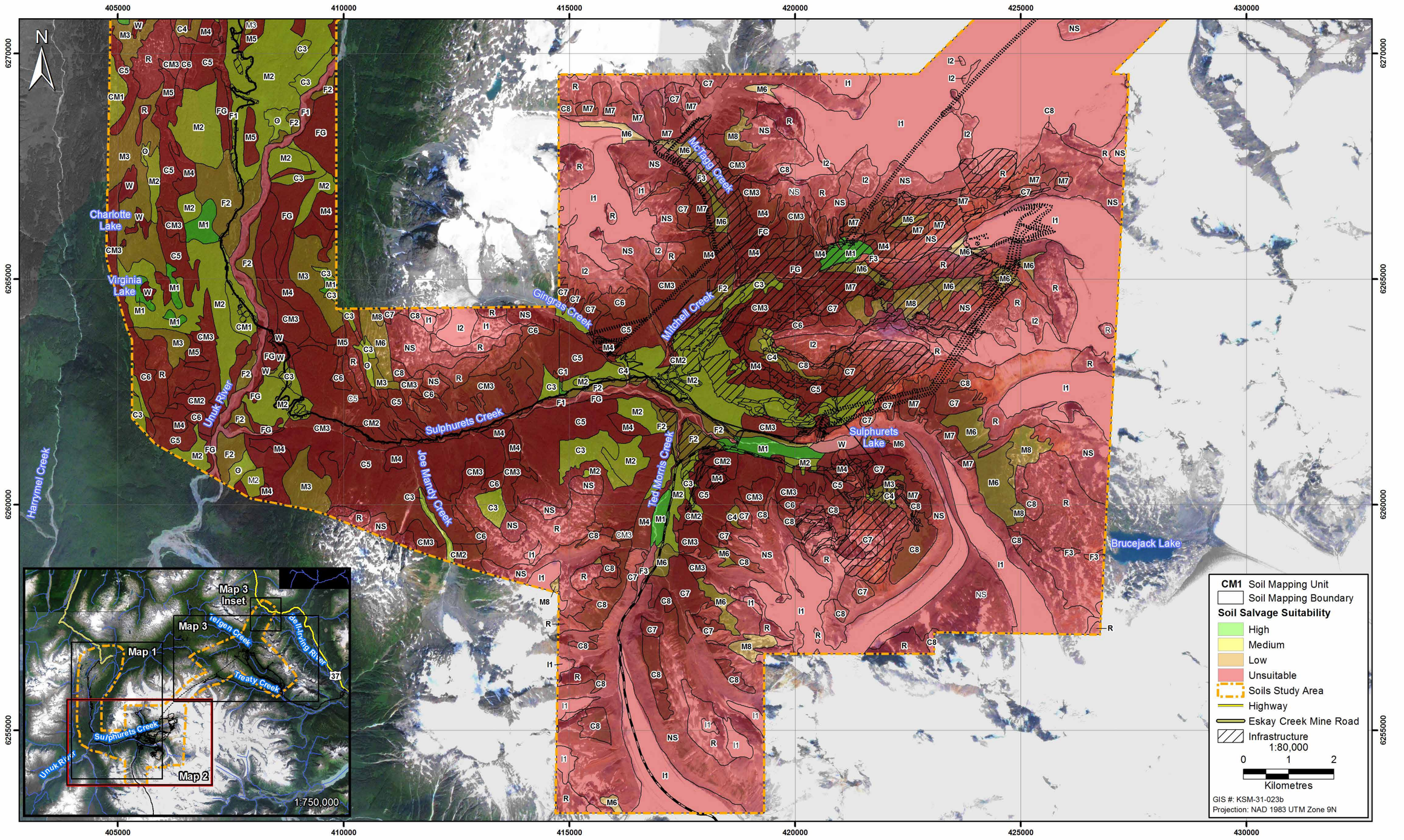

Figure 27.4-2

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KSM Project Soil Salvage Map 2

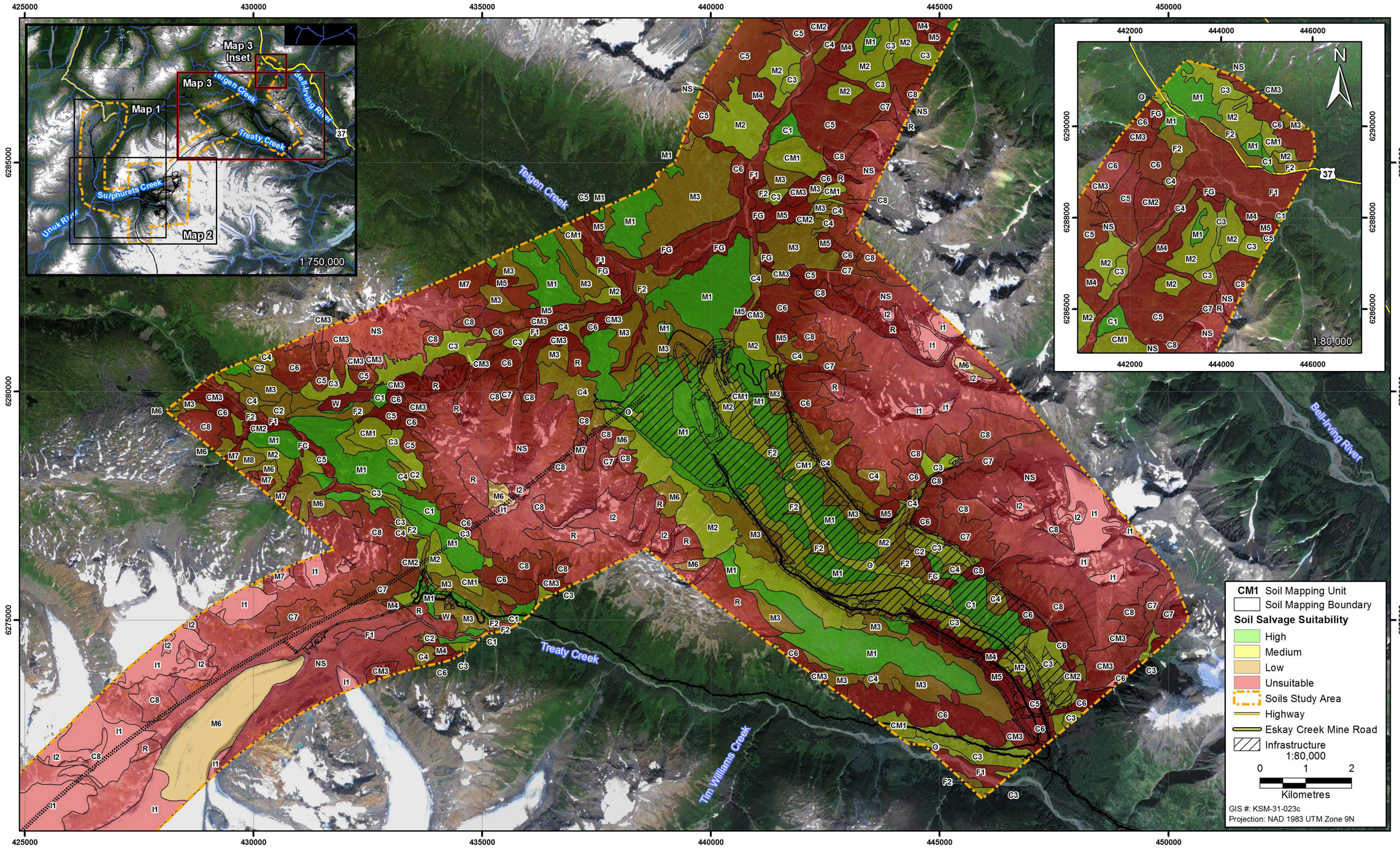

Figure 27.4-3

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KSM Project Soil Salvage Map 3

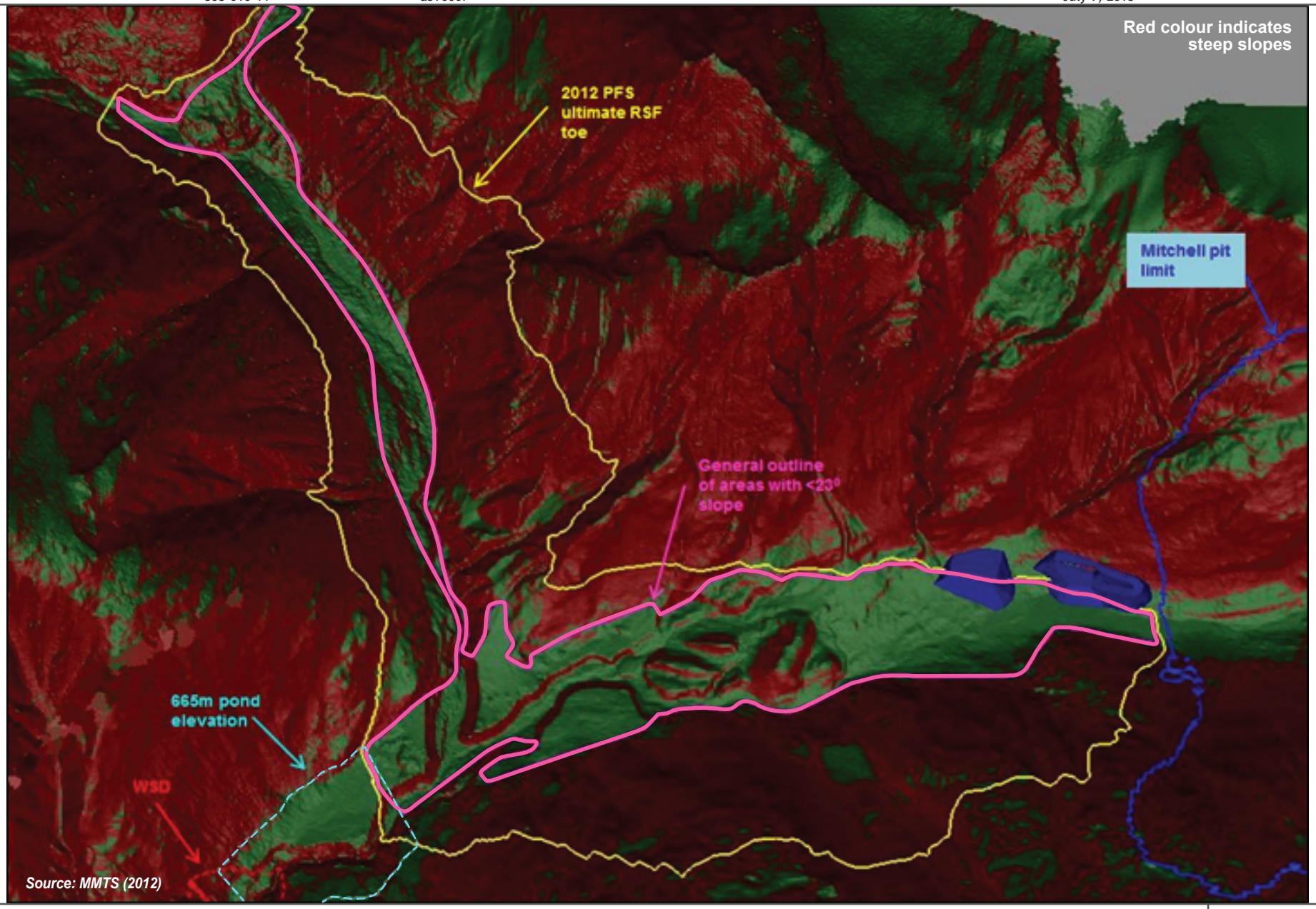

Figure 27.4-4

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Approximate Soil Salvage Area in the Mitchell and McTagg Rock Storage Facilities' Footprint

Figure 27.4-4

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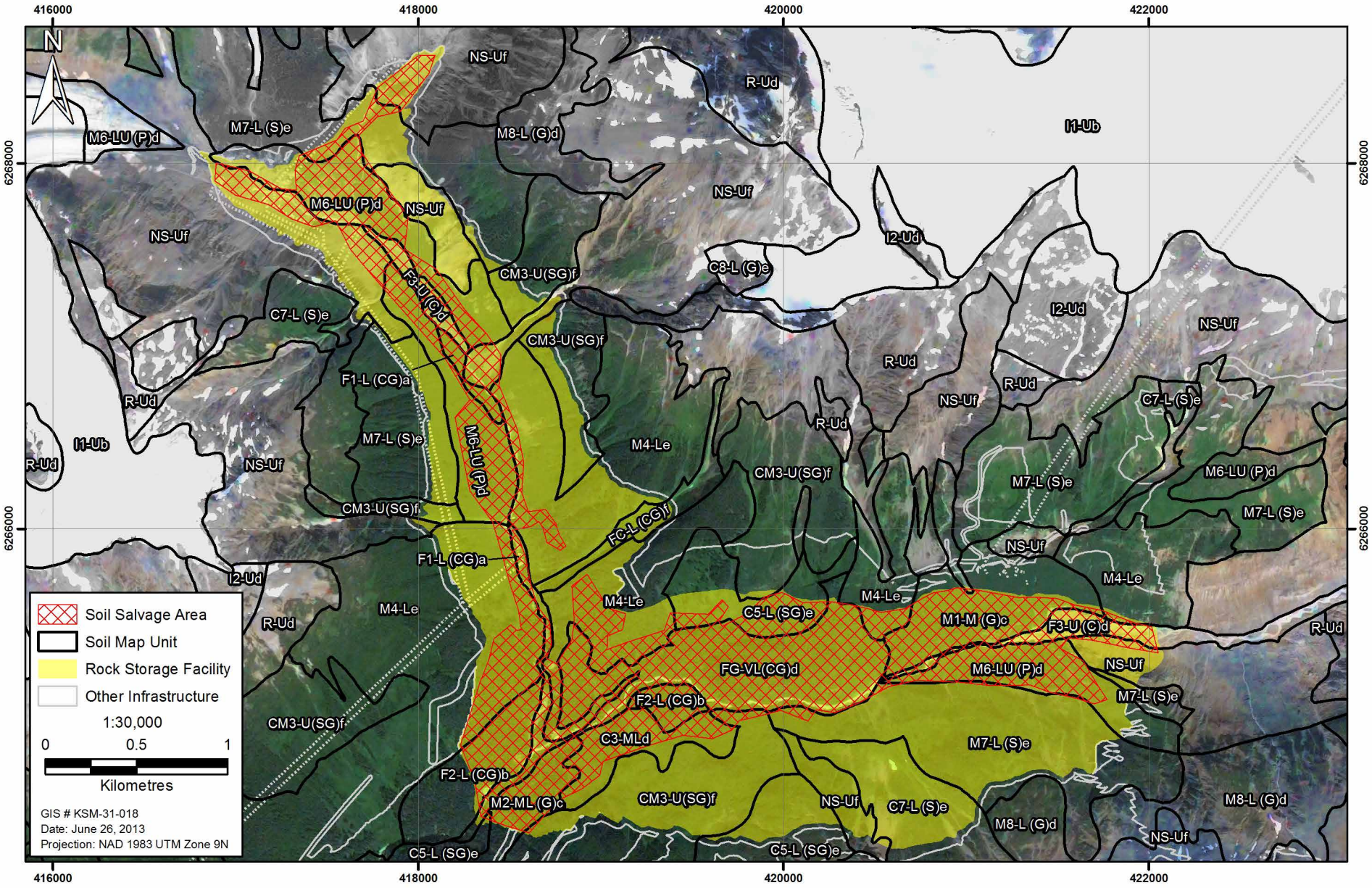

Figure 27.4-5

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Soil Suitability for Reclamation in Rock Storage Facilities' Footprints

Figure 27.4-5

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Table 27.4-3. Soil Salvage Potential in the McTagg and Mitchell Rock Storage Facilities

Rock Storage Facilities	Soil Mapping Unit	Suitability	Major Limitation	Area (ha)	Percent
McTagg	M6	Low	Gravelly, Pockets	75.6	24%
McTagg	F1	Unsuitable	Coarse	6.9	2%
McTagg	FC	Unsuitable	Coarse, Gravelly	8.5	3%
McTagg	F3	Unsuitable	Coarse	6.9	2%
McTagg	C7	Unsuitable	Steep (50-70%)	0.2	0.1%
McTagg	M4	Unsuitable	Steep (50-70%)	94.5	30%
McTagg	M7	Unsuitable	Steep (50-70%)	31.5	10%
McTagg	CM3	Unsuitable	Steep (>70%)	23.1	7%
McTagg	NS	Unsuitable	Non-Soil	66.0	21%
TOTAL				**313.3**	**100%**
Mitchell	M1	High	Coarse, Gravelly	26.9	6%
Mitchell	F2	Low	Coarse	22.7	5%
Mitchell	M6	Low	Gravelly, Pockets	27.0	6%
Mitchell	C3	Moderate Low	Gravelly	23.5	5%
Mitchell	M2	Moderate Low	Gravelly	13.5	3%
Mitchell	F1	Unsuitable	Coarse	7.2	1%
Mitchell	F3	Unsuitable	Coarse	10.3	2%
Mitchell	FG	Unsuitable	Coarse, Gravelly	71.7	15%
Mitchell	NS	Unsuitable	Non-Soil	24.5	5%
Mitchell	CM3	Unsuitable	Steep (>70)	58.1	12%
Mitchell	C7	Unsuitable	Steep (50-70%)	34.3	7%
Mitchell	C5	Unsuitable	Steep (50-70%)	33.9	7%
Mitchell	M4	Unsuitable	Steep (50-70%)	48.4	10%
Mitchell	M7	Unsuitable	Steep (50-70%)	86.4	18%
TOTAL				**488.5**	**100%**

The quality of the soils for reclamation will vary. Where subsoil will be salvaged, the surface soil will be salvaged and stored separately from suitable subsoil/overburden. Where soils are shallow, soils will be salvaged in a one-lift system. One-lift systems will also be used in areas of steep terrain where it is impractical to separate the topsoil from the subsoil. In areas where the soil that is suitable for reclamation is shallow to bedrock (less than 1 m thick), the entire zone will be salvaged in one lift. Soil is assumed to be salvageable separately from overburden in terrain with slopes with a gradient of less than 50% and therefore, in these areas, the soil will be stripped in two lifts.

The goal is to preserve as much as possible the quality of the soils that will be salvaged for reclamation purposes, recognizing that some soils will be stockpiled for as long as 55 years. Poor handling methods can degrade soils, which may reduce the success of final reclamation. Soils should not be salvaged at times when they are excessively wet as this will degrade the soil

structure. Organic soils and poorly-drained mineral soils with a peaty capping also require special handling because of their high water content and associated poor structural strength and storage problems. The organic layers will be handled and stored separately from other reclamation materials in areas where containment is provided. It is preferable to salvage these materials when they are frozen because of their poor consistency. Some pre-stripping and site drainage improvements (especially perimeter drains) may be required to increase the potential for frost penetration into these materials before winter salvage.

27.4.2.2 Salvage Equipment

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

Equipment used to handle organic soils is often mounted on wide tracks to accommodate their low bearing strength. Backhoes equipped with clean-out buckets are usually best suited for this application as they allow the operator to view the clean separation of the organic material from the underlying mineral material. In areas of extensive organic soils, floating backhoes may also be used.

27.4.3 Stockpiling

It is assumed that all salvaged soil will be placed in stockpiles because direct replacement is not possible for the majority of the site. Though very limited in extent, the potential for direct replacement of soil materials in areas no longer required for mining or other mine-related disturbances will be maximized.

27.4.3.1 Stockpile Construction

Differentiation will be made between the salvaged surface soil, subsoil/overburden, and organic soil. Separate stockpiles/storage areas will be developed, as required, to maintain the integrity of each material. Materials will be stockpiled in stable areas and vegetated to reduce potential erosion.

The topsoil stockpiles can be placed directly on native soils. The topsoil will be salvaged from the footprints of the overburden storage areas prior to constructing the overburden (subsoil) stockpiles.

27.4.3.2 Siting

The soils will generally be stockpiled near the sites from which they have been salvaged because each site will be reclaimed with soils salvaged from it.

The stockpiles will be located in specific types of area. These will include:

- areas that will not be disturbed by other mining activities before the soil is needed for reclamation purposes;
- areas of good trafficability (good drainage and level to moderately-sloping);
- areas set back from drainage courses (permanent and ephemeral);
- areas located away from potential geohazards (slides, avalanches, and flooding); and
- areas of past disturbance, if available, to minimize incremental disturbance.

The soils salvaged from the RSFs will be located in the Ted Morris Valley (see Figure 27.5-31). The soils stockpiled from the Treaty Process Plant site and the TMF area will be stockpiled at the Treaty Process Plant area. For linear disturbances, the salvaged soil materials will be stored, where practical, in windrows next to the disturbance, or in stockpiles in nearby stable terrain.

27.4.3.3 Configuration

The stockpiles will be designed according to the following standards:

- with slope gradients that are geotechnically stable, constructed in 2 m lifts with an average overall outer slope of 3:1 (horizontal: vertical);
- with slopes that can be readily re-vegetated (have received alteration, such as tracking, or that are placed loosely that both reduces the potential for sheet and rill erosion and increases suitable micro sites for seedling establishment);
- with benching to reduce slope lengths;
- with surface drainage to convey concentrated runoff to the toe of the stockpile without causing erosion; and
- with a perimeter toe ditch with basins to capture initial sediment flush.

27.4.3.4 Erosion Control

Stockpiles and disturbed areas will be subject to erosion. Therefore, they will be re-vegetated as soon as possible with a rapidly establishing native seed mix suited to the climate in the Project area to reduce potential erosion.

The dominant Biogeoclimatic Ecosystem Classification (BEC) zone (below the alpine) is Wet Very Cold Engelmann Spruce–Subalpine Fir Subzone. The following is a suitable erosion control mix for this BEC zone that can be used for erosion control:

- 25% annual/perennial or Italian ryegrass;
- 40% creeping red fescue;
- 10% Kentucky bluegrass;
- 7% timothy;
- 8% reed canary grass; and
- 10% alsike clover.

The grasses are sod-forming and the clover is a legume, which is a nitrogen fixer. This mixture can be applied at a rate of 20 kg/ha on topsoil stockpiles, and 40 kg/ha on subsoil stockpiles.

Native seed, vegetative matter, and organic matter included with salvaged topsoil will increase the complexity of the vegetation growing on the stockpiles. Native plants from adjacent areas will also encroach into re-vegetated areas and will increase the vegetative complexity in those areas. The stockpiled overburden materials will likely also require fertilizer. Where available, drained organic soils will be mixed with overburden to increase the organic matter of the overburden.

Hydromulching may be used on relatively steep, non-trafficable slopes providing an immediate protective cover (mulch/tackifier) in sensitive areas, such as near waterways.

27.4.4 Materials Balance

There are approximately 47 separate facilities that form part of the KSM Project. They range in area from less than 5 ha, such as some of the construction camps, to 1,660 ha for the TMF. The total area that will be disturbed by the end of mine operation will be approximately 4,195 ha. Following the 51.5 year mine life, the majority of the Mine Site will be closed, decommissioned, and/or reclaimed. Some facilities, such as the pits, will not be reclaimed, but will be decommissioned. Other facilities will remain in operation during the post-closure phase, such as the WSF and the Water Treatment Plant, so they will neither be decommissioned nor reclaimed. The Process Plant and TMF will be closed and reclaimed. Soil will only be required for those facilities that will be reclaimed.

27.4.4.1 Rock Storage Facilities

Reclamation of the RSFs will be focused on the slopes of the constructed RSFs. The surface area of the slopes of the RSFs will be approximately 4.4 Mm^2. The reclamation goal is to have a 50 cm thick soil cover on the slopes to provide sufficient water storage capacity, primarily to support a forested ecosystem. Therefore 2.2 Mm^3 of soil will be required to reclaim the RSFs.

The soils that will be salvaged from the RSF areas prior to development range in their suitability based on the subsoil and topography (see Figure 27.5-4). The steep topography in the RSF footprints will limit access to some of the soils suitable for reclamation (see Figure 27.5-2; Table 27.5-2), as equipment can only access soils that are located on a slope of less than 26°. Based on the extent of salvageable areas with gradients below 26°, approximately 2.2 Mm^3 of soil will be salvaged. This will include topsoil and subsoil.

The benches of the Kerr waste rock backfill located below 1,100 m in the Sulphurets Pit, based on a 50-cm cover thickness, will require approximately 61,000 m^3 of soil for reclamation. It is expected that this material will be sourced from various areas, such as the borrow pit area for the Water Storage Dam (WSD). This extra soil material will also be stored in the stockpiles located in the Ted Morris Valley.

27.4.4.2 Tailing Management Facility

Following closure of the TMF, a 50-cm cover of till will be spread on the TMF beaches. The beaches will have a 0.5% slope, so it is assumed that the till thickness will be roughly 50 cm over most of the surface, gradually thinning toward the edges. The beaches will occupy approximately 9,285,633 m^2 or 929 ha. The dam faces (the North and Southeast dams) will occupy approximately 1,363,364 m^2 or 135 ha. The dam crests, which will be used as rights-of-way for wildlife, will occupy approximately 65,881 m^2 or 6.6 ha. Approximately 1,071 ha of the TMF will be reclaimed, including the dam faces and beaches. Based on these plans, approximately 5,364,028 m^3 of soil or till is required for closure of the TMF (Table 27.4-4).

Table 27.4-4. Materials for Reclamation of the Tailing Management Facility

	3D Area		Rip-Rap		Soil	
Feature	**(m^2)**	**(hectares)**	**Depth (m)**	**Volume (m^3)**	**Depth (m)**	**Volume (m^3)**
N dam face	656,020	65.6	0.5	328,010	0.5	328,010
N dam crest	37,880	3.8	0	0	0.6	22,728
Beach	9,285,633	928.6	0	0	0.5	4,642,817
SE dam crest	28,001	2.8	0	0	0.6	16,801
SE dam face	707,344	70.7	0.5	353,672	0.5	353,672
Total	**10,714,878**	**1,071.50**		**353,672**		**5,364,028**

N = North; SE = Southeast.

27.5 Closure and Reclamation Planning

27.5.1 Introduction

This section describes the closure and reclamation approaches that will be used to close the various Project facilities and reclaim the Project area. It also includes a description of the design of new landforms created to meet the closure goals of minimizing long-term potential effects on the environment, and describes the plans for facilities that will not be closed, such as the Water Storage Facility (WSF). Reclamation will be carried out in most areas. This will include placement of soils and planting of suitable plant species.

Figures 27.5-1 and 27.5-2 show the Mine Site at closure and post-closure and Figures 27.5-3 and 27.5-4 show the PTMA at closure and post closure (see map pockets). These maps indicate the Project facilities that will be closed and reclaimed during the closure phase.

Facilities closed and reclaimed during the construction and operation phases (see Figures 4.1-2 to 4.1-5 in Chapter 4), are not indicated on the closure maps. Facilities that are closed during the closure phase are not shown on the post-closure maps.

27.5.2 Mine Site

27.5.2.1 Mitchell Pit and Block Cave Mine

27.5.2.1.1 Closure

Open Pit

The Mitchell deposit will be mined as an open pit from Year -2 to Year 23 and as an underground block cave mine from Year 26 to Year 52. The open pit operations will be developed using conventional drill and blast methods to break the rock to a size suitable for loading and transportation by haul truck. The overall pit slope angles at the end of the mine life will vary from 34° to 54°, based on wall orientation and stability (Figure 27.5-5). 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 slope includes 20 m-wide benches every five double benches (150 m). The pit will have an ultimate wall height of approximately 1,200 m. Closure of the Mitchell Pit includes backfilling with water to form a pit lake and placing large rocks on the benches to discourage wildlife access to the pit lake. The Mitchell Pit cannot be backfilled with water until underground mining is completed.

Underground Mining

The Mitchell Block Cave Mine will extend the depth of resource extraction an additional 180 m below the pit floor. Underground mining will be conducted using the block caving method. The development of the underground mine will involve constructing a primary access ramp and conveyor drifts adjacent to the open pit. Personnel, materials, and supplies will access the underground through a main access ramp, which will have been developed from a portal near the Mitchell Ore Preparation Complex (OPC) area at an 820-masl elevation. The access ramp from the surface will be sloped at 15% with a total length of 6.3 km. It will be 5 m high by 5 m wide to accommodate underground equipment, including crusher components. A second ramp to the surface will be excavated to accommodate the ore conveyor. The conveyor tunnel portal will be located 100 m from the main access ramp portal, and both ramps will have been connected every 300 m. The conveyor decline will be separated into two arms, each approximately 2 km long and sloped at approximately 17%. It will be designed to be 5.5 m wide and 4.5 m high, with the belt secured on floor supports.

The floors of the extraction drifts and draw points will be concreted for the load-haul-dump vehicles. The ore pass will be 4 m in diameter, and will be equipped with a 1-m-by-1-m grizzly. The ore passes from neighbouring extraction drifts will feed a stationary rock breaker on the secondary breaking level. This process will reduce the size of the material further by passing through a grizzly. The ore pass will be 4 m in diameter. The ore pass will be equipped with a chute that will feed a train running on the haulage level.

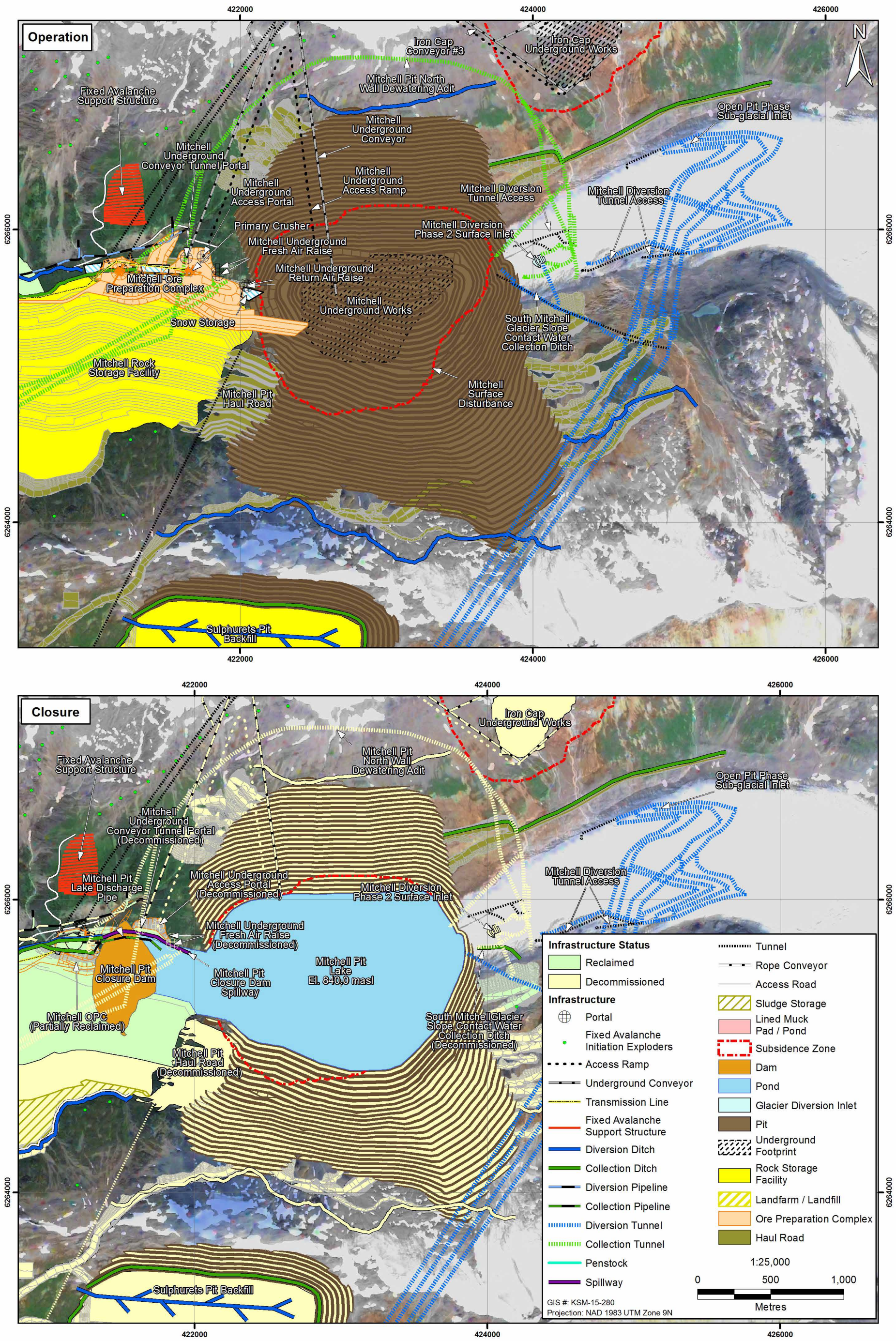

Figure 27.5-5

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Mitchell Pit at End of Operation and at Closure

Figure 27.5-5

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The secondary breakage level will be designed to provide access to stationary rock breakers. The broken material will be hauled by train on the haulage level. The secondary haulage level will be located approximately 40 m below the extraction level, and will be large enough to accommodate a load-haul-dump vehicle. The broken ore will be hauled by train to one of two gyratory crushers. A typical cross-section of the drift will be 5 m wide by 5 m high to accommodate the loaded cars under the chutes. There will be two conveyors fed by the gyratory crushers on the haulage level. The first conveyor will be connected to a larger main conveyor that will haul the broken ore to the surface. On the surface, there will be a small trunk conveyor to bring the ore to the main Mitchell/Treaty ore conveyor.

