17 Terrestrial Ecosystems

This assessment identifies and evaluates the potential effects of the proposed KSM Project (the Project) on terrestrial ecosystems. Ecosystems consist of living and non-living components that interact through the exchange of energy, nutrients, and waste. Ecosystems are dynamic and can be defined at multiple, overlapping scales, ranging from types of site-specific plant communities to broad-scale ecoregions. This assessment focuses on groups of site-specific plant communities (forested and non-forested), which are typically characterized by unique plant species composition, vegetation structure, and landscape position, and which differ in the type, quantity, and quality of functions they provide.

17.1 Terrestrial Ecosystems Setting

Some of the uses or functions provided by terrestrial ecosystems and vegetation are:

- non-timber botanical resources – plants are used for nutritional, medicinal, cultural, ornamental, and other purposes;
- cultural services – people obtain non-material benefits from ecosystems such as forests (e.g., spiritual enrichment, reflection, sense of place, and inspiration);
- carbon cycling (Chapter 6) – during photosynthesis, plants sequester carbon dioxide and produce oxygen necessary for most living organisms;
- soil stability and nutrient enrichment (Chapter 8) – plants stabilize soil (e.g., reduce erosion) and add nutrients through decomposition;
- water regulation (Chapters 12 and 13) – the timing and amount of runoff, flooding, and aquifer recharge can be strongly influenced by changes in vegetation;
- fish and wildlife habitat (Chapters 15 and 18, respectively) – plants and plant communities provide food and habitat for fish and wildlife;
- timber resources (Chapter 23) – commercial forestry represents a multi-billion dollar industry in British Columbia (BC); and
- commercial and personal recreation, including tourism (Chapter 23) and visual quality (Chapter 24) – many people find beauty in views of pristine vegetation and participate in nature-based tourism.

The regional context for many of the above functions is provided within Section 17.1.3.

17.1.1 Study Areas

Ecosystems and vegetation were characterized for a regional and local study area surrounding the Project (Figure 17.1-1). The regional study area (RSA) was delineated based on the expected use of the region by wildlife species assessed as valued components (VCs) and is used to evaluate the potential effects of the Project on wildlife and wildlife habitat (Chapter 18). Ecosystem mapping within the RSA provides a regional context for ecosystem distribution.

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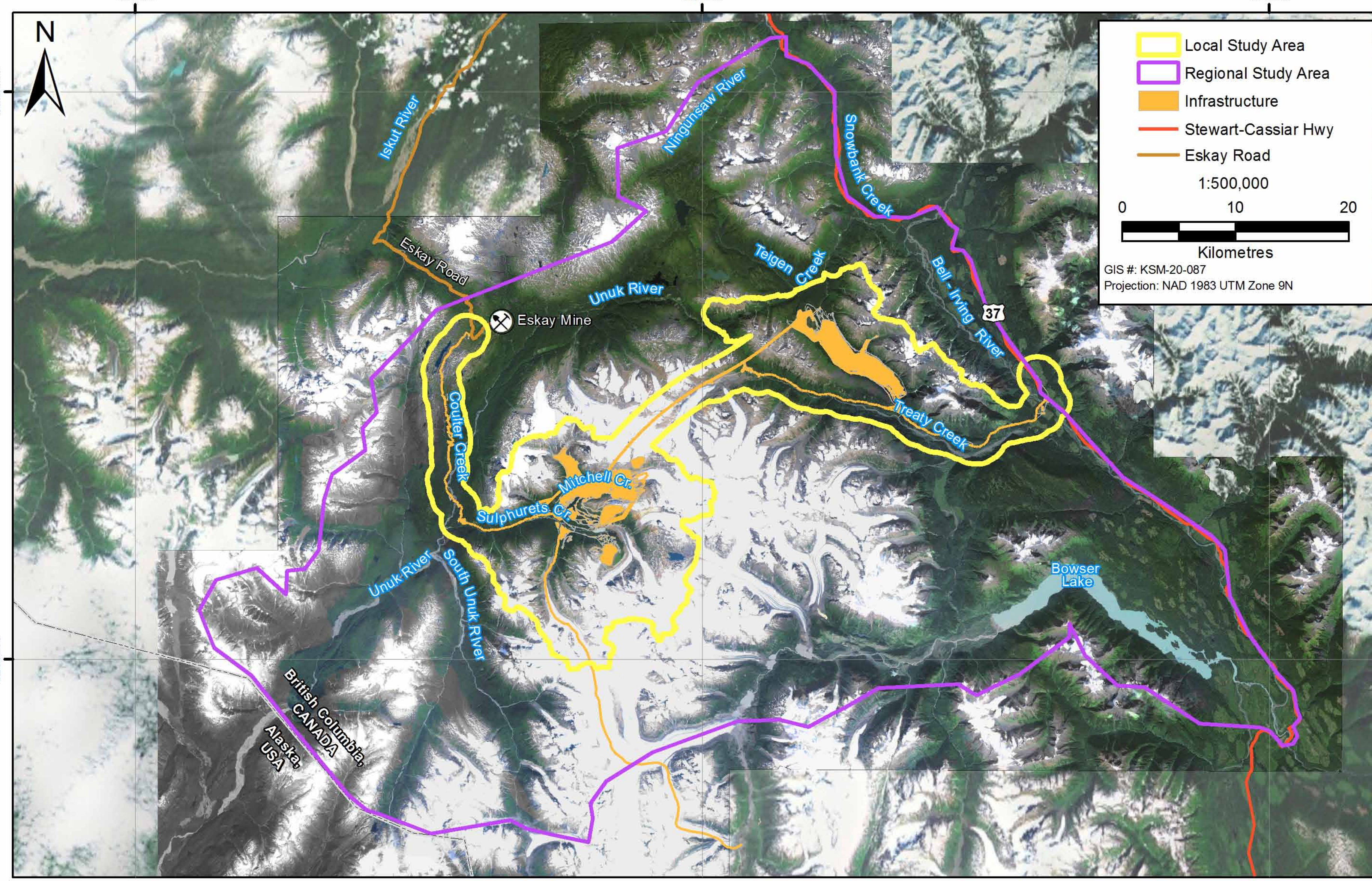

Figure 17.1-1

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Terrestrial Ecosystem Assessment Boundaries

Figure 17.1-1

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The local study area (LSA) extends to the height-of-land (beyond 1.5 km) surrounding the two major proposed developments, the Mine Site and the Processing and Tailing Management Area (PTMA), and to 1.5 km on each side of the Coulter Creek and Treaty Creek access roads. Described within Section 17.1.3, similar percentages of forested and non- or sparsely-vegetated ecosystems, including glaciers and permanent snow or ice, are mapped within the LSA and RSA. Ecosystems with a mesic moisture regime are the most common of the mapped forest ecosystems.

17.1.2 Ecosystem Mapping

Detailed within Appendix 17-A: *KSM Project: 2009 Vegetation and Ecosystem Mapping Baseline Report*, two mapping methodologies, Predictive Ecosystem Mapping (PEM) and Terrestrial Ecosystem Mapping (TEM) were used to map terrestrial ecosystems within the RSA and LSA according to BC's Biogeoclimatic Ecosystem Classification (BEC) system. A full description of the BEC methodology and associated terms is found in Banner et al. (1993) and (RIC 1998a). A legend of the mapped ecosystems, including the BEC, TEM and PEM codes used throughout this chapter, is also provided within Appendix 17-A.

In accordance with TEM standards (RIC 1998a), TEM was completed by manually mapping ecosystems; it was the basis for all footprint calculations in the effects assessment. Described within Appendix 17-A, TEM data was collected on standard ecosystem mapping data forms and was entered into Venus 5.0, the provincial data entry program for provincial ecosystem mapping projects. PEM was used to model, or predict, the ecosystem distribution within the RSA. In some areas, to ensure complete coverage of ecosystem mapping within entire watersheds, TEM data was augmented with PEM data.

In 2011, the Treaty Creek area was mapped to support potential project infrastructure. This mapping was combined with that previously completed in 2009, and is presented in Appendix 17-B.

17.1.3 Regional Ecology

The Project is situated within the Skeena Mountains Ecoregion, the Boundary Ranges Ecoregion, and the Nass Ranges Ecoregion. Towards the coast, the Boundary Ranges consist of extensive ice fields capping granitic intrusions remnant of the Coast Range Arc, and are dissected by several major river valleys, including the Nass River. The Skeena Mountain Ecoregion, inland and east of the Boundary Ranges, consists of high rugged mountains and a moist, coast/interior transition climate, supporting many glaciers. The Nass Ranges Ecoregion, with a climate somewhat transitional between coastal and interior regimes (Demarchi 1996), is a mountainous area west of the Kitimat Ranges (south of the Project). The RSA overlaps the following six BEC units (Figure 17.1-2), which are described in more detail within Appendix 17-A:

- Boreal Altai Fescue Alpine - Parkland (BAFAunp)

  Mapped along much of the lee side of the Coast Mountains and within the northern Rocky, Skeena, Omineca, and Cassiar Mountains, BAFAunp is the most extensive of the three provincial alpine BEC units (BC MFLNRO 2011). Mapped along much of the lee side of the Coast Mountains and within the northern Rocky, Skeena, Omineca and Cassiar Mountains, BAFAunp is the most extensive of the three provincial alpine BEC units (BC MFLNRO 2011).

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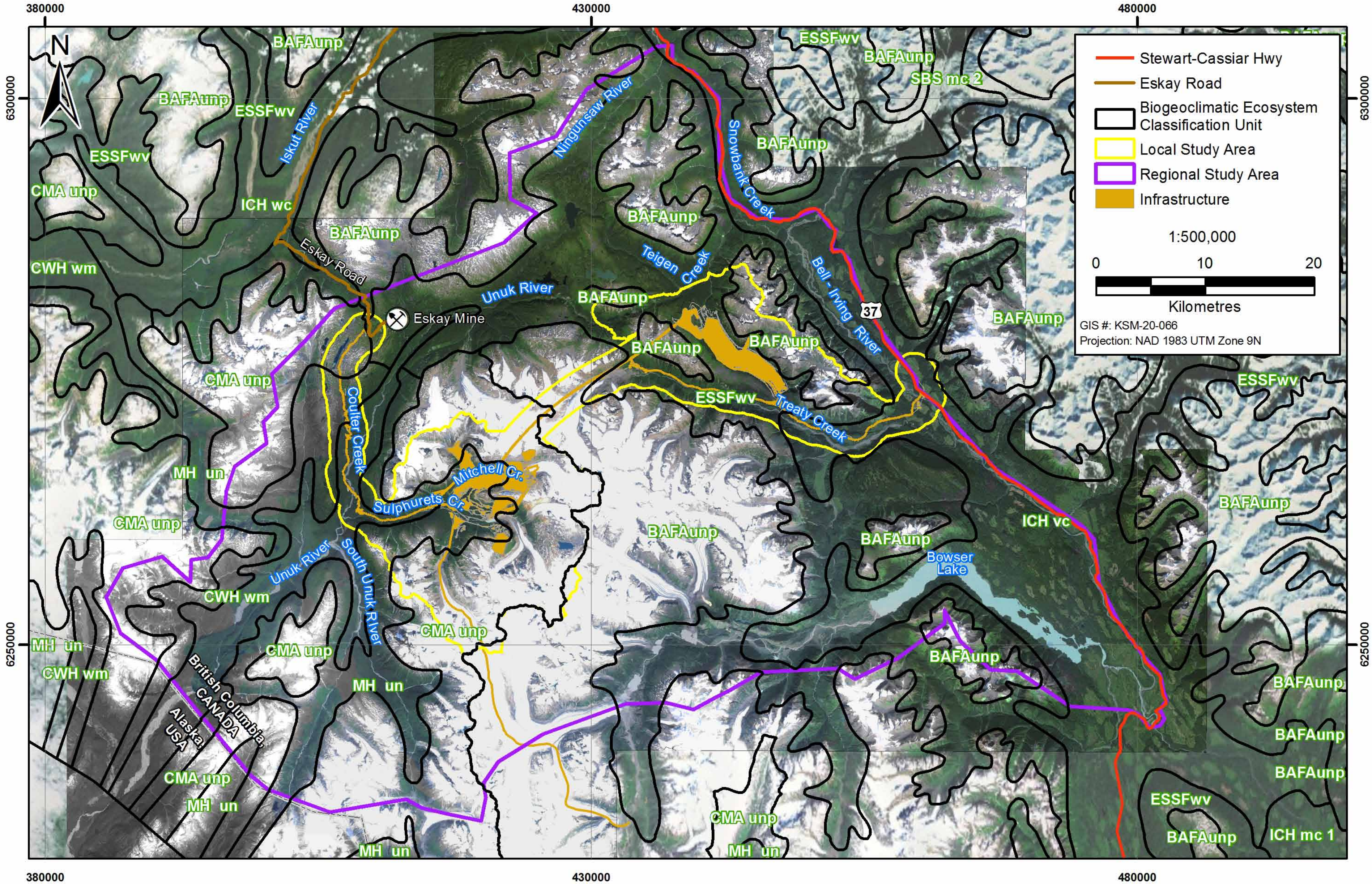

Figure 17.1-2

Biogeoclimatic Ecosystem Classification (BEC) Units in the Local and Regional Study Areas

Figure 17.1-2

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- Coastal Mountain-heather Alpine - Parkland (CMAunp)

  Mapped along the windward spine of the Coast Mountains, and subject to a maritime influence (BC MFLNRO 2011), the CMAunp tends to have a deeper snowpack and begins at lower elevations than the interior alpine BEC units.

- Wet Maritime Coastal Western Hemlock Subzone (CWHwm)

  Mapped from sea level up to the MH BEC zone, this is the most northerly subzone of the CWH zone and is notable for its heavy snowfall; steep, rocky terrain; and low plant species diversity, with infrequent western redcedar and yellow cedar, and no amabilis fir (Banner et al. 1993).

- Leeward Moist Maritime Mountain Hemlock Variant (MHmm2)

  Mapped above the CWH BEC zone and below the alpine - parkland CMAunp unit, the MH BEC zone is the coastal counterpart to the high elevation ESSF BEC zone in the province's interior. Described in Appendix 17-A, the MH units in the RSA, previously undifferentiated, were recently reclassified as the MHmm2 variant. Heavy snow, a short growing season, wet soils, and exposure to wind and cold reduces forest productivity (Banner et al. 1993).

- Very Wet Cold Interior Cedar Hemlock Subzone (ICHvc)

  Mapped from valley bottoms up to the ESSF BEC zone, this is the wettest subzone of the ICH zone and is cool and moist year-round, with a thick and long-lasting snowpack (Banner et al. 1993).

- Wet Very Cold Engelmann Spruce-Subalpine Fir Subzone (ESSFwv)

  Mapped above the ICH BEC zone and below the BAFAunp unit, the ESSF BEC zone is the interior counterpart to the high elevation MH BEC zone mapped along the province's coast. The ESSFwv is the most northerly ESSF subzone, and one of the wettest, with snowier winters and colder, moister growing seasons (Banner et al. 1993).

Four of the BEC units are forested units and two are undifferentiated alpine - parkland units. The dominant BEC unit within the RSA is BAFAunp, followed by the ESSFwv subzone. Nearly half (46%) of the RSA consists of non- and sparsely-vegetated ecosystems, 26% consists of forested ecosystems, and 21% consists of shrub-dominated ecosystems (including avalanche ecosystems).

Glaciers and permanent snow / ice comprise approximately 22% of the RSA. Of the forested area, 66% is mapped as mesic forest, followed by moist and wetter forests (12 and 11%, respectively).

The LSA overlaps the same six BEC units. The dominant BEC unit within the LSA is the CMAunp, followed by the ESSFwv subzone. Consistent with ecosystem distributions in the RSA, nearly half (48%) of the LSA consists of non- and sparsely-vegetated ecosystems, 26% consists of forested ecosystems, and 15% consists of shrub-dominated ecosystems (including avalanche ecosystems). Glaciers and permanent snow/ice comprise approximately 21% of the LSA. Of the forested area, 52% is mapped as mesic forest, followed by wetter and moist forests (each at 16%). Each of these BEC units is further described in Appendix 17-A.

A wide range of topography and vegetation communities occur within the RSA and LSA, including low elevation wetland and shrub-dominated riparian and floodplain ecosystems, low and intermediate-elevation forests, subalpine and alpine meadows, and sparsely- to non-vegetated rocky and glaciated terrain. Many of these ecosystems provide valuable habitat for wildlife, as well as economically important forest and non-timber forest resources.

The terrain above treeline is often dominated by rugged and steep exposed bedrock and glaciers. In addition to their importance as traditional travel and hunting routes for many Aboriginal groups (THREAT, pers. comm.), other functions provided by alpine ecosystems include escape terrain for mountain goats and recreational opportunities such as backcountry hiking and heli-skiing. Parkland ecosystems occupy a narrow elevation band above dense coniferous forests and below the treeless alpine ecosystems. They are characterized by discontinuous tree islands growing on elevated sites that experience earlier snowmelt and allow for drainage of excessive moisture that prohibits forest establishment at higher elevations. Avalanches are very common due to the steep topography and abundant snowfall. Avalanche track ecosystems develop in areas with frequent avalanches; the herbaceous vegetation that grows within many of these tracks provides valuable forage for several wildlife species, including grizzly and black bears. Mass wasting events such as landslides and debris flows occur regularly, many occurring in the over-steepened lateral moraines deposited during recent and ongoing deglaciation.

Below approximately 1,100 m, forested ecosystems dominate the landscape. In the Project area, they are fairly continuous, interrupted by natural disturbances including those already described (avalanches, mass wasting), as well as fluvial disturbances such as flooding, channel aggradation and degradation, and debris flows. Subalpine fir and hybrid white spruce are the dominant tree species on mesic and wetter sites, while single species stands of mountain hemlock occupy some rocky and dry sites. Western hemlock is common in the western areas of the terrestrial ecosystem study areas, but becomes less common to the east and north. Many of the forests in the lower slopes and valley bottoms are very old, at least 500 years in some areas. This is due to the rarity of stand replacement disturbance events, such as wildfire (BC MOF 1995a). In addition, there has been little in the way of forest harvesting, and that which has occurred is confined to the immediate area surrounding Highway 37. The diverse structures of these old growth forests provide a mosaic of habitats within close proximity to each other and retain an abundant biodiversity not associated with younger, less complex ecosystems. These ecosystems provide high-value habitat for marten and fisher and a diversity of forest bird species. Higher elevation forests provide forage and cover to moose and mountain goats as well as berries and herbaceous plants for bears. Early seral vegetation provides winter habitat for moose and spring forage to grizzly and black bears. During the summer and fall months, berries are an important food resource to humans and bears.