The main ventilation equipment will include two 3,000-HP and one 900-HP surface fans. There will be two 6-m-diameter fresh air raises. Both will have a fan providing 370 m^3/s of air, and both will have heaters to heat the underground mine air.

Water will be supplied by gravity, and will be delivered to the working face through a 0.2-m steel pipe. Groundwater and surface water accumulating during operation will be removed from the underground mine by pumps. Compressed air will be supplied by two compressors through steel pipes located underground.

Surface buildings and a small warehouse will be constructed next to the shop located off of the main access tunnel. Refuge stations will be located underground at each crusher. These refuge stations will also act as underground offices.

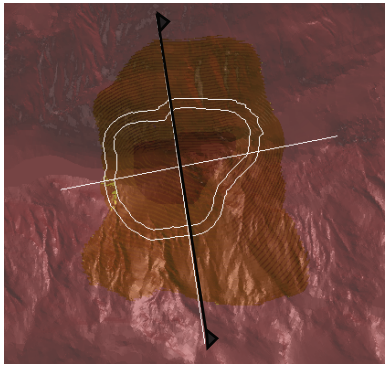
Closure of the Block Cave Mine

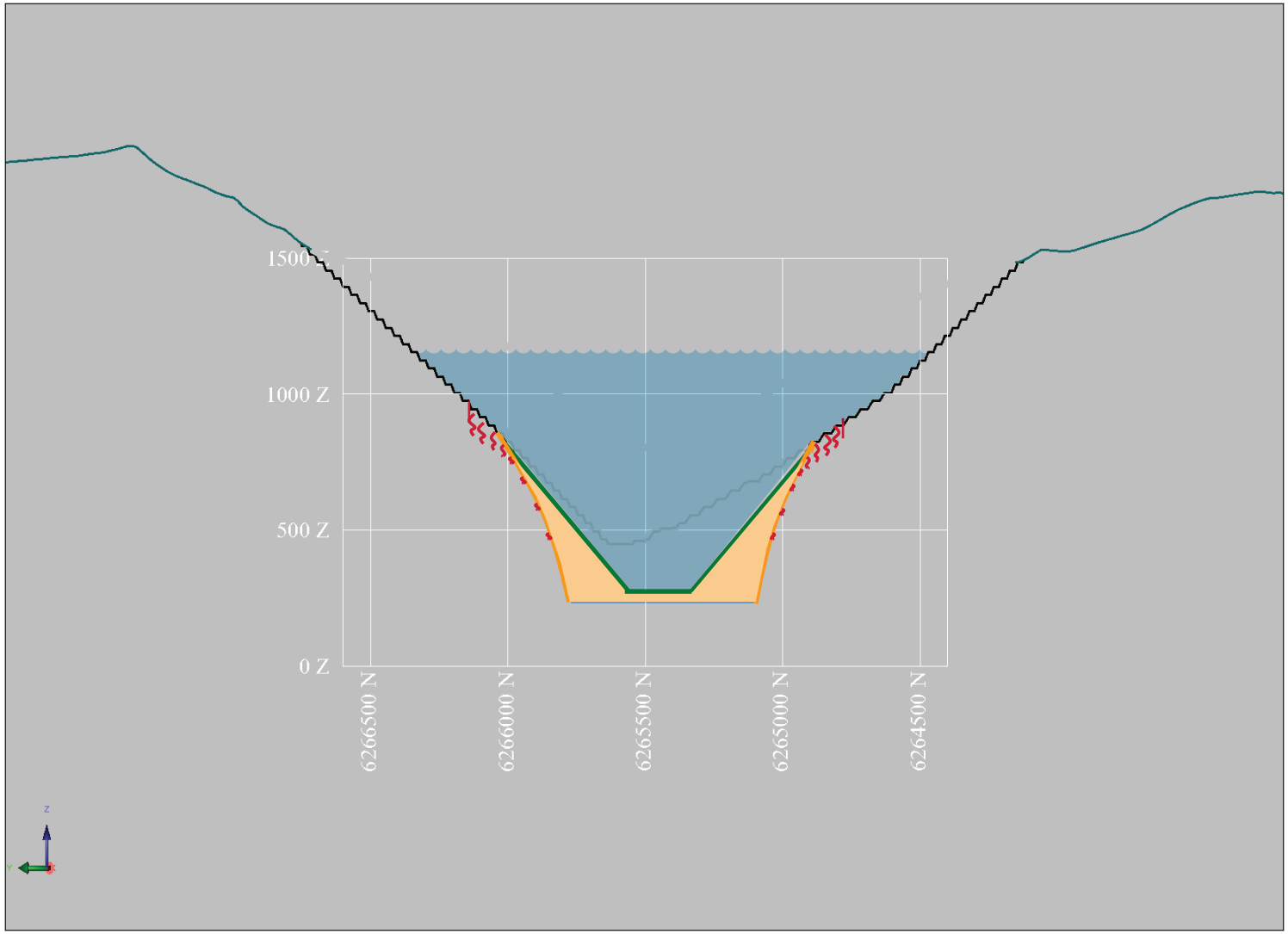
At closure, all mobile equipment and supplies will be removed and transported off site. The major infrastructure, such as crushers, rockbreakers, and conveyors will be left in the mine. Oils will be drained from motors, gears, and electrical equipment, and will be removed from the site. Explosives, chemicals, and lubricants will be removed from underground. All electrical cable and piping will be left in the mine. All surface ventilation fans will be removed. All openings to the surface will be sealed with engineered concrete plugs.

By the time block caving is completed, the area within the pit directly above the block cave footprint will have subsided into a block cave crater. A region of instability will exist around the block cave crater (Figure 27.5-6). These zones of instability will propagate further upwards along the pit slopes.

Closure of the Mitchell Pit

The Mitchell Pit will be partially flooded when underground mining is completed (Figure 27.5-5). Flooding of the pit will start in Year 52 and will take five years. Approximately 320 Mm^3 of water will be required to flood the pit to an 810-m elevation. The water will be supplied from three sources. The water collected from under the Mitchell Glacier will provide approximately 88% of the water to flood the pit. Approximately 9% of the water used to flood the pit will be supplied from the Mitchel Pit north wall dewatering adit. This adit will also collect contact water from the toe of the Mitchell Glacier. The remaining 3% of the water used to flood the pit will be supplied from precipitation and non-contact runoff. Precipitation is estimated at 2%, and surface runoff is estimated at 1%.





LEGEND

- Pit
- Final Floor
- Subsidence
- Cracking
- Water
- Rock Fill

Figure 27.5-6

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Mitchell Pit Block Cave Mine at Closure

Figure 27.5-6

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The Mitchell Pit closure dam will be constructed on the west side of the Mitchell Pit to allow for controlled discharge (Figure 27.5-5). The Mitchell Pit closure dam will be largely constructed with mine rock from the Mitchell RSF. It will have an acid-resistant asphalt core keyed into shallow bedrock near the pit rim. The dam will be located outside the zone of instability caused by subsidence of the block cave works. The crest of the closure dam will be constructed to an 870-m elevation. This will provide 60 m of freeboard above the normal pit lake. This freeboard will accommodate potential impact waves caused by landslides (e.g., a potential failure of the north or south pit wall slopes, initiated from above the pit lake) or avalanches that may enter the pit lake (Appendix 4-E).

Storm flows from events of less than 20 m^3 will be retained in the pit lake and will slowly be bled off to the WSF via the Mitchell Pit Lake discharge pipe located on the north side of the dam. This water will flow to a lined channel (North Slope collection ditch for contact water) to the WSF. The Mitchell Pit closure dam spillway will route storm flows from the pit lake associated with higher flow events to the North Slope collection ditch, which will be constructed along the north side of the Mitchell Creek Valley. The North Slope collection ditch will route extreme floods to the WSF.

As noted above, large rocks and debris will be placed on the exposed Mitchell Pit benches to reduce the potential for wildlife access to the pit lake

The Mitchell Pit north wall dewatering adit (Figure 27.5-5) will be 4.5 km long. It will no longer be required when the pit is flooded. However, the adit promotes dewatering of the pit slope, which will add to slope stability. The tunnel will be left to drain. It will be plugged with a granular plug with a low enough permeability to back up a few metres of water in the tunnel to prevent acid rock drainage in the tunnel, but the plug will not be impermeable enough to hold back groundwater from the 500-m-high pit slope.

Two twin 6-km long drainage tunnels (the Mitchell underground drainage tunnels) will be used to dewater the underground works during operation. These tunnels will be approximately 7.5 m high by 7.5 m wide. At closure, each of these tunnels will be sealed with an engineered concrete plug.

27.5.2.2 Sulphurets Pit

27.5.2.2.1 Closure

Once the Sulphurets Pit has been mined out in Year 27, mining operations will shift to the Kerr Pit. The Sulphurets Pit will then be backfilled with the waste rock from the Kerr Pit (Figure 27.5-7). The Kerr waste rock is predicted to have elevated selenium concentrations, so it will be placed in the Sulphurets Pit to allow for the management of selenium.

The Sulphurets Pit backfill will be constructed from the bottom up. Basal drain material will be placed in the bottom of the Sulphurets Pit to provide drainage of the base of the pit and any water that has moved through the Kerr backfill. Kerr waste rock will then be placed in the pit in 50 m lifts with 22 m-wide benches. The outer edge of each bench will be lined with synthetic liner for a width of 100 m such that 78 m of the liner will be covered by each subsequent lift. This will provide an internal barrier to downward movement of water within the backfill (waste rock). The benches will have a 2% slope to enable water on the benches to drain out toward the edge of each bench.

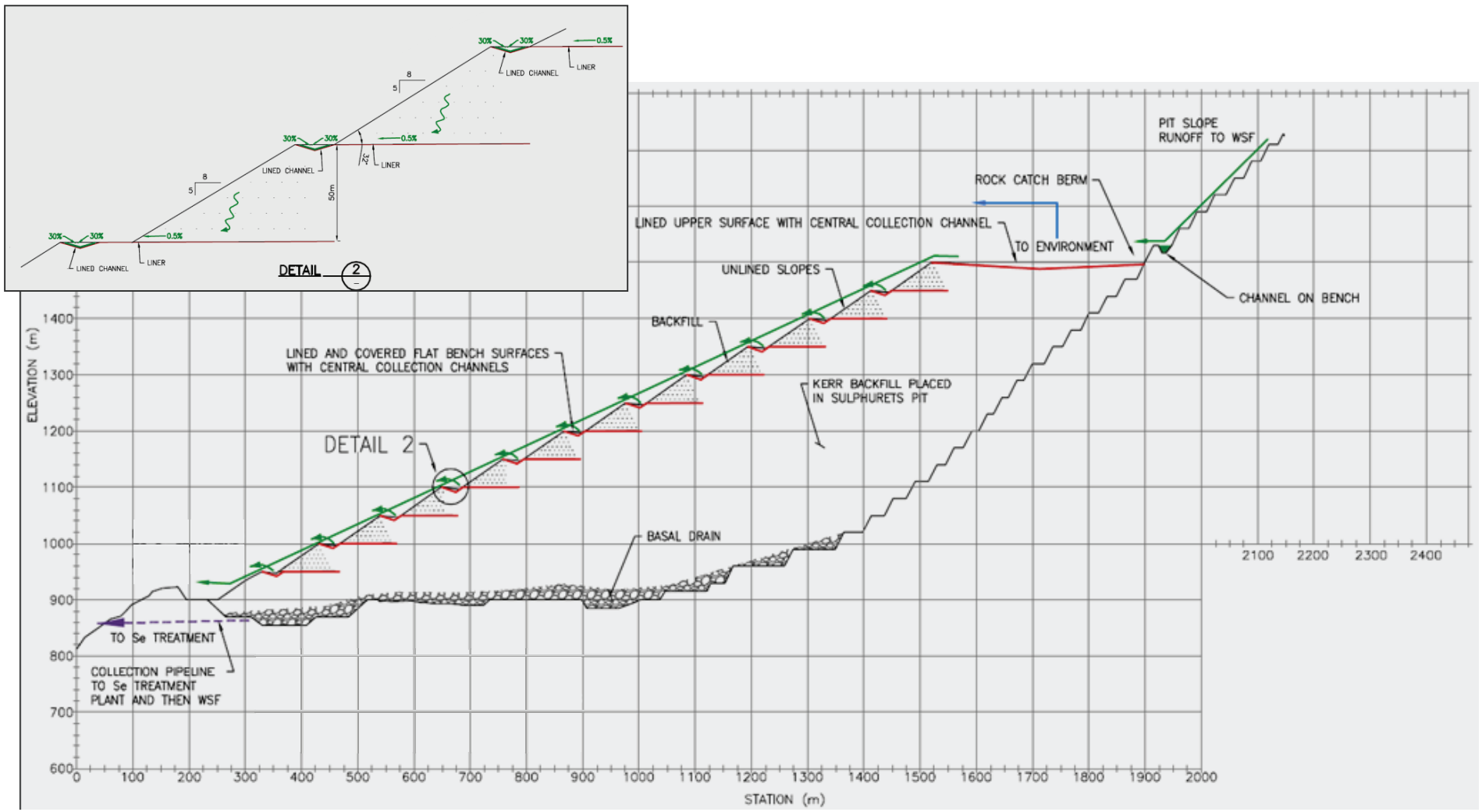

Figure 27.5-7

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Sulphurets Pit Backfill with Kerr Pit Waste Rock

Figure 27.5-7

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A central collection channel will be located on each bench to capture precipitation and water that enters the inter-bench sloping area. The water collected in the central collection channel will be directed along the benches to a 10-m-wide rock-cut step spillway constructed along the Sulphurets Pit wall from the top of the pit to the bottom (Figure 27.5-8). A channel will be built on the Sulphurets Pit bench just above the Kerr backfill. This channel will drain water to the rock-cut stepway to prevent runoff from upper Sulphurets Pit walls and benches from flowing onto the lined top of the waste rock. The water from the spillway will flow to a control weir. It will be directed to a 10-m-wide stepped spillway (Figure 27.5-8) and to a pipeline to the Selenium Treatment Plant or WTP.

Precipitation occurring on the lined Kerr waste rock will be non-contact water. It will be directed to an existing stream adjacent to the top of the waste rock. Once the backfill is completed, more than 95% of the surface will be covered with a liner.

The upper Sulphurets haul roads will be decommissioned when mining of the Sulphurets Pit is completed and when the pit has been backfilled. These roads have extensive areas of cut and fill. The cut and fill areas will be re-graded to provide stability to the road edges. All culverts will be removed to allow for the restoration of natural drainage. The road surfaces will be cross ditched to allow drainage across the surface, and they will be ripped to reduce the potential for surface erosion. Culverts will be removed off site for reuse or recycling.

Similar treatment of the lower haul road will be carried out. However, this road will be required to monitor the Kerr waste rock backfill. Therefore, the road will be narrowed from 38 m to 15 m and ditched according to forest road standards.

27.5.2.2.2 Reclamation

The Sulphurets Pit benches will be reclaimed with a 30-cm layer of protective gravel that will be placed on the liner surface, and with a 30 cm soil cover layer that will be placed over the top of the gravel layer. These benches will be re-vegetated (Figure 27.5-9) with native grass seed mix such as:

- fescue (western, Rocky Mountain, red);
- alpine timothy;
- mountain brome;
- hair bentgrass;
- blue wildrye; and
- Alaska (Sitka) brome.

Pocket trees of subalpine fir and hybrid white spruce will also be placed in the inter-bench area.

Any available stored topsoil material will be spread on the surface of the haul roads and will be re-vegetated with native grasses, as above, and with tree seedlings such as subalpine fir and hybrid white spruce.

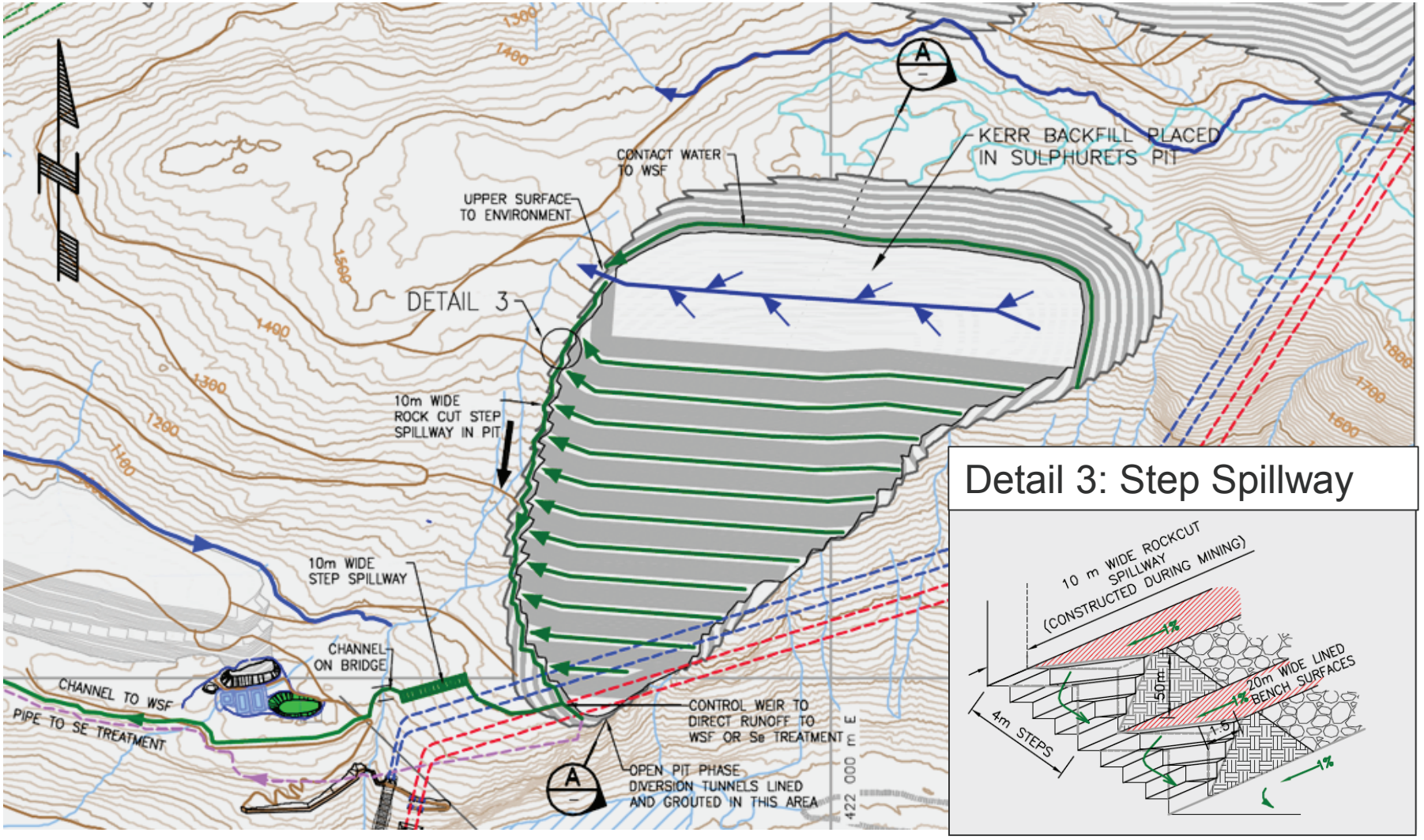

Figure 27.5-8

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Water Management on Kerr Waste Rock

Figure 27.5-8

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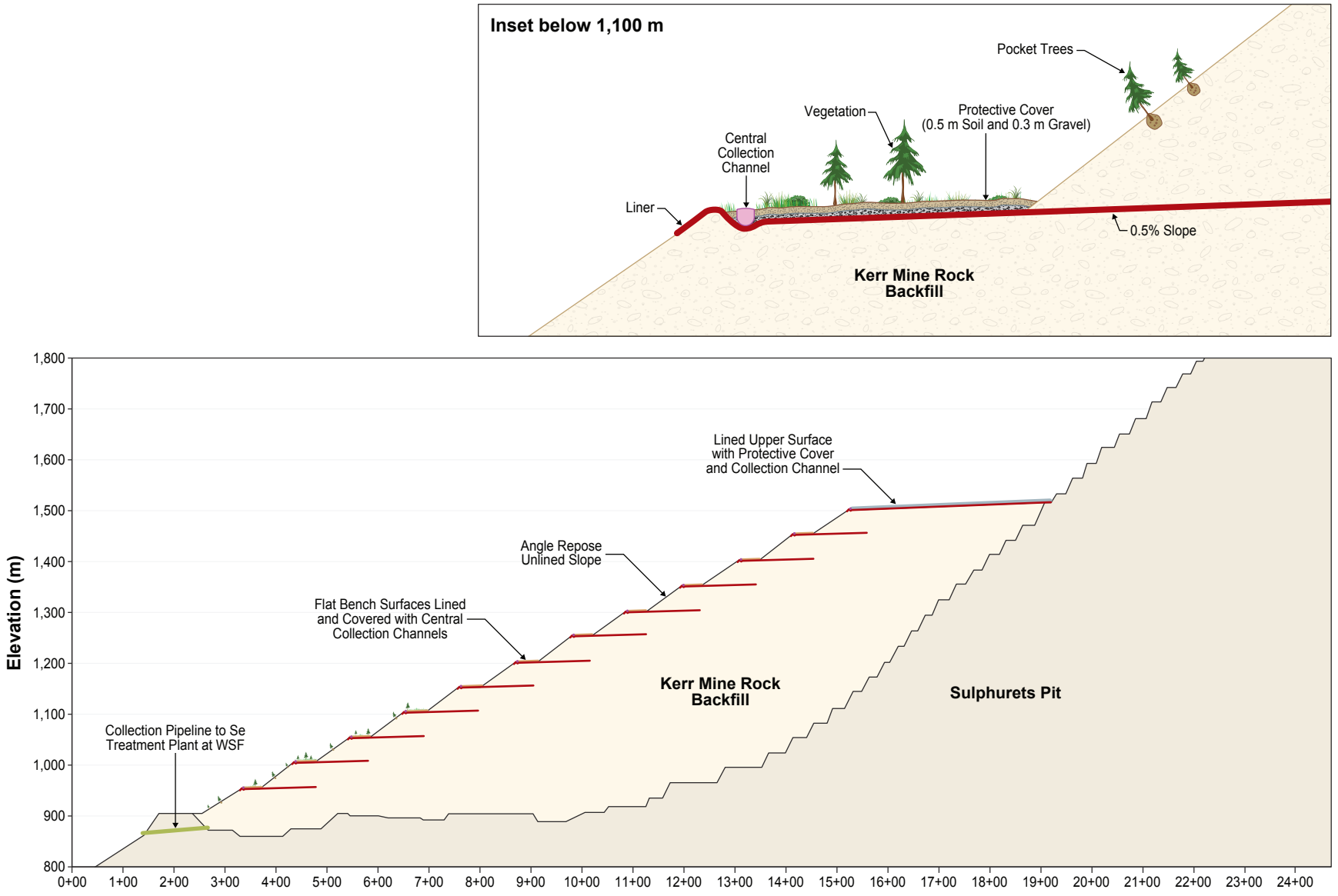

Figure 27.5-9

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Closure and Reclamation of the Sulphurets Pit Backfill

Figure 27.5-9

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27.5.2.3 Kerr Pit

27.5.2.3.1 Closure

The Kerr Pit will be located on the south slope of the Sulphurets Valley, directly south of the Mitchell Valley. The pit will have steep sidewalls and benches. The inter-bench slope angle will vary from 34° to 50°, and pit slopes will be approximately 600 m high (Tetra Tech-Wardrop 2012). The ultimate pit will be approximately 2 km by 0.5 km. The pit will be separated from the Mitchell OPC by the Sulphurets Creek Valley and Sulphurets Ridge.

The ore and waste will be transported across the Sulphurets Creek Valley to the Sulphurets Pit by the Kerr rope conveyor. At the end of mining, the Kerr rope conveyor will be dismantled and moved off site, where parts will be reused or disposed of in an appropriate facility.

During operation, the Kerr Pit will have a dewatering system, which will be designed to route contact water from the Kerr Pit. The system will include a pipeline that will be sized for the 25-year 24-hour flood event. The pipeline will route the floodwater down through the South Sulphurets Creek Valley, across the Sulphurets Creek bridge, past the Water Treatment Plant (WTP) and Selenium Treatment Plant to the WSF. The pipeline will be a high-density polyethylene-lined steel pipe, buried where possible.

At the completion of Kerr Pit mining, the bottom of the pit will be at a 960-masl elevation and the pit rim will be at a 1,056-masl elevation Appendix 4-Q). The 200-year 24-hour flood inflow volume of approximately 81,000 m^3 would raise the water level to 968 masl (i.e., a water depth of 8 m). Therefore, the pit will safely store a 200-year flood and will pass the flood via the pipeline, installed at 960 masl, to the WSF. Therefore, under normal conditions, the pit will remain drained.

The Kerr Pit external haul roads will be decommissioned. The cut and fill slopes will be re-graded for stability, where required. The culverts will be removed, and cross ditches will provide drainage. The surface will be ripped to reduce surface erosion. Any available stored topsoil material will be spread on the surface and re-vegetated. The access road will be retained to permit ongoing inspection of the pit.

27.5.2.4 Sulphurets-Mitchell Conveyor Tunnel and Associated Overland Conveyors

27.5.2.4.1 Closure

A 3-km long Sulphurets–Mitchell Conveyor Tunnel will be used to transfer crushed ore from the Kerr and Sulphurets pits and waste rock from the Sulphurets Pit to the Mitchell OPC. The tunnel will be 5 m high and 6.5 m wide. A belt conveyor will be located inside the tunnel.

At closure, this tunnel will be dismantled and all mobile equipment and supplies will be removed from the tunnel. The non-salvageable electrical cables and conveyor will be left in the tunnel. The south portal, located adjacent to the Sulphurets Pit, and a north portal, located west of Mitchell Pit, will both be sealed with engineered concrete plugs.

The overland conveyors at the Sulphurets Pit (conveyors 1 and 2 to the Sulphurets portal) will be dismantled. The other overland conveyors (the Mitchell ore stockpile feed conveyor and the Sulphurets waste conveyors 1 and 2) will also be dismantled. These conveyors will be moved off site where their parts will be reused or disposed of in an appropriate facility.

27.5.2.5 Iron Cap Block Cave Mine

27.5.2.5.1 Closure

Operation

The Iron Cap deposit will be mined by underground block caving from Year 32 to Year 51. The Iron Cap deposit is at an elevation of 1,210 masl. It is approximately 545 m long in the north-south direction, 570 m wide in the east-west direction, and has an average depth of 400 m.

Personnel, material, and supplies will access the Iron Cap Block Cave Mine through a ramp from the MTT. An ore conveyor tunnel will be developed parallel to the access ramp. The two tunnels will be connected every 300 m. Figure 27.5-10 shows a plan view of the Iron Cap Block Cave Mine layout and major infrastructure.

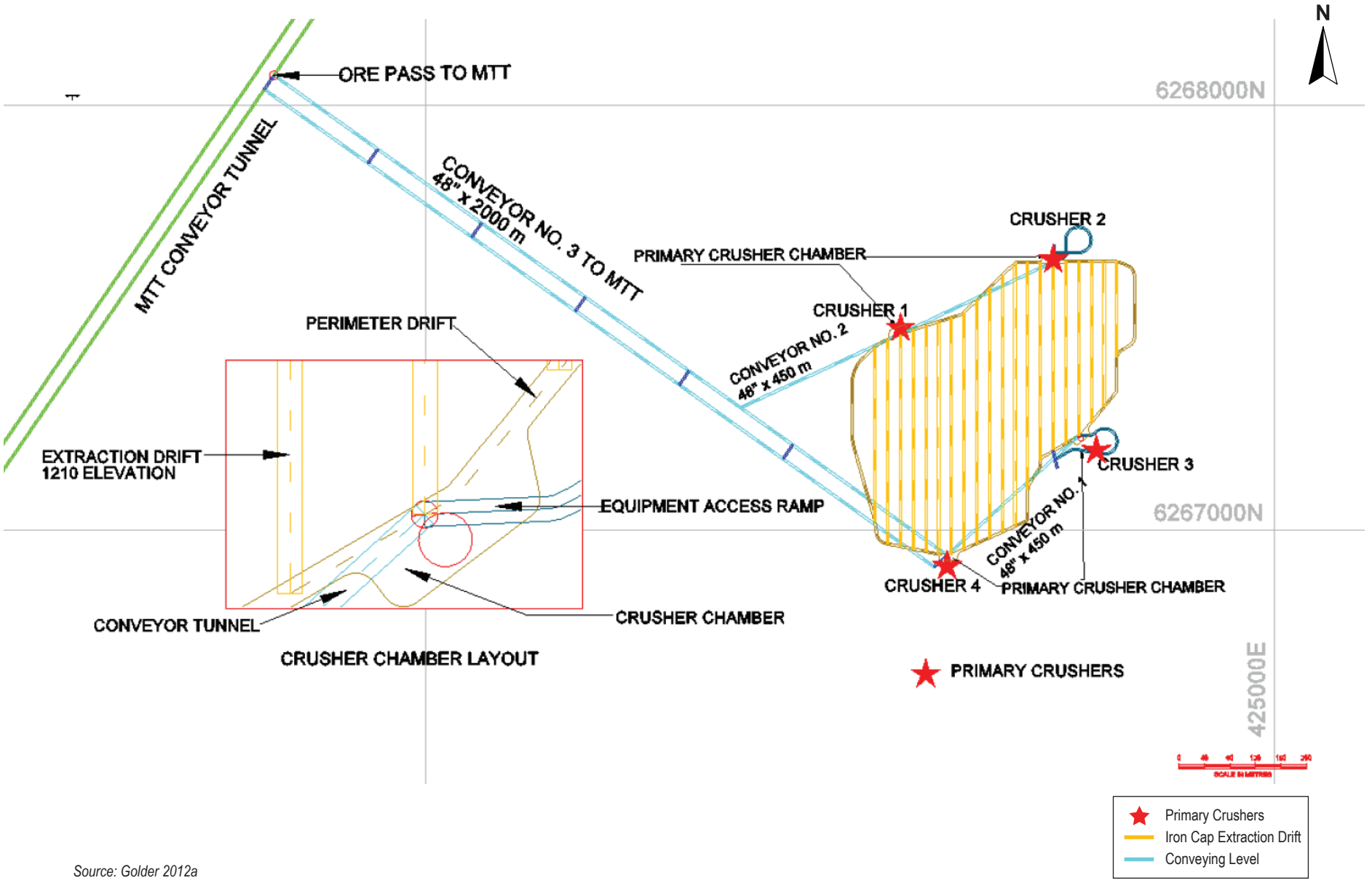
Four gyratory crushers will be used in the underground mine. Crushed ore will be transported by one of two conveyor belts, which will both feed a conveyor that will transport the ore to a 2,000-t surge bin. The main underground ventilation infrastructure will consist of two fresh air portals, two fresh air drifts, a perimeter ventilation drift, multiple internal ventilation raises, and a return air drift. Two 900-HP surface fans will be required for airflow. The floors in the underground mine will be concreted to accommodate the load-haul-dump vehicles.

Mobile equipment typical of underground mines will be used to move ore to the crushers. At peak operation, the Iron Cap Block Cave Mine will require a fleet of approximately 67 pieces of mobile equipment. The actual quantity of equipment underground at any one time will vary, depending on development and production activities and on the equipment replacement schedule.

The underground support infrastructure will include a small warehouse, which will be established next to the shop (located off of the main access tunnel near the north-east crusher). The underground will also be equipped with portable refuge stations, which will also act as underground offices.

Reclamation

At closure, all mobile equipment will be removed from underground and taken off site to be sold or recycled, or disposed of in an appropriate facility. Major equipment and infrastructure such as the crushers, rock breakers, conveyors (including belts), electrical cable, and piping will be left in the mine. Oils will be drained from the motors, and electrical gears will be removed from the site. Explosives, chemicals, and lubricants will be removed from underground. All surface ventilation fans will be removed, and all openings to the surface will be sealed with engineered concrete plugs, with the exception of the return air drifts.



Source: Golder 2012a

Figure 27.5-10

SEABRIDGE GOLD
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Plan View of Iron Block Cave Mine

Figure 27.5-10

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At the completion of mining, the surface inflow water will continue to enter the crater and flow downward through the abandoned works. Drainage from the Iron Cap Underground Works will drain directly from the lower-level ventilation tunnels of the workings by raise bores into the Mitchell Pit north wall dewatering adit. This water is considered contact water and will flow through the Mitchell Valley Drainage Tunnel and into the WSF, pending treatment in the WTP. The system is designed to accept the 200-year peak flow. The underground drifts will collapse following mining, creating a surface disturbance of approximately 96.4 ha (Figure 27.5-11, Iron Block Cave Mine at Closure).

27.5.2.6 Mitchell and McTagg Rock Storage Facilities

27.5.2.6.1 Closure

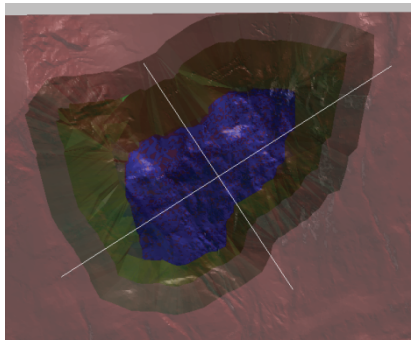
The Mitchell and McTagg RSFs represent two separate but adjacent RSFs that will be joined by a land bridge until the middle of the operation phase. The land bridge will allow waste rock to be hauled from the Mitchell RSF to the McTagg RSF. The land bridge will be removed at the end of the Mitchell open pit operation.

Following the open pit operation, but before closure, two channels will be constructed at an 810-masl elevation along the north side of the Mitchell RSF (Figure 27.5-12). One will handle non-contact water (Mitchell North closure channel), including diverted water from the East McTagg closure channel, and the other will handle contact water, including the outflow from the Mitchell Pit Lake. The fresh water (non-contact) diversion channel will be lined and located on the upslope side of the contact water channel. This will route north-slope runoff water around the WSF. The fresh water diversion will provide a source of water to wildlife.

The contact water will flow to the WSF. To reduce potential wildlife access, large rocks will be placed in the channel carrying contact water to allow flows to run under and through the rock without being accessible to wildlife as open surface water.

The Mitchell RSF will be constructed to a final elevation of 1,200 m, and the McTagg RSF to 1,020 m (Figure 27.5-13) based on the waste rock management plan. The Mitchell RSF will be located on land that has a mean slope of 26° and a maximum slope of 62°. The McTagg RSF will be located on land that has a mean slope of 30° and a maximum slope of 57°.

The RSFs will be constructed in lifts from the bottom up for stability and safety reasons, and to allow for reclamation. The lifts will be 50 m high and will be set back to form benches to permit re-sloping to 26°. This will allow for reclamation without disturbing the ultimate toe of the RSF. Some short 37° talus slopes will be maintained on the upper part of the Mitchell RSF to provide escape terrain for mountain goats, which prefer higher elevations. The area above the water storage pond will be left as a talus slope at the angle of repose (37°), as the water level in the WSF will vary depending on the season and treatment flow rates and the RSF toe will be subject to inundation. As well, the barren, steep talus slope will discourage access by wildlife to the WSF (Figure 27.5-14).



LEGEND

- Topography
- Vertical Cave
- Subsidence Zone
- Cracking Zone
- Final Material
- Rock Fill

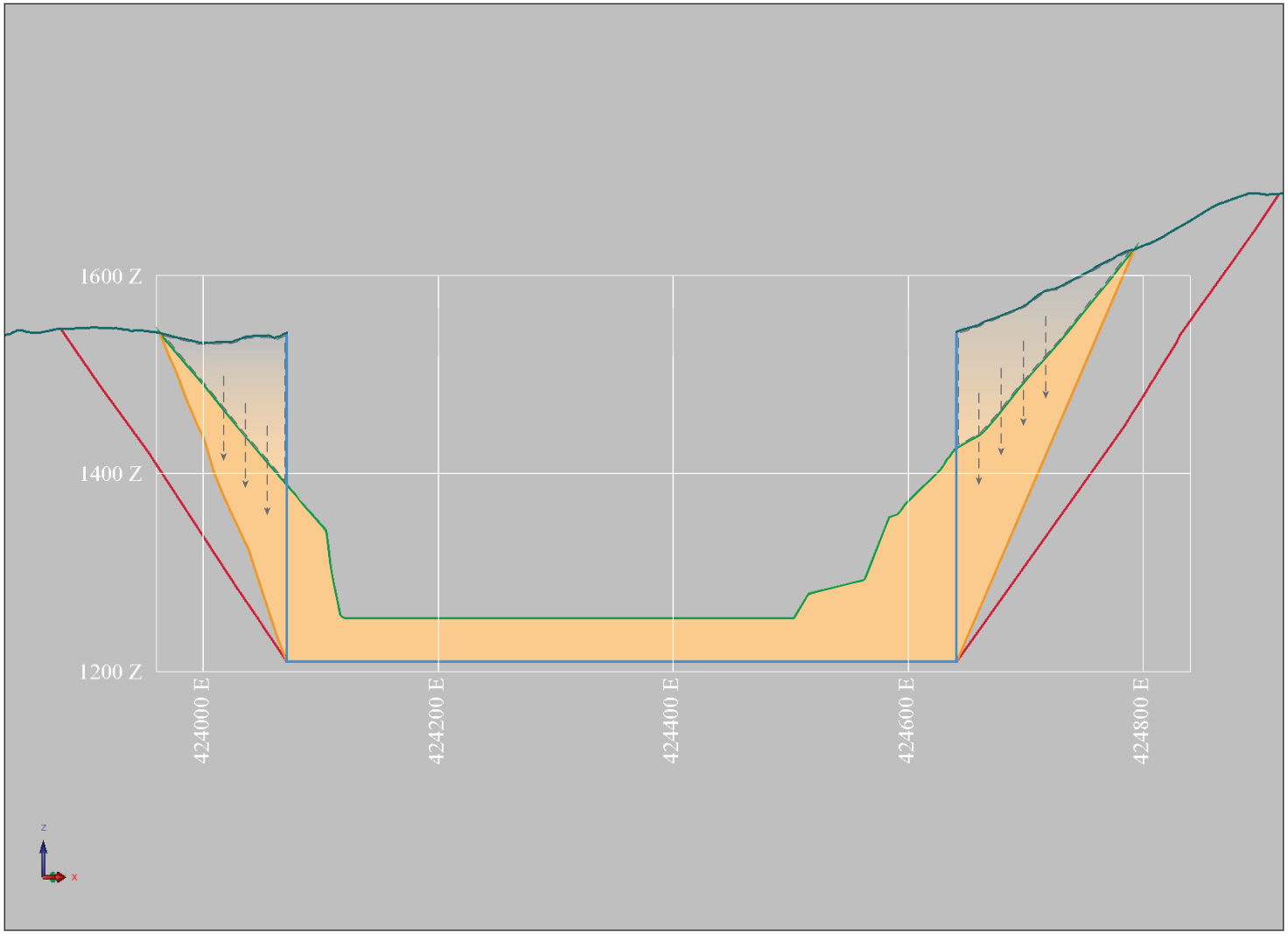


Figure 27.5-11

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Iron Cap Block Cave Mine at Closure

Figure 27.5-11

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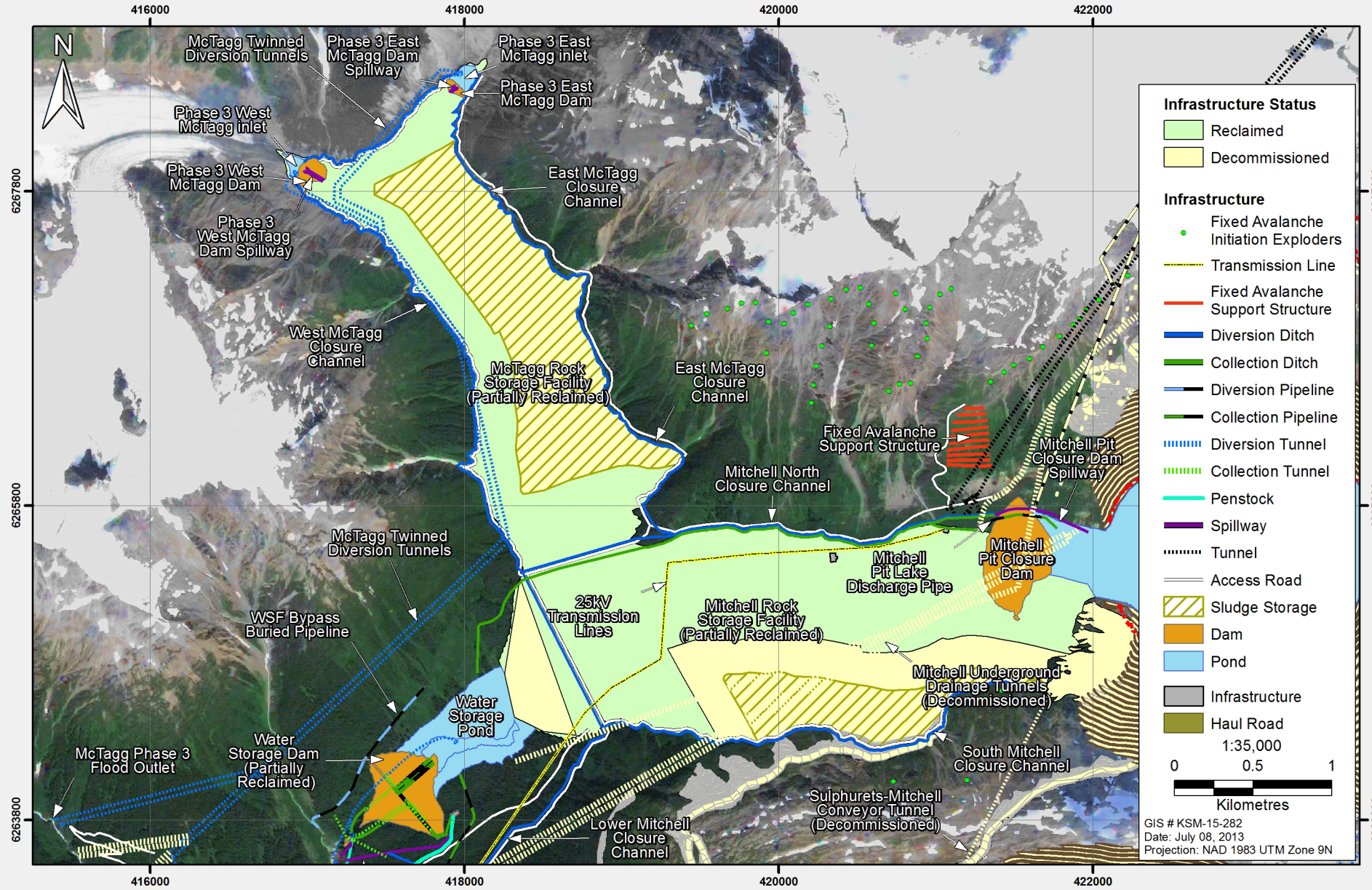

Figure 27.5-12

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Water Management of Rock Storage Facilities at Post-closure

Figure 27.5-12

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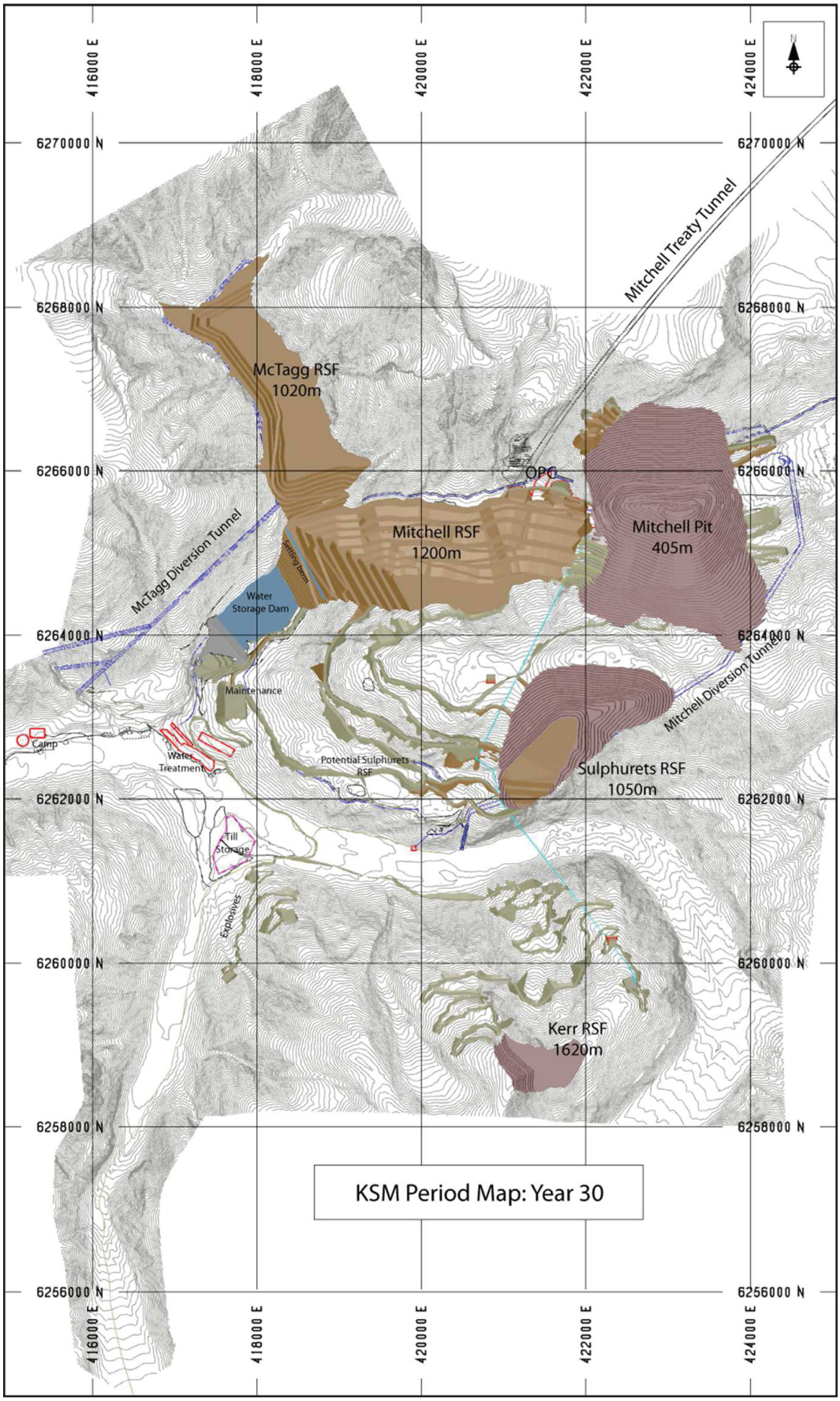

Figure 27.5-13

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Rock Storage Facilities

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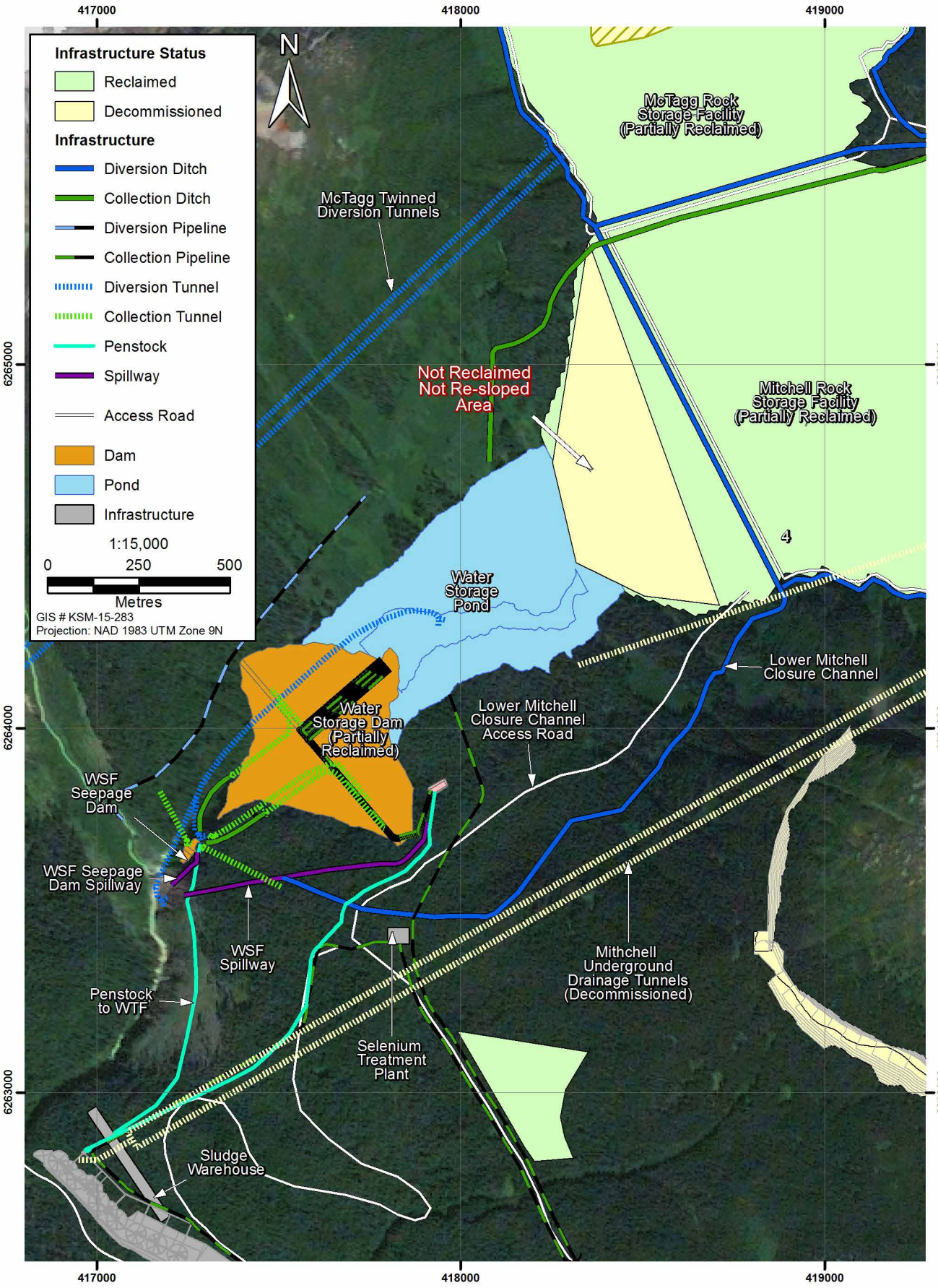

Area Above Water Storage Facility Not Reclaimed or Re-sloped

Figure 27.5-14

SEABRIDGE GOLD
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The tops of the RSFs will be used to construct secure landfills to store sludge from the WTP, for over 200 years. The sludge will be placed in 200-m-by-100-m cells, which will be 8 m deep. These cells will be continuously built up. A till/rock containment berm will be constructed around the edge of the landfills (Figure 27.5-15). A runoff collection channel will be located between the containment berm and the landfill, and this water will flow to the WSF. The landfill will be lined so that minimum seepage and precipitation will enter the RSF. The landfill will be constructed such that the surface will be covered with coarse rock (Figure 27.5-15).

The Mitchell RSF ore stockpile will be located along the northern edge of the Mitchell RSF (Figure 27.5-16). It will occupy approximately 71 ha, will be constructed starting in Year -1, and will have been totally processed by Year 30. Approximately 60% of the pile, or 40 ha, will be located on the RSF, and the other 31 ha will be located just north of the RSF.

27.5.2.6.2 Reclamation

Reclamation will include covering most slopes of the Mitchell and McTagg RSFs with about 50 cm of soil (Figure 27.5-17) to provide sufficient depth and water storage capacity for the establishment and growth of a forested ecosystem. A 50-cm soil depth will also allow for some compaction and for soil to fill interstitial spaces between the rocks and still allow for growth.

The spreading of soils will not occur during high rainfall events, if practical. The most suitable time to carry out soil spreading is the spring, so as to allow sufficient time for the vegetation to become established.

The soils stockpiled in the Ted Morris Valley will be loaded onto trucks using an excavator. The vegetation growing on the surface of the stockpiles will be included because it will increase the amount of organic matter in the soil. The soils will be spread using dozers. Care will be taken not to compact the soils during spreading, especially the surface 25 cm, since this is the prime rooting zone for plants. If soils become compacted during spreading, they will be lightly ripped to allow for vegetation establishment.

The RSFs will be vegetated with plants that are reflective of the BEC zones occurring in the Project area:

- Wet Very Cold Engelmann Spruce–Subalpine Fir Subzone (ESSFwv);
- Wet Maritime Coastal Western Hemlock Subzone (CWHwm);
- Very Wet Cold Interior Cedar Hemlock Subzone (ICHvc);
- Leeward Moist Maritime Mountain Hemlock Variant (MHmm2);
- Boreal Altai Fescue Alpine and Parkland (BAFAunp); and
- Coastal Mountain-heather Alpine and Parkland (CMAunp).

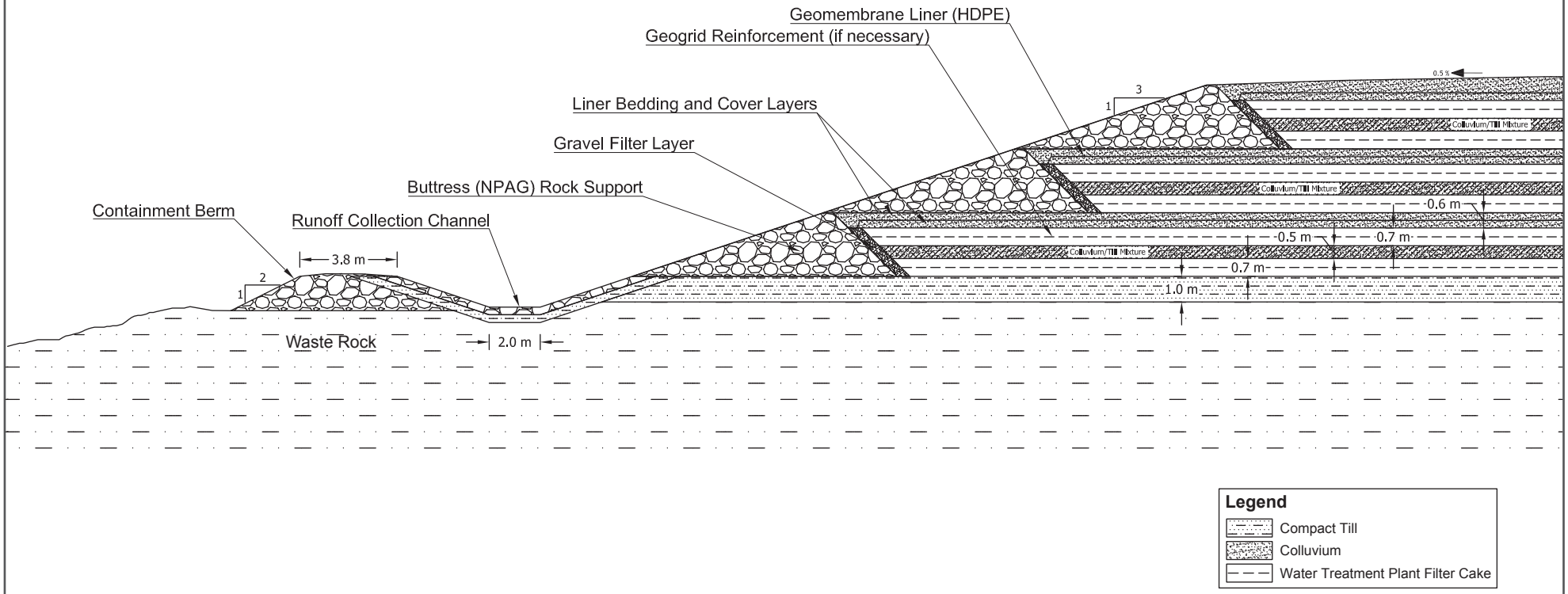

Figure 27.5-15

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Sludge Landfill Design

Figure 27.5-15

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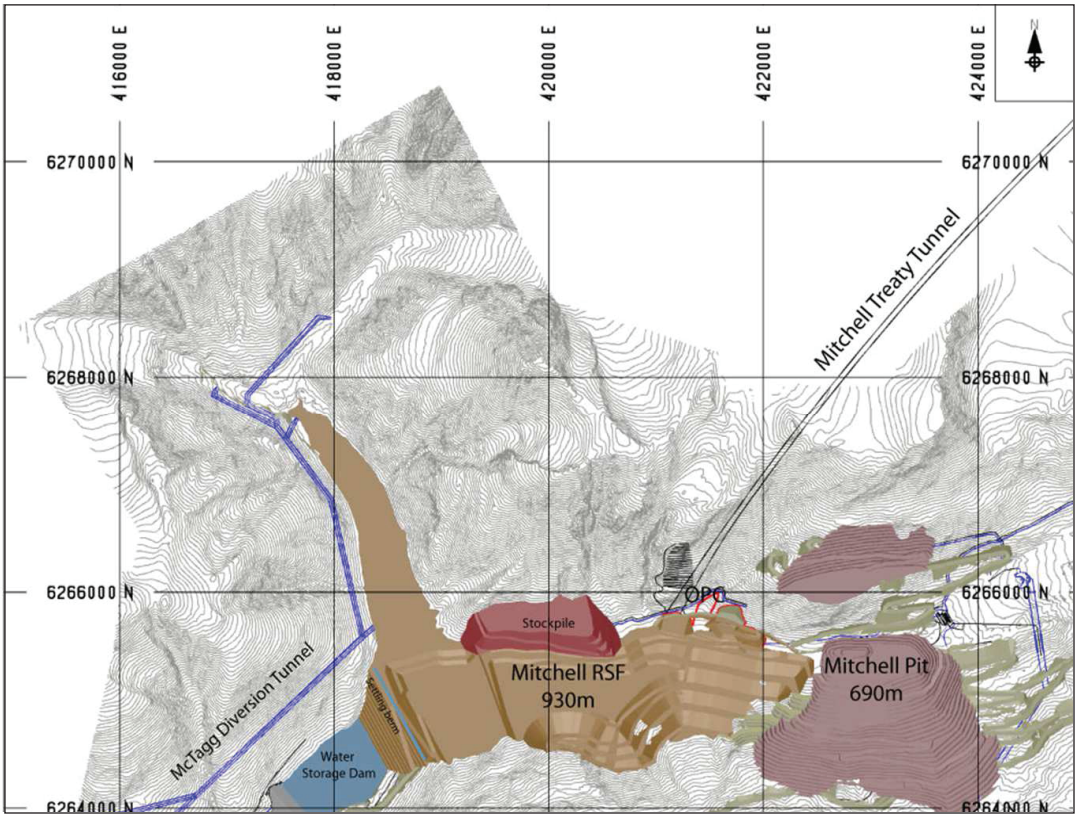
Maximum Low Grade Ore Stockpile at Operation



Reclaimed Portion Low Grade Ore Stockpile

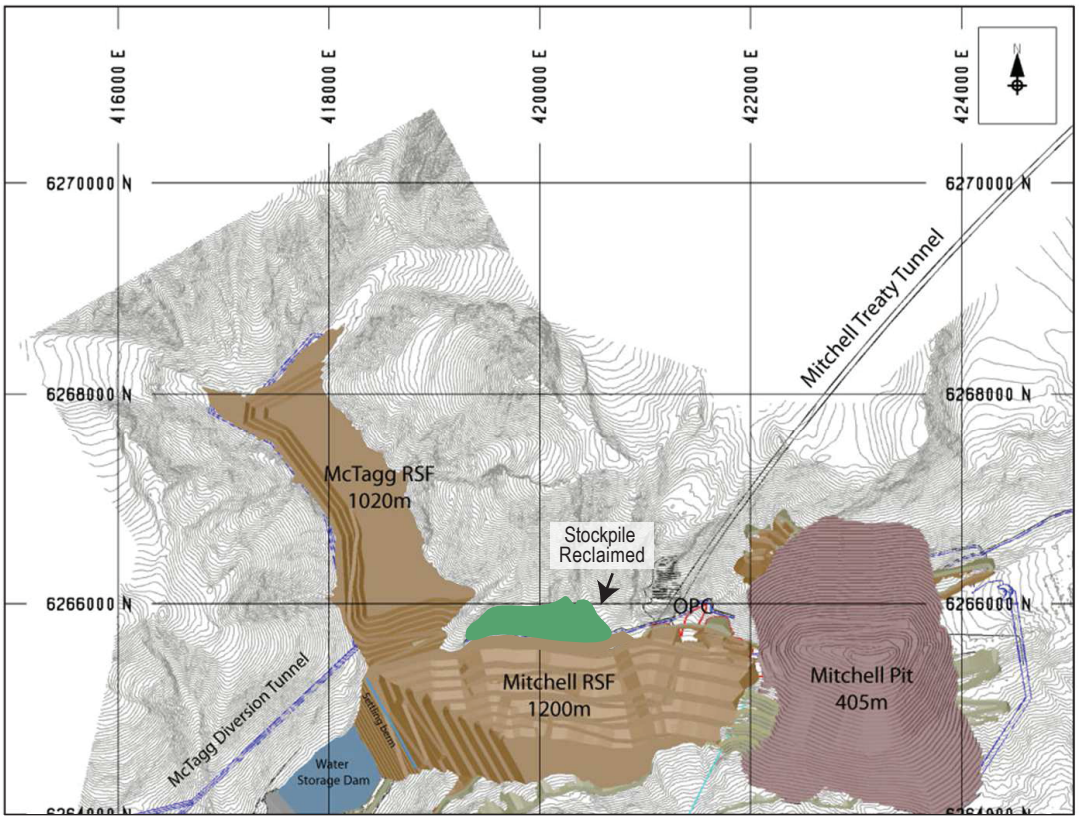


Figure 27.5-16

Reclaimed Portion of Mitchell Rock Storage Facility Ore Stockpile

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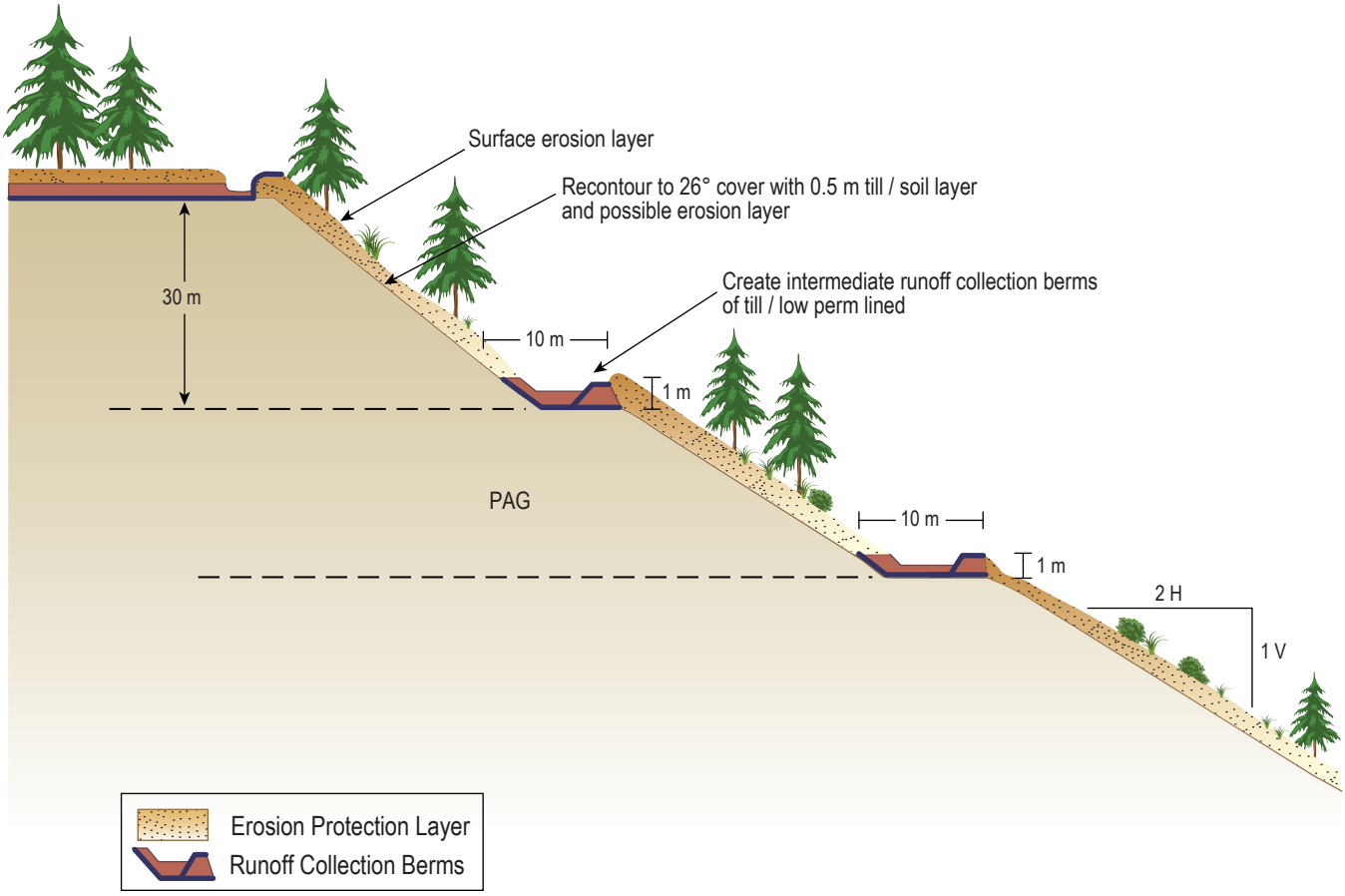

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Re-contoured and Reclaimed Mitchell and McTagg Rock Storage Facilities

Figure 27.5-17

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Four of the BEC units are forested units and two are undifferentiated parkland/alpine units. The dominant BEC unit within the Project area is the CMAunp, followed by the ESSFwv subzone. The ESSF zone generally occurs between an 800 and 1,100 masl elevation, and the ICH zone occurs below an 850-masl elevation. Nearly half (48%) of the Project area consists of non- and sparsely-vegetated ecosystems, 26% consists of forested ecosystems, and 15% consists of shrub-dominated ecosystems (including avalanche ecosystems). Of the forested area, 52% are mapped as mesic forest, followed by moist and wet forests (32%).