Ecosystems that develop along watercourses, both active and inactive, have unique attributes that provide specific values for wildlife, soil retention, and hydrological buffering. Forested ecosystems developing on aggraded fluvial deposits are very common in the terrestrial ecosystem study areas, particularly along Treaty Creek and the Unuk River. These ecosystems develop on landforms that are no longer inundated by annual flood events, but experience extensive subterranean irrigation. Cottonwood trees, a preferred nesting tree for raptors, such as bald eagles, thrive in these conditions. The resulting forest is often composed of large mature cottonwood with an understory of either subalpine fir or hybrid white spruce. Active floodplain ecosystems are subject to regular disturbance, which promotes the longevity of pioneer species, such as willow and alder, as well as herbaceous species such as lady fern, which grows in response to the high nutrient load provided by flood events and decomposition of pioneer species leaf litter. This vegetation provides forage for wildlife species that use floodplain riparian ecosystems as movement corridors. The vigorous vegetation growth also helps to retain soils that would otherwise be transported by flood events. The complex channel morphology allows for the development of backwater channel swamp and fen ecosystems. These are capable of storing large volumes of water, which mitigate flows during high water events, reducing the energy of floods downstream.

17.1.3.1 Listed Ecosystems

Twelve terrestrial and wetland ecosystems that are blue- or red-listed by the BC Conservation Data Centre (CDC) were mapped within the LSA or RSA; nine of them were identified during the terrestrial ecosystem or wetland field surveys (Table 17.1-1). Several blue-listed ecosystems are difficult to model and delineate as their landscape position and moisture regimes are similar to others. For this reason, PEM has consolidated the following ecosystems into combined units (CWHwm/06 and 07, CWHwm/09 and 10, and ICHvc/05 and 04).

Table 17.1-1. Listed Ecosystems Mapped and Predicted in the Study Areas

Scientific Name	English Name	Ecosystem Unit/Map Code	CDC Status	LSA (ha)	RSA (ha)
Terrestrial Ecosystems					
Picea sitchensis - Rubus spectabilis Wet Maritime	Sitka spruce - Salmonberry Wet Maritime	CWHwm05/SS[1]	Blue	213.4	247.9
Tsuga heterophylla - Picea sitchensis - Hylocomium splendens	Western hemlock - Sitka spruce - Step moss	CWHwm02/HM[1]	Blue	79.9	530.7
Populus trichocarpa - Abies lasiocarpa - Oplopanax horridus; Populus trichocarpa / Picea spp. - Cornus stolonifera)	Black cottonwood - Subalpine fir - Devil's club; Black cottonwood/ Spruce (hybrid) - Red-osier dogwood)	ICHvc00/Fm03; [ICHvc05/CD[2,3]]	Blue	39.5 [228.3]	3,276.3
Populus trichocarpa - Alnus rubra - Rubus spectabilis	Black cottonwood - Red alder - Salmonberry	CWHwm06/CD[1,2]	Blue	29.2	423.9
Populus trichocarpa - Abies lasiocarpa - Oplopanax horridus (Populus trichocarpa / Picea spp. - Cornus stolonifera)	Black cottonwood - Subalpine fir - Devil's club (Black cottonwood / Spruce (hybrid) - Red-osier dogwood)	ESSFwv00/Fm03	Blue	26.0	27.3
Alnus incana - Equisetum arvense	Mountain alder - Common horsetail	ICHvc00/Fl01[1]	Blue	7.8	Not mapped
Wetland Ecosystems					
Alnus incana - Athyrium filix-femina (Alnus incana - Cornus stolonifera - Athyrium filix-femina, Alnus incana - Lysichiton americanum - Athyrium filix-femina)	Mountain alder - Red-osier dogwood - Lady fern	ICHvc00/52 (Fl02, Ws01)[1]	Blue	182.8	1398.7

(continued)

Table 17.1-1. Listed Ecosystems Mapped and Predicted in the Study Areas (completed)

Scientific Name	English Name	Ecosystem Unit/Map Code	CDC Status	LSA (ha)	RSA (ha)
Wetland Ecosystems (cont'd)					
Carex sitchensis - Sphagnum spp.	Sitka sedge - Peat-mosses	ICHvc00/Wf51[1]	Red	53.6	1,022.5
Tsuga heterophylla - Sphagnum girgensohnii	Western hemlock - Common green peat-moss	CWHwm08/HS[1]	Blue	2.0	222.3
Picea sitchensis - Lysichiton americanus (Thuja plicata - Tsuga heterophylla - Lysichiton americanum)	Sitka spruce - Skunk cabbage (Western red cedar - Western hemlock - Skunk cabbage)	CWHwm09/SC[1,2] (Ws54)	Blue	14.0	177.4
Myrica gale - Carex sitchensis	Sweet gale - Sitka sedge	CWHwm00/Wf	Red	0.02	29.6
Carex sitchensis - Oenanthe sarmentosa	Sitka sedge - Pacific water-parsley	CWHwm00/Wm50[1]	Blue	0	71.5

[1] Field-identified in 2009 baseline (any BGC unit), incl. wetland plots (Rescan 2010d).
[2] Areas of these ecosystems may be less than stated, particularly for those predicted by PEM. Lumped units include: CWHwm06/CD and 07/CW; CWHwm09/SC and 10/LS; ICHvc05(CD) and 04/DD.
[3] Although not technically listed by the BC CDC, correspondence with BC CDC personnel suggests that this is an issue of limited data on their distribution.

17.1.3.2 Sensitive Ecosystems

Sensitive ecosystems include those that are considered locally threatened, fragile or inherently sensitive to disturbance. Sensitive ecosystems assessed in this chapter as VCs include riparian and floodplain ecosystems, CDC listed ecosystems, alpine and parkland ecosystems, and old forest ecosystems. Wetland ecosystems are assessed separately within Chapter 16.

17.1.3.3 Rare Plants

All of the TEM plots were inventoried in the summer months when most plants, including rare (listed) species, would be flowering and most easily identified. All plant species identified within each of the field plots were compared with the BC CDC's list of rare plants potentially occurring in the area to determine if any rare species had been identified. Using this presence / not detected survey methodology and survey intensity, none of the rare plants on the BC CDC list were identified.

The results of a recent rare plant survey completed in 2012 for Pretium Resources Inc.'s proposed Brucejack Mine have been compiled and shared with the Proponent under a Data Sharing Agreement. The sampling area for the Brucejack surveys overlaps that of the KSM Project and, of the 58 rare species identified in the survey, 38 occur within the KSM terrestrial ecosystems LSA (Table 17.1-2), most at high elevations in the Sulphurets Creek watershed (Figure 17.1-3). Of the 38 species, identified life forms include 27 lichens, 9 vascular plants, and 2 mosses, although three species (identified with an asterisk) required further confirmation. A search of the BC CDC database revealed two additional blue-listed species, Enander's sedge (*Carex lenticularis* var. *dolia)* and yellow marsh-marigold (*Caltha palustris* var. *palustris*), that were previously identified in the broader area outside of the LSA.

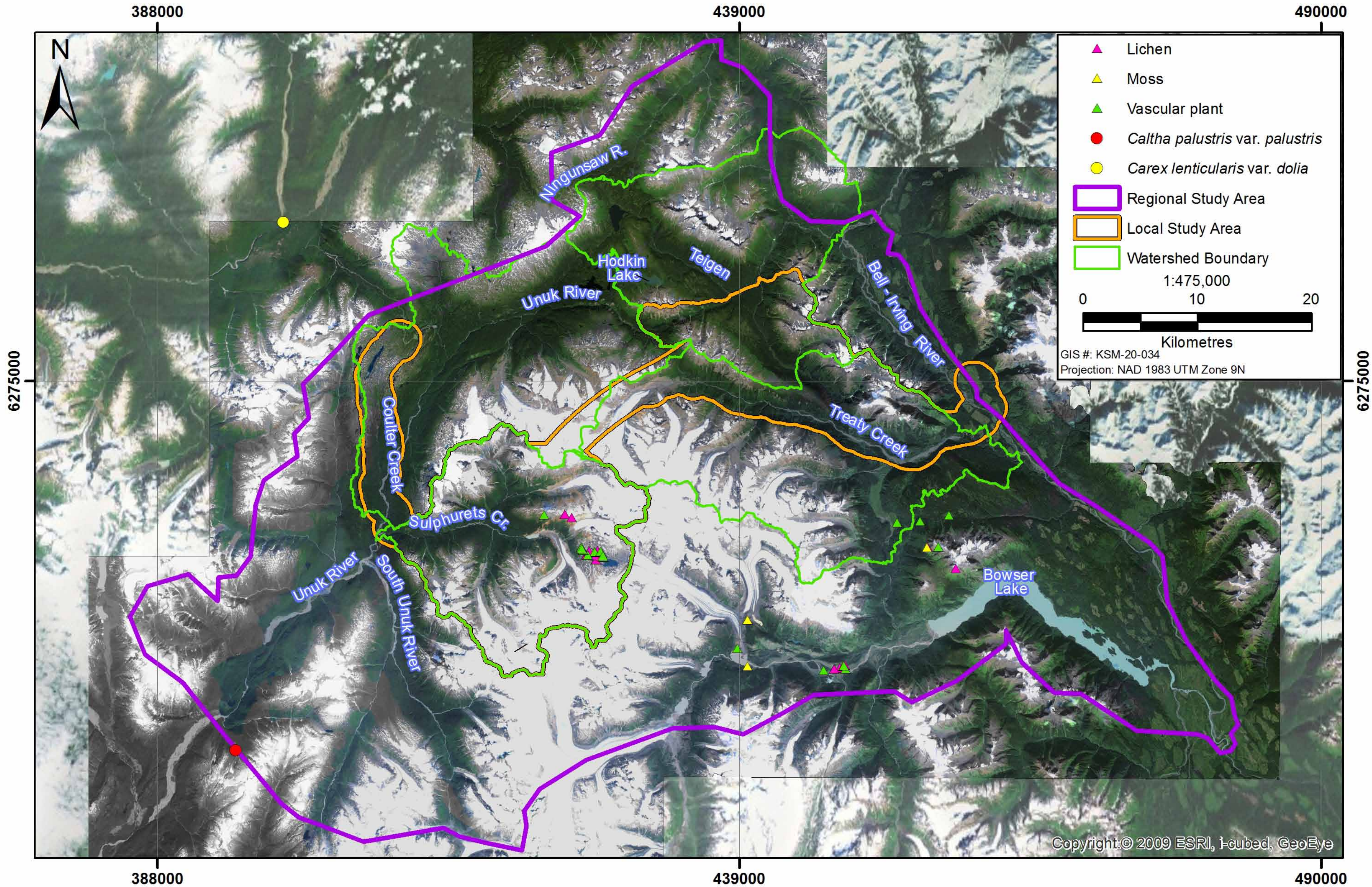

Figure 17.1-3

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Rare Plant Species within or near the Regional Study Area

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Table 17.1-2. Rare Plant Species Identified within the KSM Terrestrial Ecosystems Local Study Area

Life Form	Taxon	Life Form	Taxon
Lichen	*Allantoparmelia almquistii*	Lichen	*Stereocaulon botryosum*
Lichen	*Arctoparmelia incurva*	Lichen	*Stereocaulon depressum*
Lichen	*Bryocaulon hyperboreum*	Lichen	*Stereocaulon glareosum*
Lichen	*Bryoria nitidula*	Lichen	*Stereocaulon symphycheilum*
Lichen	*Cladonia pseudalcicornis*	Lichen	*Umbilicaria*
Lichen	*Cladonia singularis*	Lichen	*Umbilicaria aprina**
Lichen	*Collema ceraniscum*	Lichen	*Umbilicaria lambii*
Lichen	*Collema glebulentum*	Lichen	*Vestergrenopsis elaeina*
Lichen	*Lempholemma intricatum*	Moss	*Cinclidium subrotundum*
Lichen	*Lempholemma polyanthes*	Moss	*Plagiobryum demissum*
Lichen	*Leptogium imbricatum*	Vascular Plant	*Antennaria howellii x alpina**
Lichen	*Nodobryoria subdivergens*	Vascular Plant	*Carex atrata sensu stricto**
Lichen	*Parmelia skultii*	Vascular Plant	*Draba lonchocarpa* var. *thompsonii*
Lichen	*Phaeophyscia* sp. (unknown species)	Vascular Plant	*Epilobium hornemannii ssp. beringianum*
Lichen	*Placynthium asperellum*	Vascular Plant	*Micranthes* sp. *nov*
Lichen	*Solorina bispora*	Vascular Plant	*Ranunculus occidentalis* ssp. *hexasepalus*
Lichen	*Solorina octospora*	Vascular Plant	*Saxifraga oppositifolia* ssp. *smalliana*
Lichen	*Sphaerophorus fragilis*	Vascular Plant	*Saxifraga* sp. *nov*
Lichen	*Stereocaulon arcticum*	Vascular Plant	*Woodsia alpina*

17.1.4 Legislation and Best Management Practices

Legislation, organizations, guidelines, and best management practices applicable to the management of terrestrial ecosystems and vegetation for mine developments are listed and described below.

- (BC*) Mines Act* (1996a).
- (BC) *Forest and Range Practices Act* (2002a).
- (Canada) *Species at Risk Act* (SARA; 2002b).
- (BC) Conservation Data Centre (BC MOE 2007a).
- (Canada) Canadian Biodiversity Strategy (Federal-Provincial-Territorial Biodiversity Working Group 1995).
- (BC) *Weed Control Act* (1996b).
- (BC) North West Invasive Plant Council (NWIPC 2012)
- (BC) *Wildlife Act* (1996c).
- (BC) *Environmental Management Act* (2003a).

- (Canada) *Fisheries Act* (1985).
- (BC) *Fish Protection Act* (1997).

17.1.4.1 *Mines Act*

The BC Ministry of Energy, Mines, and Natural Gas (BC MEMNG) requires that TEM of a proposed mine site be completed for all mining permit applications. An LSA encompassing the mine site can be defined by natural features (i.e., watershed boundaries) or by buffers surrounding the proposed infrastructure. To enable the assessments of effects within an RSA or to enable ecosystem distribution comparisons over large areas, PEM is typically conducted within an RSA. The RSA boundary contains the LSA and may be delineated by natural boundaries, such as river drainage basins or other landscape features, or by other criteria such as habitat required or used by key wildlife species.

The BC MEMNG requires characterization of baseline metal concentrations in plant tissues. This information is used to assess changes over time and to guide reclamation planning (BC MEM 1998).

17.1.4.2 *Forest and Range Practices Act*

The *Forest and Range Practices Act* (2002a) governs all forestry activities including logging, road building, reforestation and riparian area management. The act requires that all forestry-related development be conducted in accordance with the rules and regulations identified in the act to ensure the protection of environmental values. The *Forest and Range Practices Act* (2002a) addresses ecosystems as wildlife habitat through the Identified Wildlife Management Strategy.

17.1.4.3 *Species at Risk Act*

The purpose of SARA (2002b) is to prevent species at risk from becoming extirpated or extinct and ensure the appropriate management of species to prevent them from becoming at risk. Certain species are also protected under SARA as part of wildlife habitat and in accordance with the Canadian Biodiversity Strategy. The Canadian Biodiversity Strategy provides federal legislation that supports the conservation of particular species and populations to ensure continuance of biological diversity over time (Federal-Provincial-Territorial Biodiversity Working Group 1995).

17.1.4.4 BC Conservation Data Centre

The BC CDC (BC MOE 2007a), part of the Environmental Stewardship Division in the BC MOE, classifies plant species and ecosystems at risk in the province as either red-listed (extirpated, endangered, or threatened) or blue-listed (of special concern), and tracks information regarding their conservation status and individual locations. Best management practices and guidelines for land developments recommend that red and blue-listed plants and ecosystems be protected (BC MOE 2006).

17.1.4.5 Canadian Biodiversity Strategy

As described on the website of the federal, provincial, and territorial working group on biodiversity, which was established following Canada's ratification of the Convention on Biological Diversity in December 1992, the Canadian Biodiversity Strategy, released in 1995, reaffirms that governments in Canada must create the policy and research conditions that will lead to the conservation of biodiversity and sustainable use of biological resources. By 1996, all Canadian jurisdictions had signed a statement of commitment to use the Strategy as a guide to implementing the Convention in Canada (Biodivcanada.ca 2012).

17.1.4.6 BC *Weed Control Act*

The *Weed Control Act* (1996b) regulates the management of noxious plants in BC. The act requires all land occupiers to avoid establishment and dispersal of noxious weeds as defined by the act.

17.1.4.7 North West Invasive Plant Council

The Northwest Invasive Plant Council of BC (NWIPC) developed as a committee in 1992 and a not-for-profit organization in 2004 following a request by the inter-ministerial Invasive Plant Committee to pilot a single agency regional delivery model for invasive plant programs. The NWIPC provides support and coordination advice to those involved in invasive plant management and has a stated goal of "preventing further damage to the ecosystems of the northwest and central BC from invasive alien plants" (NWIPC 2012). With a Board of Directors representing a range of stakeholder groups, the NWIPC currently has directors that represent local government, the provincial government, First Nations, agriculture industries, utilities and environmental groups. The NWIPC is governed by bylaws and a constitution and provides strategy documents for managing invasive species. A current list of the *Most Unwanted Weeds* in the region is maintained on the NWIPC website.

17.1.4.8 BC *Wildlife Act*

The provincial *Wildlife Act* (1996c) provides for conservation of specific ecosystems and ecosystem components as they provide habitat for species managed by the BC MOE.

17.1.4.9 *Environmental Management Act*

Pulling together the provisions of the previous Waste Management and Environment Management Acts into a single statute, the *Environmental Management Act* (2003a) prohibits the introduction of deleterious substances into the environment in any manner or quantity that may cause pollution to the environment as defined in the act.

17.1.4.10 Federal *Fisheries Act*

The *Fisheries Act* (1985) provides the legal framework to protect fish habitat from flooding and potential loss of land due to stream erosion and instability. Section 35 establishes rules guiding development within the Fisheries Sensitive Zones and watercourses. Section 36 establishes rules for erosion control related to land development activities, such as clearing land, grading slopes, and road construction and maintenance.

17.1.4.11 *Fish Protection Act*

The *Fish Protection Act* (1997) and associated amendments to the provincial *Water Act* (1996d) regulate provincial approvals of alterations and work in and around watercourses. The regulations focus on riparian retention, which may be involved in vegetation removal and introduction of harmful debris (clay, silt, sand, rock, or any material, natural or otherwise) into the waterways.

17.1.5 Protected Areas

BC's provincial parks protect nationally and internationally significant ecological and cultural values. Ecological reserves are areas selected to preserve representative and special natural ecosystems, plant species, and animal species. There are currently three provincial parks and one ecological reserve overlapping, or adjacent to, the RSA (Figure 17.1-4):

- Border Lake Provincial Park (800 ha);
- Lava Forks Provincial Park (7,000 ha);
- Ningunsaw Provincial Park (15,000 ha); and
- Ningunsaw River Ecological Reserve (2,372 ha).

The Ningunsaw River Ecological Reserve was established to ensure preservation of a cross-elevation sequence of three BEC zones in a transition between coastal and interior climates. Resource extraction (e.g., commercial logging, mining, and hydroelectric development) is prohibited within these protected areas. Situated well outside of the LSA boundary, the parks and ecological reserve are not expected to be adversely impacted by development and operation of the Project.

17.1.6 Old Growth Management Areas

Old forests are vertically and horizontally heterogeneous with respect to plant species and structure, resulting in microhabitats for many different species (Carey 1998). Specifically, old coniferous forests in BC typically contain large snags, coarse woody debris, large "veteran" trees, and a diverse understory. Described within Chapter 18, old-growth forest represents important habitat for certain wildlife species, including nesting habitat for northern goshawk (*Accipiter gentilis*) and cavity nesting birds, and denning habitat for marten (*Martes martes*) and black bear (*Ursus americanus*). Old forests are also valuable because of the huge amounts of carbon they store (Harmon, Ferrell, and Franklin 1990; Smithwick et al. 2002; Paw et al. 2004), their genetic diversity (Buchert et al. 1997), and their aesthetic value.

Old growth management areas (OGMAs) represent permanent retention areas, reserved from industrial modification such as clearing, harvesting, and other activities that may lead to edge-induced windthrow within the boundaries of the OGMA. The establishment of OGMAs typically results from collaborations among Aboriginal groups, the BC MOE, forest licensees or tenure holders, and other individuals. They are a critical component of most integrated resource management plans and typically have legal objectives that are enforceable under the *Forest Range and Practices Act* (2002a) and the *Land Act* (1996e).

The three OGMAs identified in the Nass South Sustainable Resource Management Plan (SRMP; BC ILMB 2012) that occur near the southern boundary of the RSA (Figure 17.1-5) are presently designated non-legal objectives within the Integrated Land Management Bureau's Land and Resource Data Warehouse. These are not close to the Project site; as such there is no expected interaction.

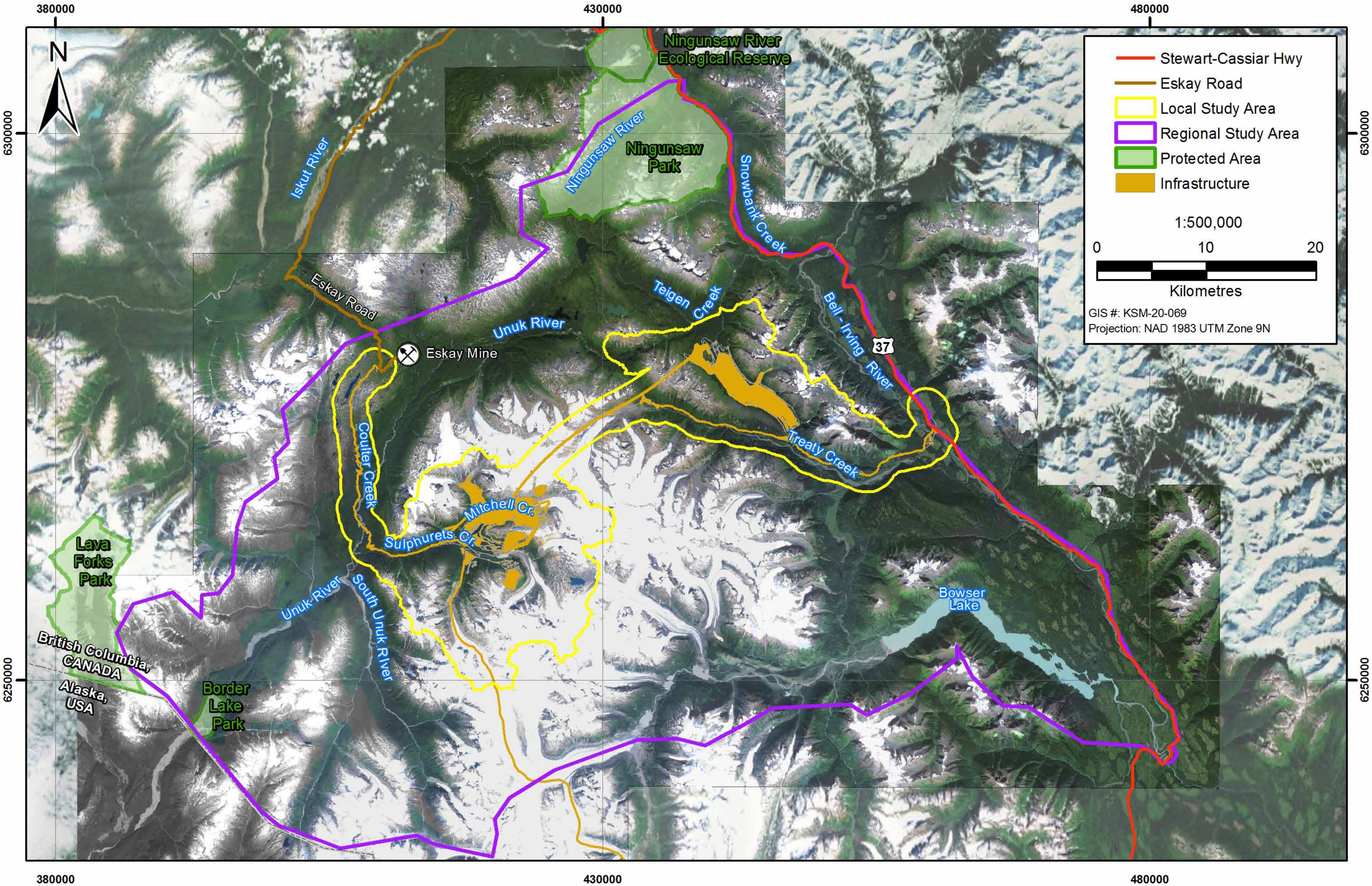

Figure 17.1-4

Protected Areas within or near the Regional Study Area

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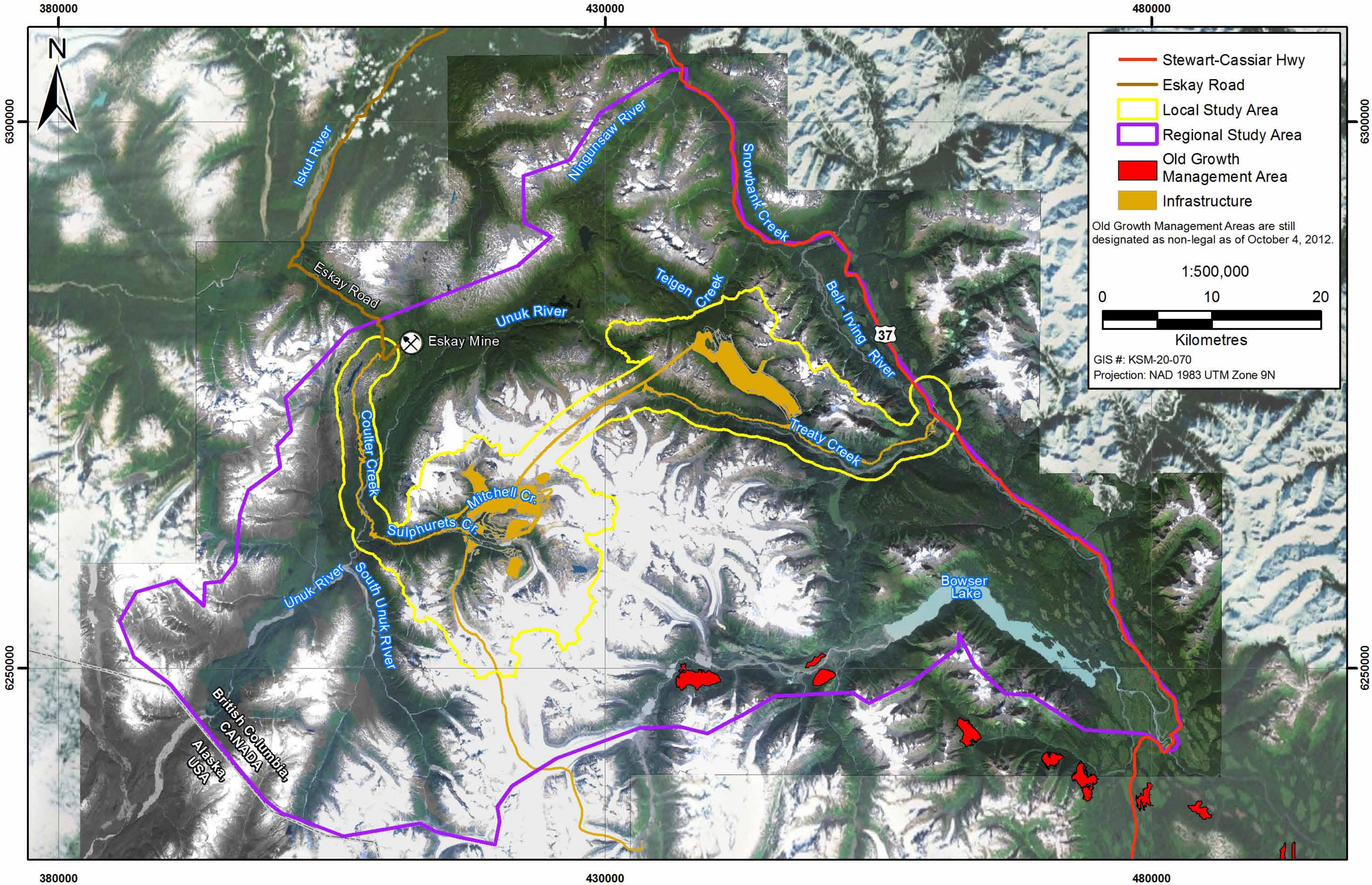

Figure 17.1-5

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Old Growth Management Areas within or near the Regional Study Area

Figure 17.1-5

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17.2 Historical Activities

Currently, a large majority of both the LSA and RSA are in essentially pristine condition with no detectable traces of past human activities.

Although resource extraction (e.g., forest harvesting, mineral extraction) has disturbed some areas of the region, forest harvesting within the RSA is not extensive due to the area's remoteness and low commercial timber quality. Within the LSA, harvesting activity between 1986 and 2009 has removed slightly over 832 ha of forest, all near Highway 37. In addition to this, the Proponent has cleared less than 2 ha to accommodate exploration infrastructure. Provincial cutblock data indicate that 6,129 ha within the RSA, concentrated along the Bell-Irving River and Highway 37, have been harvested since 1985.

Chapter 37 summarizes the previous mining projects and other mineral exploration activities within the Cumulative Effects Assessment (CEA) Area boundary. Two of these projects, the Eskay Creek Mine and Sulphurets Project, were active within the RSA.

The Eskay Creek Mine, an underground gold and silver mine that operated from 1995 to 2008, is currently in the decommissioning phase. During decommissioning, buildings and infrastructure will be removed and the area re-vegetated. The total area of ecosystems disturbed by the mine and the Eskay Creek Spur Road is less than 50 ha (F. M. Murphy and Napier 1996; Barrick Gold Inc. 2004).

Described within Chapter 5 (Effects Assessment Methodology), the Sulphurets Project operated between 1986 and 1990. It consisted of an advanced underground exploration and bulk sampling program (for gold and silver) and was not a commercial-scale mining venture.

17.3 Land Use Planning Objectives

17.3.1 Land Management Structure

The KSM Project is situated within the Regional District of Kitimat-Stikine, an administration providing local government services to member municipalities within northwestern BC. It is situated within the Kalum and Skeena-Stikine Forest Districts, and the Nass and Cassiar Timber Supply Areas (Figure 17.3-1), administrative boundaries within which forest resources are managed by the provincial Ministry of Forests, Lands and Natural Resource Operations.

The Project also overlaps portions of the Cassiar Iskut-Stikine Land and Resource Management Plan (LRMP) area, completed in October 2000 (BC ILMB 2000), and the Nass South SRMP area (Figure 17.3-2), completed in June 2012 (BC ILMB 2012). The LRMPs are sub-regional resource plans that establish the framework for land use and resource management objectives and strategies (BC ILMB and BC Ministry of Agriculture and Lands 2006); SRMPs are landscape-level plans developed to address sustainable management of land, water, and resources. They focus on similar issues and values as regional plans or LRMPs (e.g., timber, biodiversity, tourism) but at a more detailed level.

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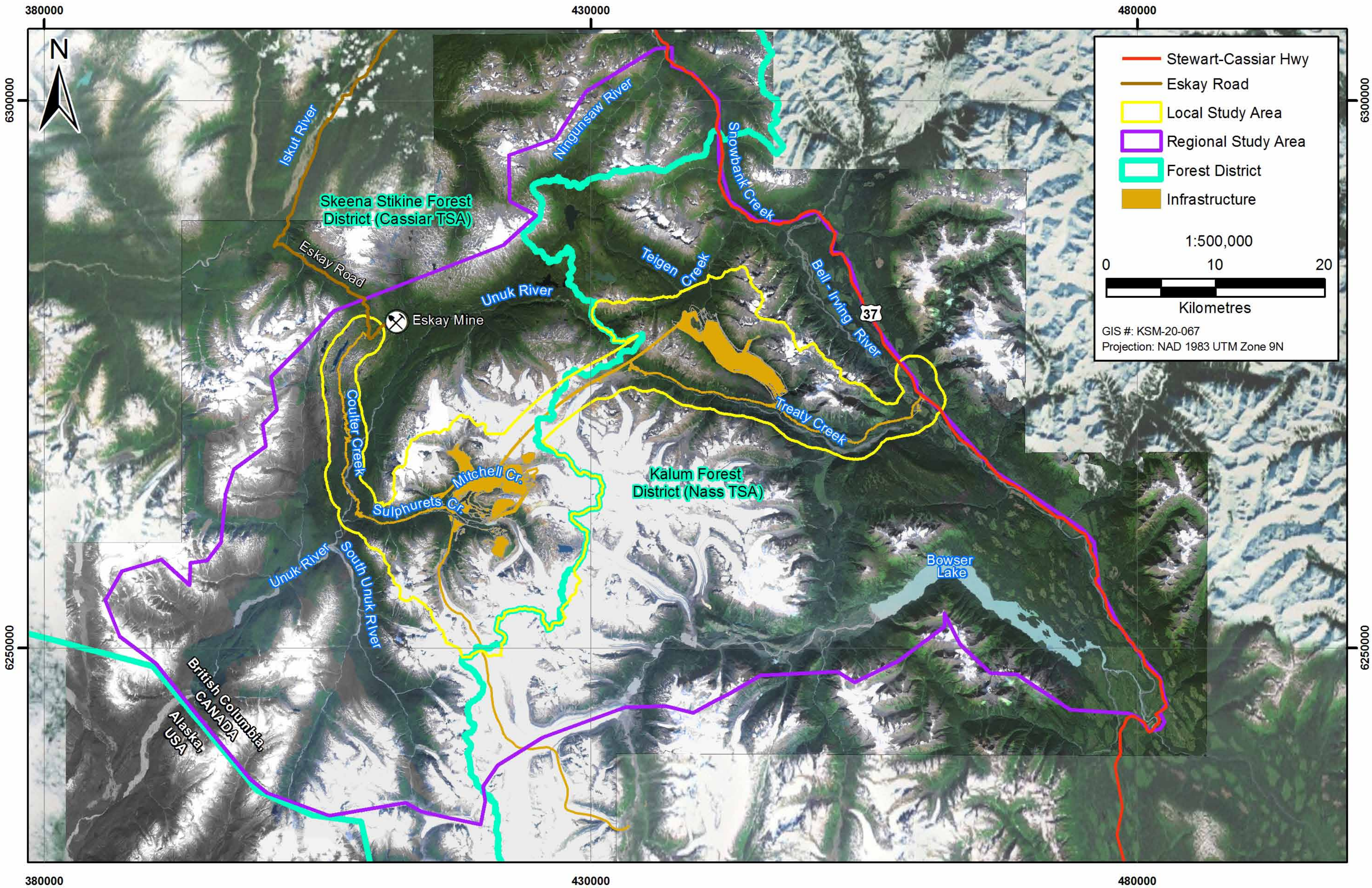

Figure 17.3-1

SEABRIDGE GOLD
KSM PROJECT

Forest Districts and Timber Supply Areas (TSA)

Figure 17.3-1

Rescan
Engineers & Scientists

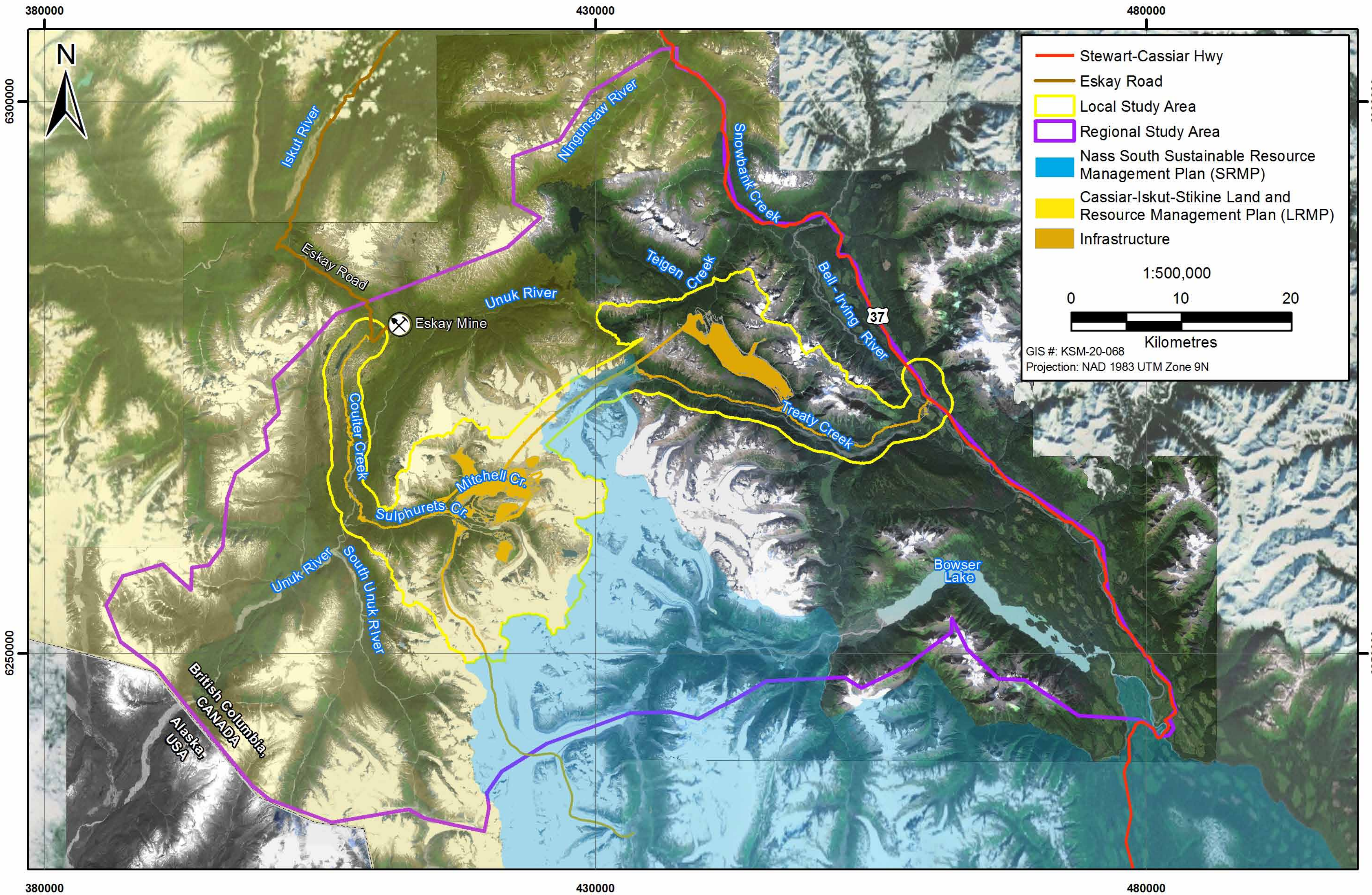

Figure 17.3-2

Land and Resource Management Planning Boundaries

Seabridge Gold
KSM PROJECT

Figure 17.3-2

Rescan
Engineers & Scientists

For example, SRMPs are used to identify OGMAs, to address specific economic development issues such as agriculture or tourism development, and to help manage values such as spiritual and cultural resources identified by Aboriginal groups (BC ILMB and BC Ministry of Agriculture and Lands 2006). The Nass South SRMP (BC ILMB 2012) involves collaboration between the Gitanyow First Nation, Nisga'a Nation, key local stakeholders, and government organizations.