The re-vegetation program will focus on planting of native grasses, shrubs, and tree seedlings to achieve, with time, a forest cover similar to the ecosystems currently on site. The native seed mix will include:

- fescue (western, Rocky Mountain, red);
- alpine timothy;
- mountain brome;
- hair bentgrass;
- blue wildrye; and
- Alaska (Sitka) brome.

All of the above listed plants are bunchgrasses with the exception of red fescue, which is rhizomatous. These grasses are all suitable for erosion control and for browse. Fireweed and lupine will also be planted. Lupine is a nitrogen fixer.

Shrubs and tree seedlings may be obtained from local nurseries or may be grown on site. Shrubs will include species such as willow, alder, and *Vaccinium spp*. (e.g., blueberry and huckleberry), mountain ash, red elderberry, and false azalea, all of which occur in the Project area (Appendix 17-A). Willow and blueberry are rapidly-establishing plant species, and are an important source of browse. Alder also establishes quickly and is a nitrogen fixer.

Tree seedlings will include subalpine fir, hybrid white spruce, Sitka willow, and Sitka alder, as these occur in the area.

The vegetative surface coverage will increase with time, progressively protecting the soil from surface erosion. As the vegetation becomes more established, it will reduce the amount of precipitation entering the RSF as the plant roots will take up water from the soils. Also, precipitation on the leaves of plants will be available for evaporation, further reducing the amount of water entering the soil cover and ultimately the RSF. The vegetated slopes will provide wildlife habitat. The vegetation and soil cover will be become net carbon sinks. Approximately 440 ha of the two RSFs will be reclaimed.

The north end of the McTagg sludge landfill will be reclaimed to forage vegetation suitable for mountain goats if there is sufficient soil. If this occurs, the surface will be covered with 50 cm of soil. This area will then be vegetated with native species.

In the area of the Mitchell RSF ore stockpile adjacent to the RSF, the trees will be removed and the site grubbed in preparation for the stockpiling of ore.

Some rock fragments are expected to remain on the surface after the stockpiled ore material has been processed. The stockpiled ore will have been acid-generating, which will affect the underlying soil. With little available topsoil and given the slope limitations, reclamation of this area will be focused on tree and shrub planting and broadcast seeding. Liming may be required where planting is carried out because of the acid rock drainage potential of the stockpiled ore, and of any remaining residual ore which is not processed.

27.5.2.7 Mitchell Ore Preparation Complex

27.5.2.7.1 Closure

The Mitchell OPC is located west of the Mitchell Pit. The Mitchell OPC will include facilities for rock crushing, coarse ore storage, and fuel storage, as well as an ore stockpile feed conveyor, an electrical substation, and roads (Figure 27.4-18). It will also be the location of the southern portals of the MTT and the Mitchell underground access and conveyor adits. The Mitchell OPC will occupy approximately 44 ha.

At the completion of mining, the Mitchell OPC will be decommissioned. Equipment will be removed from the site. The electrical substation will remain. All other structures will be dismantled and removed. Foundations will be broken up, and the concrete rubble will be buried on site. Any soils that are contaminated with fuel will be excavated and treated at a landfarm to remediate the soil.

The eastern part of the OPC will be flooded as part of the closure of the Mitchell Pit (Figure 27.5-18). Part of the Mitchell OPC will be covered with the Mitchell Pit closure dam.

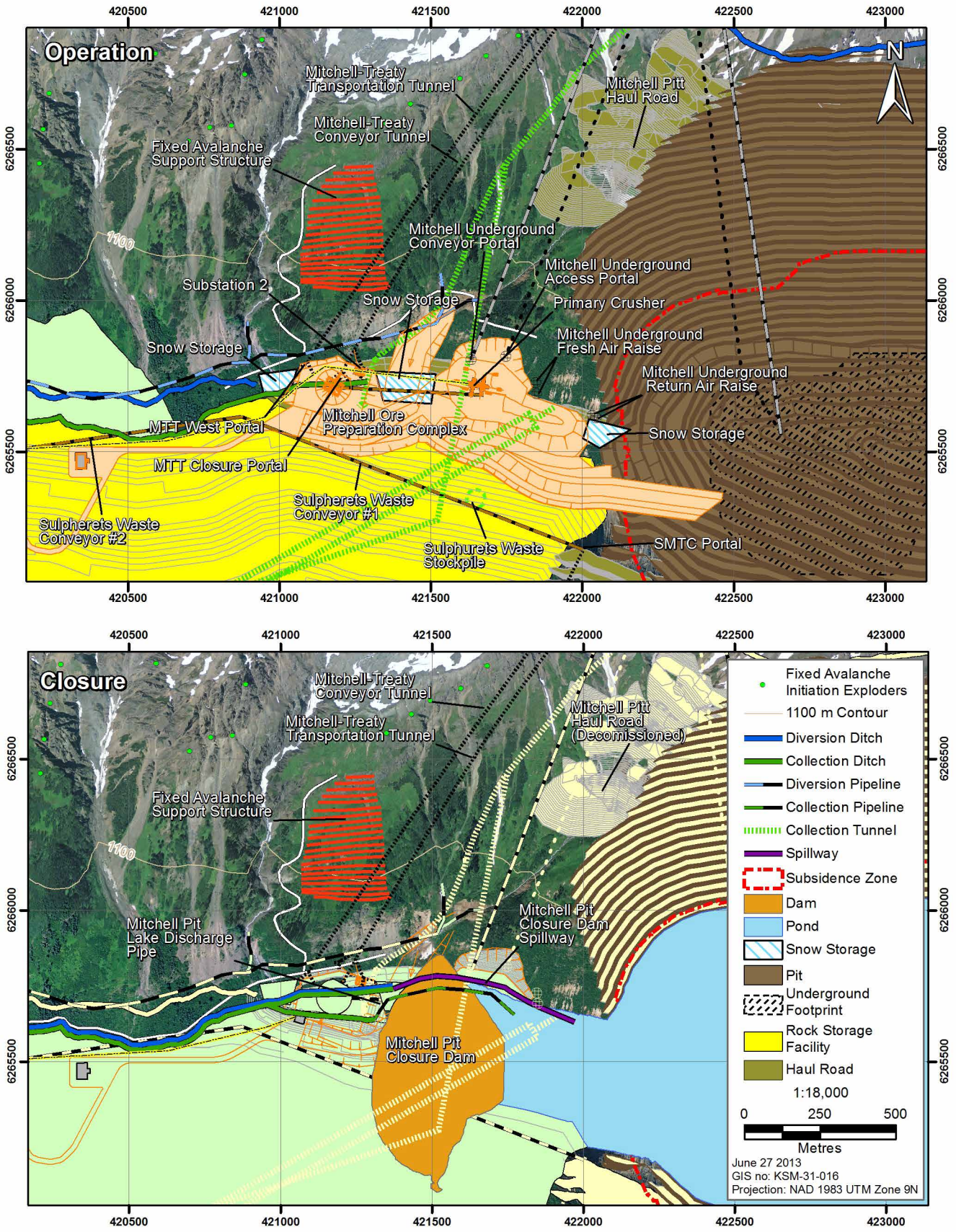
27.5.2.7.2 Reclamation

The Mitchell OPC ground surface will be highly compacted as a result of ore processing activities. Therefore, the ground will be ripped in two directions to promote drainage. Because the ore will be acid-generating, the dust and fine material resulting from the crushing activities will result in acidic soils at the ground surface. Therefore, the site will be covered with gravel that will potentially include a lime mixture. Once the surface has been ripped and covered with crushed rock, the area will be covered with up to 50 cm of topsoil. The reclaimed area will then be re-vegetated with native species as described for the RSFs in Section 27.5.2.6.2.

27.5.2.8 Mitchell Diversion Tunnels

27.5.2.8.1 Closure

The twinned, parallel Mitchell Diversion Tunnels (MDT) will divert water from the Mitchell Glacier and the surrounding catchment during operations. This water will be discharged into a bedrock stepped spillway and into Sulphurets Creek. This will prevent water from entering the Mitchell Pit during open pit and underground mining. These diversion tunnels will also be used to generate hydro-electric power from the Upper Sulphurets Power Plant during operations. The diversion tunnels will continue to be used for hydro-electric power generation during closure, except when the water is being diverted to the Mitchell Pit. The electricity generated will be used to operate the WTP.



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Mitchell Ore Preparation Complex during Operation and at Closure

Figure 27.5-18

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27.5.2.9 McTagg Twinned Diversion Tunnels

27.5.2.9.1 Closure

The McTagg Twinned Diversion Tunnels (MTDT) will direct non-contact, glacial meltwater and runoff to Gingras Creek, which drains into Sulphurets Creek. The diverted flows will be used to generate hydro-electric power during operations. Power will continue to be produced during the closure phase. The McTagg Power Plant will be located east of the Gingras Creek bridge, and will be maintained indefinitely to generate electricity. The electricity will be used to operate the WTP, or will be sold for use in the provincial electricity grid.

27.5.2.10 Water Storage Facility and Water Treatment Plant

The WSF will remain in service after mine closure to continue collecting contact water that requires treatment.

The WTP is a high-density-sludge lime treatment facility. Sludge produced from the WTP will be dewatered, producing a filter cake with a water content of approximately 40%. Approximately 165,000 m^3 of filter cake will be produced annually.

The WTP and support infrastructure will remain in operation during the closure and post-closure phases. The plant will operate primarily in the spring, summer, and fall months, and minimally in the winter. The lime material will be transported to the site, and will be consumed during these warmer periods. At closure and post-closure, the filter cake (sludge) will be hauled by truck during the summer to the top of the RSFs and placed in an engineered landfill.

An ion exchange selenium treatment plant will be constructed prior to mining of the Kerr Pit. Water will be pre-treated with caustic soda in a feed tank, and will then undergo an iron removal stage through solid-liquid separation. The overflow water will then undergo multimedia filtration to remove fine particles before being treated using ion exchange columns. The treated effluent would then be routed to the WSF for further treatment. The plant will remain in service after mine closure.

27.5.2.11 Mitchell Truck Shop

27.5.2.11.1 Closure

The Mitchell Truck Shop, located in the Lower Mitchell Creek Valley northeast of the WTP and south of the WSD, will occupy approximately 14 ha. The truck shop will be a pre-engineered building, approximately 186 m long by 49 m wide and 13 m high, and will accommodate the maintenance and repair of mobile equipment. It will contain eight maintenance bays, two light vehicle repair bays, one truck and lube bay, one truck wash bay, one welding and machine shop, one electrical and instrumentation shop, one 1,200-m^2 storage warehouse with an upper level mezzanine area, and one dry area including lockers, offices, restrooms, first aid, and emergency vehicle storage. An exterior pad area 30 m by 30 m will be provided for the tire bay. The shop will also include fuel storage facilities, a sewage treatment plant using a rotating biological contactor, and an incinerator.

At closure, all equipment and supplies will be removed and disposed of off site. All oils and fuels will be removed from storage facilities and disposed of at an approved waste oil recycle facility. The electrical, lighting, and heating systems will be removed. Once the buildings have been emptied, they will be dismantled. Metal and any other material that can be recycled will be taken off site for recycling. Demolition materials will be taken off site and disposed of in a regulated facility. Flammables will be incinerated and some waste materials will be landfilled. Foundations of buildings will be broken up, and the concrete rubble will be buried on site where it will be used for road bed materials or placed on the RSFs before they are reclaimed. The ground surface will be sampled and analyzed to determine the degree of hydrocarbon contamination in high use areas. All contaminated soils will be excavated and treated in a landfarm facility.

27.5.2.11.2 Reclamation

The site will then be ripped to 30 cm in two directions to remove compaction and to allow for downward surface drainage. Soils previously salvaged from the area and stockpiled at the site will be spread on the surface. Care will be taken not to compact the soils. Any compacted areas will be lightly ripped. The area will be planted with native grasses, trees, and shrubs as described in Section 27.5.2.6.2.

27.5.3 Mitchell-Treaty Twinned Tunnels

The MTT are approximately 23-km long, and will be used to provide a transportation route for personnel and supplies from the Mine Site to the PTMA. One tunnel will contain a fuel and water pipeline, electrical cables, and conveyors for transporting crushed ore to the Treaty Process Plant during operation. The other tunnel will be used for vehicles that will transport personnel and supplies to the Mine Site. Both tunnels will have ventilation, lighting, and fire control systems.

At closure and post-closure, the tunnels will be required to provide ongoing access to the Mine Site because the Coulter Creek access road, which serves the Mine Site during operation, will be decommissioned. As the Mine Site WTP will continue to operate post-closure, lime will be required and will be transported from the PTMA through the tunnels to the Mine Site. All supplies for monitoring, maintenance, and the operation of the WTP will be transported through the tunnels.

27.5.4 Processing and Tailing Management Area

The PTMA will be located in the Upper Treaty and Teigen Creek areas. The processing area will include numerous structures related to ore processing as well as other facilities (Figure 27.5-19). The following is a description on how these facilities will be closed and the areas reclaimed. Water treatment for carbon-in-leach (CIL) water will be maintained on stand-by during closure until it is clear that it will not be required.

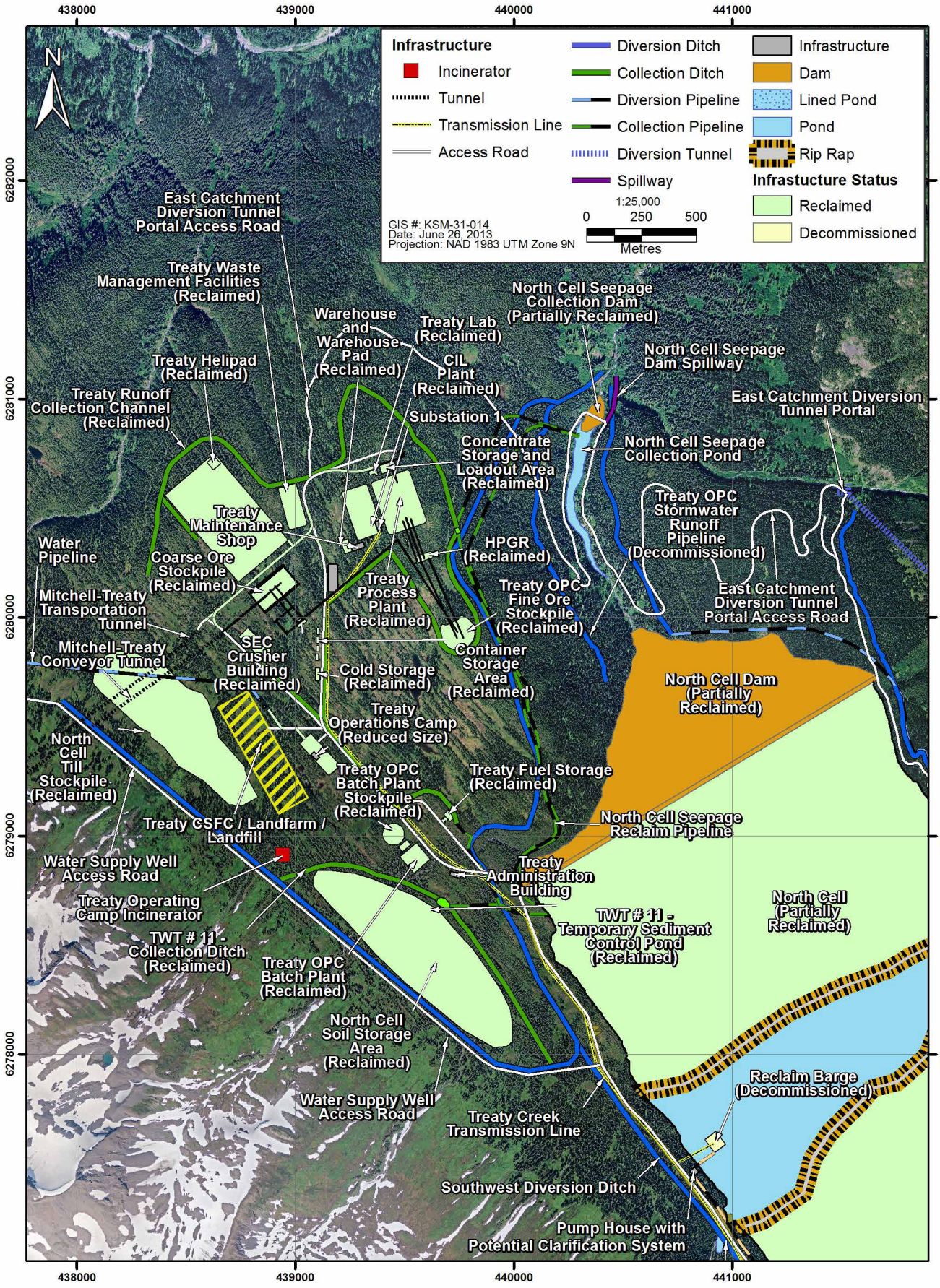

Figure 27.5-19

Plant Site Facilities at End of Operation

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27.5.4.1 Treaty Process Plant, Carbon-in-Leach Plant, and Other Structures

27.5.4.1.1 Closure

There will be several structures at the PTMA that will be closed at the completion of mining. These include the Treaty Process Plant, the Carbon-in-Leach (CIL) Plant, the Treaty OPC waste management facilities, the Treaty OPC Batch Plant, the Crusher Building, and several other structures such as the warehouse and lab. All of these structures contain equipment that must be removed at closure. The Treaty Process Plant and CIL Plant include equipment such as:

- cone crushers;
- high pressure grinding rolls;
- ball mills;
- copper-gold/molybdenum bulk flotation cells;
- concentrate dewatering equipment; and
- leaching equipment.

At closure, any remaining processing chemicals will be moved off site and disposed of in a designated facility. All oils and lubricants will be removed from equipment and moved off site to a designated disposal facility. The equipment will be dismantled, and components will be taken off site for reuse, recycling, or disposal in an on-site landfill. Electrical wiring and any other electrical components will be removed and taken off site for disposal.

Once all of the equipment has been removed, the buildings will be dismantled and the materials will be moved off site for recycling or disposal. Any contaminated soil will be collected and placed in the landfarm. Any materials that can be incinerated will be incinerated on-site. The concrete foundations of the various buildings will be broken up, buried, and used for road maintenance or as armouring in TMF reclamation. All equipment and debris will be removed from around the structures.

27.5.4.1.2 Reclamation

The footprint areas and the area surrounding the buildings will be deep-ripped to reduce compaction and to improve surface drainage. Approximately 30 cm of soil will be spread over the area as the surface material will be native soil that will provide additional rooting depth and soil water storage capacity for vegetation establishment and growth. Care will be taken not to compact the soil. The area will then be re-vegetated with native plants as described in Section 27.5.2.6.2.

27.5.4.2 Coarse and Fine Ore Stockpiles

27.5.4.2.1 Closure

All of the ore in the coarse and fine stockpiles will be processed. The footprint areas will be cleaned and ripped to reduce compaction and to increase downward drainage.

27.5.4.2.2 Reclamation

The footprint areas will be covered with a lime mixture and topsoil, and then vegetated with native plants as described for the RSFs in Section 27.5.2.6.2. The high traffic areas around the stockpiles will likely be compacted. These areas will also be ripped to reduce compaction and increase drainage. Once the sites are prepared, 30 cm of topsoil will be spread over the surface as the stockpiles will have been placed on native soils. The areas will then be re-vegetated with native plants.

27.5.4.3 Treaty Ore Preparation Complex Batch Plant Stockpile

27.5.4.3.1 Closure

The Treaty OPC may contain stockpiled materials left over from operations consisting of sands and gravels. Any remaining materials will be used for road maintenance or as rip-rap along the beach edges in the TMF. Once the materials have been removed, the site will be reclaimed.

27.5.4.3.2 Reclamation

The surface and surrounding high traffic areas will be ripped to 30 cm depth to reduce compaction and to improve drainage. Remnant coarse fragments will likely remain, so a 50 cm layer of soil will be spread on the surface over the stockpile area, grading to 30 cm over the high traffic area occurring on native soil. Care will be taken to not compact the soils. Once the site is prepared, the site will be re-vegetated with native plants as described in Section 27.5.2.6.2.

27.5.4.4 Temporary Water Treatment 8 - Unlined Muck Pad

27.5.4.4.1 Closure

The muck pad that will be developed for the construction of the MTT process plant portals will be reclaimed once portal construction is completed in the construction phase. The coarse rock material from the muck pad is predicted to be non-potentially acid generating. The pad will be re-graded at closure.

27.5.4.4.2 Reclamation

The high traffic area around the muck pad will be ripped to reduce compaction and to improve soil drainage. Once the pad and surrounding area have been prepared, a 50-cm layer of soil will be spread on the pad footprint and will be graded to 30 cm on the adjacent area. The pad footprint will also be re-vegetated with native plants as described in Section 27.5.2.6.2.

27.5.4.5 Laydown Areas

27.5.4.5.1 Closure

There will be two laydown areas in the PTMA: one large construction laydown area and a smaller MTT portal laydown area, which will be reclaimed during construction. A helipad will also be located on the large construction laydown area. These laydown areas will be covered with gravel to allow for trafficability while they are used. The helipad will also have a gravel pad.

Before reclamation, both areas will be inspected for hydrocarbon contamination because equipment and vehicles will be stored in these areas. In stained areas, the gravel will be pushed

aside and stained soils will be excavated and placed in the landfarm. Hydrocarbon-covered gravel will also be placed in the landfarm.

27.5.4.5.2 Reclamation

The laydown areas will be ripped to 30 cm to reduce compaction and to improve surface drainage. They will then be covered with 50 cm of soil and re-vegetated with native plants as described in Section 27.5.2.6.2.

27.5.4.6 Landfarm

27.5.4.6.1 Closure

The landfarm will be closed in the post-closure phase because it will be used during closure for treating any contaminated soils that were excavated during the construction, operation, and closure phases. When the landfarm is no longer required, the soils will be checked to assess if treatment has occurred. When no further treatment is required, the landfarm will be closed.

27.5.4.6.2 Reclamation

Once the land-farmed materials have been treated, the area will be covered with 30 cm of soil and will be re-vegetated with native plants as described in Section 27.5.2.6.2.

27.5.4.7 Structures Required Post-closure

Some structures in the PTMA will be required for on-going monitoring of the KSM Project post-closure (Figure 27.5-20). These include:

- the office complex;
- the ambulance building;
- substation 1;
- the operating camp incinerator;
- the administration building; and
- the operating camp (reduced in size from the operation phase).

As described above, the MTT will remain open because the WTP will continue to operate post-closure, and reagents, including lime and personnel operating the WTP, will be transported through the tunnels. A smaller camp will be required to accommodate personnel.

27.5.4.8 Tailing Management Facility

27.5.4.8.1 Closure

The TMF will be developed with three separate ponds referred to as “cells”: the North Cell, the South Cell, and the middle Centre Cell. The North Cell will be constructed first and will operate between Year 1 and Year 25. The North Cell will be bounded by the North and Splitter dams. Rougher tailing will be deposited in the North Cell. The North dam will have a starter earth fill dam and an inner till core, and will be built up with cycloned, coarse rougher tailing. These coarse tailing will not be potentially acid generating because the PAG components will have been removed.

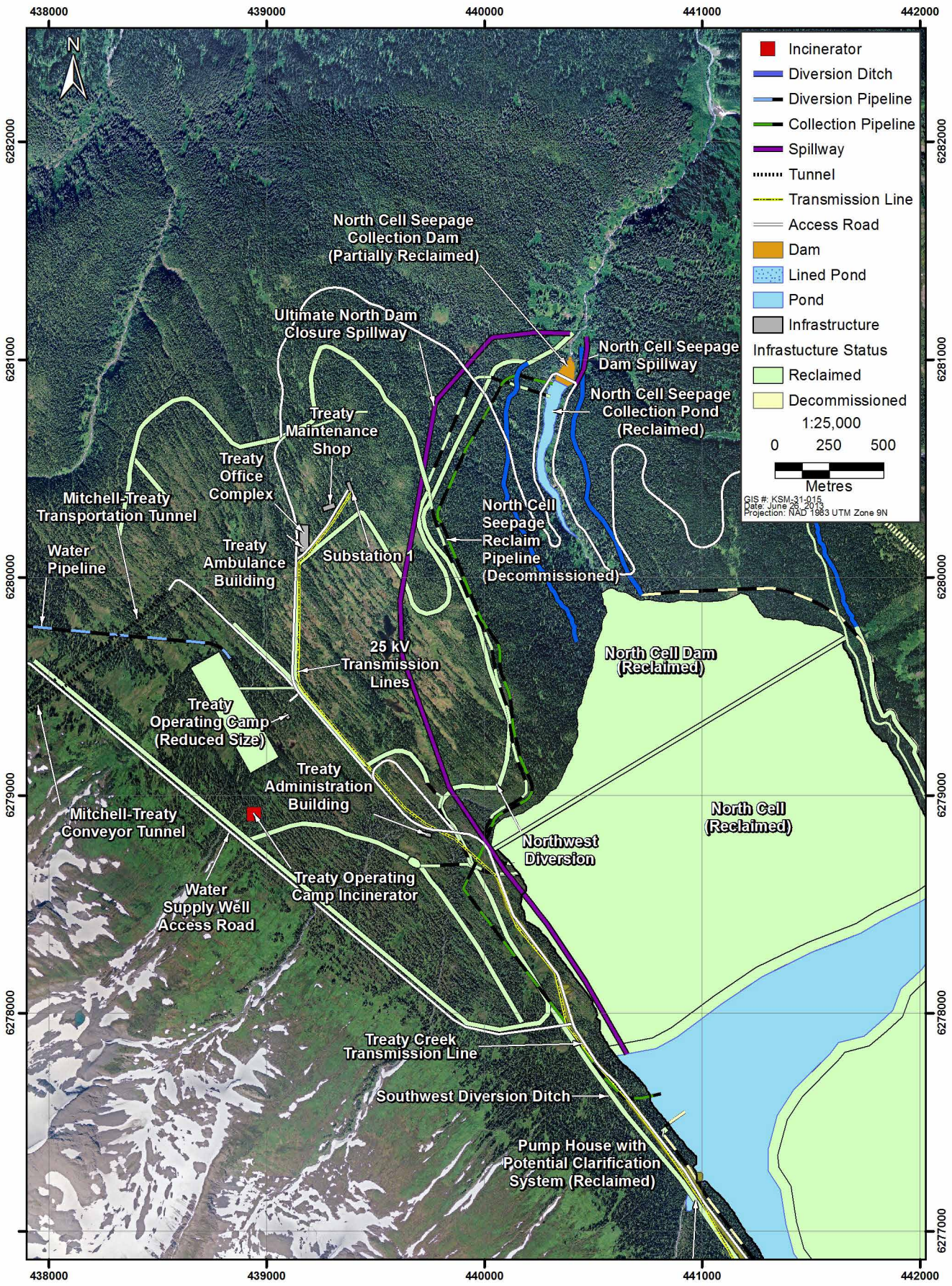

Figure 27.5-20

Treaty Process Plant Site Facilities at Post-closure

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The Centre Cell will be located between the North and South cells (Figure 27.5-21). It will operate at the same time as the North and the South cells operate. The CIL tailing will be deposited into the Centre Cell. The CIL tailing are sulphide-rich tailing, which will be in contact with cyanide during processing. The Centre Cell will be fully lined. It will be bound by the Splitter and Saddle dams, and the CIL tailing will be kept submerged with a 3-m water cover during operation to prevent oxidation of the CIL tailing.

The South Cell will be bound by the Saddle and Southeast dams. It will operate between Year 25 and Year 51.5. Similar to the North dam, the Southeast dam will have a starter earth fill dam and an inner till core, and will be built up with cycloned, coarse rougher tailing.

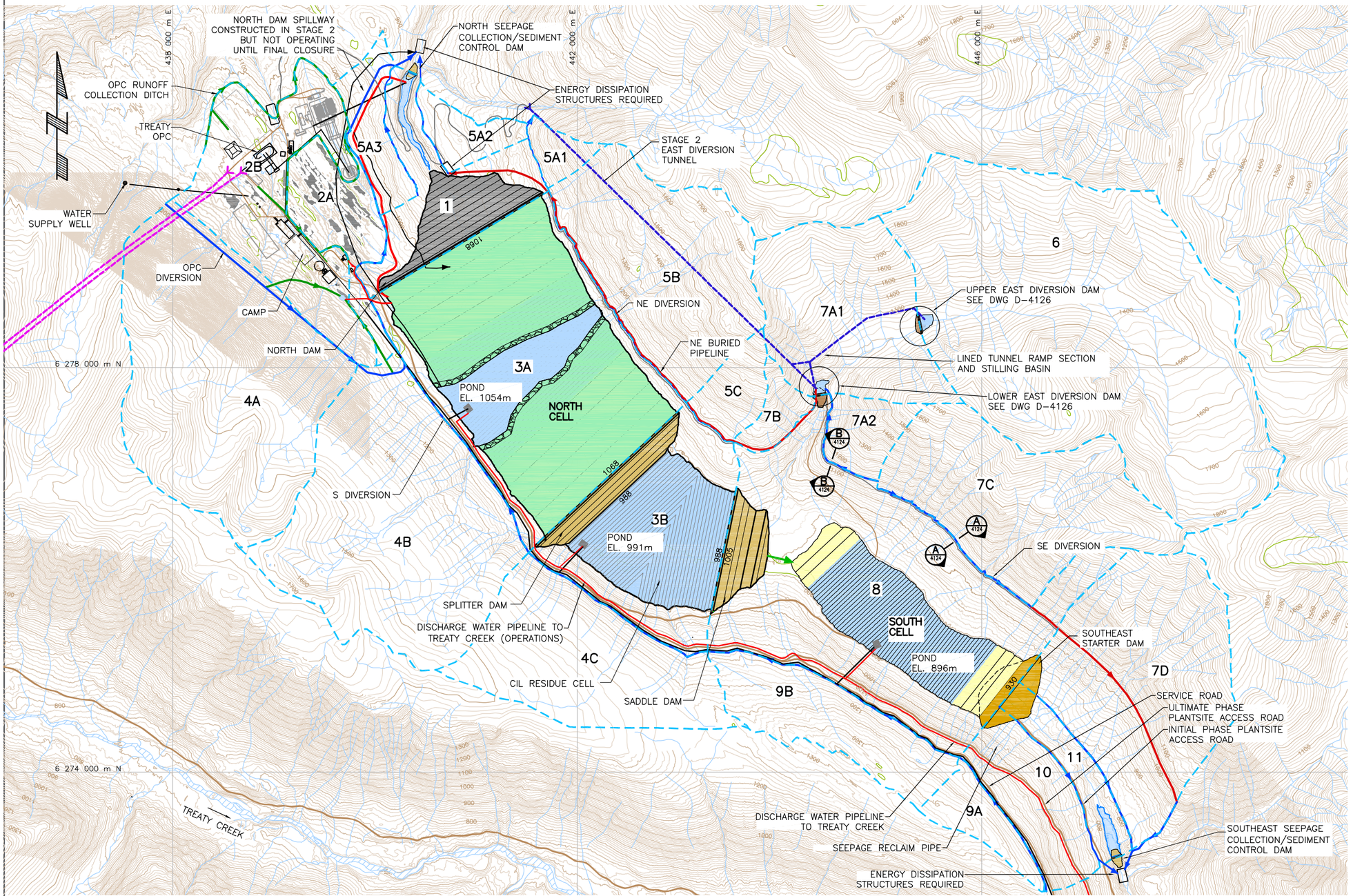
Prior to closure, each of the cells will contain separate ponds (Figure 27.5-22). Beaches will be developed in the North and South cells as the tailing are deposited. The CIL tailing containing most of the sulphides will remain submerged. The sulphide tailing will be introduced subaqueously so that there will be no beaches constructed with CIL tailing.

The North Cell will be closed roughly five years after tailing deposition into it ceases. The timeline is based on the predicated time required for tailing water quality to improve sufficiently to satisfy water quality standards set for TMF discharges. For closure, the exposed beach will be expanded, decreasing the open water portion of the cell (Figure 27.5-23) and reducing the potential for erosion of the dams. In order to minimize the need for dredging in constructing the beaches, strategic deposition of tailing will occur during late-stage North Cell operations. The majority of beach shaping will be done by moving the spigot points onto the beaches during final operation. Additional beach area will also be created by pumping down the pond level at closure. The water will be discharged to Treaty Creek. The objective is to increase the distance from the pond to the dam to reduce the potential for overtopping and erosion of the dam after closure, to reduce the flotation pond volume to the minimum possible at closure, and to provide additional wildlife habitat development.

The South Cell will be closed by means similar to those used to close the North Cell, with the beach surface increased to reduce potential effects on the dams and to provide additional wildlife habitat. The increased beach area will result in a reduced amount of open water in the cell (Figure 27.5-24).

The Centre Cell will be the last cell to be closed. It is predicted that the water quality in the cell will satisfy water quality discharge standards approximately five years following mine closure. The CIL tailing in the CIL Lined Pond will be covered with approximately 1 m of non-reactive rougher tailing. The submerged Centre Cell tailing will remain below water with a water cover of 5 m at closure. The beaches in the Centre Cell will be increased by strategic placing of the spigots. This will reduce the amount of open water in the pond.

Dredging of the channels within the flotation tailing may be required in areas where runoff into the pond has the potential to scour the water-covered tailing, causing turbulence and the suspension of sediment. Rip-rap will be used along these dredged areas to protect them from further scouring (Figure 27.5-25). As well, a strip of rip-rap approximately 1 m wide will be placed along the beaches at the water's edge to prevent erosion of the beach edge.