Outlined within the Cassiar Iskut-Stikine LRMP (BC ILMB 2000), general vegetation and ecosystem-related goals include:

- maintaining a landbase that contains the indigenous diversity of plants, animals and other living organisms;
- maintaining healthy aquatic and riparian ecosystems;
- maintaining viable populations of rare, threatened and endangered plants and plant communities; and
- maintaining a landbase with functional habitats and representative ecosystems across the landscape and at the stand level.

Outlined within the Nass South SRMP (BC ILMB 2012), general vegetation and ecosystem-related goals include:

- ensuring ecosystem function across the range of ecosystem types, reflective of the historic natural disturbance regimes;
- maintaining habitat connectivity;
- connecting old-growth management areas;
- providing a continuum of relatively undisturbed habitats possessing interior forest conditions;
- protecting and maintaining the effectiveness of riparian habitats, which have disproportionately high biodiversity values; and
- preserving Gitanyow and Nisga'a traditional use sites and maintaining opportunities for traditional uses of the land.

Smaller watershed sustainability plans, as developed by the Gitanyow First Nation, for example, have been incorporated within larger land management plans, including the Nass South SRMP. Within wilp Wii'litsxw traditional territory (downstream of the Project), the SRMP also provides protection of ecologically sensitive areas, high-value habitats, traditional use sites, and OGMAs (BC ILMB 2012).

Within their traditional territories, current Gitxsan watershed planning includes sustainable development plans for each of the nine watersheds that incorporate considerations regarding Aboriginal title, contribute to capacity building and enhance economic conditions (Gwaans 2007; Appendix 30-D). Development planning tools may include full-cost accounting of social and environmental values, environmental assessment to avoid or minimize negative impacts, and ecosystem management (Gwaans 2007). Issues of concern are identified at a watershed level and may include information regarding plant resources, fish and wildlife habitat, culturally modified trees, historical sites, and information about the respective wilp (Gitxsan Chiefs' Office 2010).

17.4 Spatial and Temporal Boundaries

17.4.1 Spatial Boundaries

The spatial boundaries of the RSA and LSA are depicted in Figure 17.1-1. To ensure coverage of complete watersheds, the 2009 LSA boundary was revised to incorporate height-of-land (beyond 1.5 km) surrounding the Mine Site and the PTMA. Watershed boundaries surrounding the Mine Site and PTMA, as used for the hydrologic assessments, were retained, thereby enabling the assessment of potential effects on terrestrial ecosystems at a watershed level. The 66,500-ha LSA has been sub-divided into five separate areas due to the relatively large geographic separation among the infrastructure components, variety of landforms, and vegetation types present in the LSA and the different types of effects expected from various infrastructure. These areas include the Coulter Creek Access Corridor, the Sulphurets Creek watershed (proposed Mine Site), the Mitchell-Treaty Twinned Tunnels, the PTMA, and the Treaty Creek Access Corridor. Although not reported in this manner, sub-dividing the LSA helped identify the potential effects within the specific geographic areas. This information was included as descriptive text within the effects assessments.

The 338,000-ha RSA was based on the extent of expected use of the region by the wildlife species assessed as VCs. Ecosystem mapping within the RSA provides regional context to the results within the LSA and was referenced in the assessment of potential cumulative effects. Potential effects on terrestrial ecosystems were estimated within a Project footprint that is approximately 4,050 ha (at the end of operation) and contains:

- all proposed infrastructure;
- 100 m degradation buffer surrounding the linear access road and transmission line corridors;
- 300 m degradation buffer surrounding the Mine Site and PTMA; and
- small, fragmented areas that are less than 200-m wide or long and surrounded on three or four sides by infrastructure or its buffer.

These boundaries were chosen based on the types and locations of potential effects on terrestrial ecosystems further described in Section 17.7.

17.4.2 Temporal Boundaries

Temporal boundaries for the effects assessment include the following:

- construction phase – 5 years;
- operation phase – 51.5 years;
- closure phase – 3 years; and
- post-closure phase – 250 years.

Baseline conditions described in Section 17.1 and Appendix 17-A are used as a reference against which potential effects are assessed.

This assessment will consider the potential effects of the construction and operation phases together in order to assess the maximum cumulative effects of the land clearing that will occur throughout both phases. In most cases, the maximum effect on terrestrial ecosystems is recognized at the end of the operation phase.

17.5 Valued Components

The seven terrestrial ecosystems VCs selected for the assessment are introduced and briefly addressed within this section.

Terrestrial ecosystem VCs were selected based on information from several documents and databases including the Application Information Requirements (AIR) and comments from local Aboriginal groups, public, government, and the Technical Working Group. Selection also considered information from the BC CDC (BC MOE 2007a), the BC MOE's Sensitive Ecosystem Inventory (BC MOE 2007b), the SARA (2002b) Public Registry (Government of Canada 2010), the Nass South SRMP (BC ILMB 2012), and the Cassiar Iskut-Stikine LRMP (BC ILMB 2000). Coordinating with Rescan's wildlife discipline during VC selection ensured that habitat of importance to local wildlife species (i.e., avalanche tracks) was also considered.

Summarized within sub-appendix B (Nisga'a Nation Issues Tracking Table) of the Nisga'a Nation Consultation and Issues Summary Report (in Chapter 3, Appendix 3-K), identified Terrestrial Ecosystem concerns pertain to wetland compensation; this is addressed specifically within Chapter 16 (Wetlands). A review of the Nisga'a Final Agreement (NLG, Province of BC, and Government of Canada 1998) provided information on the traditional and current use of terrestrial ecosystems and plant communities by Nisga'a Nation.

Summarized within sub-appendix E (First Nations Issues Tracking Table) of the First Nations Consultation and Issues Summary Report (in Chapter 3, Appendix 3-N), identified Terrestrial Ecosystem concerns include the effects on the sustainability of berries and medicines, introduction of alien invasive plants and concerns regarding plans for timber in the water storage facility (WSF) area. Further information on the traditional and current Aboriginal use of terrestrial ecosystems, plant and mushroom resources was assembled and summarized within a review for each of the Aboriginal groups with overlapping asserted territories. These ethnographic reports, prepared by Rescan and provided as appendices, formed the basis of much of the Aboriginal information (Chapters 29 and 30). Sources of Aboriginal information included:

- Appendix 30-A: Tahltan Nation Traditional Knowledge and Use Desk-based Research Report (Rescan 2012c);
- Appendix 30-B: Skii km Lax Ha Traditional Knowledge and Use Research Report (Rescan 2013);
- Appendix 30-C: Gitanyow First Nation Traditional Knowledge and Use Desk-based Research Report (Rescan 2012a);

- Appendix 30-D: Gitxsan Nation Traditional Knowledge and Use Desk-based Research Report (Rescan 2012b); and
- Tahltan Traditional Use Study of the Northwest Transmission Line Project – Interim Report (THREAT 2009).

Each Aboriginal group identified plant, mushroom, and berry harvesting as important uses of the land. Many plant species present in the region are harvested and used for medicinal or nutritional purposes (see Chapters 29 and 30 for more details). Managing to maintain botanical forest products (mushrooms, berries, and medicinal plants) is a goal of both the Cassiar-Stikine LRMP (BC ILMB 2000) and the Nass South SRMP (BC ILMB 2012).

As outlined within Appendices 30-A through 30-D, the use of plants by local Aboriginal groups varies widely, with berry and mushroom harvesting identified by most groups as important food and economic activities. Berries are harvested from different elevations, depending on season, with high elevations providing fruit much later into the summer and fall. Many of the culturally important plant species, including berry shrubs, have overlapping habitats. Thus, habitats such as avalanche tracks, riparian areas, and alpine meadows are valued as a whole by Aboriginal groups (Chapters 29 and 30). These habitats have been mapped with PEM and TEM.

Appendix 17-C (Assessment of Culturally Important Plants) adopts a coarse-filter approach that assesses potential effects for the collective group of plants, regardless of their use. The assessment is ecosystem-based and therefore easily cross-referenced with the mapping for the LSA and RSA. Potential pine mushroom habitat is assessed separately within this document due to its local economic importance.

17.5.1 Valued Components Included in the Assessment

Seven VCs were selected for this assessment (Table 17.5-1). Each VC is detailed in this section.

Table 17.5-1. Identification and Rationale for Terrestrial Ecosystems Valued Component Selection

Valued Component Category	Valued Component	Identified by*				Rationale for Inclusion
		AG	G	P/S	O	
Culturally Important	Potential pine mushroom habitat	X			X	• Important to the regional economy. • Valued by Aboriginal groups (see Chapters 29 and 30).
	Avalanche track ecosystems	X			X	• Habitat for several plant species valued by Aboriginal groups (see Chapters 29 and 30). • Important wildlife habitat.
Listed and Culturally Important	Listed ecosystems	X	X		X	• Represent a rare, threatened, or at-risk component of regional and/or global biodiversity. • Valued by Aboriginal groups (see Chapters 29 and 30).

(continued)

Table 17.5-1. Identification and Rationale for Terrestrial Ecosystems Valued Component Selection (completed)

Valued Component Category	Valued Component	Identified by AG	G	P/S	O	Rationale for Inclusion
Sensitive and Culturally Important	Riparian and floodplain ecosystems	X	X		X	• Important for fish and wildlife habitat. • Sensitive to changes in environment (especially hydrology). • Protected by Federal Legislation (*Fisheries Act* [1985]). • Habitat for several plant species valued by Aboriginal groups (see Chapters 29 and 30).
Sensitive and Culturally Important	Alpine and parkland ecosystems	X			X	• Sensitive to disturbance (e.g., trampling). • The footprint area contains large areas of alpine ecosystems. • Habitat for several plant species valued by Aboriginal groups (see Chapters 29 and 30). • Valued by Aboriginal groups.
	Old forests	X			X	• Valued by Aboriginal groups (see Chapters 29 and 30). • Discussed as an important management consideration in the LRMP and SRMP. • Important for wildlife.
Other Culturally and Ecologically Important Ecosystems	Other terrestrial ecosystems	X			X	• Important to maintain a diversity of natural ecosystems and seral stages. • Provide a range of wildlife habitat, recreation areas, etc. • Many plant species are traditionally harvested by Aboriginal groups (see Chapters 29 and 30).

***AG = Aboriginal Group – Nisg̱a'a Nation and First Nations interests and values, identified through desk-based research and comments; G = Government (including legislation); P/S = Public/stakeholder comments; O = other (SRMP/LRMPs, best management practices, professional judgment or technical expertise).**

17.5.1.1.1 Potential Pine Mushroom Habitat

The pine mushroom (*Tricholoma magnivelare*) is the most economically important wild mushroom harvested in BC (Wiensczyk and Berch 2001). Local Aboriginal groups also identify mushroom harvesting as an important cultural activity and economic generator. Pine mushroom harvesting was identified as important by Nisga'a Lisims Government during public consultation and is described as an important resource within the Nass South SRMP (BC ILMB 2012) and the Cassiar Iskut-Stikine LRMP (BC ILMB 2000). The latter makes reference to the Tahltan use of this resource, in particular.

Commercial pine mushroom crops are harvested within the Nass River valley, near Gitlaxt'aamiks (New Aiyansh), within the ICHmc2 BEC variant. This area, well south of the proposed Project, represents the warmest and driest variant of the ICHmc subzone (Wiensczyk and Berch 2001). Lower elevations along the Treaty Creek and Coulter Creek Access Corridors occur within the CWHwm and ICHvc subzones, in wetter climate less suitable for pine mushroom development. However, some harvesting does occur along the Eskay Creek Mine road north of the Project area (Coast Mountain Hydro Corp. 2002).

Prime pine mushroom habitat occurs in low elevation forest communities predominantly between the ages of 80 to 160 years, although they are also noted to occur in mature forests up to 250 years (Trowbridge, MacAdam, and Kranabetter 1999). All forests containing quality pine mushroom habitat have an open canopy that allows light to penetrate to the forest floor (Gamiet, Ridenour, and Philpot 1998). Additional site characteristics include soils that are well to rapidly drained, coarse-textured, with high coarse fragment content. Pine mushrooms are restricted to sites with poor-to-medium soil nutrients and soil moisture that is drier than typical for the BEC zones they occur within (Trowbridge, MacAdam, and Kranabetter 1999; Wiensczyk and Berch 2001).

To locally refine the potential mushroom habitat, BEC units considered of nil potential to support mushroom habitat (CMAunp and BAFA unp) were excluded. Further communication (M. Kranabetter, pers. comm.) indicated that high-elevation BEC units in this area (ESSFwv and MHmm2) are not suitable pine mushroom habitat. As pine mushrooms were identified in the field within the ICHvc subzone, on dry slopes above the proposed Treaty Creek access road, this subzone was included as potential habitat. Potential mushroom habitat was mapped within the CWHwm subzone, primarily along the Coulter Creek access road and along the Unuk River and lower Sulphurets Creek. At the site level, mushroom habitat was further refined through an assessment of the terrain and soils information to identify level areas supporting rapidly-drained fluvial or glaciofluvial deposits, as well as slopes and crests with morainal veneers over bedrock, or associated with glaciofluvial terraces.

17.5.1.1.2 Avalanche Track Ecosystems

Avalanche track ecosystems, dominated by a dense cover of deciduous shrubs or herb species, are often linear features but could also cover much wider areas of sloping terrain. They establish where repeated snow and rock slides, and excessive moisture prevent coniferous forest establishment (RIC 1998b). They typically begin in the alpine or subalpine zones where there is abundant snow accumulation and steeply sloping valley walls. The frequency of avalanches in a particular track varies, with some areas re-disturbed annually or semi-annually and other areas over a much longer time-frame. Areas that are disturbed more frequently have fewer shrubs and a greater proportion of herbaceous species. In the LSA, avalanche tracks typically include a variety of shrub and herb species including Sitka alder (*Alnus viridis* subsp. *sinuata*), willows (*Salix* spp.), salmonberry (*Rubus spectabilis*), Sitka valerian (*Valeriana sitchensis*), arrow-leaved groundsel (*Senecio triangularis*), Indian hellebore (*Veratrum viride*), and cow-parsnip (*Heracleum Maximum;* Banner et al. 1993).

As identified within the Assessment of Culturally Important Plants (Appendix 17-C) and the desk-based ethnographic reports (Appendices 30-A through 30-D), several of these plant species have cultural importance to local Aboriginal groups (Chapters 29 and 30).

Avalanche track ecosystems also represent important foraging areas for bears in the subalpine zones of BC (Appendix 18-B) and are implicitly assessed as part of effects to bear habitat in Chapter 18.

17.5.1.1.3 Listed Ecosystems

Preserving biodiversity (the number, variety, and variability of living things) is a common goal of many government and non-governmental organizations in BC (Biodiversity BC 2008) and is a specific management objective listed in the region's land and resource management plans

(BC ILMB 2000, 2012). Best management practices and guidelines for land developments recommend that red- and blue-listed ecosystems be protected (BC MOE 2006). Preserving red-listed ecosystems and conserving blue-listed ecosystems are objectives to meet the biodiversity goals within the Nass South SRMP (BC ILMB 2012). Maintaining populations of listed plants and ecosystems is also an objective within the Cassiar Iskut-Stikine LRMP (BC ILMB 2000).

17.5.1.1.4 Riparian and Floodplain Ecosystems

Riparian and floodplain ecosystems typically occupy a small proportion of landscapes and contain species and habitats that are often not present elsewhere (BC MOF 1995b). Riparian and floodplain ecosystems contribute coarse woody debris and organic litter to streams, moderate stream temperatures, and increase bank stability to reduce erosion (Banner and MacKenzie 1998), all of which contribute to fish habitat (see Chapter 15 for more details).

Riparian and floodplain ecosystems are sensitive to changes in hydrological regime (e.g., flooding frequency and duration). The *Fisheries Act* (1985) requires riparian areas to be protected, and the *Canadian Environmental Assessment Act* (1992) requires that they be considered in an environmental assessment. These ecosystems have also been recognized within both the Nass South SRMP (BC ILMB 2012) and Cassiar Iskut-Stikine LRMP (BC ILMB 2000) as important ecosystems to manage well. The potential effects of the KSM Project on the extent of riparian and floodplain ecosystems are considered within this chapter; the potential effects with respect to fish habitat are assessed in Chapter 15. These ecosystems have also been recognized within both the Nass South SRMP and Cassiar Iskut-Stikine LRMP as important ecosystems to manage well (BC ILMB 2000, 2012). The potential effects of the KSM Project on the extent of riparian and floodplain ecosystems are considered within this chapter; the potential effects with respect to fish habitat are assessed in Chapter 15. Although vegetation productivity in riparian zones varies throughout the LSA and RSA, all riparian vegetation is considered of equal value for this assessment.

17.5.1.1.5 Alpine and Parkland Ecosystems

Elevations above the treeline (including non-vegetated areas such as snowfields, ice patches, and glaciers) were widely used by the Tahltan First Nation (THREAT, pers. comm.) and likely used by other Aboriginal groups as important historical travel routes and hunting areas. High elevations represent important habitat for highly-valued wildlife species including mountain goats and grizzly bears.