TMF/CIL CATCHMENT AREAS	
CATCHMENT	AREA (ha)
1	156.6
2A	96.4
2B	249.6
3A	546.8
3B	283.1
4A	503.4
4B	487.9
4C	272.9
5A1	26.0
5A2	44.2
5A3	64.9
5B	307.6
5C	49.6
6	874.1
7A1	262.9
7A2	53.8
7B	31.9
7C	341.7
7D	372.9
8	650.7
9A	52.9
9B	154.6
10	118.5
11	63.7

LEGEND

- SERVICE ROAD
- PROPOSED ACCESS ROAD
- CONTACT WATER DIVERSION
- NORTH DAM SPILLWAY
- CATCHMENT BOUNDARY
- FRESH WATER DIVERSION
- PIPELINE
- DIVERSION TUNNEL
- TWIN ORE HAULAGE / SERVICE TUNNELS FROM MITCHELL
- NORTH AND SADDLE DAMS
- RECLAIMED DAM SLOPE
- TAILING
- RECLAIMED TAILING SURFACE
- TAILING POND
- RIPRAP
- RECLAIM BARGE

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT. 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA.
2. DATUM: NAD83 UTM ZONE 9.

NOT FOR CONSTRUCTION

SCALE: 0 1000m

Source: Klohn Crippen Berger (2012).

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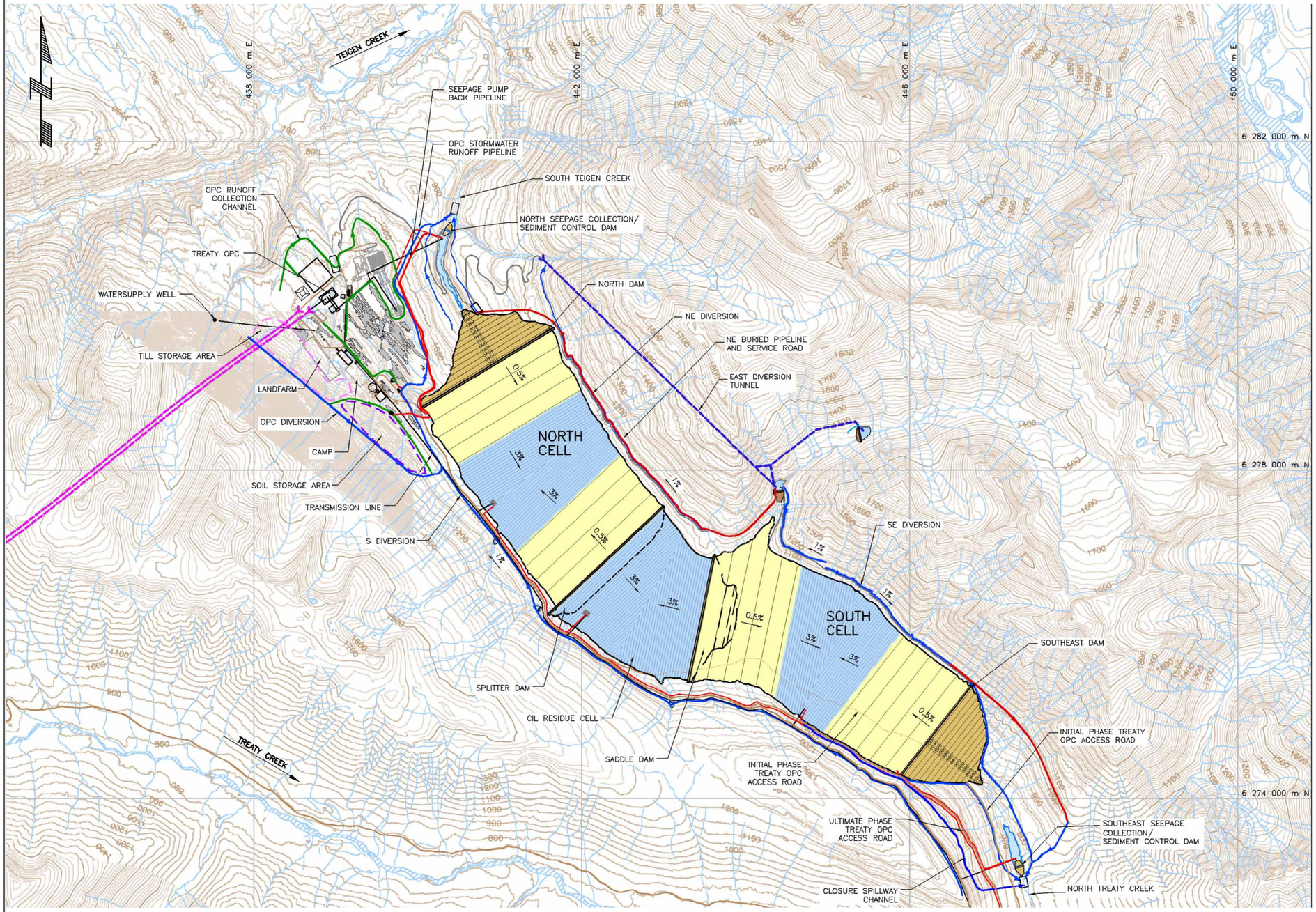
Figure 27.5-21

Construction of the Tailing Management Facility



LEGEND

- TRANSMISION LINE
- SERVICE ROAD
- PROPOSED ACCESS ROAD
- CONTACT WATER DIVERSION
- FRESH WATER DIVERSION
- PIPELINE
- DIVERSION TUNNEL
- TWIN ORE HAULAGE / SERVICE TUNNELS FROM MITCHELL TO TREATY OPC
- CYCLONE SAND DAMS
- TAILING
- TAILING POND
- RECLAIM BARGE
- WETLAND (FEB 2010)

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT, 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA.
2. DATUM: NAD83 UTM ZONE 9.
3. TMF TREATY ORE PROCESSINC COMPLEX AND CAMP RECEIVED ON MAY 11, 2012.

NOT FOR CONSTRUCTION

SCALE: 0 1000 m

Source: Klohn Crippen Berger (2012).

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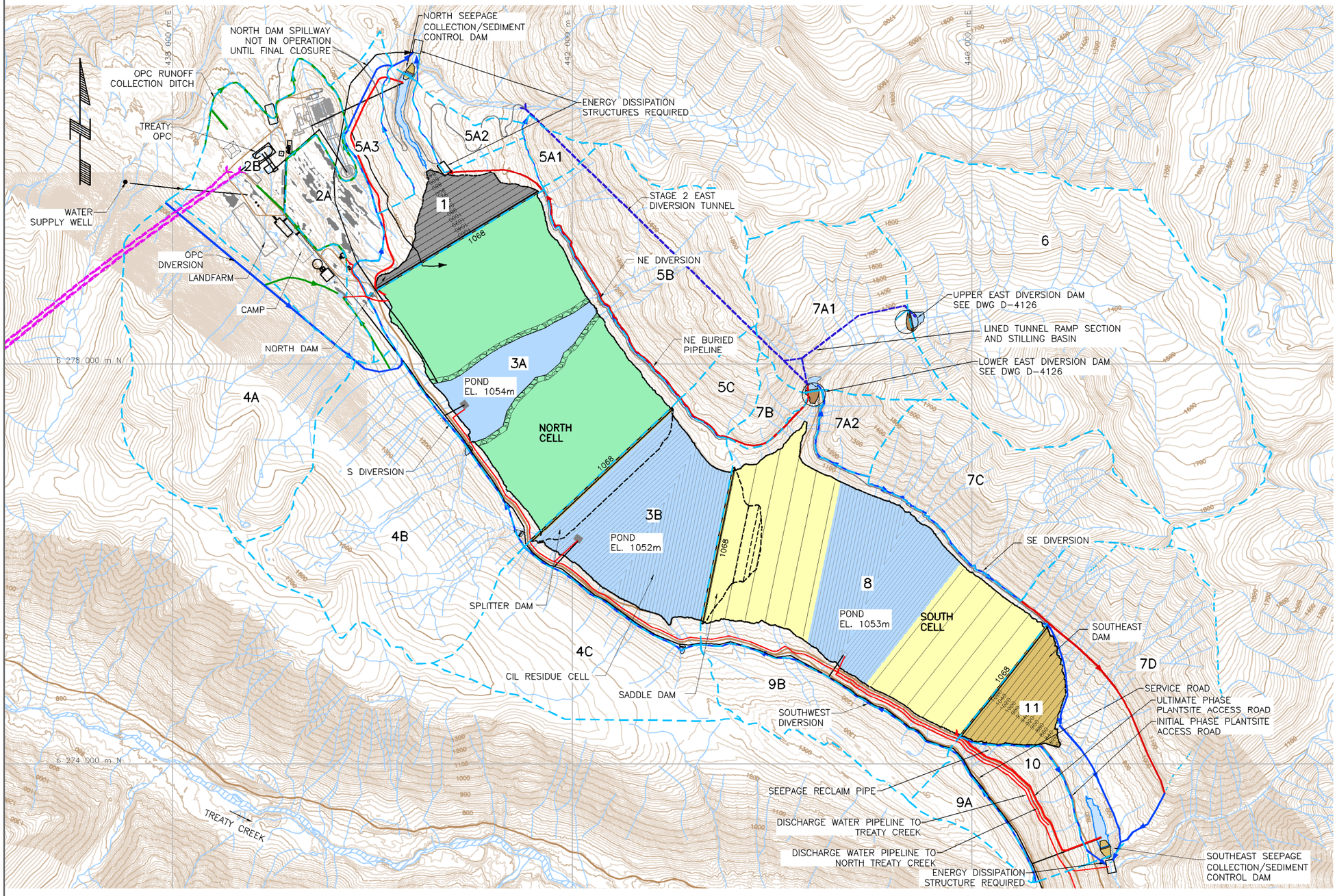
Figure 27.5-22

Ponds in the Tailing Management Facility



TMF/CIL CATCHMENT AREAS	
CATCHMENT	AREA (ha)
1	156.4
2A	96.4
2B	249.6
3A	546.8
3B	283.1
4A	503.4
4B	487.9
4C	272.9
5A1	26.0
5A2	44.2
5A3	64.9
5B	307.6
5C	49.6
6	874.1
7A1	262.9
7A2	53.8
7B	31.9
7C	341.7
7D	346.3
8	650.7
9A	52.9
9B	154.6
10	98.7
11	112.6

LEGEND

- SERVICE ROAD
- PROPOSED ACCESS ROAD
- CONTACT WATER DIVERSION
- NORTH DAM SPILLWAY
- CATCHMENT BOUNDARY
- FRESH WATER DIVERSION
- PIPELINE
- DIVERSION TUNNEL
- TWIN ORE HAULAGE / SERVICE TUNNELS FROM MITCHELL
- NORTH AND SADDLE DAMS
- RECLAIMED DAM SLOPE
- TAILING
- RECLAIMED TAILING SURFACE
- TAILING POND
- RIPRAP
- RECLAIM BARGE

NOTES

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2. DATUM: NAD83 UTM ZONE 9.

NOT FOR CONSTRUCTION

SCALE: 0 1000m

Source: Klohn Crippen Berger (2012).

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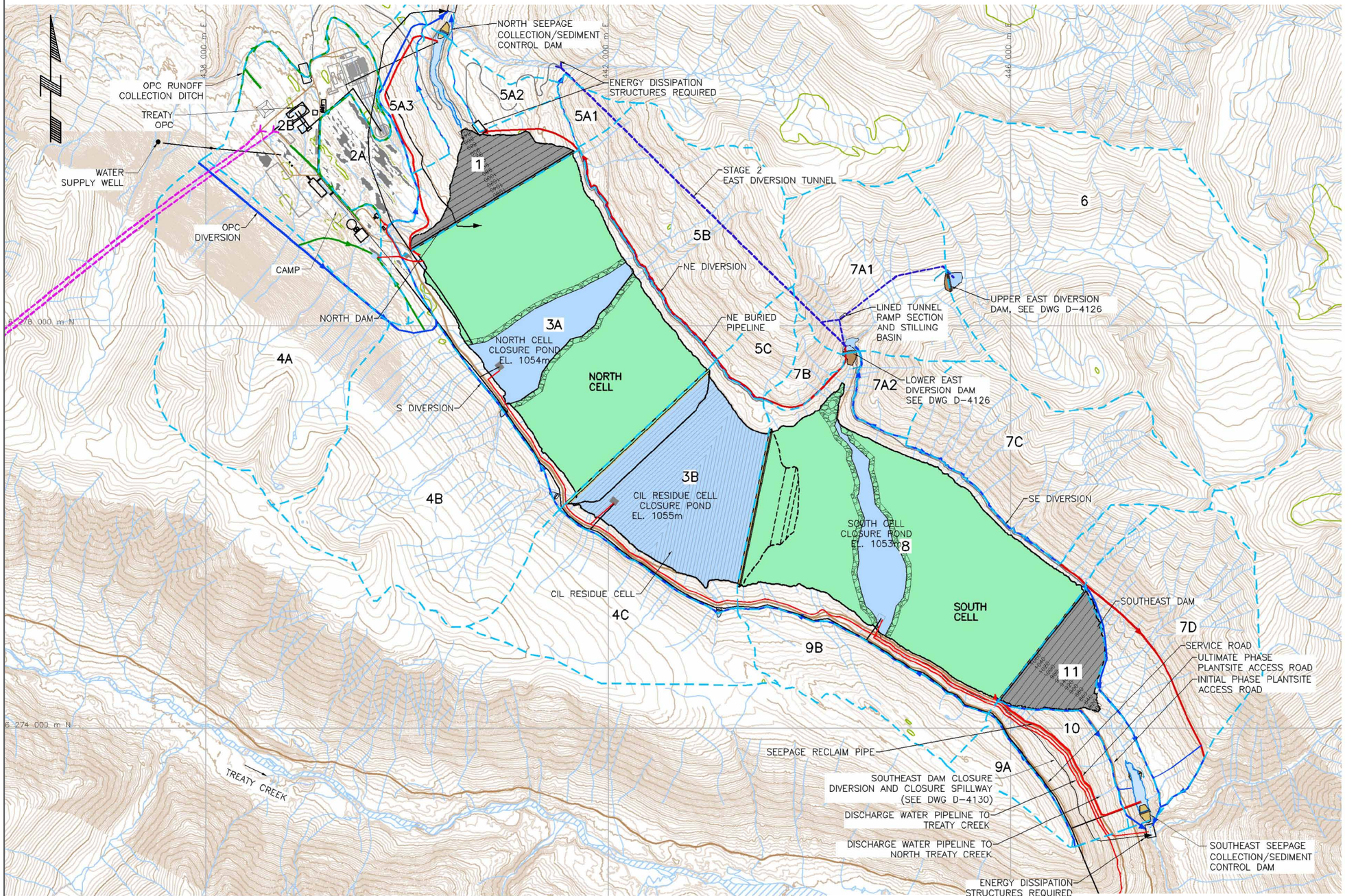
Figure 27.5-23

Closure of the North Cell



TMF/CIL CATCHMENT AREAS	
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7B	31.9
7C	341.7
7D	346.3
8	650.7
9A	52.9
9B	154.6
10	98.7
11	112.6

LEGEND

- SERVICE ROAD
- PROPOSED ACCESS ROAD
- CATCHMENT BOUNDARY
- FRESH WATER DIVERSION
- CONTACT WATER DIVERSION
- PIPELINE
- CLOSURE DIVERSION CHANNEL AND CLOSURE SPILLWAY
- DIVERSION TUNNEL
- TWIN ORE HAULAGE / SERVICE TUNNELS FROM MITCHELL
- TAILING POND
- RECLAIMED TAILING SURFACE
- RECLAIMED DAM SLOPE
- RIPRAP COVER

NOTES

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2. DATUM: NAD83 UTM ZONE 9.

NOT FOR CONSTRUCTION

SCALE: 0 1000m

Source: Klohn Crippen Berger (2012).

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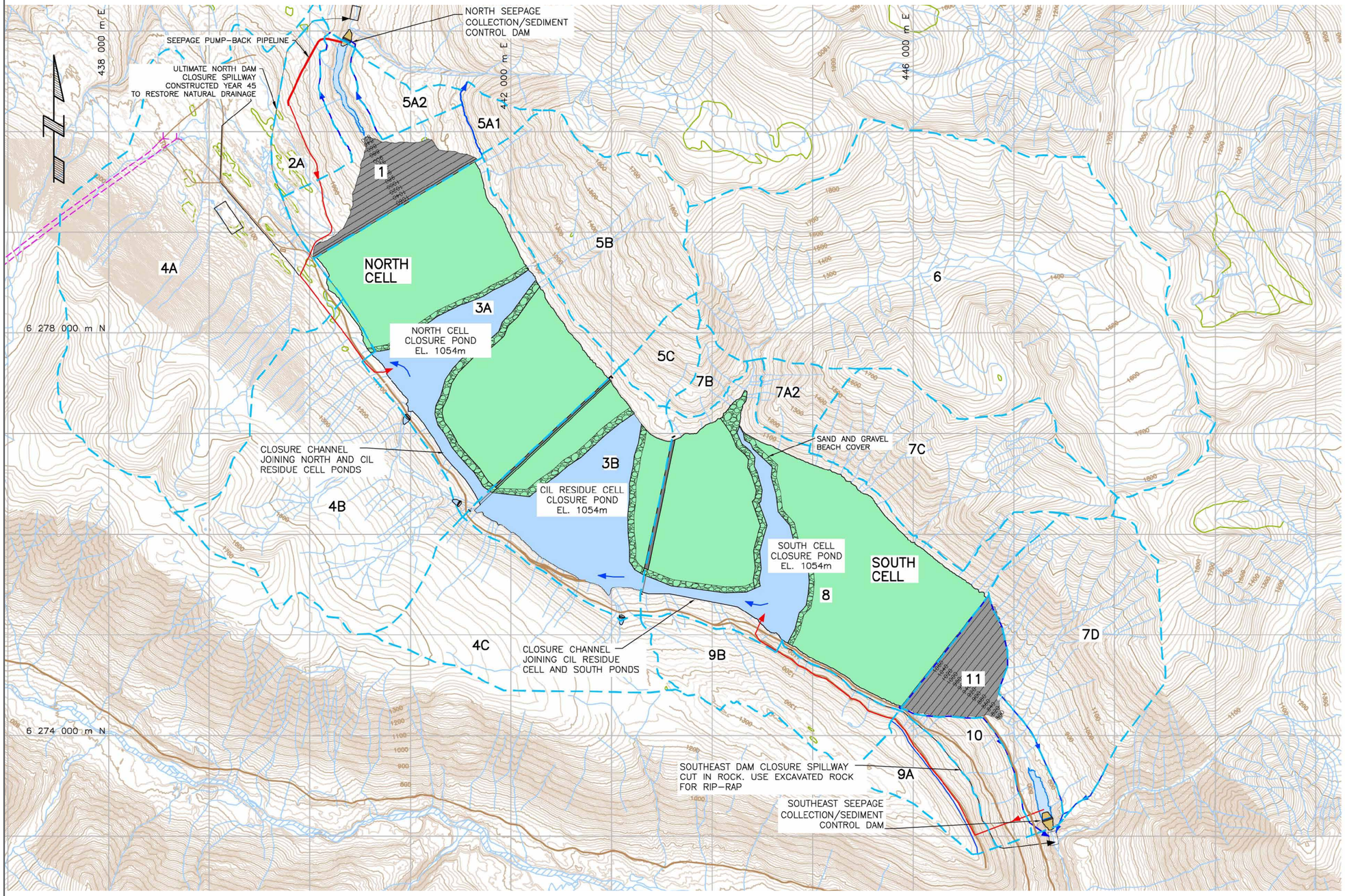
Figure 27.5-24

Expansion of Beaches and Decrease in Pond Area for South Cell Reclamation



TMF/CIL CATCHMENT AREAS	
CATCHMENT	AREA (ha)
1	166.4
2A	80.3
2B	0
3A	527.2
3B	283.1
4A	832.2
4B	498.8
4C	272.9
5A1	26.0
5A2	44.2
5A3	0
5B	307.6
5C	49.6
6	1137.0
7A1	0
7A2	53.8
7B	31.9
7C	341.7
7D	346.3
8	636.6
9A	85.6
9B	169.3
10	65.4
11	112.6

LEGEND

- SERVICE ROAD
- PROPOSED ACCESS ROAD
- CATCHMENT BOUNDARY
- FRESH WATER DIVERSION
- CONTACT WATER DIVERSION
- PIPELINE
- CLOSURE DIVERSION CHANNEL AND CLOSURE SPILLWAY
- DIVERSION TUNNEL
- TWIN ORE HAULAGE / SERVICE TUNNELS FROM MITCHELL
- TAILING POND
- RECLAIMED TAILING SURFACE
- RECLAIMED DAM SLOPE
- RIPRAP COVER

NOTES

1. BASEMAP 10m INTERVAL CONTOUR LIDAR DATA RECEIVED FROM SEABRIDGE, SEPT, 2008, AND 20m INTERVAL CONTOUR FROM BC TRIM DATA.
2. DATUM: NAD83 UTM ZONE 9.

NOT FOR CONSTRUCTION

SCALE A 0 1000 m

Source: Klohn Crippen Berger (2012).

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Figure 27.5-25

TheTailing Management Facility at Post-closure

A 20-m wide channel will be constructed along the southwest side of the TMF to allow the pond water to flow freely at an elevation of 1,054 masl (Figure 27.5-25). Closure pond levels may have to be adjusted, depending on the actual consolidated tailing elevations observed after deposition and settlement. The rock cut spillway channels will be at the same elevation so that, if required, water can be routed either to South Teigen or North Treaty creeks by adjusting the elevation of inlet weirs or control gates at the spillways. This system will allow for spillway maintenance by temporarily routing water to either spillway. Approximately 70% of flow will go to North Treaty Creek, and 30% will be used to maintain South Teigen Creek flows. These ratios are approximate, based on hydrological predictions and fisheries requirements.

The dam faces will be constructed with rougher tailing. A 1-m-thick layer of rip-rap will be placed on the surface to reduce erosion of the non-cohesive tailing used to construct the dams.

The North Cell spillway will be constructed during operation, but it will not be used until final closure. Rock from spillway excavations will provide the rip-rap that will be placed on the beach edges. The South Cell spillway channel will be cut into rock on the west abutment of the Southeast dam. This will allow for the routing of floods from the South Cell beyond the Southeast seepage collection dam to a stepped rock-cut spillway discharging into North Treaty Creek.

During operation, the East Catchment Diversion dam and the Upper East Catchment Diversion dam will direct diverted water through the East Catchment diversion tunnel to South Teigen Creek. The diverted water will also be directed north in a buried pipeline (Northeast buried pipeline) to South Teigen Creek. These dams and diversions will be located on steep, sedimentary bedrock slopes with some of the lower portions of the diversion alignments vegetated with alder trees. At post-closure, the East Catchment Diversion tunnel portals will be sealed.

The Northeast diversion ditch will be breached at closure to allow water from the catchment basins to flow into the TMF.

The Southeast diversion ditch is located on steep, talus-covered slopes, with several large creeks crossing the diversion alignment. The slope of the catchment is typically 2H:1V to 3H:1V, with little underbrush or tall trees. Part of the Southeast diversion ditch will be an open channel. Two buried pipelines will occur in the downstream half. During operation, catchment water will be diverted north to South Teigen Creek. This diversion will be breached at post-closure, once the North Cell closure spillway becomes operational and allows flow from its catchment area into the TMF.

The North Cell and the Southeast seepage collection dams will remain in place post-closure. Water will be pumped back into the TMF pond until seepage collection pond water quality meets regulatory permit requirements. The seepage ponds downstream of the seepage collection dams will become wetlands.

27.5.4.8.2 Reclamation

Following operations, the TMF will be reclaimed to provide for wildlife and wetland habitat. The dams and beaches of the TMF will be reclaimed in stages, with the North Cell being

reclaimed during operation, the South Cell during closure, and the Centre Cell during post-closure.

A 50-cm soil cover will be placed on the dam faces over the rip-rap so that the dam faces can be re-vegetated. The surface will be placed roughly on the dam face to reduce potential surface erosion. The dam faces will be planted with native grasses, including the following:

- fescue (western, Rocky Mountain, red);
- alpine timothy;
- mountain brome;
- hair bentgrass;
- blue wildrye; and
- Alaska (Sitka) brome.

Fireweed and lupine will also be planted. Lupine is a nitrogen fixer. Shrubs will include species such as *Vaccinium* spp. (e.g., blueberry and huckleberry), soopolallie, elderberry, and mountain ash.

The crests of the North and Southeast dams will be 20 m wide. These will operate as wildlife corridors across the valley. Soil covers will be deposited to a depth of 60 cm, to support large trees for shelter and screening of wildlife without risk to the dam crests. These crest areas will be vegetated to a forest cover. Tree seedlings will include subalpine fir and hybrid white spruce, as well as grasses and shrubs, as described above.

Reclamation of the beaches will not be carried out until the beach surface is sufficiently drained to allow for the use of heavy equipment. A 50-cm cover of till will be spread on the TMF beaches (Figure 27.5-26). The beaches will have a 0.5% slope, so it is assumed that the till thickness will be roughly 50 cm over most of the surface, gradually thinning toward the edges.

The cover will be vegetated with native plants to allow for the development of wildlife habitat that will become wetland habitat between the beach edge and 2 m below the water surface. Till will be loosely placed onto the rip-rap to increase the potential for wetland development. Native trees, grasses, and shrubs such as the *Vaccinium* species (black huckleberry or Alaskan blueberry), and fireweed, cow parsnip, and lupine, and berry-producing shrubs (e.g., soopolallie, elderberry, and mountain ash), will be planted on the upper parts of the beach. Black cottonwood could be planted toward the beaches. Willow is also suited to wet conditions, but the roots cannot be submerged. Sedges can be planted in the wetter areas since their roots can be submerged. Wetlands will develop between the area where the water table is at 60 cm below the surface and a water depth of 2 m or less, to allow sufficient light for submergent vegetation to exist (Figure 27.5-27). The beaches will grade to 3% below the water (Figure 27.5-22). In water deeper than 15 cm, floating leaf vegetation can be used (e.g., pond weed and yellow pond lily). These plants can be transposed from adjacent wetlands, or they can be propagated.

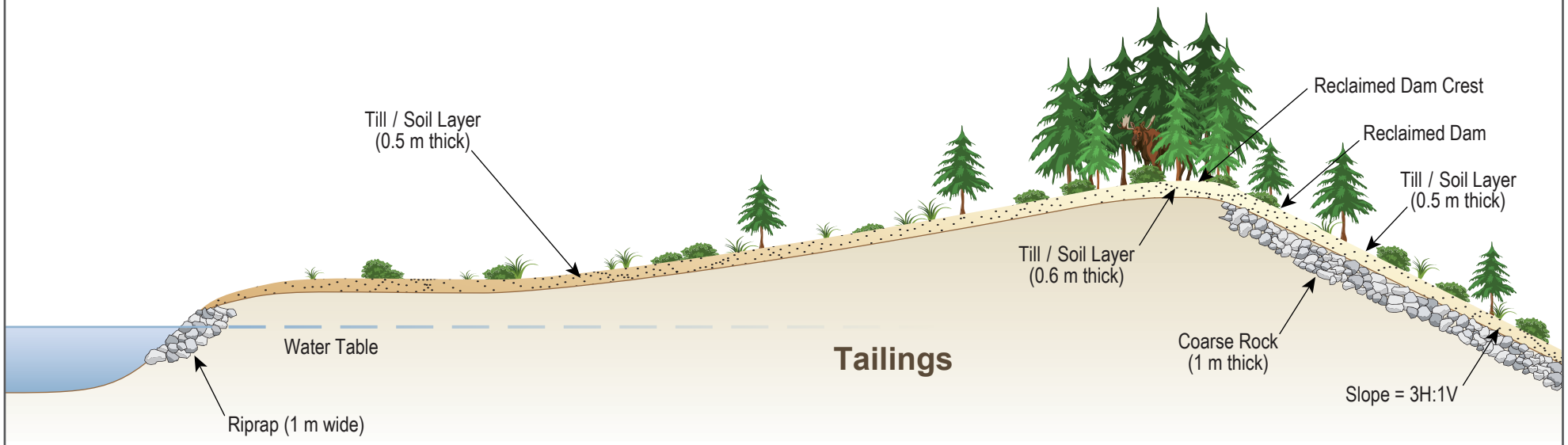

Figure 27.5-26

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Reclamation of the Tailing Management Facility

Figure 27.5-26

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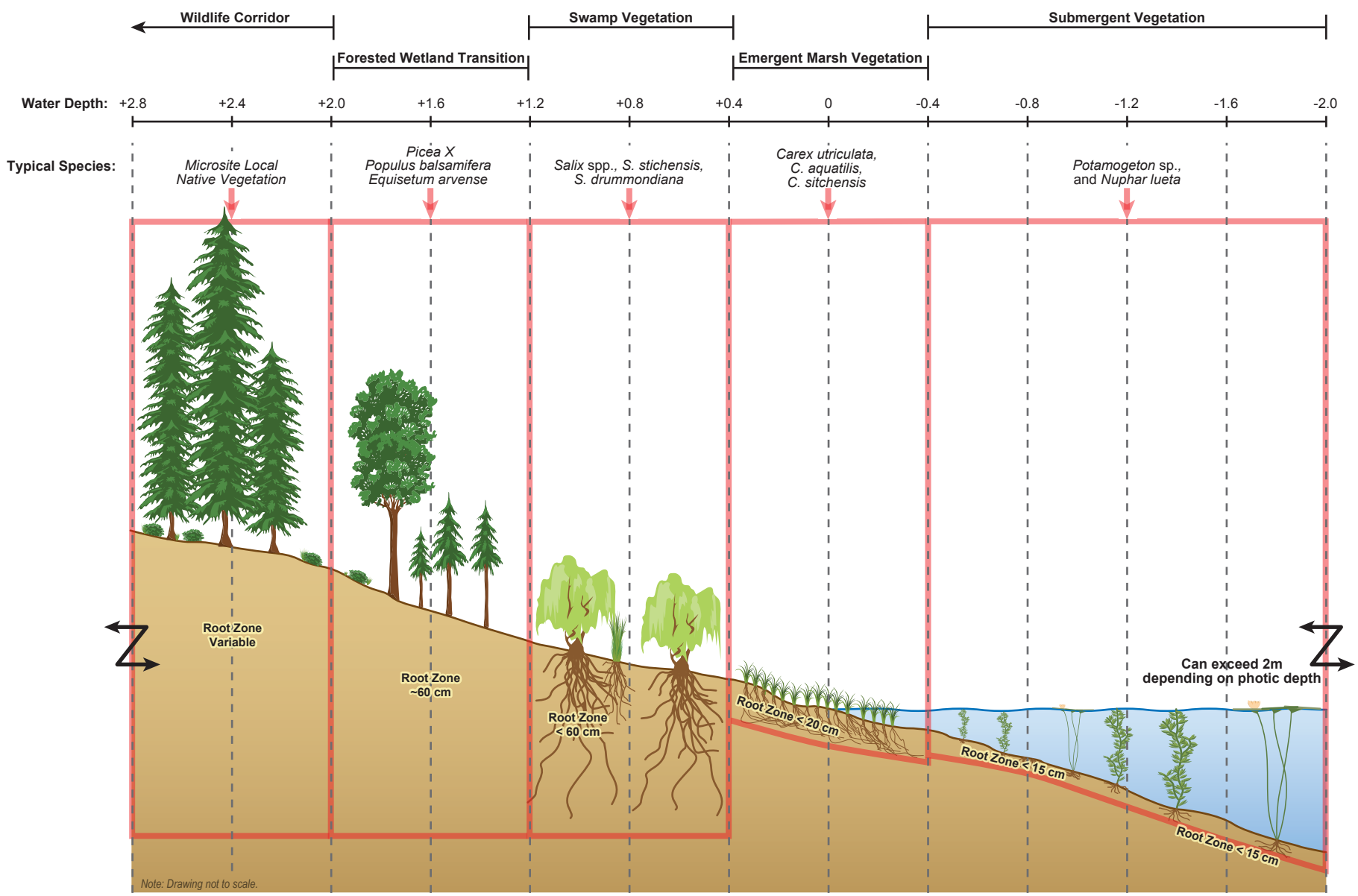

Figure 27.5-27

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Wetland Development in the Tailing Managment Facility at Post-closure

Figure 27.5-27

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27.5.5 Access Roads

27.5.5.1 Treaty Creek Access Road

During closure and post-closure, the Treaty Creek access road (TCAR) will provide the only remaining road access to the Project site. All materials and personnel will be transported via the TCAR, which will extend to the Treaty Process Plant site and the MTT portals, which will all remain open to allow for access to the Mine Site post-closure.

27.5.5.2 Coulter Creek Access Road

27.5.5.2.1 Closure

The Coulter Creek access road (CCAR) will be decommissioned post-closure, as described in Appendix 27-A. The bridges will be dismantled, and materials that are combustible will be burned. Concrete will be broken and used as rip-rap along the creeks, if required, to reduce potential surface erosion that could occur during the dismantling of the bridges.

Culverts will be removed to restore natural drainage patterns. Cross-ditching will provide drainage across roads and will reduce the potential for surface erosion. The surface of the road and any compacted areas will be ripped, where required, to promote surface drainage and to reduce runoff and potential road bed failure.

27.5.5.2.2 Reclamation

Some soil may be salvaged when the road bed is being constructed. The stockpiled soils will be stored near the sites where they have been salvaged so that they can be spread when needed for reclamation. They will be vegetated with native seed mix and tree seedlings as described in Section 27.5.2.6.2.

There are numerous areas designated for borrow pits, log landings, and waste areas, especially where the road route runs along Sulphurets Creek (Figures 27.5-28, 27.5-29, and 27.5-30). Soils salvaged from these areas will be spread and re-vegetated.

27.5.6 Quarry and Borrow Sources

27.5.6.1 Closure

The borrow areas will be cleared and grubbed. The quarry and borrow areas will be re-sloped and re-contoured to ensure escape routes for wildlife and to restore natural landscape.

27.5.6.2 Reclamation

Borrow sites located in granular material will be reclaimed. Stockpiled topsoil will be spread and the areas will be re-vegetated as described for the RSFs in Section 27.5.2.6.2. Quarries developed in bedrock will not be reclaimed.

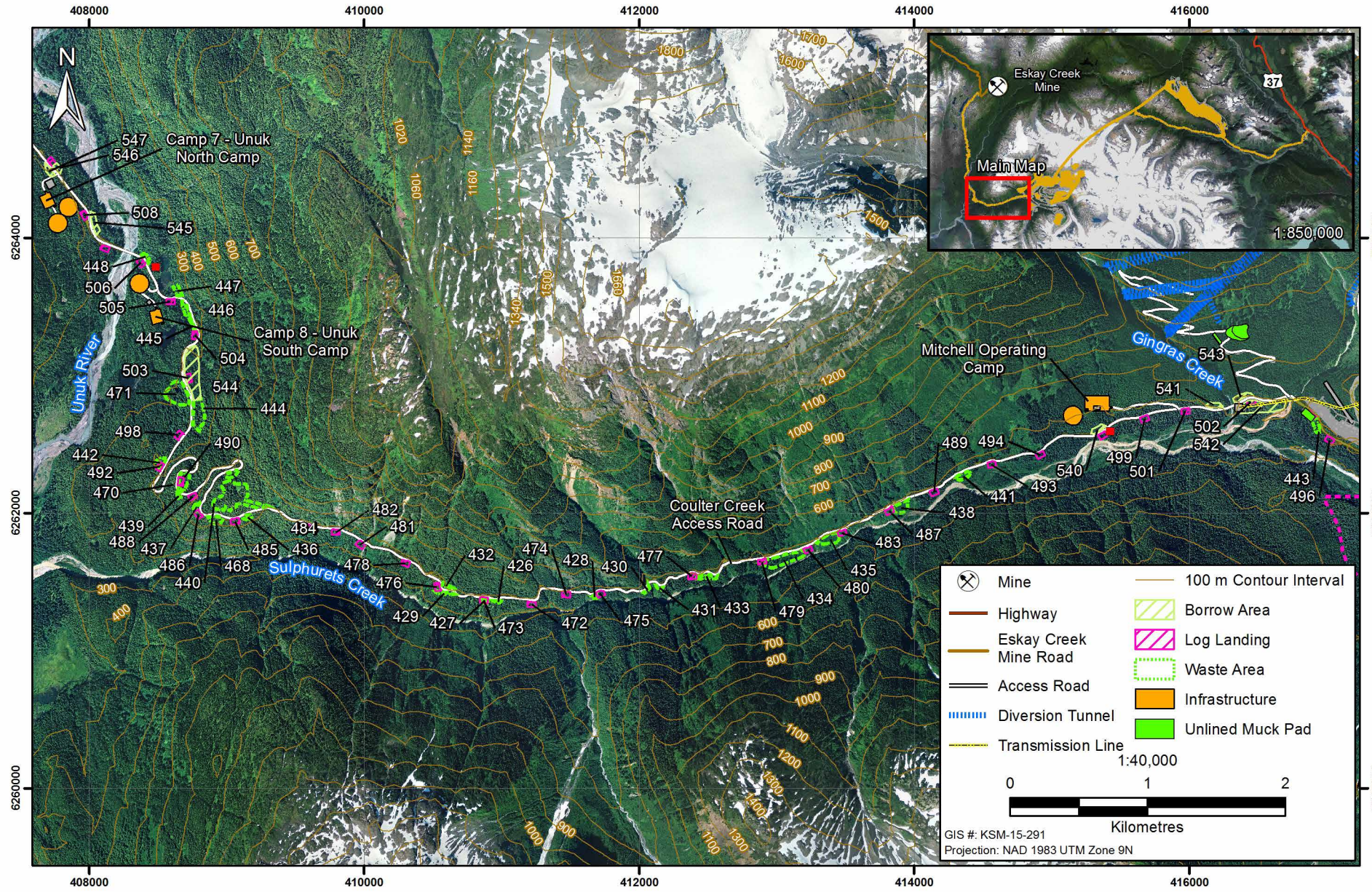

Figure 27.5-28

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Overburden Stockpiles and Borrow Sites Along the Coulter Creek Access Road

Figure 27.5-28

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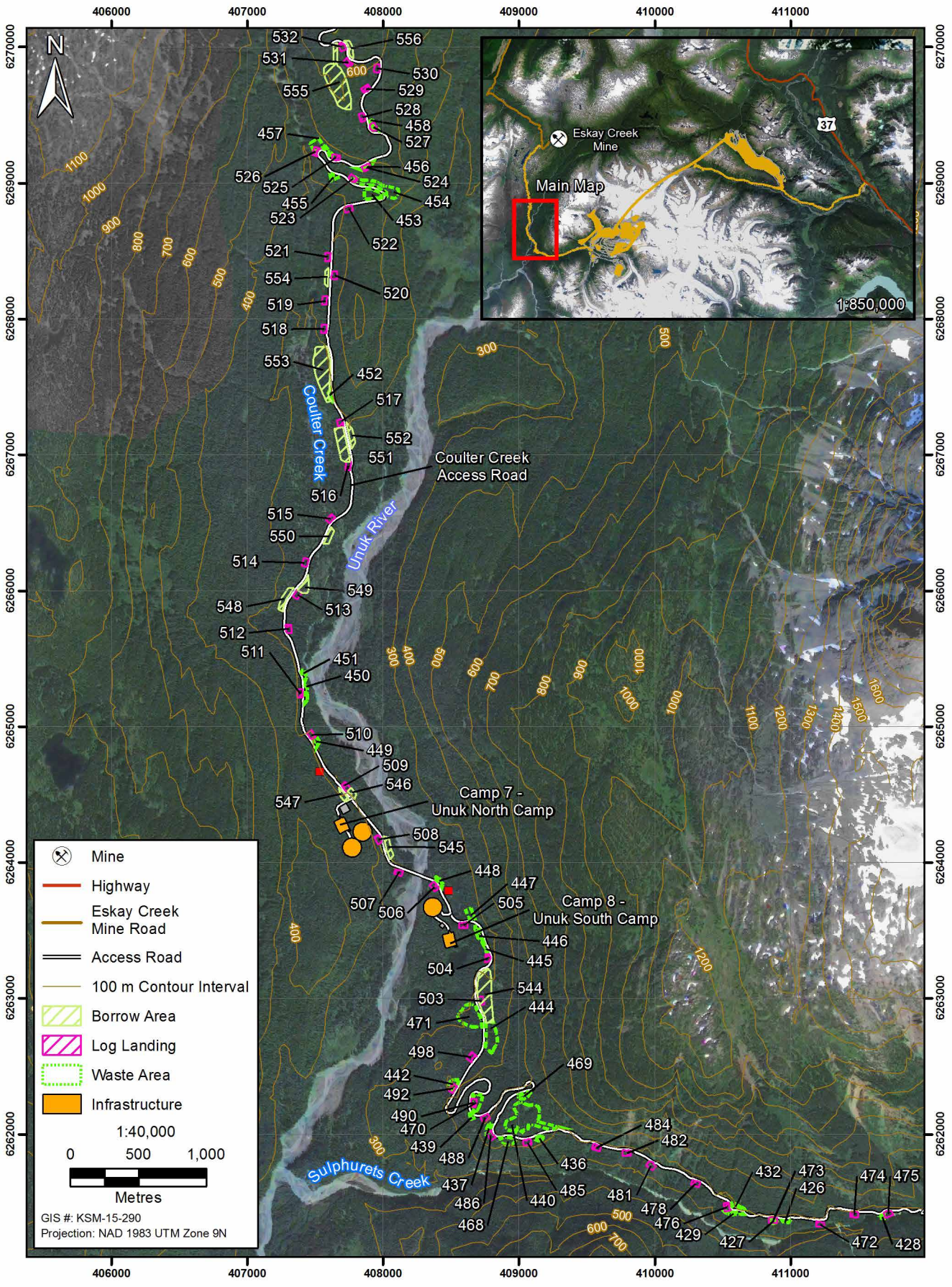

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Overburden Stockpiles and Borrow Sites Along the Coulter Creek Access Road

Figure 27.5-29

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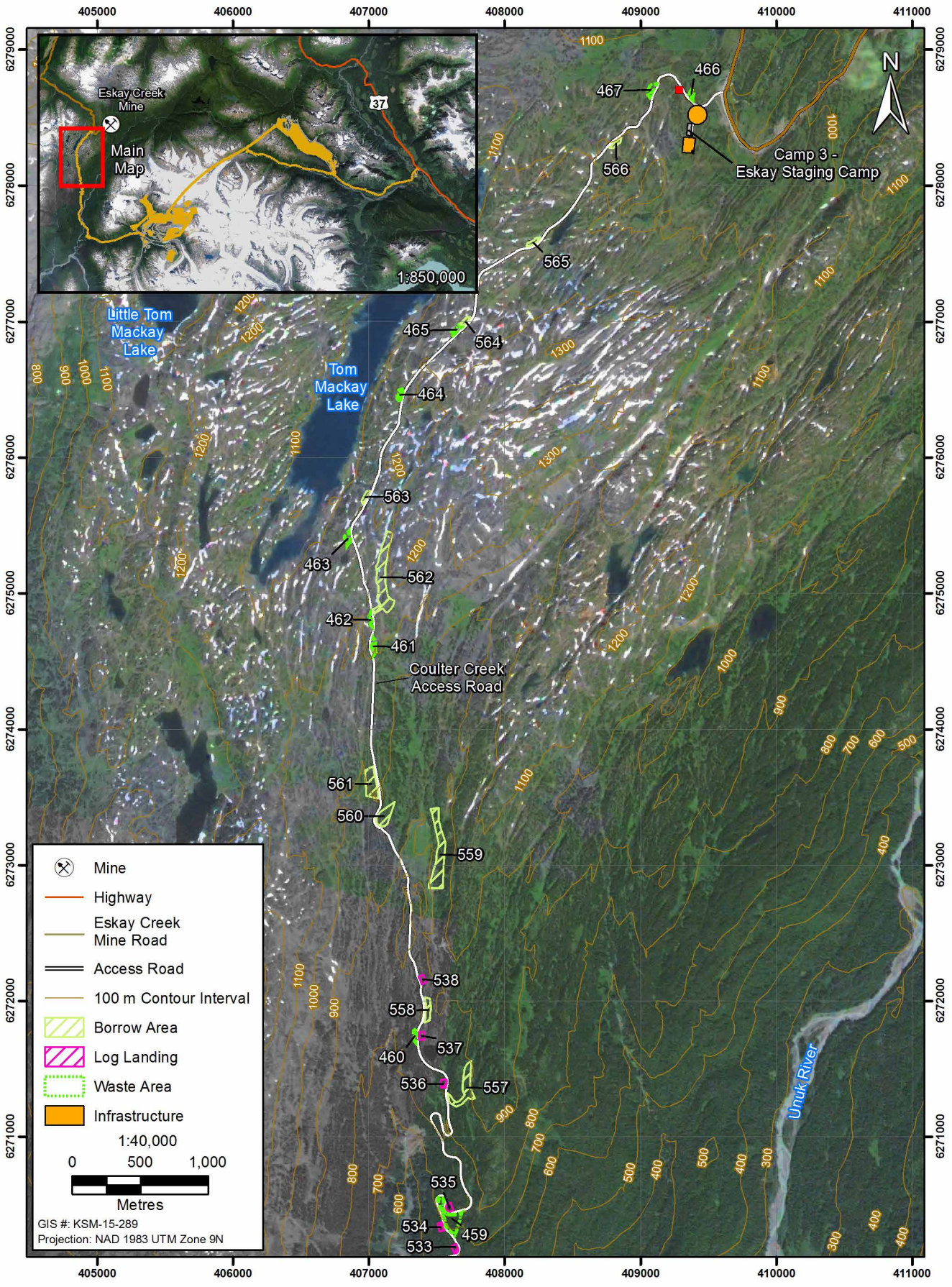

Figure 27.5-30

Overburden Stockpiles and Borrow Sites Along the Coulter Creek Access Road

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27.5.7 Explosives

27.5.7.1 Closure

Explosives for the Project will be manufactured on site. The Explosives Manufacturing Facility, the explosives magazine, and the prilled ammonium (AN Prill) storage area will be located at separate sites (Figure 27.5-31). All three sites will be located in the Ted Morris Valley. The manufacturing of explosives will be planned to minimize the accumulation of excess AN Prill and fuel at the end of mining.

All surfactant, oils and fuels, chemicals, and diesel storage tanks will be removed from the manufacturing facility and disposed of in a designated facility. All equipment will be removed. Wiring and transformers will be removed from the site and will be reused or recycled. The Explosives Manufacturing Facility will be dismantled, and any recyclable materials will be taken off site. Materials that can be incinerated will be treated on site. Other materials will be disposed of in the on-site landfill, if suitable for the landfill. The concrete foundations will be broken up, and the concrete rubble will be buried on site, spread on the RSFs, or used where required. All contaminated soils will be taken to the landfarm facility. The gate and fence around the explosives manufacturing compound will be dismantled and sent off site for recycling or reuse.

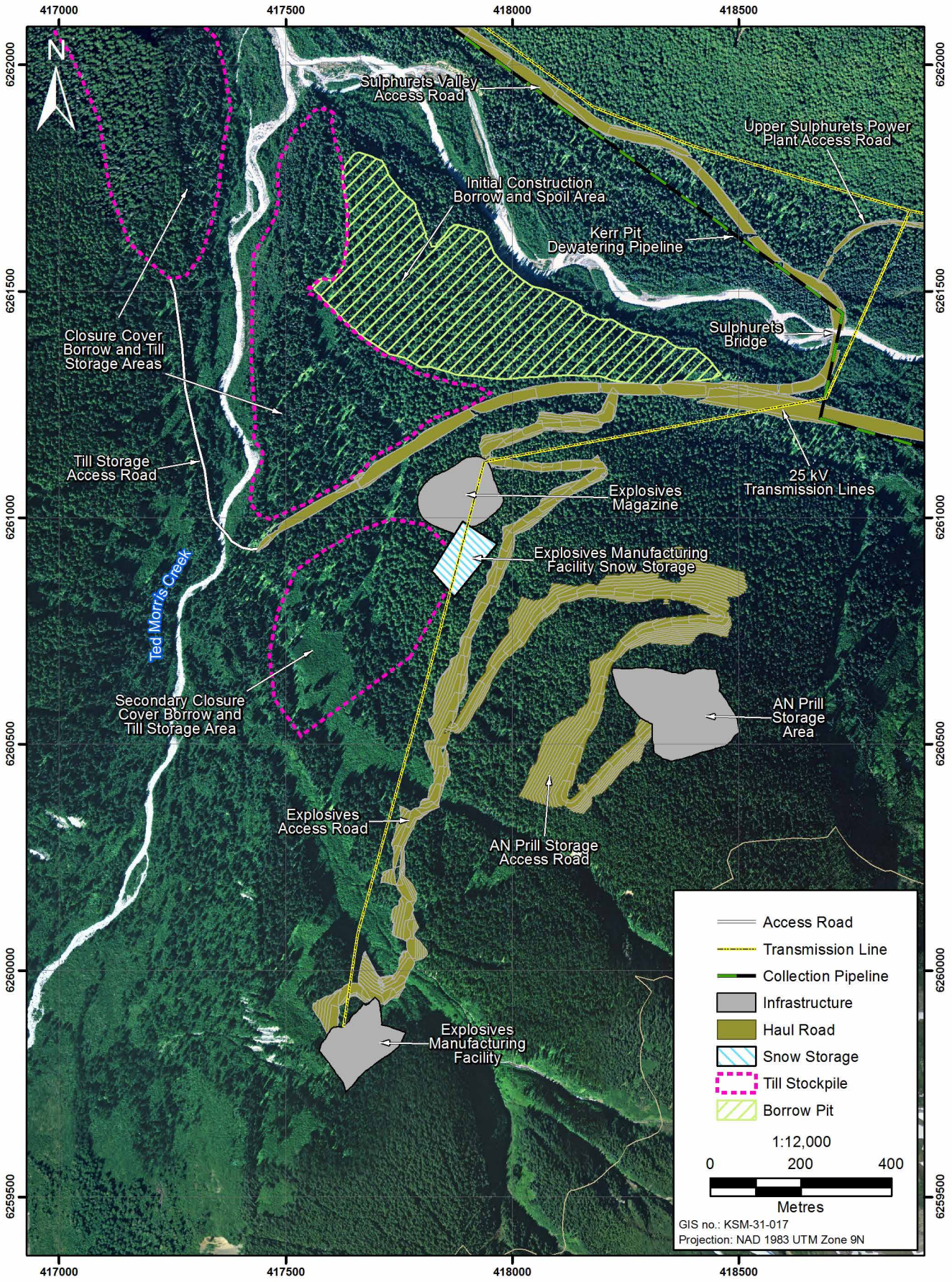
The building footprint and surrounding parking areas will be compacted as a result of the use of the site. In preparation for reclamation, the surface will be ripped in two directions to a depth of 30 cm to increase drainage.

The AN prill storage area will be closed. Any remaining prill will be used as fertilizer or will be disposed of off-site in a regulated facility. All electrical wire and transformers will be salvaged or will be removed from the site and reused or recycled. The building will be dismantled and its materials recycled, incinerated, or disposed of in the landfill, if suitable, as described above. Contaminated soils will be treated in the landfarm. The site and adjacent areas will be deep-ripped in two directions, as described above.

The explosives magazine will be removed at closure. Any remaining explosives will be detonated on site in a regulated manner to minimize impact to the environment. Similar to the other facilities, the building will be dismantled. The site will be ripped to reduce compaction.

27.5.7.2 Reclamation

The soils that will have been salvaged and stockpiled during construction of each of the facilities will be spread over the surface and vegetated with native plants as described for the RSFs in Section 27.5.2.6.2. With time, the vegetation community will become more complex as native plants growing in the adjacent areas gradually move into the reclaimed areas.



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Location of the Explosives Manufacturing Area, AN Prill Storage Area, and Explosives Magazine

Figure 27.5-31

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27.5.8 Mini Hydro Plants and Energy Recovery

Several energy recovery and mini-hydro plants are included in the Project development plan. These plants generate electrical power by making use of facilities already included in the Project, resulting in significant net Project energy savings. All of the plants, similar to small independent power producer hydro-electric plants, will operate unattended and will be automatically controlled by programmable logic controller (PLC) systems. The power will be fed into the local mine distribution transmission lines. The power plants will be used to provide electricity for the Project's closure requirements, or the electricity may be sold back to BC Hydro under the Standing Offer Program (Appendix 4-J).

27.5.8.1 Water Treatment Plant Energy Recovery

Water pumped from the water storage pond to the WTP will generate electric power. A small impulse Turgo-type turbine will be used. The output may be fed into the plant power distribution system at the WTP. This facility will continue to operate after mine closure.

27.5.8.2 Mitchell Diversion Hydro – Upper Sulphurets Power Plant

The Upper Sulphurets Power Plant will make use of the normal (but not flood) stream flows that will be diverted around the mining operations by the Mitchell Diversion Tunnels to produce energy. The installation will consist of a Pelton turbine and will be very similar to independent power producer run-of-river hydro plants because it will make use of natural flows, unimpounded by water storage facilities or any other works other than those required to divert water around the mine. The equipment will be housed in a small powerhouse building near Sulphurets Creek. Power will be delivered to the electrical distribution system. This plant will continue to operate after mine closure.

27.5.8.3 McTagg Diversion Hydro – McTagg Power Plant

The McTagg Power Plant will generate energy in a manner similar to the Upper Sulphurets Power Plant. The McTagg Power Plant will be constructed in Year 10, once the diversion tunnel inlets of the MTDT are raised in Phase 2. It will consist of two Pelton turbines and will feed power into the plant distribution system at the WTP. This facility will continue to operate after mine closure.

27.5.9 Muck Pads and Sediment Ponds

27.5.9.1 Closure

There are a number of muck pads and sediment ponds located in the Project area. The sediment ponds will be backfilled with not potentially-acid-generating (NPAG) rock to bring the surface to grade. The berms of the ponds will be pulled into the pond area to provide a level surface.

27.5.9.2 Reclamation

The muck pads will be covered with a layer of soil 30 to 50 cm deep, and will be re-vegetated with native plants. The surface of the muck pads will be rough, and some of the soil placed on these facilities will fall between coarse fragments, resulting in a variable thickness of soil. This will result in plant establishment that will be successful in some areas while other areas will

remain un-vegetated. The soils will be vegetated with the native grass mix described for the RSFs in Section 27.5.2.6.2.

Approximately 50 cm of soil will be spread over the surface of the backfilled sediment ponds. The areas will then be re-vegetated with species consistent with the adjacent vegetation. Care will be taken not to compact the soil cover. If it becomes compacted, it will be lightly ripped to provide for root establishment. These areas will be vegetated with the native grass seed mix.

27.5.10 Construction and Operation Camps

27.5.10.1 Closure

There will be 2 operating camps (the Mitchell Accommodation Complex and the Treaty Operating Camp) and 12 construction camps. The camps will range in area from less than 1 ha to a maximum of 16.9 ha, with most camps occupying less than 5 ha (Table 27.5-1).

There will be 11 construction camps (1 at Granduc, 4 at the Mine Site, 3 at the PTMA and 3 along the CCAR), varying in size with several accommodating 50 people or less. All construction camps will be closed either during the construction phase, or at the end of construction. The largest construction camp in the Mine Site will be Camp 10: Mitchell Secondary Camp, which will accommodate 400 people. The largest camp in the PTMA will be Camp 5: Treaty Plant Camp, which will accommodate 700 people. Both of these large camps will be closed at the end of construction.

There will be two operating camps, the Mitchell operating camp, which will accommodate 350 people, and the Treaty operating camp, which will accommodate 250 people. The Treaty operating camp will be reduced in size at closure, and will then be similar in size to the current Eskay Creek Mine operating camp. It will be used to support ongoing operation and monitoring.

The camps will generally include portable trailers, an incinerator, materials and equipment storage areas, a helicopter pad, a helicopter fuelling area, fuel storage, a septic field, water/sewage treatment, and diesel generators. The portables will be set up so that they can be dismantled and used at the different sites, as required.

For closure, the portables and all equipment and buildings will be removed. Fuels will be drained from the generators and tanks, and will be disposed of in a regulated disposal facility. The generators and fuel tanks will be removed from the site for reuse or recycling. The soils in the fuel storage areas will also be checked for hydrocarbon contamination. If hydrocarbon contamination is found, soils will be excavated and transported to the landfarm for remediation.

All construction and operation camp sites will be reclaimed to a slope compatible with the surrounding natural topography. The high traffic areas will be ripped in two directions to increase surface drainage and to allow for deeper root penetration.

Table 27.5-1. Construction and Operating Camps

Camps	Project Year	Size (People)	Area (ha)	Surficial Material	Biogeoclimatic Zone
Camps during Construction					
Camp 1: Granduc Staging Camp	-6 to -3				
Camp 2: Ted Morris Camp	-5 to -3	50	0.8	glacio-fluvial	Mountain Hemlock
Camp 3: Eskay Staging Camp	-5 to -3	50	2.9	morainal	Mountain Hemlock
Camp 6: Treaty Saddle Camp	-5 to 0	120	3.5	morainal	Engelmann Spruce – Subalpine Fir
Camp 11: Treaty Marshalling Yard Camp	-5 to 0	60	16.9	morainal	Interior Cedar – Hemlock
Camp 7: Unuk North Camp	-4 to -3	40	4.7	morainal	Coastal Western Hemlock
Camp 8: Unuk South Camp	-4 to -3	40	3	glacio-fluvial	Coastal Western Hemlock
Camp 9: Mitchell Initial Camp	-5 to -1	140	1.6	morainal/colluvial	Mountain Hemlock
Camp 4: Mitchell North Camp	-3 to -1	125	5.2	morainal/glacio-fluvial	Mountain Hemlock
Camp 10: Mitchell Secondary Camp	-5 to 0	400	1.6	morainal/colluvial	Mountain Hemlock
Camp 5: Treaty Plant Camp	-5 to 0	700	4.1	morainal	Engelmann Spruce – Subalpine Fir
Camps during Operation					
Mitchell Operating Camp	- 3 to LOM	350	0.1	morainal	Mountain Hemlock
Treaty Operating Camp	- 2 to LOM	250	8.4	morainal	Engelmann Spruce – Subalpine Fir

27.5.10.2 Reclamation

The surficial materials and BEC zone information indicates that the camps will be located on a range of surficial materials and in various BEC zones. Prior to construction, topsoil will have been salvaged from the camp site areas and stockpiled along the edges of the camps. At closure, this soil will be spread over the disturbed areas. These areas will then be re-vegetated with the native grasses, shrubs, and tree seedlings that were described for the RSFs in Section 27.5.2.6.2. The tree seedlings will be selected based on the tree species occurring in the vicinity. It is predicted that with time, the vegetation community will become more complex as native plants growing along the edges of the camps sites will also naturally re-establish within the reclaimed areas.

Closure of the gravel helipads will entail topping the gravel with 50 cm of soil in order to provide sufficient moisture holding capacity for replanted vegetation and adequate rooting depth for tree seedlings. Approximately 20 cm of topsoil will be spread in areas that occur on native soils. These areas will also be re-vegetated with the native plants and tree seedlings described for the RSFs in Section 27.5.2.6.2.

27.6 Post-closure Landscape

27.6.1 Overview

The post-closure objectives for the Project are to provide stable landforms and to reclaim as much of the disturbed areas as practical to wildlife habitat. As noted above, general wildlife habitat will be achieved by re-vegetating with native species suited to the Project area. However, the RSFs and the TMF provide an opportunity to develop more specific wildlife habitats focusing on mountain goat, grizzly bear, marmot, and moose. To effectively develop a meaningful wildlife habitat management strategy for reclamation of these facilities at closure and post-closure, definite objectives for habitat creation are identified. These objectives provide a framework to facilitate the development of target vegetation and topographic conditions (Figure 27.6-1). While the objectives focus on mountain goats, grizzly bears, marmot and moose, these habitat types will also provide value to other wildlife species or groups.

27.6.2 Rock Storage Facilities

Reclamation of the RSFs is focused on providing habitat for mountain goats, grizzly bears, and marmots because these species occur in this area, are of high socio-economic value, and are of conservation concern. Mountain goats require steeper slopes to escape predators such as grizzly bears and wolves. Marmots are burrowing animals that prefer grasses, and function as grizzly bear and eagle prey.

The RSFs have been divided into seven units (Figure 27.6-2) that include a range of wildlife habitat types to provide diversity. A key factor in the closure design of the RSFs is the distance to escape terrain for mountain goats. Mountain goats generally do not forage in areas that are more than 500 m away from escape terrain. Mountain goats will use barren areas with slopes greater than 35° as escape terrain. The area between 1,100 and 1,200 masl on the Mitchell RSF will be left at 37° and will remain barren for this purpose. The escape terrain (Wildlife Habitat 2, Figure 27.6-2) will occupy approximately 88 ha (Table 27.6-1).

PROJECT # 0196301-0028-002 GIS No. KSM-31-005_T July 3, 2013

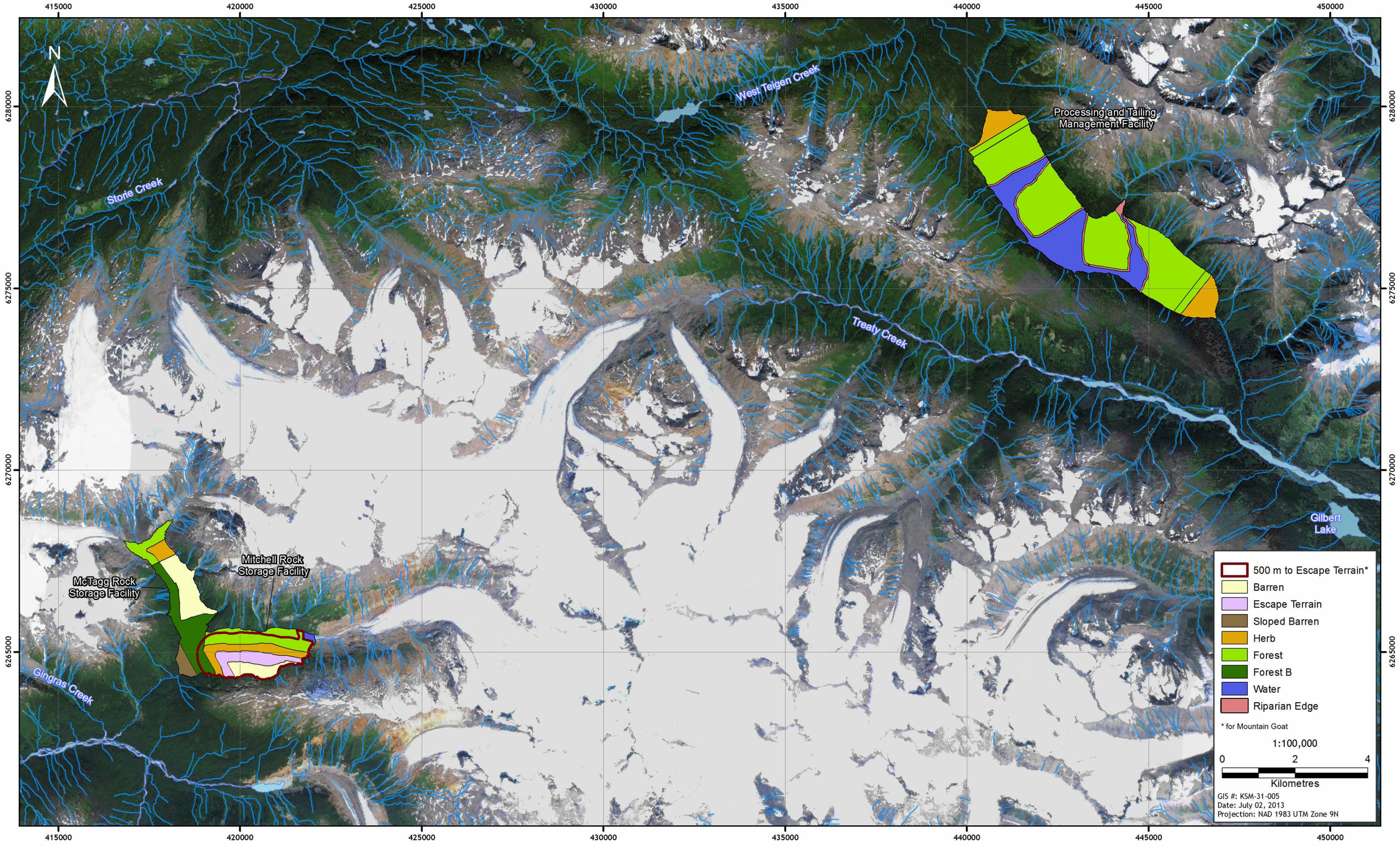

Figure 27.6-1

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Closure and Reclamation Plan for the Rock Storage Facilities and the Tailing Management Facility at Post-closure

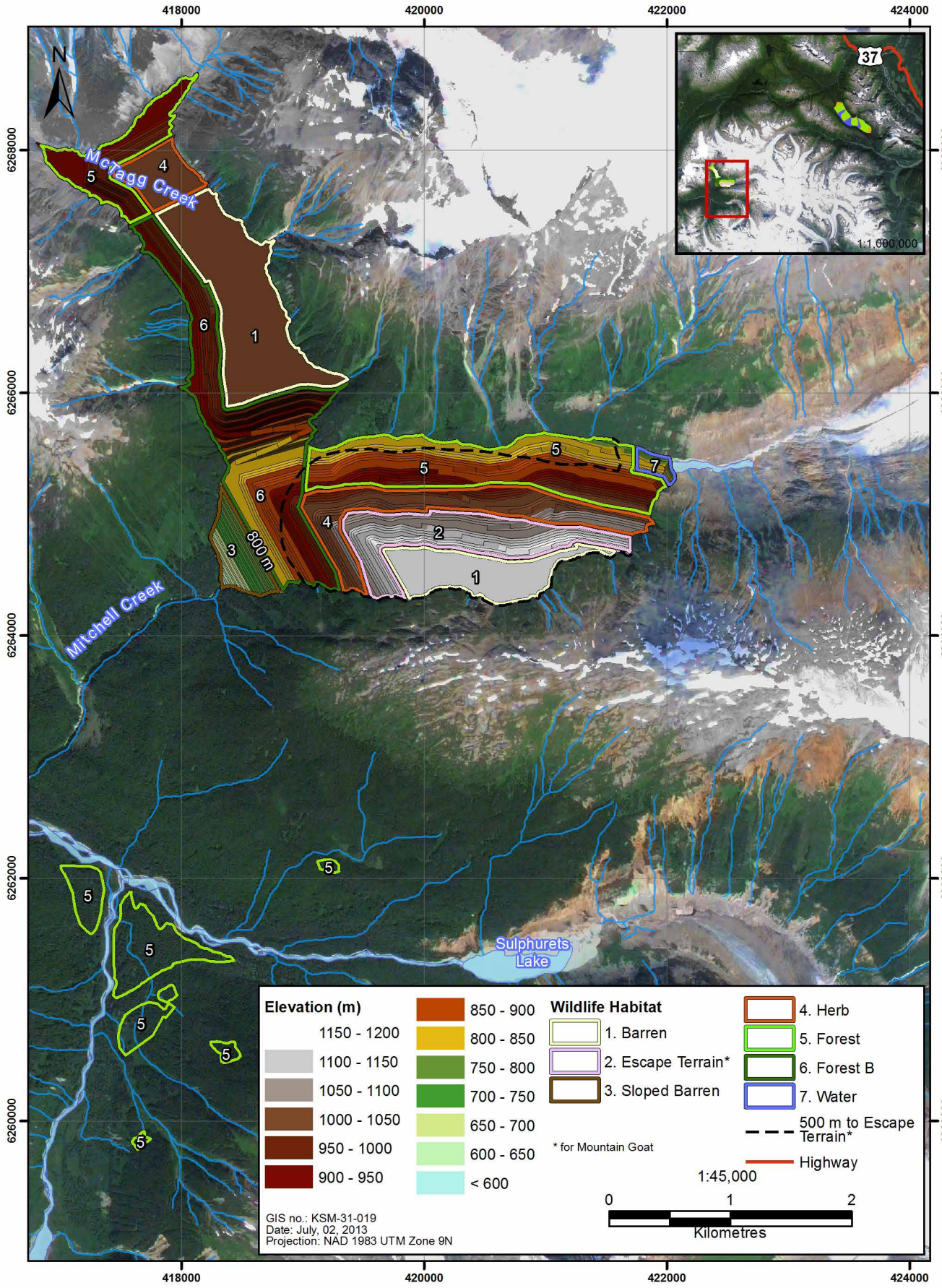

Figure 27.6-2

Closure and Reclamation Plan for the Rock Storage Facilities at Post-closure

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Table 27.6-1. Wildlife Habitat on the Mitchell and McTagg Rock Storage Facilities

	Wildlife Habitat	Area (ha)	Percent
Mitchell RSF	4. Herb	87	12
	5. Forest	141	19
	2. Escape terrain (Barren)	88	12
	1. Barren (Top)	53	7
	3. Sloped barren	31	4
	6. Forest B	73	10
McTagg RSF	4. Herb (Top)	25	3
	5. Forest	51	7
	1. Barren (Top)	109	14
	6. Forest B	97	13
Total		**755**	**100**

The Mitchell RSF will be primarily planted to herbs (grasses) and shrubs, such as willow, (Wildlife Habitat 4), to provide forage for mountain goats and possibly for hoary marmots, which have been observed to use steeper slopes in the area. The preferred forage for marmot includes natural grasses and sedges, and herbs such as Sitka valerian, groundsel, fireweed, Indian hellebore, cow parsnip, etc. This vegetation is also valuable for grizzly bears. These species will likely move into this and other zones and increase the complexity of the vegetative community. This area on the Mitchell RSF will occupy approximately 87 ha.