Alpine and parkland ecosystems are considered sensitive because disturbed vegetation may not recover to pre-disturbance levels even in the long term (Frank and del Moral 1986; Forbes, Ebersole, and Strandberg 2001; Mingyu et al. 2009). This is particularly true of dwarf shrubs and krummholz trees, which despite their small stature can be very old because the harsh growing conditions in the alpine result in slow growth. The importance of alpine ecosystems is recognized in the Cassiar-Iskut Stikine LRMP (BC ILMB 2000). Aboriginal groups value a range of plant species found in alpine and parkland ecosystems including cow-parsnip and fireweed (*Epilobium* spp.), which often grow within herbaceous meadows, and crowberry (*Empetrum nigrum*) and common juniper (*Juniperus communis*), which often occur within krummholz and mountain-heather communities (Chapters 29 and 30). High elevations also yield blueberry crops later in the fall after the lower elevation berry crops and salmon runs have finished.

17.5.1.1.6 Old Forests

Old forests are structurally complex stands typically containing large snags, coarse woody debris, large trees, and a diverse understory. As explained in Section 17.1.6, old forests are important wildlife habitat, stores of carbon and genetic resources, and serve as recreational areas. Maintaining areas with the structure of old forests is a management objective within the Nass South SRMP (BC ILMB 2012).

The term "old forest" may be confusing as it sometimes refers to forest structure and other times to forest age. The age at which a forest attains typical old-growth structural characteristics such as large veteran trees, ample coarse woody debris, and a sparse understory, depends on ecosystem type and natural disturbance regime. In the TEM data set, old forests are those mapped as structural stage 7.

17.5.1.1.7 Other Terrestrial Ecosystems

This VC comprises the remaining vegetative land cover (i.e., that which is not listed by the BC CDC or considered sensitive). It includes young and mature forests of differing composition and structure, as well as herb- and shrub-dominated areas.

Maintaining a diversity of tree species, seral stages, and ecosystems represent management objectives within the Nass South SRMP (BC ILMB 2012) and Cassiar Iskut-Stikine LRMP (BC ILMB 2000). Tree species diversity and genetic diversity within species both contribute to the resilience of forest ecosystems and their ability to combat, recover from, or adjust to disease, insect infestations, climatic variations, and other disturbances. In addition, many trees, shrubs, forbs, lichens, and mosses found in varying terrestrial ecosystems are valued by Aboriginal groups (Chapters 29 and 30). The Tahltan Nation, specifically, refers to the importance of deciduous forests and shrub-herb communities (Chapter 30).

Provincial best management practices recognize that greater ecosystem diversity tends to support greater wildlife diversity through the provision of a variety of food sources, cover, and breeding and rearing areas (BC MOE 2006). Maintaining a full range of ecosystem types across a landscape (or region, or globe, depending on the scale of effort) is a common coarse-filter approach to biodiversity conservation as a reasonable way to conserve the variety of species and communities therein (Noss 1996; Margules and Pressey 2000; Biodiversity BC 2008).

17.5.2 Valued Components Excluded from Assessment

Three VCs—rare plants, cedar trees, and OGMAs—were initially considered for this assessment, but were not considered further (Table 17.5-2). Rare plant species are tracked and monitored by the BC CDC, COSEWIC, and SARA and are described in the Cassiar Iskut-Stikine LRMP (BC ILMB 2000) and Nass South SRMP (BC ILMB 2012) as important to protect. They were not considered further in this assessment as none were identified during the presence / non-presence surveys associated with the baseline (TEM) field studies in the area. Presented earlier, several rare plants (largely lichens and mosses) have recently been identified at high elevations within the Project area as part of the rare plant survey completed for Pretium Resources Inc.'s proposed Brucejack Mine.

Table 17.5-2. Terrestrial Ecosystems Valued Components Considered and Excluded from Further Analysis

Valued Component	Identified by*				Rationale for Exclusion
	AG	G	P/S	O	
Rare plants	X	X		X	No rare plants identified during TEM baseline studies
Cedar trees	X			X	Cedar is not widespread in the area
Old Growth Management Areas				X	There are no OGMAs within or directly adjacent to the Project footprint (Figure 17.1-5)

*** AG = Aboriginal Group – Nisga'a Nation and First Nations interests and values, identified through desk-based research and comments; G = Government (including legislation); P/S = Public/stakeholder comments; O = other (SRMP/LRMPs, best management practices, professional judgment or technical expertise).**

Dedicated rare plant surveys will be conducted prior to development, in order to guide on-the-ground infrastructure construction. In particular, the lichen, moss and vascular plant species of potential significance identified through the Brucejack Mine surveys will be assessed throughout other portions of the KSM Project area.

Maintaining a sustainable supply of cedar is an objective stated in the Nass South SRMP (BC ILMB 2012). Western redcedar (*Thuja plicata*) and yellow-cedar (*Chamaecyparis nootkatensis*) have extensive historical use records by Aboriginal groups in BC for a variety of cultural applications. However, baseline field surveys and regional field guides indicate that both western redcedar and yellow cedar are quite uncommon in this region (Pojar, Klinka, and Demarchci 1991; Banner et al. 1993). For this reason, cedar was not retained as a VC.

As no OGMAs occur within either the KSM footprint or the LSA, they are not considered further in this assessment.

17.6 Scoping of Potential Effects for Terrestrial Ecosystems

Potential effects on terrestrial ecosystems and vegetation resulting from the Project, or similar industrial developments, were raised by Aboriginal groups, government, community members, experts, and professionals. These issues, summarized in Table 17.6-1, were raised in a variety of forums and reports including public/stakeholder comments, reviews of best management practices, scientific literature, and land use plans. How and when these Project-related potential effects may arise is summarized in Sections 17.6.1 to 17.6.4, and an overview of the potential interactions between specific Project areas and VCs are provided in Tables 17.6-2 to 17.6-8. Although several issues, or types of effect, are identified within Table 17.6-1, Tables 17.6-2 through 17.6-8 generalize them into Vegetation Loss (direct loss due to vegetation clearing) and Vegetation Degradation (degradation effects due to changes to the structure, composition and function of plant communities, introduction of invasive plant species, deposition of fugitive dust, and windthrow). The tables identify potential effects associated with broad Project Regions and do not identify specific infrastructure components. Each of the identified Project areas typically consist of many smaller components that contribute to the loss or degradation. For example, the Coulter Creek Access Corridor includes 15 components, including waste and borrow areas, log landings, bridges, and avalanche control structures. A detailed description of the effects is provided in Section 17.7.

Table 17.6-1. Terrestrial Ecosystems Issues Identified during Scoping

Issue	Identified by*				
	AG	G	P/S	O	AIR
Loss of terrestrial ecosystems and plants of interest	X			X	x
Alteration of natural patterns of diversity (seral stage diversity, ecosystem diversity)	X			X	
Introduction of invasive plant species	X	X	X	X	X
Fugitive dust	X			X	X
Changes to ecosystem composition/structure/function due to changes in hydrology				X	
Windthrow				X	X

*** AG = Aboriginal Group – Nisg̲a'a Nation and First Nations interests and values, identified through desk-based research and comments; G = Government (including legislation); P/S = Public/stakeholder comments; O = other (SRMP/LRMPs, best management practices, professional judgment or technical expertise).**

Table 17.6-2. Overview of Potential Effects on Pine Mushroom Habitat

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Treaty Creek Access Corridor	X	X
	Camp 7: Unuk North Camp	X	X
	Mitchell Operating Camp	X	X
	Coulter Creek Access Corridor	X	X

Table 17.6-3. Overview of Potential Effects on Avalanche Track Ecosystems

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Coulter Creek Access Corridor	X	X
	McTagg and Mitchell Rock Storage Facilities	X	X
	Mitchell Ore Preparation Complex	X	X
	Kerr and Mitchell Pits		X
	Water Storage Facility (WSF)	X	X
	Water Treatment and Energy Recovery Area	X	X
	Explosives Manufacturing Facility	X	X
Processing and Tailing Management Area	Treaty Creek Access Corridor	X	X
	Mitchell-Treaty Twinned Tunnels, Mitchell-Treaty Saddle Area	X	X
	North and South Cell Tailing Management Facilities	X	X
	East Catchment Diversion	X	X

Table 17.6-4. Overview of Potential Effects on Listed Ecosystems

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Coulter Creek Access Corridor	X	X
	Camp 7: Unuk North Camp	X	X
	Camp 8: Unuk South Camp	X	X
Processing and Tailing Management Area	Treaty Creek Access Corridor	X	X
Off-site Transportation	Highways 37 and 37A		X

Table 17.6-5. Overview of Potential Effects on Riparian and Floodplain Ecosystems

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Camp 3: Eskay Staging Camp		X
	Camp 7: Unuk North Camp		X
	Camp 8: Unuk South Camp		X
	Coulter Creek Access Corridor	X	X
	Mitchell Operating Camp		X
	McTagg and Mitchell Rock Storage Facilities and Sulphurets Laydown Area	X	X
	McTagg Diversion Tunnel	X	X
	McTagg Power Plant	X	X
	Mitchell Ore Preparation Complex	X	X
	Mine Site Avalanche Control		X
	Kerr, Sulphurets, and Mitchell Pits	X	X
	Upper Sulphurets Power Plant	X	X
	Water Storage Facility	X	X
	Water Treatment and Energy Recovery Area	X	X
	Explosives Manufacturing Facility	X	X
Processing and Tailing Management Area	Treaty Creek Access Corridor	X	X
	North and South Cell Tailing Management Facilities	X	X
	East Catchment Diversion	X	X
	Centre Cell Tailing Management Facility	X	X
	Camp 12: Highway 37 Construction Camp	X	X
Off-site Transportation	Highways 37 and 37A		X

Table 17.6-6. Overview of Potential Effects on Alpine and Parkland Ecosystems

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Camp 3: Eskay Staging Camp	X	X
	Coulter Creek Access Corridor	X	X
	McTagg Rock Storage Facility and Diversion Tunnels	X	X
	Mitchell Rock Storage Facility	X	X
	Mine Site Avalanche Control	X	X
	Kerr, Mitchell, and Sulphurets Pits	X	X
	Sulphurets Laydown Area		
	Kerr Rope Conveyor	X	X
Processing and Tailing Management Area	Construction Access Adit	X	X
	Mitchell-Treaty Twinned Tunnels, Mitchell-Treaty Saddle Area	X	X
	East Catchment Diversion	X	X
	North and South Cell Tailing Management Facilities	X	X

Table 17.6-7. Overview of Potential Effects on Old Forest Ecosystems

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Coulter Creek Access Corridor	X	X
	Treaty Creek Access Corridor	X	X
	Camp 7: Unuk North Camp	X	X
	Mitchell Operating Camp	X	X
	Explosives Manufacturing Facility	X	X
	Camp 2: Ted Morris Camp	X	X
	Sulphurets Access Road	X	X
	Sulphurets Laydown Area	X	X
	Water Treatment and Energy Recovery Area	X	X
	Mitchell Rock Storage Facility	X	X
	Water Storage Facility	X	X
Processing and Tailing Management Area	South Cell TMF, North Cell TMF	X	X
	Saddle Dam, Splitter Dam, North Dam	X	X
	Centre Cell TMF	X	X

Table 17.6-8. Overview of Potential Effects on Other Terrestrial Ecosystems

Project Region	Project Area	Vegetation Loss	Vegetation Degradation
Mine Site	Most Project Areas and Components	X	X
Processing and Tailing Management Area	Most Project Areas and Components	X	X

17.6.1 Construction

Appendix 17-D provides the scoping table that identifies the Project components present during the construction phase. The majority of the proposed construction activities will necessitate land clearing with subsequent vegetation loss. Construction activities could also result in several other effects including the spread of invasive plant species, fugitive dust deposition (e.g., from blasting and road construction), changes to hydrology (e.g., via road and drainage ditch construction and construction of the TMF and diversion channels), and windthrow (at forest edges following land clearing). Refer to the Fish and Aquatic Habitat Effects Assessment in Chapter 15 for a detailed assessment of hydrology-related effects on aquatic habitat, including vegetated riparian habitat.

17.6.2 Operation

Appendix 17-D provides the scoping table that identify the Project components that are present and reclaimed during the operation phase. Vegetation that was lost during construction will remain lost where infrastructure is maintained during operation. Where vegetation cleared during the construction phase is reclaimed during the operation phase (whether through planting or seeding), it will continue to be considered degraded throughout operation, as it is assumed the time to restore a functional ecosystem, in comparison to pre-development conditions, will exceed the duration of the operation phase (51.5 years). Vegetation is considered degraded within the transmission lines' right-of-way, because although vegetation will remain, it will be altered in terms of structure and composition. Continued construction during operation will result in additional vegetation loss.

Vegetation degradation during operation will result from continued construction activities. For example, windthrow risk will be elevated adjacent to cleared areas. As well, degradation is expected from various operational activities. The maintenance of roads and transmission lines and the movement of people and equipment along these linear features could result in the movement of invasive plant species and the production of fugitive dust. Blasting and ore haulage will also produce fugitive dust.

17.6.3 Closure

Appendix 17-D provides the scoping table that identifies the Project components present, reclaimed, and decommissioned during the closure phase. At the end of operation, much of the Project infrastructure will be removed and the area reclaimed, although some infrastructure will be maintained indefinitely. Objectives for the reclamation of vegetation are based upon the restoration of wildlife habitat. Specific reclamation objectives vary throughout the Project area; some areas will be reclaimed to grasses and forbs, some to shrubs (willow and alder), and others to coniferous trees. The reclamation objectives are outlined within the Closure Plan in Chapter 27.

Closure activities have potential to further degrade vegetation. The limited use and maintenance of roads has potential to produce fugitive dust and to introduce and spread invasive plant species. Introduction of invasive plants can occur inadvertently due to contaminated seed mixes or from non-native seed mixes that may act as invasive species (e.g., crested wheatgrass).

17.6.4 Post-closure

Appendix 17-D provides the scoping table that identifies the Project components that are present and reclaimed during the post-closure phase.

17.7 Potential for Residual Effects for Terrestrial Ecosystems

Assessed within Chapter 8 (Terrain Surficial Geology and Soils), soil loss resulting from erosion, slope failure, burial, excavation, or construction reduces the area available to support vegetation growth and to provide necessary nutrients, carbon, and water cycling. Similarly, changes in site drainage patterns, soil contamination, or alteration of attributes such as organic matter content, pH, nutrient availability, and microbial activity, can also affect natural ecosystem function. The potential hydrology-related effects on aquatic habitat, including riparian ecosystems, are detailed within the effects assessment in Chapter 15 (Fish and Aquatic Habitat). The potential effects on terrestrial ecosystems that are assessed in this chapter include vegetation loss and degradation. Measures to mitigate the potential loss and degradation of the terrestrial ecosystem VCs resulting from the Project include the following:

- carefully plan during the Project design stage to minimize clearing dimensions and subsequent vegetation loss and disturbance;
- adhere to the general management considerations within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20);
- reclaim vegetated habitats in accordance with the end land use objectives;
- avoid and/or reduce windthrow according to best management practices through retaining wind-firm trees, feathering edges, topping/pruning of individual trees, and monitoring for windthrow along clearings and road edges;
- avoid the introduction and spread of invasive plants through developing on-site training and education programs, minimizing the creation of suitable habitat, minimizing potential for transport into the Project area, and detecting/eradicating identified plants;
- reduce effects on terrain and soil by adhering to the Terrain, Surficial Geology and Soil Management and Monitoring Plan (Chapter 26.13); and
- reduce fugitive dust accumulation by adhering to the Air Quality Management Plan (Chapter 26.11).

The potential effects of vegetation loss and degradation, with accompanying mitigation measures, are described in Sections 17.7.1 (Vegetation Loss) and 17.7.2 (Vegetation Degradation), with summary tables of loss and degradation estimates. The specific Project components are identified within Table 17.7-2, in Section 17.7.1.2.

Vegetation loss estimates resulting from vegetation clearing were calculated within the proposed Project footprint, and degradation estimates were calculated within a buffer surrounding the footprint. The results, calculated from TEM data and reported as an area (ha) and percentage of the mapped baseline distribution, are assessed at two different scales: 1) within the entire LSA and 2) within local watershed boundaries.

The watershed baseline distributions are derived primarily from TEM, with augmentation of PEM data in areas without TEM data. Watersheds are frequently adopted for environmental planning and management as they capture interacting physical and biological components, thus allowing for landscape-specific assessments of the status of, and linkages between, the different components (Montgomery, Grant, and Sullivan 1995). Described within Section 17.8, the ecological thresholds and magnitude determination are defined at the watershed assessment level. The watersheds used in this effects assessment (percentage of watershed covered by ecosystem mapping in parentheses), are depicted in Figure 17.7-1 and include:

- Treaty Creek (100%);
- Sulphurets Creek (100%);
- upper Unuk River, upstream of the Sulphurets Creek and Unuk River confluence (94%); and
- Teigen Creek (87%).

The watersheds containing the majority of proposed infrastructure (Sulphurets Creek and Treaty Creek) have complete ecosystem mapping coverage. As mapping does not cover the entire upper Unuk River and Teigen Creek watersheds, the percentage estimates for vegetation loss and degradation within these two watersheds represent maximum effects. Ne effects are expected on those portions of watersheds without ecosystem mapping data.

17.7.1 Vegetation Loss

Vegetation associated with each of the terrestrial ecosystem VCs will be lost within the Project footprint during construction, as described below and summarized in Table 17.7-1.

Table 17.7-1. Summary of Project-specific Vegetation Loss

Valued Component Category	Terrestrial Ecosystem Valued Component	Total Extent (ha) Lost at End of Operation[1,2]
Culturally and Ecologically Important	Potential pine mushroom habitat	65.8
	Avalanche track ecosystems	670.9
Listed and Culturally Important	Listed ecosystems	26.9
Sensitive and Culturally Important	Riparian and floodplain ecosystems	537.8
	Alpine and parkland ecosystems	392.6
	Old forests	276.4
Other Culturally and Ecologically Important	Other terrestrial ecosystems	1,737.3

[1] As determined by overlaying the footprint on the TEM.
[2] Total lost not additive as VCs are overlapping.

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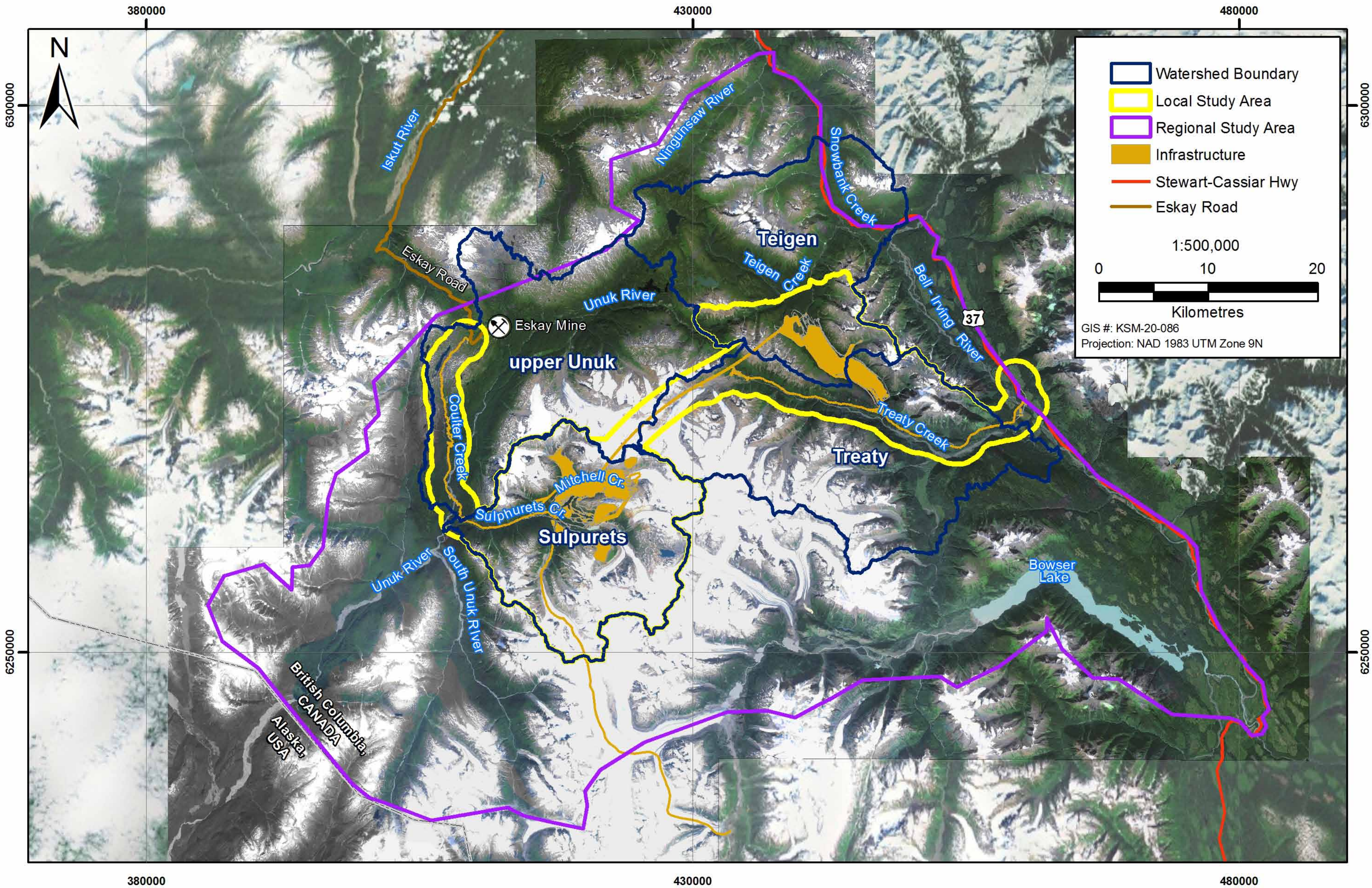

Figure 17.7-1

Watershed Boundaries for Terrestrial Ecosystems Effects Assessment

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Vegetation loss results from the physical clearing of ecosystems within the Project footprint. In order to assess the terrestrial ecosystems that will be lost due to Project clearing, the proposed footprint was overlaid on the mapped distribution of the VCs. Each VC was mapped during baseline studies and is described in Section 17.5.1, with the exception of pine mushroom habitat which was modelled separately using the BEC units, site series, surficial materials, soil drainages, soil orders, and vegetation structural stages in which pine mushrooms are known to grow.

Areas that will be lost at the end of operation are shown in Figures 17.7-2a and 2b. All vegetation loss estimates were derived from the TEM information, with the exception of a couple of listed ecosystems that required grouping, as PEM often cannot differentiate between ecosystems with similar moisture and nutrient regimes. In such circumstances, losses were calculated for each ecosystem using the TEM and, for the grouped units, using the PEM.

17.7.1.1 Mitigation for Vegetation Loss

Vegetation loss will be minimized during Project construction and operation and sensitive ecosystems will be avoided, where possible. In order to accomplish this, roads and transmission lines are designed to minimize the number of water crossings and to avoid running parallel to watercourses. Clearing activities will include low-impact techniques, where possible, such as hand clearing and topping, and erosion prevention and bank stabilization techniques to minimize potential for secondary loss of trees. Details are provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26.

Detailed in the Fish Habitat Compensation Plans (Appendices 15-Q and 15-R), additional riparian habitat will be created to compensate for the habitat that will be lost along fish-bearing streams. This work will be staged to coincide with the timing of the habitat loss. However, some fish habitat compensation activities will also require the removal of riparian vegetation. For example, the construction of side-channel and off-channel streams, inlets, outlets, and ponds, will require removal of some existing vegetation to make room for these new features, and roads may have to be constructed to access compensation sites. The amount of riparian vegetation disturbed will be very small relative to the overall habitat created, however. Provided as Appendix 16-B, the Wetland Habitat Compensation Plan details the process of compensating the lost wetland area resulting from development of the Tailing Management Facilities.

Vegetated ecosystems that are lost at the end of the closure phase (Figures 17.7-3a and 17.7-3b), which may be suitable for reclamation, are addressed within Chapter 27. Reclamation typically involves removal of infrastructure, re-contouring the surface profile to blend with local topography, replacement of overburden and/or soil, soil fertilization, and re-vegetation. Some areas at lower elevations will be reclaimed to a mixture of grass and forbs, some to deciduous shrubs, and some to coniferous trees (Chapter 27). Alpine areas will not be re-vegetated because success, although not impossible, is very difficult due to the short growing seasons and harsh conditions to which many species are not adapted (Chambers 1997).

The goal of reclamation is to restore productive, self-sustaining vegetated ecosystems composed of native plant species that achieve the wildlife habitat management objectives addressed within the Closure Plan (Chapter 27). Other functions of re-vegetation include erosion prevention, hydrologic regulation, and visual quality. Where vegetation loss occurs within high elevation forest or alpine - parkland ecosystems, reclamation will not be able to restore baseline conditions for a long time, if at all. The microclimate in several areas, especially within the upper McTagg and Mitchell Creek valleys, is very cold and vegetation development is slow. Reclamation within areas subject to snow avalanches from steep slopes above may limit the vegetation species that can establish and adapt to disturbance. Competition among plant species that were seeded versus those that would naturally establish can also pose potential problems. Other site factors that drive the development of terrestrial ecosystems, the ecosystems that establish, and the functions they provide, are likely to differ from those present at baseline. This includes surficial material depth and texture, slope steepness, aspect, and soil moisture and nutrient regimes.

17.7.1.2 Potential for Residual Effects

Table 17.7-2 summarizes the potential residual effects for each of the Terrestrial Ecosystem VCs. In total, nearly 4,050 ha of vegetated terrestrial ecosystems will be cleared to make way for Project infrastructure. Vegetation loss is expected to be a residual effect for each of the terrestrial ecosystem VCs despite reclamation because of reasons outlined in the previous section. The loss estimates for each VC are detailed in Tables 17.7-3 to 17.7-17 and are based on the total area anticipated to be lost at the end of the operation phase, which includes losses accrued during construction.

17.7.1.3 Potential Pine Mushroom Habitat: Residual Effects due to Vegetation Loss

Approximately 6% of the potential pine mushroom habitat within the LSA could be lost by the end of the operation phase (Tables 17.7-3 and 17.7-4). The mapped potential habitat aligns with known locations within the Treaty Creek drainage, suggesting the mapping provides a reasonable approximation of suitable habitat.

Loss of potential habitat includes areas of mature and old forest that will be cleared along portions of the Coulter Creek and Treaty Creek access roads (Table 17.6-2; Figures 17.7-4a and 17.7-4b). Smaller areas of potential habitat loss could result from development of Camp 7: Unuk North Camp and the access road for the Mitchell operating camp. Although mitigation strategies specific to potential pine mushroom habitat are not proposed, adhering to the general management considerations within the Vegetation Clearing Management Plan (Chapter 26.20.1) will minimize the effects on potential pine mushroom habitat.

Portions of the Coulter Creek access road (i.e., between the Eskay Creek Mine road and the Unuk River) will be reclaimed during the operation phase. Of the 66 ha lost, 34 ha (52%) occur in areas designated for reclamation activity, almost all within the upper Unuk River and Sulphurets Creek watersheds. Potential pine mushroom habitat could establish in these areas in the far future, if the forest structure, species composition, and soil conditions are suitable for their development. During the closure phase, reclamation of an additional 0.6 ha is proposed. However, as reclaimed areas are unlikely to provide suitable mushroom habitat for many decades into the future, residual effects are expected, with construction phase losses assumed to continue through to closure (Table 17.7-4).

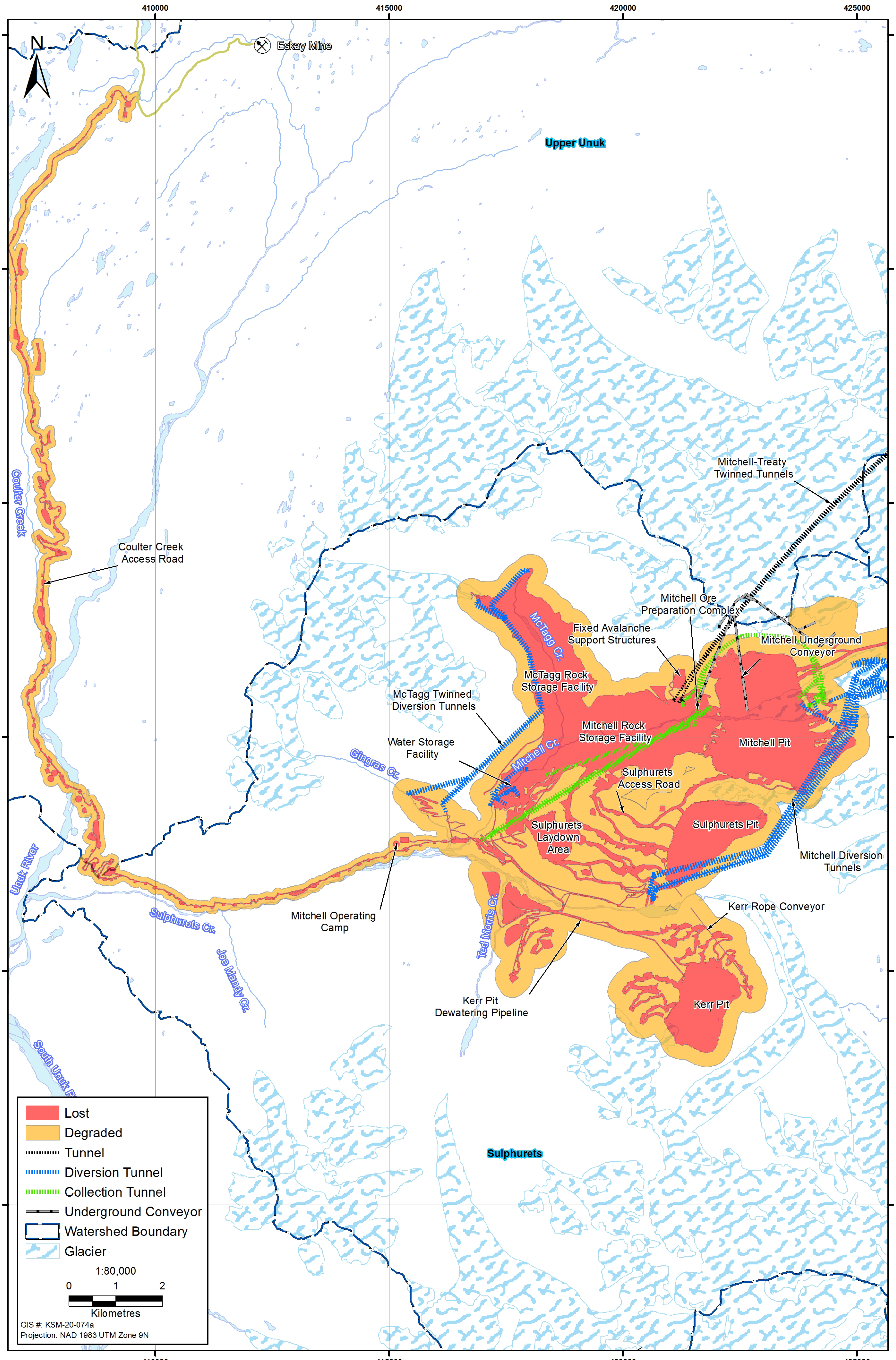

Figure 17.7-2a

Footprint at the End of Operation: Mine Site and Coulter Creek Access Road

PROJECT # 868-016-28 GIS No. KSM-20-074c_T January 9, 2013

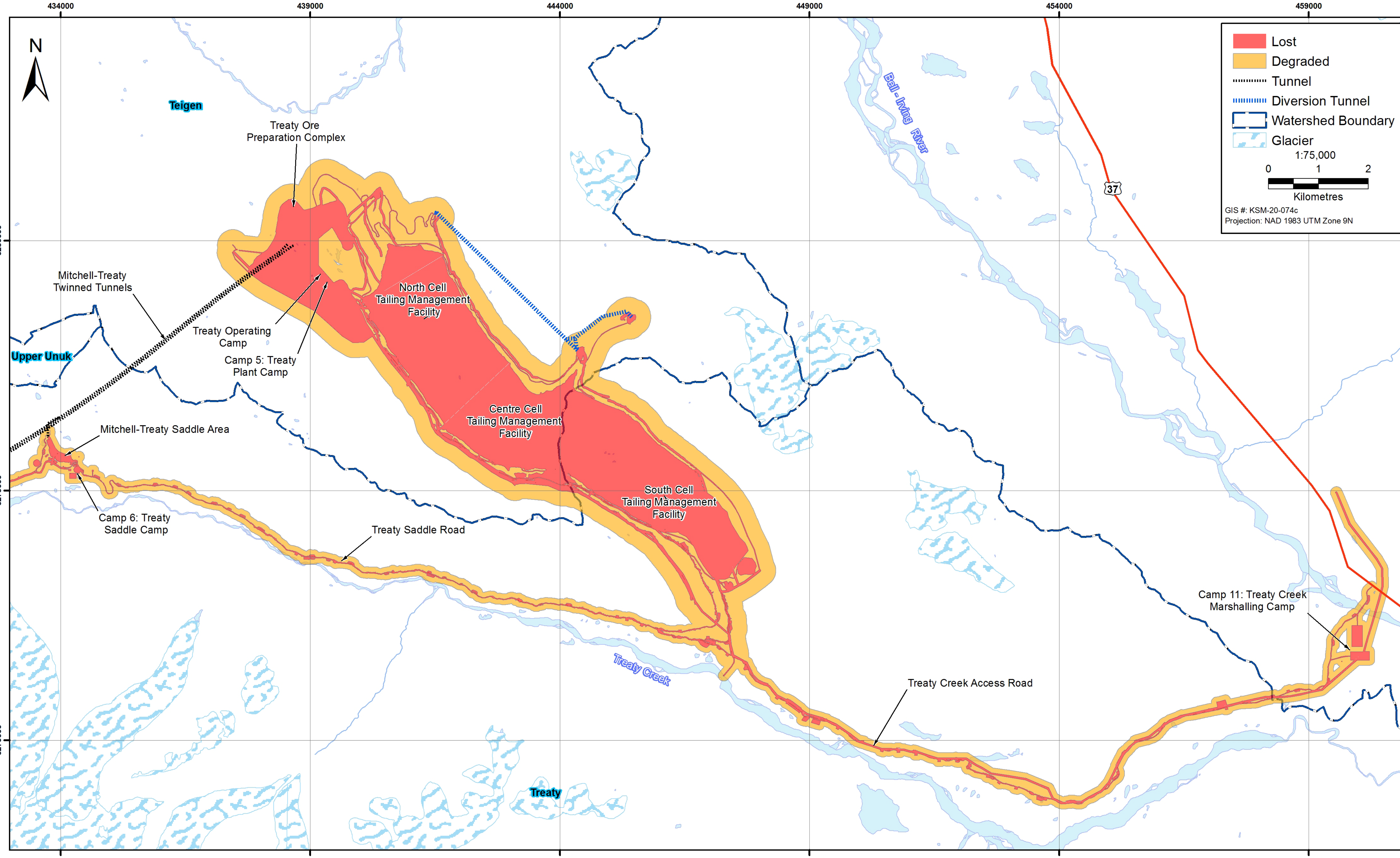

Figure 17.7-2b

Footprint at the End of Operation: Processing and Tailing Management Area and Treaty Creek Access Road

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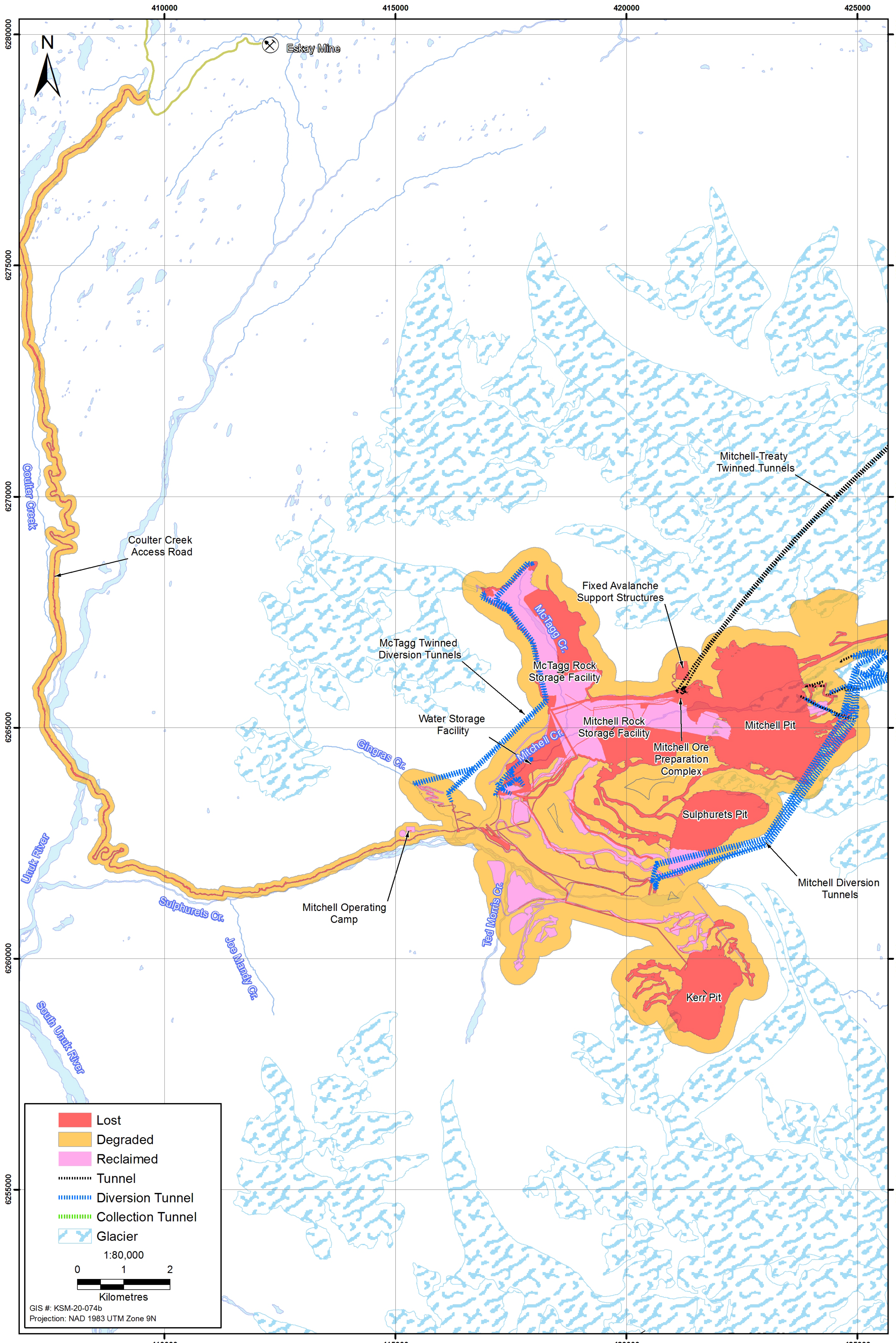