The area below the herb vegetation group on the north side of the Mitchell RSF will be planted to forest (Wildlife Habitat 5), which will include tree species, such as subalpine fir and hybrid white spruce, as well as grasses and shrubs, and will support a wide range of wildlife. This area will occupy approximately 141 ha.

The area above the WSF, up to to 810 masl, will remain at a 37° slope and will not be vegetated to discourage wildlife from accessing the WSF (Wildlife Habitat 3, Figure 27.6-2). This area will occupy approximately 31 ha. The area above Wildlife Habitat 3 will be re-vegetated using less palatable shrubs such as false azalea, and tree/shrub species, such as Sitka alder (Wildlife Habitat 6, Forest B) to further discourage wildlife from using the area above the WSF. Vegetation in Wildlife Habitat 6 will include grasses, but efforts will be made to re-vegetate the area with less palatable species. This area will occupy approximately 73 ha.

The McTagg RSF is located in an area used by mountain goats and other wildlife. The RSF will be divided into a northern area, which will be enhanced for goat habitat, and a southern area where wildlife habitat will not be enhanced. The southern area is close to the WSF, and considering the concerns for water quality in the WSF, the Wildlife Habitat 6 zone will extend to the south and southwest slopes of the McTagg RSF. This area will occupy approximately 97 ha (Figure 27.6-2).

Enhancement of the northern area for mountain goat will be carried out in an attempt to keep goats away from the WSF, as with the Mitchell RSF. Therefore, the north and northwest facing slopes of the McTagg RSF will be planted to conifer forest (Wildlife Habitat 5) to provide good wildlife habitat to facilitate winter use. This area will occupy approximately 51 ha.

Sludge will be landfilled on top of the RSFs. As sludge may be accessible to burrowing animals, such as hoary marmot, this animal species will be monitored for exposure to contaminated sludge. The northern portion of the sludge landfill on top of the McTagg RSF may be reclaimed if there is sufficient soil for reclamation, once that end of the RSF is no longer required for sludge disposal.

The sludge landfill will be covered with coarse material as part of the design. Areas that will be reclaimed will require soil. As the surface will be coarse material, the soil cover will be 50 cm thick to allow sufficient rooting depth and water storage capacity for vegetation. The reclaimed area will be planted to herb vegetation to provide spring forage for mountain goat (and other species including marmot and grizzly bear; Wildlife Habitat 4). This area will occupy approximately 25 ha on the top of the McTagg RSF.

In summary, approximately 474 ha or 65% of the Mitchell and McTagg RSFs will be reclaimed for wildlife habitat, and 88 ha or 12% will be left unreclaimed as escape terrain for mountain goats.

27.6.3 Tailing Management Facility

The TMF closure objectives will also focus on creating a diverse range of wildlife habitat (Figure 27.6-3). The closure objectives will include the development of primary and secondary habitat management, with a focus on moose and grizzly bears. The goal will be to manage the TMF beaches as early winter habitat (i.e., winter use during non-snowpack-limiting periods). This goal will be achieved by promoting vegetation forage that will be used by moose during fall, early winter, and early spring. The TMF is positioned at an elevation that would be used in transition from summer to winter moose habitats. It is also likely that moose will occur in this area during rutting season and will likely use the open area during this period. Achieving these habitat objectives will be influenced by the ability of the site to produce vegetation that will provide forage and cover for moose. The emphasis will be on attaining a cover of willow, cottonwood, alder, grasses, subalpine fir, and hybrid white spruce (Wildlife Habitat 12, Forest). Willow can be planted in the drier parts of the beach. The reclaimed beaches will occupy approximately 929 ha (Table 27.6-2).

Table 27.6-2. Reclamation of the Tailing Management Facility

TMF	Wildlife habitat	Area (ha)	Percent
Beaches	12. Forest	929	69
Corridors	13. Forest	7	1
Dams	10. Herb	136	10
Shore	11. Riparian Edge (Wetland)	267	20
Total		**1,339**	**100**

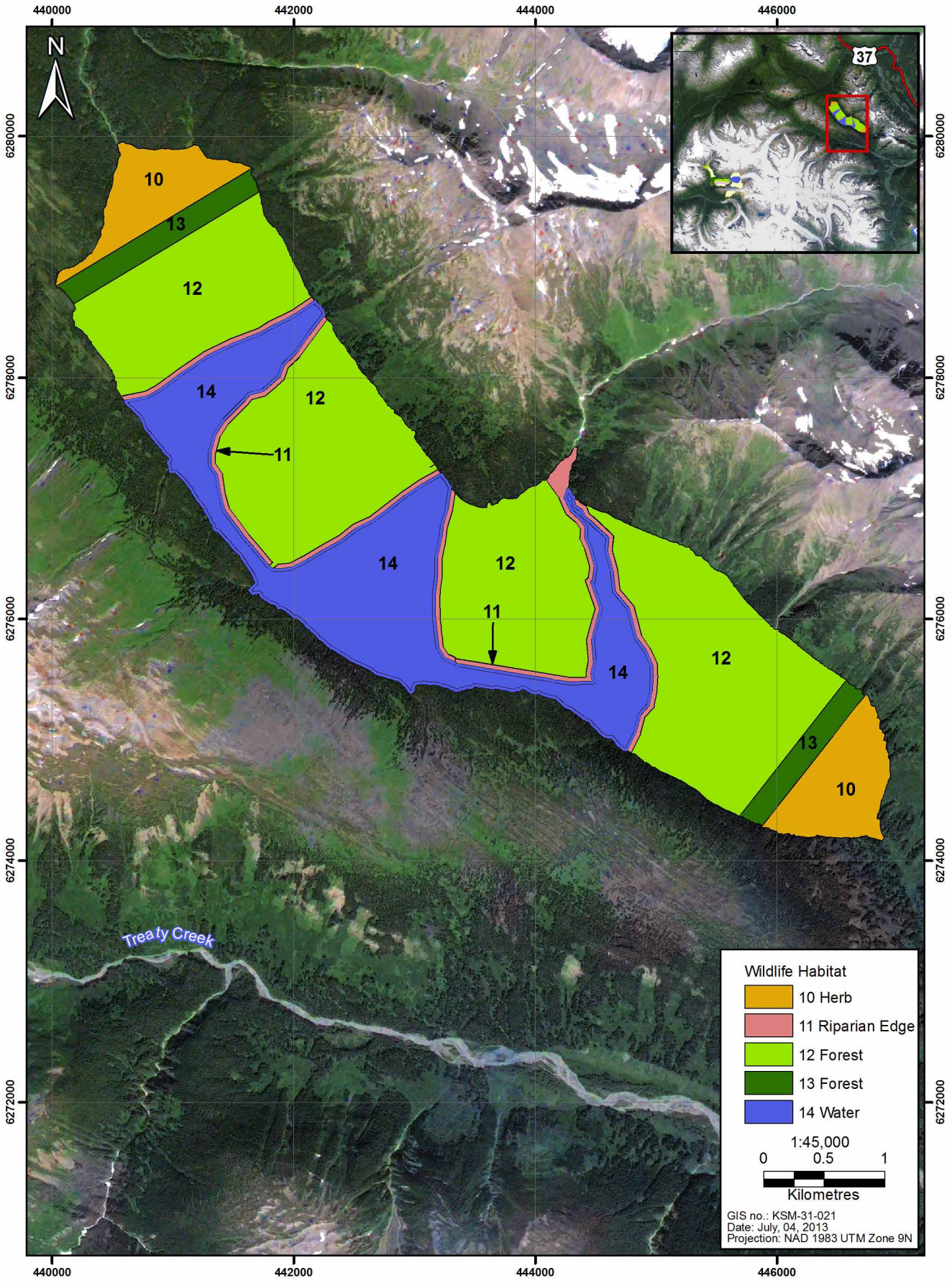

Figure 27.6-3

Closure and Reclamation of the Tailing Management Facility at Post-closure

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Wildlife habitat objectives for the TMF dams include grizzly bear forage areas during spring and summer. For spring habitat, areas that could be vegetated with grasses, sedges, or herbs will be selected. The mesic upland areas will be vegetated with *Vaccinium* species (black huckleberry or Alaskan blueberry) to promote grizzly bear summer forage value. Other vegetation could include fireweed, cow parsnip, and lupine, and berry-producing shrubs (e.g., soopolallie, elderberry, and mountain ash) known to be attractive to bears (Wildlife Habitat 10, Figure 27.6-3). The dams will occupy approximately 136 ha.

The primary goal for the dam crests is to create wildlife corridors where wildlife can cross from one side of the valley to the other. The corridors will be planted with a mixture of trees, such as subalpine fir and hybrid white spruce, as well as grasses and shrubs to develop a complex vegetative community with mature trees to provide shelter and screening cover for wildlife, encouraging the use of these areas as cross-valley linkages (Figure 27.5-26). The wildlife corridors are designated as Wildlife Habitat 13. Wildlife Habitat 13, which will occupy approximately 7 ha.

A secondary objective of reclamation at the TMF is to manage vegetation for a long-term goal of developing a complex, riparian edge along the banks of the open water. The development of a complex riparian edge would include establishing black cottonwood that in 100 years would support mature stems with cavities for waterfowl nesting, bat day roosts, and possibly fisher or black bear denning. To achieve this, cottonwood/balsam poplar that would survive moose browsing should be planted along the water edge (Wildlife Habitat 11, Riparian/Wetland).

The tailing beach edges also provide an opportunity to compensate for wetland habitat loss, based on the assumption that water quality will eventually meet guidelines set for release of TMF water to the environment. The goal will be to produce a wetland complex of swamp, marsh, and shallow open water (Figure 27.5-27). Wetlands will develop in areas bounded on the upland side by tailing beaches beneath which the water table is located at no more than 60 cm depth, and on the pond side by a surface water depth of 2 m or less, to allow sufficient light for submergent vegetation to exist. Some till will be placed on the roughly 1-m wide rip-rap strip protecting the beach edge from erosion. This will also provide a soil base for establishment of wetland vegetation.

Willow is also suited to wet conditions but the roots cannot be submerged. Sedges can be planted in the wetter areas since their roots can be submerged. In water deeper than 15 cm, floating leaf vegetation can be established (e.g., pond weed and yellow pond lily). These plants can be transposed from adjacent wetlands or they can be propagated. With time, the plants will mature and the biodiversity will increase to mimic a natural wetland. Based on a beach slope of 0.5% and an underwater slope of 3%, approximately 147.9 ha of emergent wetland and 119.2 ha of submergent wetland could be developed in the TMF (Figure 27.6-4; Wildlife Habitat 11, Riparian/Wetland).

The seepage collection dams will remain in place. The areas upstream of the seepage collection dams will be wet. The ponds are predicted to decrease in water volume with time. They will likely overgrow and also become wetlands that support wildlife, such as moose.

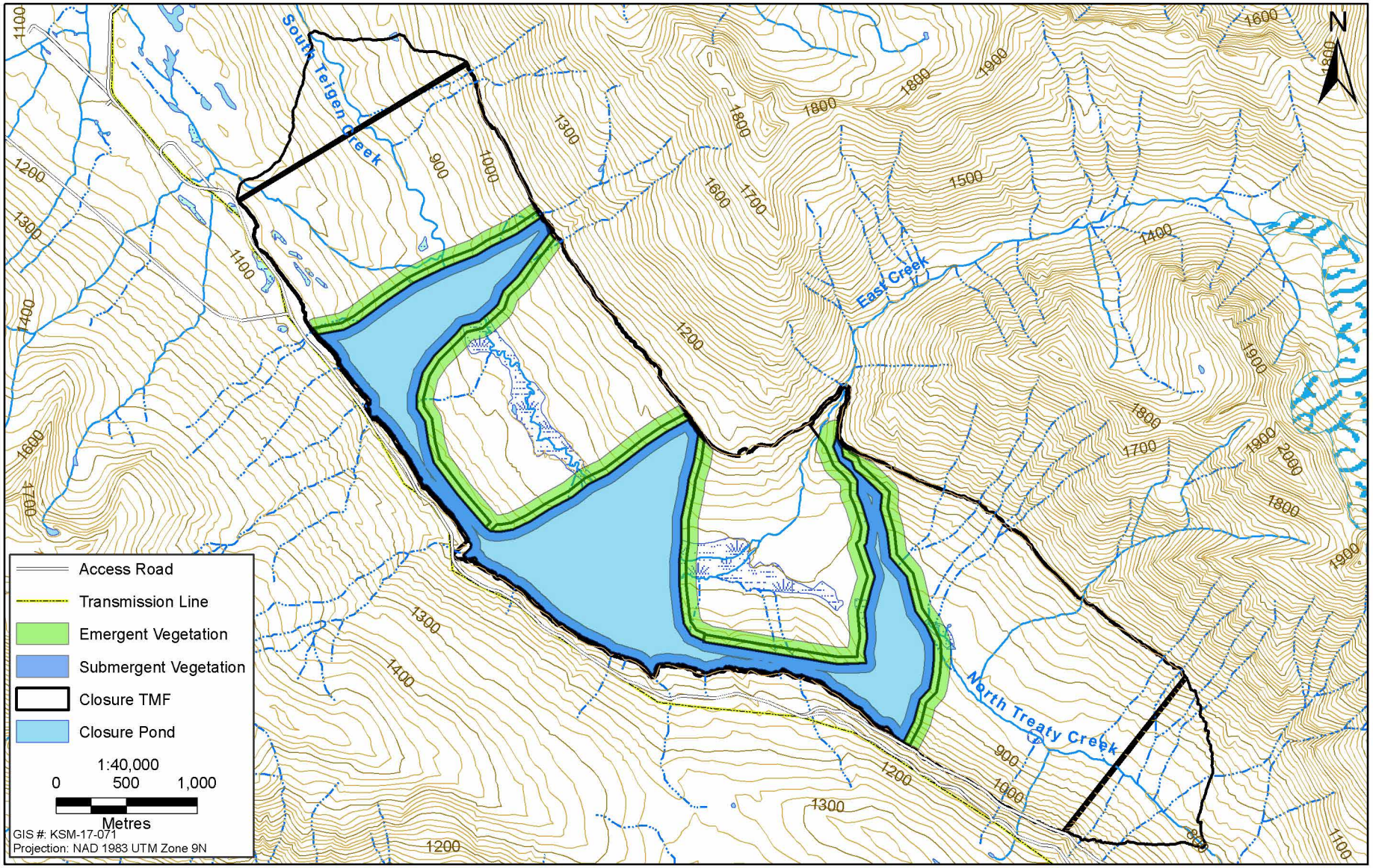

Figure 27.6-4

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Wetland Developed in the Tailing Management Facility at Post-closure

Figure 27.6-4

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All vegetation and habitat creation programs require monitoring to establish if defined habitat objectives are being met. Incorporating adaptive management into the plan is also recommended to achieve the greatest benefit to wildlife from the reclaimed areas.

A view of the TMF dam, beaches, and open water at post-closure is presented in Figure 27.6-5. Approximately 1,339 ha of the TMF will become wildlife habitat.

27.7 Closure and Reclamation Schedule

The reclamation schedule will include progressive reclamation, where possible, as this will reduce the potential effects of the Project on the environment.

The reclamation schedule is divided into the four phases of the Project: construction (5 years), operation (51.5 years), closure (3 years), and post-closure (250 years; see Figures 27.7-1 to 27.7-4). Some facilities, such as construction camps and the temporary sludge landfill, will be closed and reclaimed during the construction phase (Year -5 to Year -1). A few facilities will be closed during the operation phase (Year 1 to Year 52), such as the Mitchell RSF ore stockpile, the Sulphurets Pit, and the TMF North Cell. The greater part of the Project will be closed during the closure phase (Year 52 to Year 55), with some components closed during the post-closure phase (Year 56 to Year 306). As well, ongoing water treatment, monitoring, and management will be required into the post-closure phase. Figures 27.7-1 to 27.7-4 indicate which areas remain disturbed and which are reclaimed, by phase. Except for the RSFs and the TMF, once an area is reclaimed, it appears as the original satellite image in the subsequent map. A summary figure (Figure 27.7-5) indicates the total area reclaimed and not reclaimed for the whole Project.

Some areas that are disturbed during the early part of construction will not be reclaimed because they will be covered with other facilities, such as the RSFs. The facilities that will be reclaimed during the construction phase (Appendix 27-B) will occupy approximately 31 ha (Table 27.7-1).

Table 27.7-1. Reclaimed and Disturbed Areas by Phase

	Construction		Operation		Closure		Post-closure	
	ha	%	ha	%	Ha	%	ha	%
Disturbed	2,551	99	4,195	85	2,554	60	2,439	94
Reclaimed	31	1	767	15	1,678	40	152	6
Total	2,582	100	4,962	100	4,232	100	2,592	100

During the operation phase, 767 ha or 15% of the total Project area will be reclaimed. This reclamation will include the North Cell TMF, which will occupy 382 ha, and the South Cell borrow area, which will occupy 96 ha (Appendix 27-B).

The greater part of reclamation will occur during the closure phase. Approximately 1,678 ha of disturbed areas are reclaimed during this phase. This represents approximately 40% of the Project area in the closure phase. In this phase, 474 ha of the RSFs will be reclaimed. The RSFs cannot be reclaimed sooner, as construction of the RSFs proceeds from the bottom up and the slopes will have to be re-graded in preparation for reclamation once access to the slopes can occur.

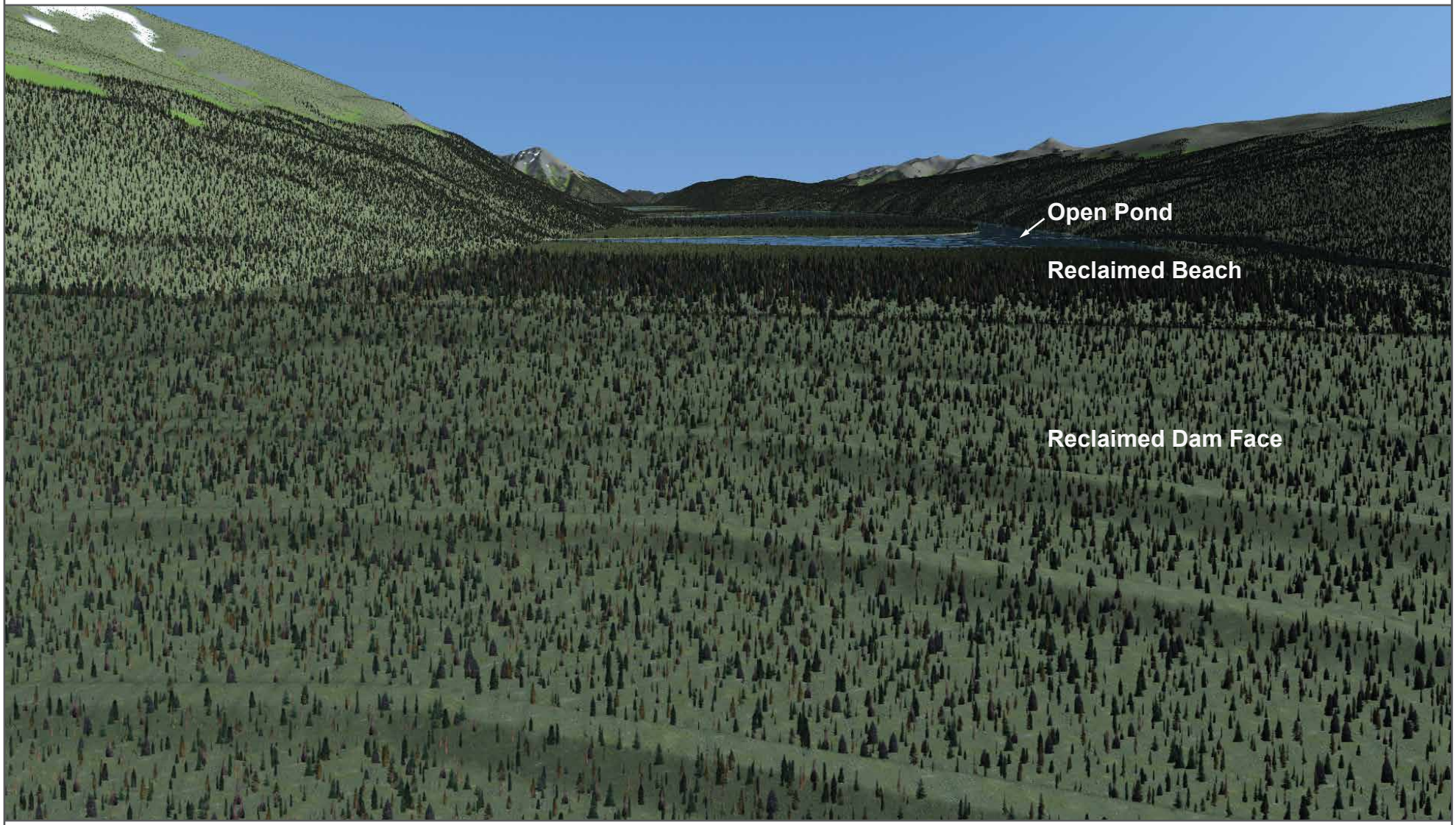

Figure 27.6-5

SEABRIDGE GOLD
KSM PROJECT

Tailing Management Facility Dam, Beaches, and Pond at Post-closure

Figure 27.6-5

Rescan™
Engineers & Scientists

PROJECT # 0197301-0028-002 GIS No. KSM-31-002_T July 4, 2013

410500 420500 430500 440500 450500 460500

6280500 6270500 6260500

Unuk Lake
Hodkin Lake
Teigen Creek
South Teigen Creek
West Teigen Creek
Treaty Ore Preparation Complex
Treaty Operating Camp
East Catchment Diversion
Camp 5: Treaty Plant Camp
Mitchell-Treaty Saddle Area
Camp 6: Treaty Saddle Camp
Treatys Adit Road
Treaty Creek
Treaty Creek Access Road
Camp 11: Treaty Creek Marshalling Camp
Bell-Irving River
Oweegee Lake
Skowill Creek
37
Gilbert Lake
Eskay Creek Mine
Tom MacKay Lake
Eskay Creek
Storie Creek
Coulter Creek Access Road
Coulter Creek
Unuk River
Mitchell RSF
Mitchell OPC
McTagg Twinned Diversion Tunnels
Water Storage Facility
Mitchell Pit
Mitchell Diversion Tunnels
Camp 7: Unuk North Camp
Gingras Creek
Mitchell Creek
Sulphurets Pit
Sulphurets Creek
Camp 8: Unuk South Camp
Mitchell Operating Camp
Explosives Manufacturing Facility
Sulphurets Laydown Area
Brucejack Lake
Knipple Glacier
South Unuk River
Todedada Lake

N

Highway
Eskay Creek Mine Road
Disturbed Construction Phase
Relaimed Construction Phase

1:150,000

0 2.5 5
Kilometres

GIS #: KSM-31-002
Date: July 04, 2013
Projection: NAD 1983 UTM Zone 9N

Figure 27.7-1

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Reclaimed and Disturbed Areas End of Construction Phase

PROJECT # 0197301-0028-002 GIS No. KSM-31-003_T July 4, 2013

410500 420500 430500 440500 450500 460500

6280500 6270500 6260500

Unuk Lake
Hodkin Lake
Teigen Creek
South Teigen Creek
West Teigen Creek
Treaty Ore Preparation Complex
Treaty Operating Camp
East Catchment Diversion
Camp 5: Treaty Plant Camp
North Cell Tailing Management Facility
Bell-Irving River
37
Oweegee Lake
Skowill Creek
Camp 3: Eskay Staging Camp
Eskay Creek Mine
Eskay Creek
Storie Creek
Mitchell-Treaty Saddle Area
Camp 6: Treaty Saddle Camp
Treatys Adit Road
CIL Lined Pond
Treaty Creek
South Cell Tailing Management Facility
Camp 11: Treaty Creek Marshalling Camp
Coulter Creek Access Road
Coulter Creek
Unuk River
Treaty Creek Access Road
Gilbert Lake
Mitchell RSF
McTagg RSF
Mitchell OPC
McTagg Twinned Diversion Tunnels
Water Storage Facility
Mitchell Pit
Mitchell Creek
Mitchell Diversion Tunnels
Camp 7: Unuk North Camp
Sulphurets Pit
Sulphurets Creek
Camp 8: Unuk South Camp
Mine Site WTF
Kerr Rope Conveyor
Mitchell Operating Camp
Kerr Pit
Brucejack Lake
Knipple Glacier
Explosives Manufacturing Facility
Sulphurets Laydown Area
Todedada Lake

N

Highway
Eskay Creek Mine Road
Reclaimed at Operation Phase
Disturbed at Operation Phase

1:150,000

0 2.5 5
Kilometres

GIS #: KSM-31-003
Date: July 04, 2013
Projection: NAD 1983 UTM Zone 9N

Figure 27.7-2

Reclaimed and Disturbed Areas End of Operation Phase

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

PROJECT # 0197301-0028-002 GIS No. KSM-31-004_T July 4, 2013

410500 420500 430500 440500 450500 460500

6280500 6270500 6260500

Unuk Lake
Hodkin Lake
Telgen Creek
South Telgen Creek
West Telgen Creek
Treaty Ore Preparation Complex
Bell-Irving River
37
N
Camp 3: Eskay Staging Camp
Eskay Creek Mine
Tom MacKay Lake
Eskay Creek
Storie Creek
Treaty Operating Camp
East Catchment Diversion
Camp 5: Treaty Plant Camp
North Cell Tailing Management Facility
Oweegee Lake
Skowill Creek
Mitchell-Treaty Saddle Area
Camp 6: Treaty Saddle Camp
Treatys Adit Road
CIL Lined Pond
Treaty Creek
South Cell Tailing Management Facility
Camp 11: Treaty Creek Marshalling Camp
Coulter Creek Access Road
Coulter Creek
Unuk River
Treaty Creek Access Road
Gilbert Lake
Mitchell RSF
McTagg RSF
Mitchell OPC
McTagg Twinned Diversion Tunnels
Water Storage Facility
Mitchell Creek
Mitchell Pit
Mitchell Diversion Tunnels
Camp 7: Unuk North Camp
Sulphurets Pit
Sulphurets Creek
Camp 8: Unuk South Camp
Mine Site WTF
Kerr Rope Conveyor
Mitchell Operating Camp
Kerr Pit
Brucejack Lake
Knipple Glacier
Explosives Manufacturing Facility
South Unuk River
Todedada Lake

Highway
Eskay Creek Mine Road
Reclaimed at Closure Phase
Disturbed at Closure Phase

1:150,000

0 2.5 5
Kilometres

GIS #: KSM-31-004
Date: July 04, 2013
Projection: NAD 1983 UTM Zone 9N

Figure 27.7-3

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Reclaimed and Disturbed Areas End of Closure Phase

PROJECT # 0197301-0028-002 GIS No. KSM-31-010_T July 4, 2013

410500 420500 430500 440500 450500 460500

6280500 6270500 6260500

Unuk Lake
Hodkin Lake
Telgen Creek
Treaty Ore Preparation Complex
West Telgen Creek
Camp 3: Eskay Staging Camp
Eskay Creek Mine
Tom MacKay Lake
Eskay Creek
Storie Creek
Treaty Operating Camp
East Catchment Diversion
Camp 5: Treaty Plant Camp
North Cell Tailing Management Facility
Oweegee Lake
Skowill Creek
Mitchell-Treaty Saddle Area
Camp 6: Treaty Saddle Camp
Treatys Adit Road
CIL Lined Pond
Treaty Creek
South Cell Tailing Management Facility
Camp 11: Treaty Creek Marshalling Camp
Coulter Creek Access Road
Coulter Creek
Unuk River
Treaty Creek Access Road
Gilbert Lake
Mitchell RSF
McTagg RSF
Mitchell OPC
McTagg Twinned Diversion Tunnels
Water Storage Facility
Mitchell Creek
Mitchell Pit
Camp 7: Unuk North Camp
Gingras Creek
Mitchell Diversion Tunnels
Sulphurets Pit
Sulphurets Creek
Camp 8: Unuk South Camp
Mine Site WTF
Kerr Rope Conveyor
Mitchell Operating Camp
Kerr Pit
Brucejack Lake
Knipple Glacier
South Unuk River
Todedada Lake
37
N

Highway
Eskay Creek Mine Road
Reclaimed at Post-closure Phase
Disturbed at Post-closure Phase

1:150,000

0 2.5 5
Kilometres

GIS #: KSM-31-010
Date: July 04, 2013
Projection: NAD 1983 UTM Zone 9N

Figure 27.7-4

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Reclaimed and Disturbed Areas End of Post-closure Phase

PROJECT # 0197301-0028-002 GIS No. KSM-31-020_T July 4, 2013

410500 420500 430500 440500 450500 460500

6280500 6270500 6260500

N

Unuk Lake
Hodkin Lake
Telgen Creek
Treaty Ore Preparation Complex
West Telgen Creek
37
Eskay Creek Mine
Camp 3: Eskay Staging Camp
Tom MacKay Lake
Eskay Creek
Storie Creek
Treaty Operating Camp
East Catchment Diversion
Camp 5: Treaty Plant Camp
North Cell Tailing Management Facility
Oweegee Lake
Skowill Creek
Mitchell-Treaty Saddle Area
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Treaty Creek
South Cell Tailing Management Facility
Camp 11: Treaty Creek Marshalling Camp
Coulter Creek Access Road
Coulter Creek
Unuk River
Treaty Creek Access Road
Gilbert Lake
Mitchell RSF
McTagg RSF
Mitchell OPC
McTagg Twinned Diversion Tunnels
Water Storage Facility
Mitchell Pit
Camp 7: Unuk North Camp
Gingras Creek
Mitchell Creek
Mitchell Diversion Tunnels
Sulphurets Pit
Sulphurets Creek
Camp 8: Unuk South Camp
Mine Site WTF
Kerr Rope Conveyor
Mitchell Operating Camp
Explosives Manufacturing Facility
Sulphurets Laydown Area
Kerr Pit
Brucejack Lake
Knipple Glacier
South Unuk River
Todedada Lake

Highway
Eskay Creek Mine Road
Reclaimed Area Post-closure
Disturbed Area Post-closure

1:150,000

0 2.5 5
Kilometres

GIS #: KSM-31-020
Date: July 04, 2013
Projection: NAD 1983 UTM Zone 9N

Figure 27.7-5

SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Total Reclaimed and Final Disturbed Area at Post-closure

The beaches of the South Cell will be constructed and reclaimed at closure. The beaches of the Centre Cell will be created and reclaimed during post-closure. The Coulter Creek access road will also be closed post-closure.