Figure 17.7-3a

Footprint at End of Closure: Mine Site and Coulter Creek Access Road

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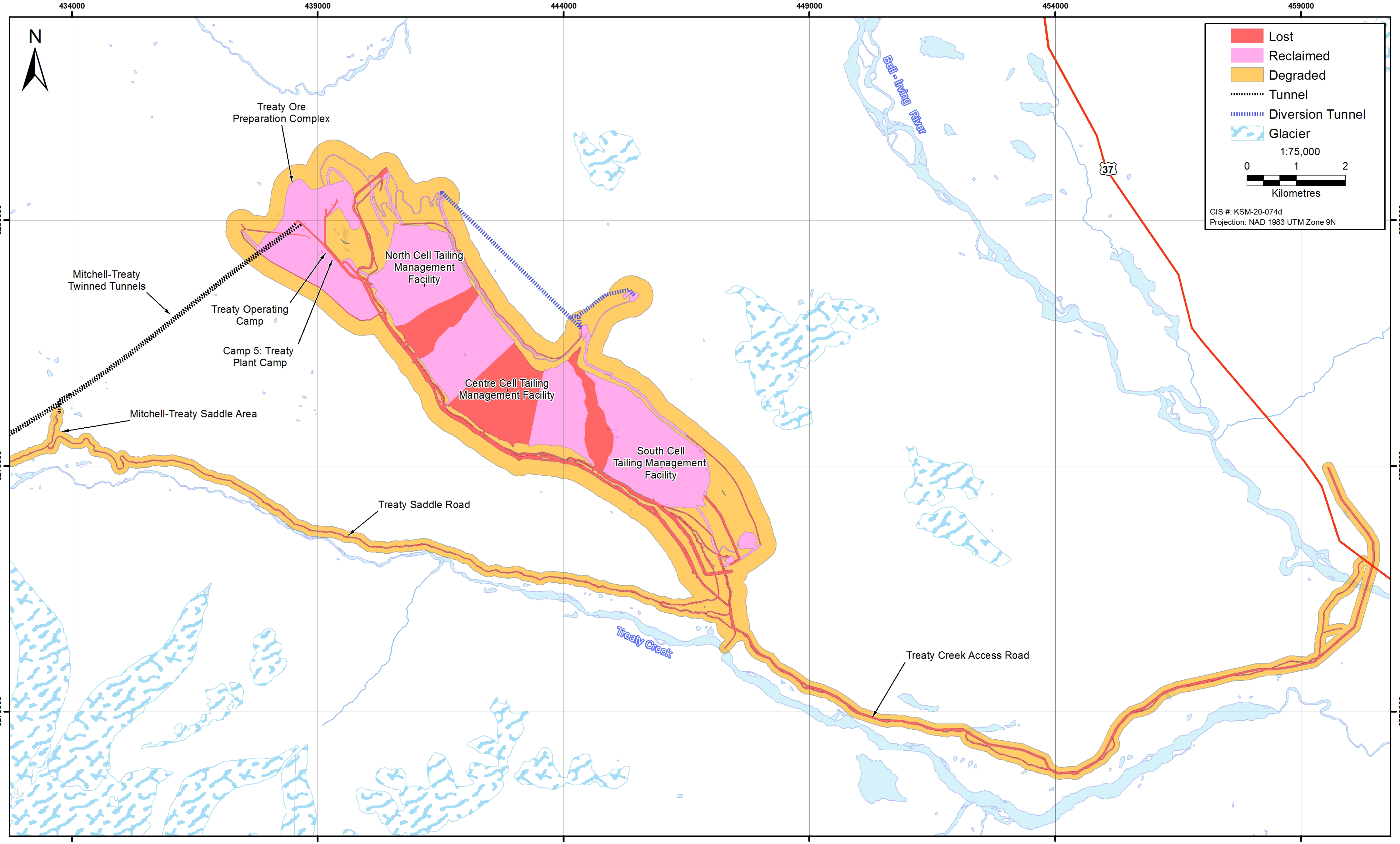

Figure 17.7-3b

Footprint at the End of Closure: Processing and Tailing Management Area and Treaty Creek Access Road

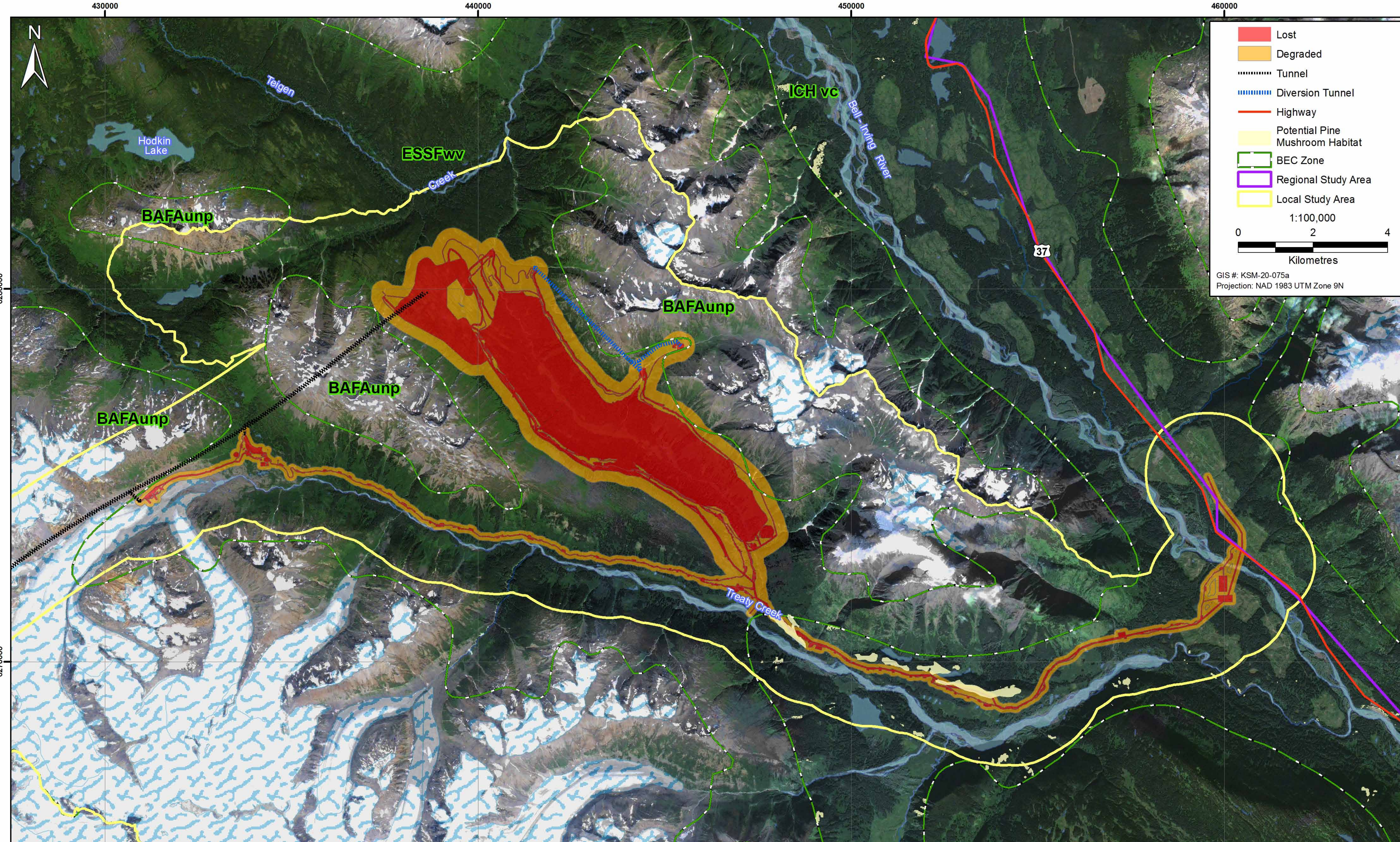

Figure 17.7-4a

Loss and Degradation - Potential Pine Mushroom Habitat: PTMA and Treaty Creek Access Road

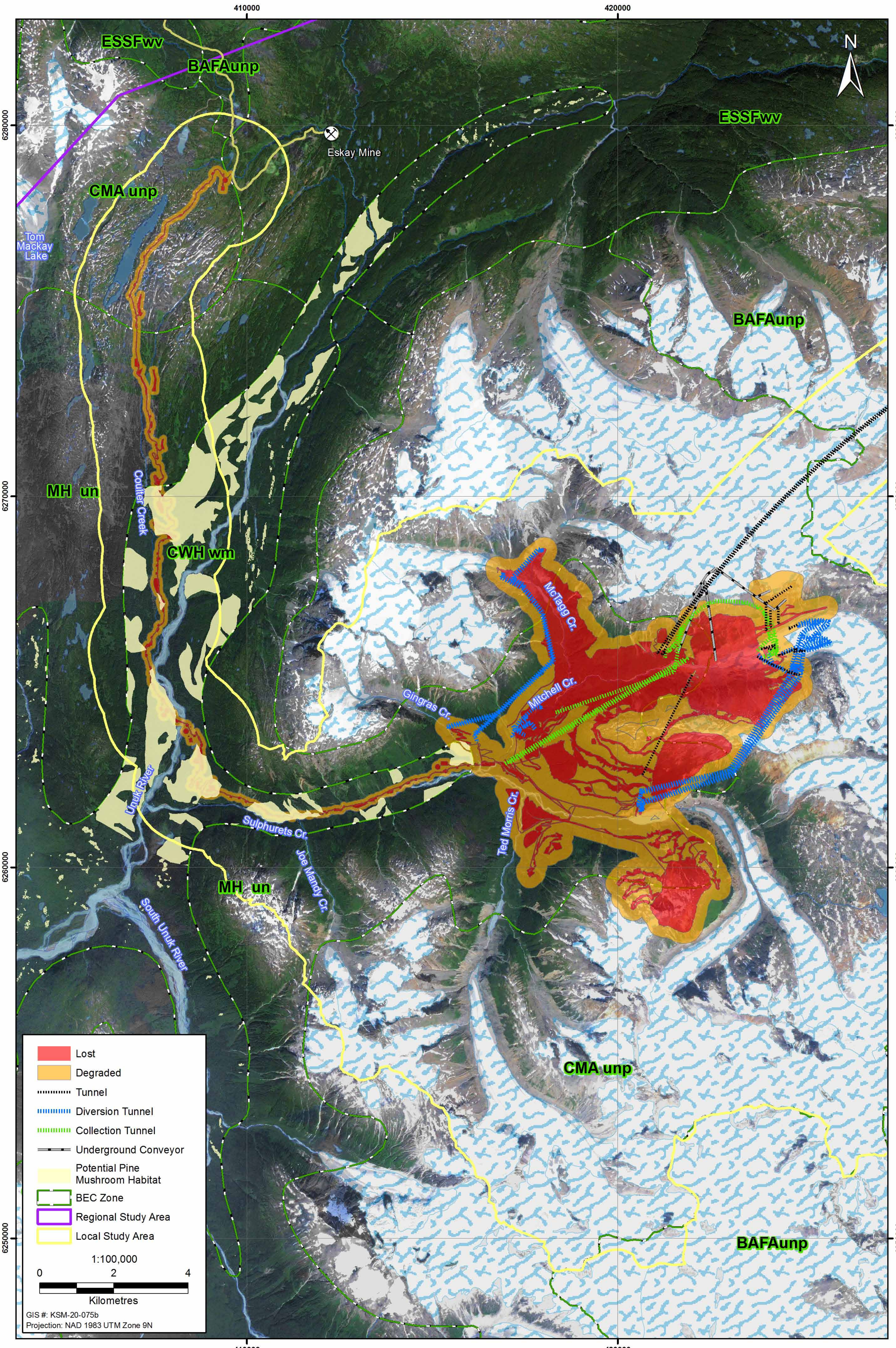

Figure 17.7-4b

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Loss and Degradation - Potential Pine Mushroom Habitat: Mine Site and Coulter Creek Access Road

Figure 17.7-4b

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Table 17.7-2. Summary of Potential Residual Effects on Terrestrial Ecosystem Valued Components from Vegetation Loss and Degradation

Valued Component (Effect)	Timing Start	Project Area(s)	Component(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Pine Mushroom Habitat (Vegetation Loss)	Construction Phase	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Access roads, creek crossing structures, bridges, waste areas, borrow areas, log landings	Loss of potential pine mushroom habitat	Management Practices, Reclamation	Adherence to the general management considerations within the Vegetation Clearing Management Plan (Chapter 26.20.1). Minimize clearing to the dimensions required; Preferentially retain mature and old trees, where option exists to clear younger stands.	Yes	Loss of potential pine mushroom habitat
		Camp 7: Unuk North Camp						
		Mitchell operating camp	Access road					
Pine Mushroom Habitat (Vegetation Degradation	Construction Phase	Project areas as above for vegetation loss	Project components as above for vegetation loss	Degradation of potential pine mushroom habitat	Management Practices, Monitoring and Adaptive Management, Reclamation	Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS (2010) Windthrow Manual; Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow
Avalanche Track Ecosystems (Vegetation Loss)	Construction Phase	Kerr Pit, Mitchell Pit and Mitchell Ore Preparation Complex	Access roads	Loss of avalanche track ecosystems	Management Practices, Reclamation	Pre-construction review of mapped avalanche polygons to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required	Yes	Loss of avalanche track ecosystems
		Water Storage Facility	Borrow pits, WSF Bypass Buried Pipeline, Water Storage Pond					
		Coulter Creek Access Corridor (within Sulphurets watershed)	Coulter Creek access road					
		Explosives Manufacturing Facility	Explosives road					
		Temporary Frank Mackie Glacier access route	Access route					
		North Cell Tailing Management Facility						
		East Catchment Diversion						
		Water Treatment and Energy Recovery Area	Penstock to WTP					
	Operation Phase	McTagg Rock Storage Facility	Access road, Rock Storage Facility					
		Mitchell Rock Storage Facility	Rock Storage Facility, north slope diversion ditch, access road					
		South Cell Tailing Management Facility						
Avalanche Track Ecosystems (Vegetation Degradation)	Construction Phase	Project areas as above for vegetation loss		Degradation of avalanche track ecosystems	Management Practices, Monitoring and Adaptive Management	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow (if adjacent to treed ecosystem)
Listed Ecosystems (Vegetation Loss)	Construction Phase	Coulter Creek Access Corridor; Treaty Creek Access Corridor		Loss of listed ecosystems	Management Practices, Reclamation	Pre-construction review of mapped and known listed ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required; Preferentially retain mature and old trees, where option exists to clear younger stands.	Yes	Loss of potential listed ecosystems
		Camp 7: Unuk North Camp						
		Camp 8: Unuk South Camp						
Listed Ecosystems (Vegetation Degradation	Construction Phase	Project areas as above for vegetation loss		Degradation of listed ecosystems	Management Practices, Monitoring and Adaptive Management	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS (2010) Windthrow Manual; Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow

(continued)

Table 17.7-2. Summary of Potential Residual Effects on Terrestrial Ecosystem Valued Components from Vegetation Loss and Degradation (continued)

Valued Component (Effect)	Timing Start	Project Area(s)	Component(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Riparian and Floodplain Ecosystems (Vegetation Loss)	Construction Phase	Access roads: Coulter Creek, Treaty Creek, Treaty Saddle, Sulphurets Valley, and explosives access roads	Bridges, creek crossings, borrow areas, waste areas and log landings	Loss of riparian and floodplain ecosystems	Management Practices, Reclamation	Pre-construction review of mapped riparian and floodplain ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Adhere to the legislated riparian reserve and/or management zone setbacks under FRPA; Minimize clearing to the dimensions required	Yes	Loss of riparian and floodplain ecosystems
		North, Centre and South Cell Tailing Management Facilities						
		Kerr, Sulphurets and Mitchell Pits						
		McTagg and Mitchell Rock Storage Facilities						
		Sulphurets laydown area						
		Water Storage Facility						
Riparian and Floodplain Ecosystems (Vegetation Degradation)	Construction Phase	Project areas as above for vegetation loss		Degradation of riparian and floodplain ecosystems	Management Practices, Monitoring and Adaptive Management	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS (2010) Windthrow Manual; Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow
Alpine and Parkland Ecosystems (Vegetation Loss)	Construction Phase	Camp 3: Eskay Staging Camp	Camp and associated infrastructure	Loss of alpine and parkland ecosystems	Management Practices	Pre-construction review of mapped alpine and parkland ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required; Use of low disturbance clearing methods, where feasible	Yes	Loss of alpine and parkland ecosystems
		Coulter Creek Access Corridor	Access road, creek crossing structures, bridges					
		Mitchell Rock Storage Facility						
		Mine Site Avalanche Control	Support Structure and access road					
		Kerr, Sulphurets and Mitchell Pits	Sulphurets access road, Kerr Pit access road, Mitchell Pit haul road, Kerr Pit Crusher					
		Sulphurets laydown area	Satellite Maintenance Facility					
		Temporary Frank Mackie Glacier access route	Temporary Frank Mackie Glacier access route					
		Construction Access Adit						
		Mitchell-Treaty Saddle Area						
		East Catchment Diversion						
		North, Centre and South Cell Tailing Management Facilities	North Cell Till Stockpile, Treaty Ore Preparation Complex Diversion, Water Supply Well access road, Southeast Diversion and service road					
	Operation Phase	McTagg Rock Storage Facility and Diversion Tunnels	Rock Storage Facilities, Phase 3 East and West Inlets and Dams, West McTagg Operation Channel					
		Kerr Rope Conveyor	Kerr Rope Conveyor					
Alpine and Parkland Ecosystems (Vegetation Degradation)	Construction Phase	Project areas as above for vegetation loss	Project components as above for vegetation loss	Degradation of alpine and parkland ecosystems	Management Practices	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition

(continued)