As can be seen in Table 27.7-1, approximately 2,440 ha of the Project area will not be reclaimed. The unreclaimed areas will primarily include the pits; the WSF; the tops of the RSFs; the TMF ponds, which will occupy approximately 387 ha; and a few small buildings and roads that will be required for monitoring and maintenance purposes. The Treaty Creek access road will also be required for access to the site. It will occupy approximately 159 ha. The Mitchell Pit will occupy approximately 686 ha, the Sulphurets Pit Backfill will occupy approximately 222 ha, and the Kerr Pit will occupy approximately 278 ha (Appendix 27-B).

27.8 Reclamation Monitoring

Reclaimed areas will be monitored to ensure reclamation is successful and to identify areas that may require further treatment. The grass/legume 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. Areas that are bare may indicate that the soils are compacted or that more seed is required to achieve good surface cover. If the soils are compacted, they will be roughened and loosened to reduce compaction and provide for rooting of plants.

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 for chlorosis and other indicators of inadequate fertility. These plants may need additional fertilizer, additions of organic matter, or protection from browsing by wildlife. Vegetation in the early years will be fragile and susceptible to damage by snow and browsing. 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.

27.9 Research Programs

Several research programs will be carried out during operation. The Sulphurets Pit Backfill upper benches and the top of the facility will be used to assess the effects of various soil cover depths in terms of supporting vegetation. This will also provide an opportunity to assess various plant species, such as alpine species, as much of the Project area occurs in the alpine.

Soils will be placed on the waste rock. As the waste rock will have acid-generating potential, the soils will be assessed for metals, pH, and salts at the soil/waste rock interface.

A portion of the RSFs will be used to test the soil cover thickness on 26° slopes that will result in successful reclamation. The establishment and productivity of the native seed, shrubs, and tree seedlings will be assessed. This information will be used to finalize the reclamation vegetation mix on the RSFs. As well, the tree line occurs at approximately 1,100 masl. Generally, 50 cm of soil will be placed on the RSFs for reclamation, but a thinner layer may be suitable in alpine areas where the alpine grasses have a shallower rooting depth than a forested ecosystem.

A native seed collection program will be developed. Seed selection will be based on the species currently growing in the Project area that will meet the wildlife objectives. Research will include seed viability, seed storage, and seed propagation studies. The closed construction camps will be areas where site preparation techniques can be assessed and a research reclamation program can be carried out using native seed and tree seedlings collected from adjacent areas.

The initial temporary sludge landfill that will be required for sludge disposal before the TMF is constructed can be used to assess the design and reclamation of the long-term sludge disposal landfill to be placed on top of the RSFs. Evaluating the effects of covering a portion of the landfill with soils and re-vegetation will make possible better reclamation planning for the long-term sludge landfill.

The North Cell of the TMF will be closed at approximately Year 30. This will provide an opportunity to conduct wetlands trials to guide the development of wetlands. As well, the vegetation planning for the wildlife corridors, the beaches, and the dam faces can be tested in plot studies in the North Cell.

27.10 Temporary Mine Shutdown and Mine Closure

The closure and reclamation plan covers on-site Project facilities. This plan will generally be suitable to close the facilities and reclaim the site at any stage of operation. The TMF has been designed in stages (cells) and will be closed in stages. If the Project is stopped prematurely, some engineering adjustments may be required to accommodate premature closure. Water treatment will be carried out as required.

27.11 Closure Costing

This section provides an estimate of closure and reclamation costs. Some areas will be closed during the construction phase, such as the construction camps. A small portion will be closed during the operation phase, such as the North Cell TMF; and a small portion during the post-closure phase, such as the Centre Cell TMF and the Coulter Creek access road (Table 27.7-1). The greater portion of the facilities will be closed during the closure phase. As well, monitoring will be required during the post closure phase and these costs are also provided. The WTP will continue to operate post-closure and the annual cost of lime has been estimated.

The estimated cost of closure and reclamation is provided in Table 27.11-1. It includes labour and materials costs. The cost of soil placement, site preparation, and re-vegetation is generally included under reclamation costs unless otherwise stated. The costs relate to the closure activities proposed for each type of facility, as previously described, as well as the reclamation approach described for these facilities.

The cost of the closure of the McTagg and Mitchell RSFs has been estimated at $70,620,000. This estimate includes the cost of re-sloping ($13.7 M), soil placement ($55.6 M), and re-vegetation ($1,320,000). Soil salvage for the RSFs will cost approximately $43.8 M. Soil salvage will occur during operation and so is not included in the closure and reclamation costs.

Table 27.11-1. Closure and Reclamation Costing

Rock Storage Facilities	$70,620,000
Sulphurets Pit Backfill	$6,868,920
Sealing of Openings (11)	$1,743,775
Block Cave Mines	$1,053,000
Conveyors	$1,404,000
Crushers (3)	$1,263,600
Buildings / Structures Mine Site	$2,482,204
Mine Site Roads	$191,877
Buildings / Structures – Treaty Process Plant Site	$8,796,060
Tailings Management Facility	$24,674,524
Camps	$2,354,740
Reclamation (other Project facilities)	$7,304,080
Coulter Creek Access Road	$3,015,077
Total	**$131,771,857**

The cost of closing the Sulphurets Pit Backfill of the Sulphurets Pit has been estimated at $6,868,920. This estimate includes the cost of placing the liner on the benches and the top of the placed waste rock, as well as placing the protective cover on the benches and top of the waste rock.

The cost of closure of the TMF is estimated at $24,674,524. This estimate includes the cost of spreading the soil on the beaches and dam faces, as well as re-vegetation.

The reclamation costs have been estimated at $7,304,080 for site preparation, soil spreading, and re-vegetation for the other facilities. This includes areas such as the Mitchell OPC, the Sulphurets Pit Backfill, and the Treaty OPC.

The cost of closing and reclaiming parts of the Coulter Creek access road has been estimated at $3,015,077.

27.12 Post-closure

27.12.1 Water Treatment Plant

The WTP will operate 24 hours per day. The largest volume of water to be treated will be handled between April and November. The annual cost of operating the WTP has been estimated at $1,046,800 for labour and $15,139,200 for lime, for a total annual operating cost of $16,186,000. The annual cost of sludge disposal, including loading and trucking, is estimated at $4,197,500. The annual total cost for labour, lime, and sludge disposal has been estimated at $20,383,500.

27.12.2 Selenium Treatment Plant

The Selenium Treatment Plant will operate 24 hours per day. The largest volume of water to be treated will be handled between April and November. The annual cost of operating the Selenium Treatment Plant has been estimated at $6,656,620, including labour.

27.12.3 Closure and Post-closure Monitoring

Monitoring is required under Section 10.7.30 of the Health, Safety and Reclamation 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. The results of the monitoring program are to 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 following is a brief description of the closure and post-closure monitoring plans proposed for the Project.

27.12.3.1 Surface Water Quality

Surface water quality will be monitored at sites with the potential to incur effects attributable to Project infrastructure, such as the WTP and the TMF.

Water sampling at the Mine Site WTP discharge point (end of pipe) will ensure that effluent meets discharge permit limits; this sampling will be undertaken when discharges occur. Water samples will also be collected at downstream sites on a monthly or quarterly basis, as required by regulations and permitting requirements (these have still to be determined). Sampling sites will be located downstream of infrastructure, with both near-field and far-field exposure to Project activities, so that a gradient of potential effects can be assessed. Reference sites will be located either upstream (if possible) or in unaffected watersheds with similar hydrological conditions. All water samples will be analyzed for the physical parameters stipulated by the MMER (SOR/2002-222), in addition to a number of other physio-chemical parameters, including anions, nutrients, total cyanide, total organic carbon, and total and dissolved metals.

In addition to the ongoing monitoring required at discharge points, the post-closure monitoring program will include sampling of TMF water in the early summer and late fall (during open water periods) for the first 5 years, then annually for the next 10 years as part of a risk approach to wildlife use of the TMF. Results of water quality analyses will be compared to either Canadian Council of Ministers of the Environment (CCME) or BC Ministry of Environment (BC MOE) water quality guidelines for the protection of aquatic life or to site-specific water quality objectives developed for the Project during permitting (CCME 1999; BC MOE 2006).

Costs (in 2013 dollars) per weekly discharge event sampling are estimated as follows:

- field time: one day technician time = $300;
- laboratory fees: three samples (including one field blank) = $1,050; and
- equipment, transportation, other miscellaneous costs = $100.

Costs (in 2013 dollars) per monthly monitoring event are estimated as follows:

- field time: one day technician time = $300;
- laboratory fees: six samples (including one duplicate, one trip blank, one field blank) = $2,100; and
- equipment, transportation, other miscellaneous costs = $100.

The total annual cost for sampling is $109,000.

The cost assumptions include:

- field and reporting work conducted by technician working at a rate of $30.00/hour;
- quarterly data analysis and reporting: three days technician time = $900;
- analytical costs: $350 per sample; and
- ground transportation adequate to access all sites.

27.12.3.2 Aquatic Resources and Fish

Monitoring programs for biological aquatic resources and fish are required by the MMER (SOR/2002-222) and will form part of the permitting conditions (to be determined) set downstream of the Mine Site WTP for as long as discharges from the WTP continue. Sediment samples will include the measurement of moisture content, particle size, cyanides, nutrients, organic carbon, and total metal concentrations. For primary producers, chlorophyll *a* biomass and taxonomy samples will be analyzed to assess changes in biomass, genus richness, relative abundance, evenness, and diversity (Simpson's diversity index). Benthic invertebrates will be identified and enumerated by a taxonomist to allow determination of invertebrate density, genus richness, relative abundance, evenness, Simpson's diversity index, Ephemeroptera, Plecoptera, and Trichoptera genus richness, and Bray-Curtis similarities. Fish (or alternatives such as caged bivalves) will be sampled every three to five years and assessed for a number of endpoints related to community structure, energy use, energy storage, and survival. Tissue metal analysis will also be undertaken on benthic invertebrates and, if required, on fish also, to determine the risk of accumulation of metals through the aquatic food chain.

At the TMF, sampling for aquatic resources (sediment and benthic invertebrates only) will be done annually, concurrently with the collection of water samples. Sediment samples will include measurement of moisture content, particle size, cyanides, nutrients, organic carbon, and total metal concentrations. Benthic invertebrates will be collected for measurement of tissue metals to determine if metal concentrations are increasing or have the potential to bioaccumulate in the aquatic food chain. The sampling methodology and lab analysis will be consistent with the *British Columbia Field Sampling Manual* (BC MWLAP 2003), the BC *Water and Air Baseline Monitoring Guidance Document for Mine Proponents* (BC MOE 2012), and the *Environmental Data Quality Assurance Regulation* (; see also Appendices 15-B and 15-D).

During the closure/post-closure phases, fish biology sampling would occur on sites still subject to the MMER (i.e., sites downstream of the receiving environment of Project effluent discharges such as downstream of the WTP). This will occur once every three to five years consistent with standard methodology (Appendix 15-A). Costs include the following:

- field mobilization and sampling time: 5 days fish biologist + 4 days assistant time = $8,000;
- data analysis and reporting: 30 days fish biologist time = $24,000;
- laboratory fees: tissue metals, age, and fecundity samples = $30,000; and
- equipment, transportation, other miscellaneous costs = $2,500.

The total cost would be $64,500 every three to five years (depending on the frequency required under the MMER). This averages $12,900 per year over a five-year cycle, and $21,500 annually over a three-year cycle.

During the closure/post-closure phases, aquatic resources (sediment, benthic, periphyton) sampling will also occur on sites still subject to the MMER (estimated four sites), concurrent with fish sampling every 3 to 5 years. In addition, during the first 10 years of the closure phase sampling will occur annually at sites in the TMF (estimated at an additional four sites) as outlined in the closure plan below.

The costs of sampling sites subject to the MMER (estimated to total four sites) during closure/post-closure, with travel days (two per person), on a three- or five-year cycle include:

- field mobilization and sampling time (eight sites): four days aquatic biologist + three days assistant time = $6,000;
- data analysis and reporting: included as part of fish biology reporting;
- laboratory fees: benthic invertebrate sampling, sediment sampling = $11,000; and
- equipment, transportation, other miscellaneous costs = $1,500.

The total cost would be $18,500 every three to five years, which averages out to an annual cost of $3,700/year over a five-year cycle or $6,167/year over a three-year cycle.

Costs for annual sampling for sites within the TMF for monitoring during the first 10 years of post-closure, with travel days (two per person), include:

- field mobilization and sampling time (four sites): four days aquatic biologist + three days assistant time = $6,000;
- data analysis and reporting: two days aquatic biologist time = $1,600;
- laboratory fees: benthic invertebrate sampling (tissue metals), sediment sampling = $6,300; and
- equipment, transportation, other miscellaneous costs = $1,500.

The total cost would be $15,400 annually in the first 10 years of the post-closure phase.

27.12.3.3 Groundwater Monitoring

Groundwater monitoring will include sampling and water level measurements from wells up-gradient and down-gradient of mine components with expected environmental effects. The proposed monitoring plan includes nine monitoring wells in the Mine Site and seven in the PTMA. Sample analysis will include parameters identical to those reported in the baseline assessment: physical parameters (pH, total dissolved solids, turbidity, etc.), nutrients (including total organic carbon), cyanide, and total and dissolved metals. Monitoring events are proposed at quarterly (seasonal) intervals during closure and for the first five years of the post-closure phase. Thereafter, a progressive reduction in monitoring frequency is proposed, contingent upon water quality data meeting water quality standards.

Costs (in 2013 dollars) per monitoring event are estimated as follows:

- field time: eight days technician time = $2,400;
- data analysis and reporting: seven days technician time = $1,700;
- laboratory fees: 20 samples (including two duplicates, one trip blank, one field blank) = $7,000; and
- equipment, transportation, other miscellaneous costs = $1,500.

The total cost per sampling event is estimated at $12,300, and the total annual cost for seasonal sampling is $49,500.

The cost assumptions include:

- field and reporting work conducted by technician working at a rate of $30.00/hour; and
- ground transportation adequate to access all wells.

27.12.3.4 Reclamation and Soils Monitoring

Annual monitoring will be carried out (within the growing season) for the closure period and the first five years post-closure. Monitoring of metal concentrations within both terrestrial plant tissues and soils will be undertaken. Both vegetation and soil sampling will be concentrated within areas that were reclaimed during the closure and post-closure phases. For vegetation, the target plant species, wherever possible, will include species collected during the baseline surveys (Rescan 2010b; *2009 Vegetation and Ecosystem Mapping Baseline Report*, Appendix 17-A) and surveys conducted throughout construction and operation. However, the choice of plant species will remain flexible to accommodate the dominant species that are growing during post-closure, as well as other species of local importance to human health and/or wildlife during post-closure.

Within the McTagg and Mitchell RSFs, 10 sampling locations (with two replicate samples collected per location) will be established, and both vegetation tissue and soil samples will be collected at these locations. Within the TMF, 20 representative sampling locations

(with two replicate samples per location) will be established across the TMF. Thirty vegetation samples will be collected per sampling event.

According to the sampling protocols in place at the time of sampling, soil and plant tissue samples will be prepared and submitted for laboratory analysis to determine the metal concentrations. Results will be compared to previous results, and will be shared with the wildlife and human health disciplines for assessment against known toxicity thresholds. As well, the success of reclamation will be assessed. Areas where retreatment is required will be identified and the sites will be retreated.

The cost estimates (in 2013 dollars) per monitoring event include:

- field time (including travel): three days technician time – $2,400;
- data analysis and reporting: two days technician time – $1,600;
- laboratory fees: 120 samples – $24,000;
- helicopter expense: $5,000; and
- equipment, accommodation, other miscellaneous: $1,000.

The total cost per sampling event is projected to be $34,000.

A progressive reduction in monitoring frequency is proposed, contingent upon data indicating stable metal concentrations and well established vegetation. Biennial measurements are proposed for Years 57 to 62.

27.12.3.5 Geotechnical Stability

The RSFs, the TMF, and all dams will be monitored for stability according to the various guidelines, including the Canadian Dam Association's Dam Safety Guidelines (CDA 2007). Monitoring of the RSFs will be carried out to allow for record keeping and will include 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.

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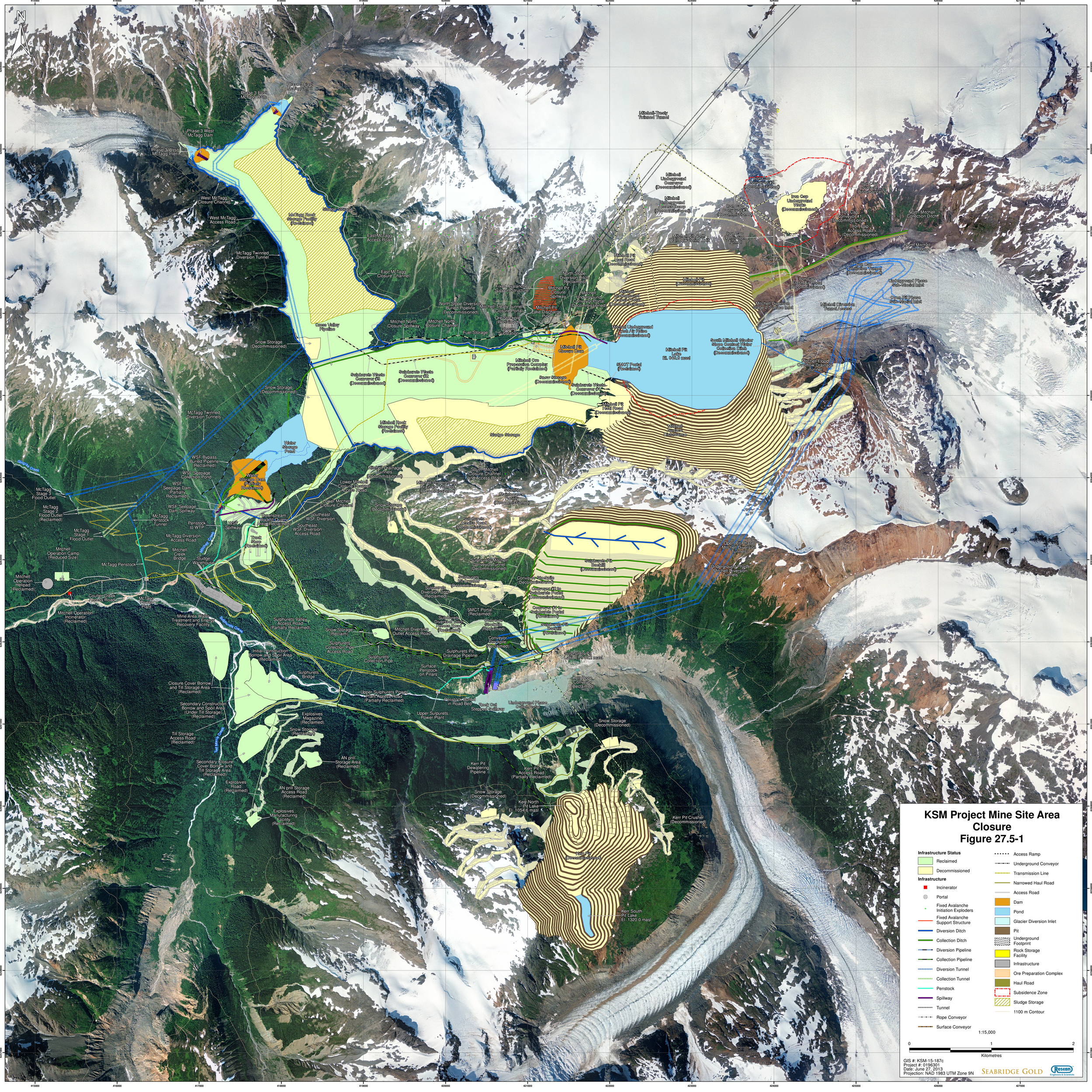
MAP POCKET


N
Phase 3 East McTagg Dam
Phase 3 East McTagg Inlet
Phase 3 West McTagg Dam
Phase 3 West McTagg Inlet
West McTagg Closure Channel
West McTagg Access Road
McTagg Rock Storage Facility (Reclaimed)
Sludge Storage
East McTagg Access Road
McTagg Twinned Diversion Tunnel
East McTagg Closure Channel
Mitchell-Treaty Twinned Tunnel
Mitchell Underground Conveyor (Decommissioned)
Mitchell Underground Access Ramp (Decommissioned)
Iron Cap Conveyor #2 (Decommissioned)
Iron Cap Underground Waste (Decommissioned)
Iron Cap Surface Disturbance
Iron Cap Conveyor #1 (Decommissioned)
Iron Cap Access Road (Decommissioned)
North Mitchell Collection Ditch
North Mitchell Access Road
Mitchell Pit North Wall Dewatering Adit
Iron Cap Ventilation Tunnel
Iron Cap Return Air Portal
Mitchell Pit Haul Road (Decommissioned)
Iron Cap Ventilation Tunnel (Decommissioned)
Iron Cap Fresh Air Portal (Decommissioned)
Underground Phase Sub-Glacial Inlet
Open Pit Phase Sub-Glacial Inlet
Mitchell Diversion Tunnel/Adits
Mitchell Pit (Decommissioned)
North Slope Diversion Ditch (Reclaimed)
Mitchell Pit Closure Spillway
Mitchell Underground Conveyor Portal (Decommissioned)
Mitchell Underground Access Portal (Decommissioned)
Mitchell Diversion Stage 2 Surface Inlet
Fixed Avalanche Support Structure
North Slope Diversion Buried Pipeline (Decommissioned)
Mitchell-Treaty Tunnel Closure Portal
Mitchell Pit Lake Discharge Pipe
Ore Stockpile (Reclaimed)
Closure Substation
Mitchell North Closure Spillway
Mitchell North Closure Channel
Fuel Storage
Cross Valley Pipeline
Mitchell Underground Fresh Air Raise (Decommissioned)
South Mitchell Glacier Slope Contact Water Collection Ditch (Decommissioned)
Snow Storage (Decommissioned)
Mitchell Pit Closure Dam
Mitchell Pit Lake El. 948.0 masl
Mitchell Flood Overflow Drainage Tunnel
Mitchell Ore Preparation Complex (Partially Reclaimed)
Sulphurets Waste Conveyor #2 (Decommissioned)
Sulphurets Waste Conveyor #3 (Decommissioned)
SMCT Portal (Reclaimed)
Snow Storage (Decommissioned)
Sulphurets Waste Conveyor #4 (Decommissioned)
Mitchell Pit Haul Road (Decommissioned)
Mitchell Rock Storage Facility (Reclaimed)
Mitchell Surface Disturbance
Sludge Storage
Water Storage Ponds
WSF Bypass Buried Pipeline (Reclaimed)
Gingras Creek
WSF Seepage Collection Pond
Water Storage Dam (Partially Reclaimed)
Mitchell Drainage Tunnels (Decommissioned)
South Mitchell Closure Channel and Access Road
Mitchell Underground Drainage Tunnels (Decommissioned)
Satellite Maintenance Facility (Decommissioned)
Lower Mitchell Closure Channel Access Road
Lower Mitchell Closure Channel
Snow Storage (Decommissioned)
Sulphurets Access Road (Decommissioned)
Southeast WSF Diversion
Southeast WSF Diversion Access Road
Downstream Rockfill Quarry Area (Reclaimed)
WSF Spillway
Truck Shop (Reclaimed)
Mitchell Creek
Sludge Warehouse
McTagg Penstock
Penstock to WTP
McTagg Diversion Access Road
Mitchell Operation Camp (Reduced Size)
Mitchell Operation Helipad (Reclaimed)
Coulter Creek Access Road
McTagg Power Plant
Mitchell Operation Incinerator (Reclaimed)
Mine Area Water Treatment and Energy Recovery Facility
Sulphurets Creek
Sulphurets Valley Access Road (Partially Reclaimed)
Snow Storage (Reclaim)
Mitchell Diversion Outlet Access Road
Sulphurets Diversion Ditch Access Road (Reclaimed)
Sulphurets Diversion Ditch (Reclaimed)
Conveyor Stockpile (Reclaimed)
Conveyor #4 to Sulphurets Portal (Decommissioned)
Conveyor #4 to Sulphurets Portal (Reclaimed)
Sulphurets Pit Backfill (Reclaimed)
Sulphurets Mitchell Conveyor Tunnel (Decommissioned)
Sulphurets Pit Backfill (Decommissioned)
Conveyor Stockpile (Decommissioned)
Conveyor Stockpile (Reclaimed)
Sulphurets Pit Lake El. 1010.2 masl
Sulphurets Collection Pipe Access Road
Sulphurets Collection Pipe
Sulphurets Pit Drainage Pipeline
Surface Penstock on Pillars
Initial Construction Borrow and Spoil Area (Reclaimed)
Sulphurets Bridge
Kerr Rope Conveyor (Reclaimed)
Closure Cover Borrow and Till Storage Area (Reclaimed)
Upper Sulphurets Power Plant Access Road (Partially Reclaimed)
Penstock Buried in Road Bed
Rock Cut Stepped Spillway
Underground Phase Outlet Portal
Upper Sulpurets Power Plant
Secondary Construction Borrow and Spoil Area (Under Till Storage) (Reclaimed)
Explosives Magazine (Reclaimed)
Snow Storage (Reclaimed)
Till Storage Access Road (Reclaimed)
Red Mosquito Creek
Snow Storage (Decommissioned)
AN prill Storage Area (Reclaimed)
Kerr Pit Dewatering Pipeline
Kerr Pit Access Road (Partially Reclaimed)
Secondary Closure Cover Borrow and Till Storage Area (Reclaimed)
Explosives Road (Reclaimed)
AN prill Storage Access Road (Reclaimed)
Snow Storage (Decommissioned)
Kerr North Pit Lake El. 1054.6 masl
Kerr Pit Crusher (Decommissioned)
Explosives Manufacturing Facility (Reclaimed)
Kerr Pit (Decommissioned)
Kerr South Pit Lake El. 1320.0 masl
Open Pit Phase Mitchell Diversion Tunnels
Underground Phase Mitchell Diversion Tunnels
KSM Project Mine Site Area Closure
Figure 27.5-1
Infrastructure Status
Reclaimed
Decommissioned
Infrastructure
Incinerator
Portal
Fixed Avalanche Initiation Exploders
Fixed Avalanche Support Structure
Diversion Ditch
Collection Ditch
Diversion Pipeline
Collection Pipeline
Diversion Tunnel
Collection Tunnel
Penstock
Spillway
Tunnel
Rope Conveyor
Surface Conveyor
Access Ramp
Underground Conveyor
Transmission Line
Narrowed Haul Road
Access Road
Dam
Pond
Glacier Diversion Inlet
Pit
Underground Footprint
Rock Storage Facility
Infrastructure
Ore Preparation Complex
Haul Road
Subsidence Zone
Sludge Storage
1100 m Contour
1:15,000
0
1
2
Kilometres
GIS #: KSM-15-187c
Project #: 0196301
Date: June 27, 2013
Projection: NAD 1983 UTM Zone 9N
SEABRIDGE GOLD
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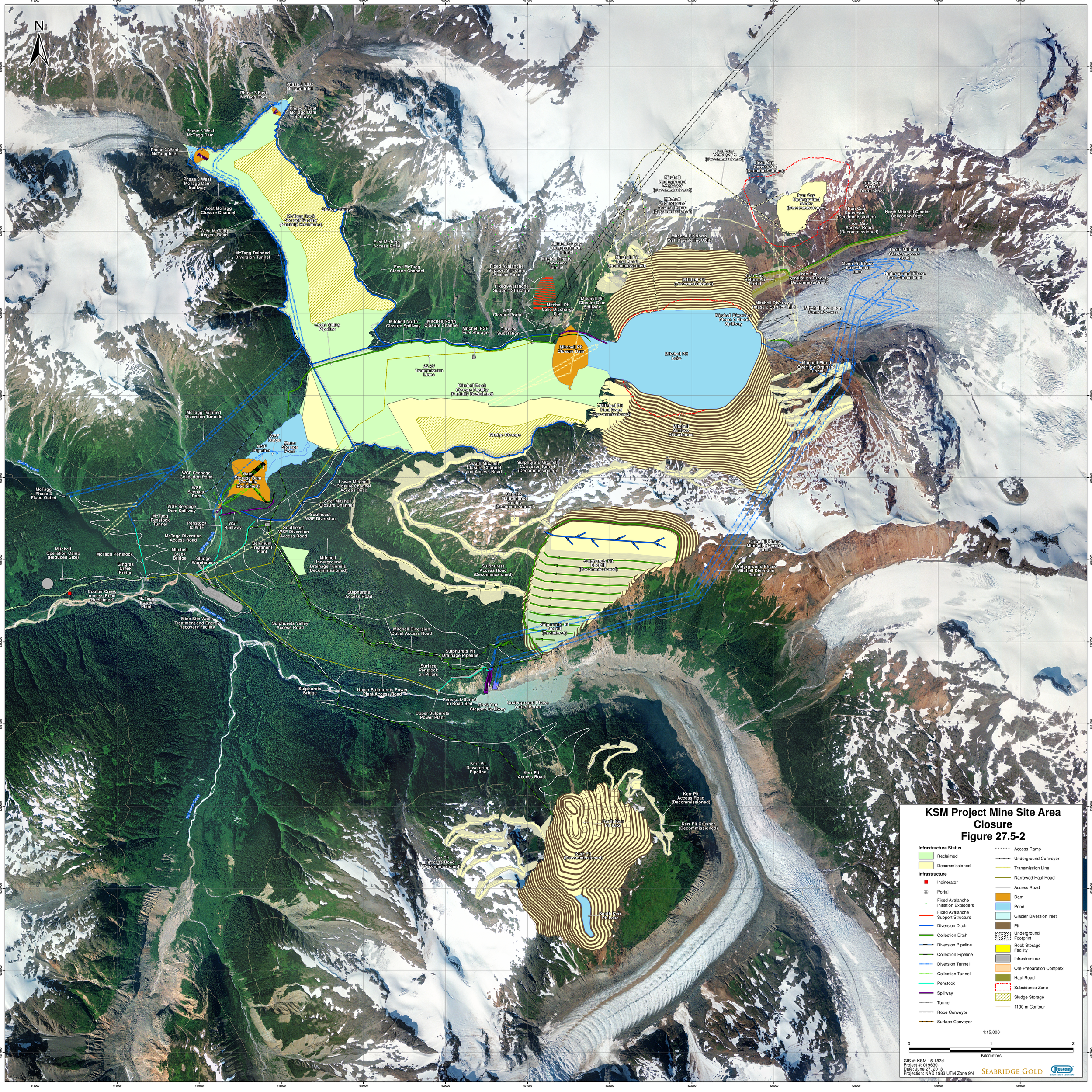

KSM Project Mine Site Area Closure
Figure 27.5-2

Infrastructure Status
- Reclaimed
- Decommissioned

Infrastructure
- Incinerator
- Portal
- Fixed Avalanche Initiation Exploders
- Fixed Avalanche Support Structure
- Diversion Ditch
- Collection Ditch
- Diversion Pipeline
- Collection Pipeline
- Diversion Tunnel
- Collection Tunnel
- Penstock
- Spillway
- Tunnel
- Rope Conveyor
- Surface Conveyor
- Access Ramp
- Underground Conveyor
- Transmission Line
- Narrowed Haul Road
- Access Road
- Dam
- Pond
- Glacier Diversion Inlet
- Pit
- Underground Footprint
- Rock Storage Facility
- Infrastructure
- Ore Preparation Complex
- Haul Road
- Subsidence Zone
- Sludge Storage
- 1100 m Contour

1:15,000

0 1 2 Kilometres

GIS #: KSM-15-187d
Project #: 0196301
Date: June 27, 2013
Projection: NAD 1983 UTM Zone 9N

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Processing and Tailing Management Area At Closure
Figure 27.5-3

Infrastucture Status
- Reclaimed
- Decommissioned

Infrastructure
- Incinerator
- Diversion Ditch
- Diversion Pipeline
- Collection Pipeline
- Diversion Tunnel
- Spillway
- Tunnel
- Transmission Line
- Access Road
- Infrastructure
- Dam
- Lined Pond
- Pond
- Rip Rap
- Haul Road
- Fisheries Compensation Wetland
- 1100 m Contour

1:15,000

0 1 2

Kilometres

GIS #: KSM-15-188c
Project #: 0196103
Date: June 27, 2013
Projection: NAD 1983 UTM Zone 9N

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Processing and Tailing Management Area at Post Closure
Figure 27.5-4

Infrastucture Status
- Reclaimed
- Decommissioned

Infrastructure
- Incinerator
- Collection Ditch
- Collection Pipeline
- Diversion Ditch
- Diversion Pipeline
- Diversion Tunnel
- Effluent Discharge Pipeline
- Spillway
- Tunnel
- Transmission Line
- Access Road
- Infrastructure
- Dam
- Pond
- Rip Rap
- Haul Road
- Fisheries Compensation Wetland
- 1100 m Contour

1:15,000

0 1 2

Kilometres

GIS #: KSM-15-188d
Project #: 0196301
Date: June 27, 2013
Projection: NAD 1983 UTM Zone 9N

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