Table 17.7-2. Summary of Potential Residual Effects on Terrestrial Ecosystem Valued Components from Vegetation Loss and Degradation (completed)

Valued Component (Effect)	Timing Start	Project Area(s)	Component(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Old Forest Ecosystems (Vegetation Loss)	Construction Phase	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Access roads, creek crossing structures, bridges, waste areas, borrow areas, log landings	Loss of old forest ecosystems	Management Practices, Reclamation	Pre-construction review of mapped old forest ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required	Yes	Loss of old forest ecosystems
		Camp 7: Unuk North Camp						
		Mitchell operating camp						
		Explosives Manufacturing Facility	Explosives road					
		Camp 2: Ted Morris Camp						
		Sulphurets access road						
		Sulphurets laydown area						
		Water Treatment and Energy Recovery Area						
		Mitchell Rock Storage Facility						
		Water Storage Facility						
		North, Centre and South Cell Tailing Management Facilities						
		Saddle Dam, Splitter Dam, North Dam						
Old Forest Ecosystems (Vegetation Degradation)	Construction Phase	Project areas as above for vegetation loss	Project components as above for vegetation loss	Degradation of old forest ecosystems	Management Practices, Monitoring and Adaptive Management	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS (2010) Windthrow Manual; Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow
Other Terrestrial Ecosystems (Vegetation Loss)	Construction Phase	Most Project areas		Loss of other ecosystems	Management Practices, Reclamation	Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1). Minimize clearing to the dimensions required; Preferentially retain mature and old trees, where option exists to clear younger stands.	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow
Other Terrestrial Ecosystems (Vegetation Degradation)	Construction Phase	Most Project areas		Degradation of other ecosystems	Management Practices, Monitoring and Adaptive Management	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS (2010) Windthrow Manual; Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Yes	Potential for introduction and spread of invasive plant species, dust deposition, damage from windthrow

Table 17.7-3. Potential Pine Mushroom Habitat Lost at End of Operation – Local Study Area Assessment

Suitable BEC Units	Area Lost (Ha)	Baseline Area (Ha)	Portion (%) of Baseline Area Lost
CWHwm / ICHvc	65.8	1,112.7	5.9

Table 17.7-4. Potential Pine Mushroom Habitat Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
Upper Unuk River	Coulter Creek Access Corridor	42.9	1,302.8	3.3
Sulphurets Creek	Mine Site	13.1	256.5	5.1
Treaty Creek	Treaty Creek Access Corridor	9.8	152.9	6.4

17.7.1.4 Avalanche Track Ecosystems: Potential Residual Effects due to Vegetation Loss

Within the LSA, an estimated 670 ha of avalanche track ecosystems could be lost at the end of Project operation (Table 17.7-5), representing 13% of the baseline distribution. Most of the loss (63%) occurs within the Sulphurets Creek watershed (Table 17.7-6). Within this single watershed, there is an estimated loss of 27% of the baseline distribution, due primarily to loss of shrub (alder and willow)-dominated ecosystems within the MHmm2 BEC Variant. The majority of loss results from development of the McTagg and Mitchell Rock Storage Facilities (RSFs), Water Storage Facility, Mitchell Ore Preparation Complex, and the Mitchell and Kerr pits. Loss of avalanche ecosystems also results from development of the Coulter and Treaty Creek access roads and along access roads required for the Explosives Manufacturing Facility and Temporary Frank Mackie Glacier access route.

Table 17.7-5. Avalanche Track Ecosystems Lost at End of Operation – Local Study Area Assessment

BEC Unit / TEM Code	Ecosystem Name	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
MHmm2/51	Avalanche Track (Shrub)	422.7	1,244.7	34.0
ESSFwv/51	Avalanche Track (Shrub)	203.1	1,472.3	13.8
CMAunp/51	Avalanche Track (Shrub)	31.0	238.1	13.0
CWHwm/51	Avalanche Track (Shrub)	5.9	200.7	2.9
ICHvc/51	Avalanche Track (Shrub)	5.2	76.0	6.8
ICHvc/VG	Avalanche Track (Valerian – Arrow-leaved groundsel)	1.3	36.3	3.6
ESSFwv/VG	Avalanche Track (Valerian – Arrow-leaved groundsel)	1.0	50.4	2.0
BAFAunp/51	Avalanche Track (Shrub)	0.7	16.8	4.2
Total		**670.9**	**5,097.4**	**13.2**

Table 17.7-6. Avalanche Track Ecosystems Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
Sulphurets	Mine Site	456.9	1,695.2	27.0
Treaty	Treaty Creek Access Corridor (incl. Treaty Saddle road), South Cell TMF	179.7	4,078.4	4.4
Teigen	North Cell TMF	33.9	3,943.2	0.9
Upper Unuk	n/a	0.0	1,746.7	0.0

Within the Treaty Creek valley, the majority of loss will result from development of the Treaty Saddle road, with smaller losses on the west-facing slopes above the TMF North and South cells, including the East Catchment Diversion (Figures 17.7-5a and 17.7-5b). Most of this loss occurs from shrub (alder and willow)-dominated ecosystems within the ESSFwv BEC Subzone. As the restoration of avalanche ecosystems is not an objective within the Closure Plan (Ch. 27), vegetation loss within these ecosystems will continue through the post-closure phase.

17.7.1.5 Listed Ecosystems: Identification of Potential Residual Effects due to Vegetation Loss

Vegetation loss could affect 8 of the 12 listed ecosystems mapped or predicted in the LSA by the end of the operation phase, with nearly 36 ha lost (Table 17.7-7) during the construction phase, totalling 4.2% of the baseline distribution. Most of the ecosystems affected are located in the Bell-Irving, Treaty Creek, and Coulter Creek watersheds (Figures 17.7-6a and 17.7-6b, Table 17.7-8) and are associated with proposed access roads. Proposed infrastructure associated with Camps 7 and 8, and Unuk North and South camps, also overlap areas mapped as listed ecosystems.

Table 17.7-7. Listed Ecosystems Lost at End of Operation – Local Study Area Assessment

BEC Unit/Site Series (TEM Code)	General Ecosystem Type	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
ICHvc/05 (CD)	Floodplain Forest	12.5	228.3	5.5
ICHvc/00 (52)	Wetland Shrub/Herb	7.1	182.8	3.9
CWHwm/02 (HM)	Drier Forest	7.0	79.9	8.7
CWHwm/05 (SS)	Floodplain Forest	6.4	213.4	3.0
ICHvc/00 (Wf51)	Wetland Shrub/Herb	1.4	53.6	2.6
ICHvc/00 (Fl01)	Wetland Shrub/Herb (Floodplain)	0.6	7.8	7.7
CWHwm/06 (CD)	Floodplain Forest	0.6	29.2	2.1
CWHwm/09 (SC)	Wetland Forest (Riparian)	0.01	14.0	0.07
CWHwm/08 (HS)	Wetter Forest	0.0	2.0	0.0
CWHwm/00 (Wf)	Wetland Shrub/Herb	0.0	0.02	0.0
ICHvc/00 (Fm03)	Floodplain Forest	0.0	39.5	0.0
ESSFwv/00 (Fm03)	Floodplain Forest	0.0	26.0	0.0
Total		**35.6**	**876.5**	**4.1**

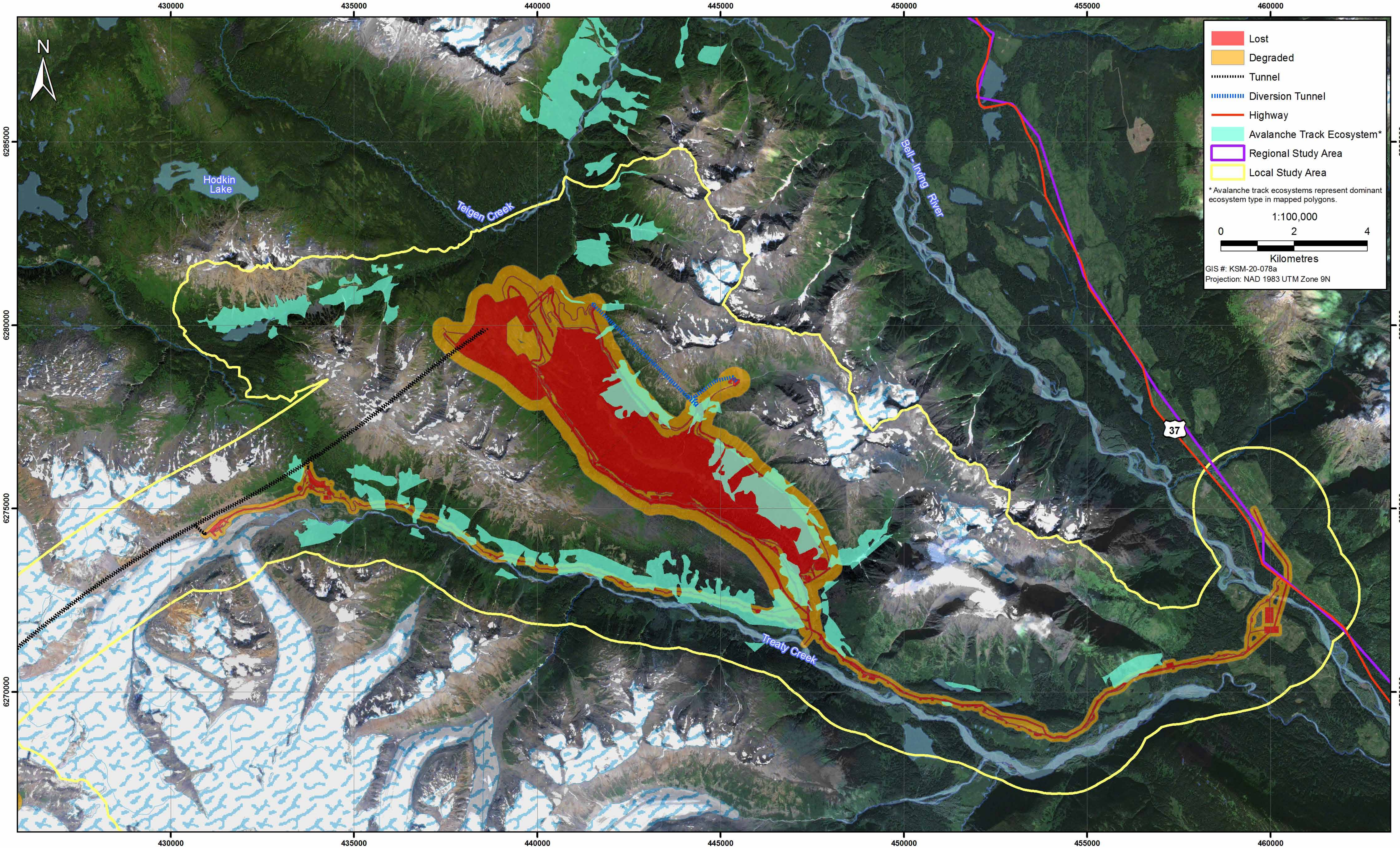

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Figure 17.7-5a

Loss and Degradation - Avalanche Track Ecosystems: PTMA and Treaty Creek Access Road

PROJECT # 868-016-28 GIS No. KSM-20-078b_T December 11, 2012

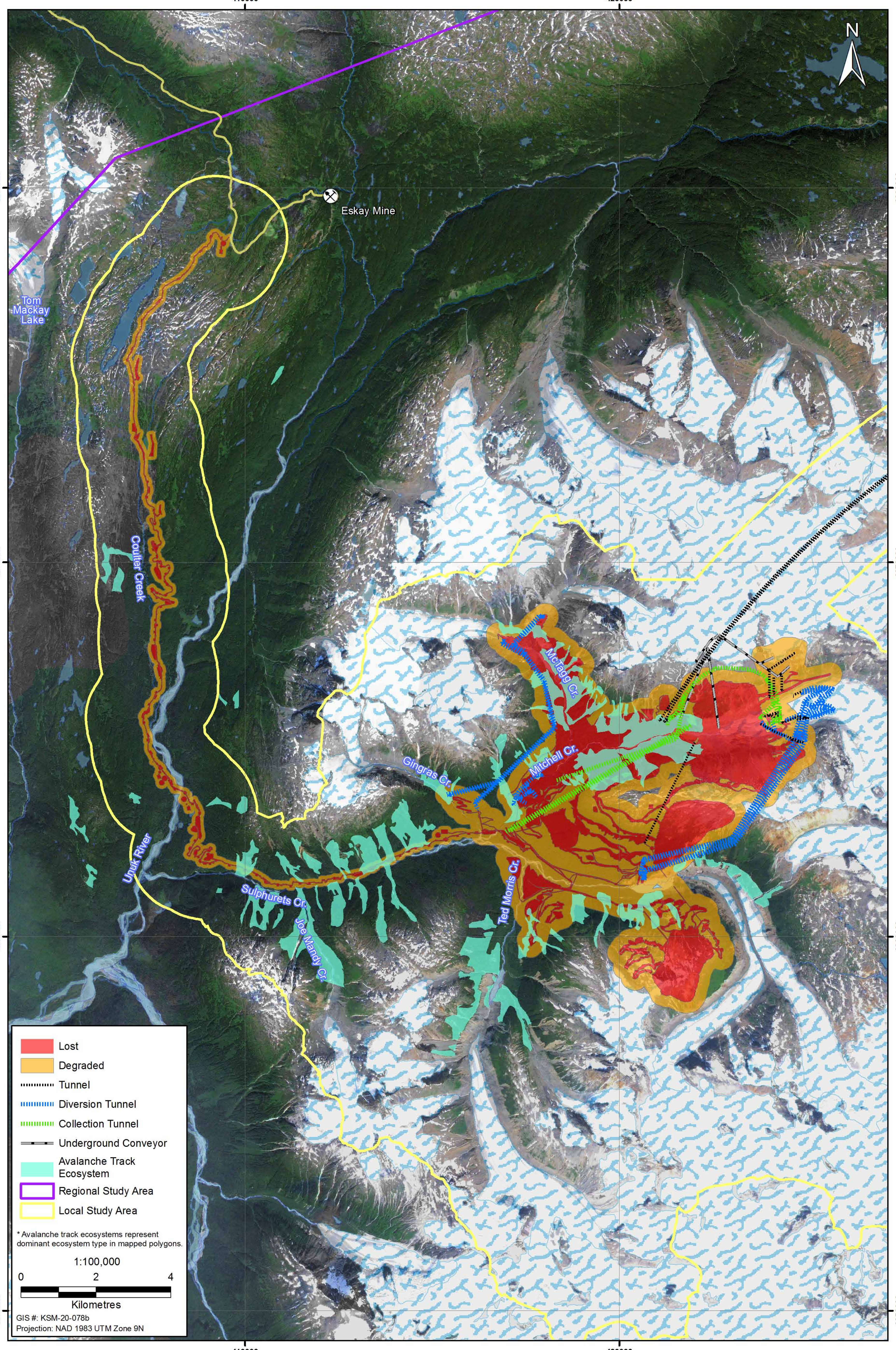

Figure 17.7-5b

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Loss and Degradation - Avalanche Track Ecosystems: Mine Site and Coulter Creek Access Road

Figure 17.7-5b

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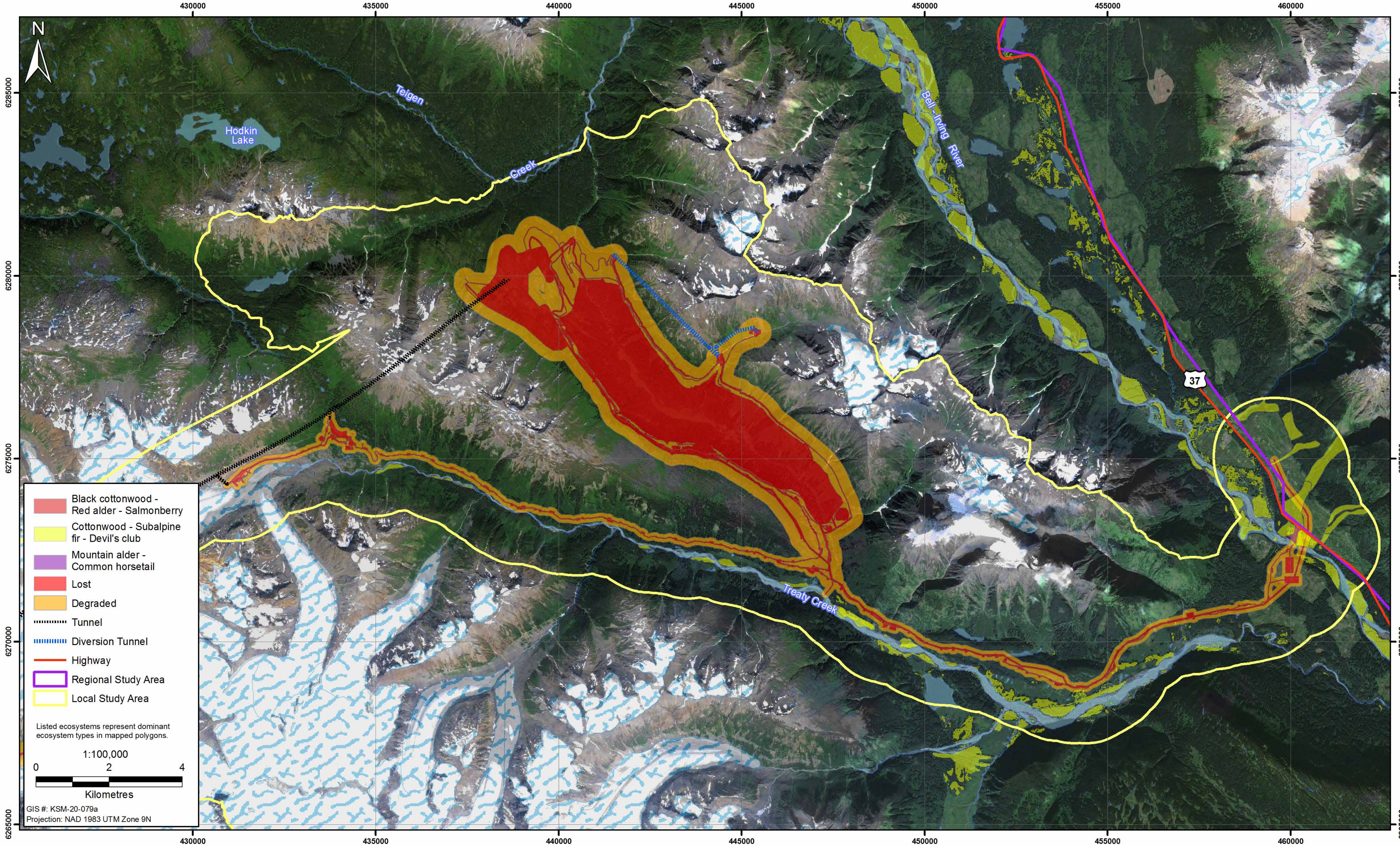

Figure 17.7-6a

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Loss and Degradation - Listed Ecosystems: PTMA and Treaty Creek Access Road

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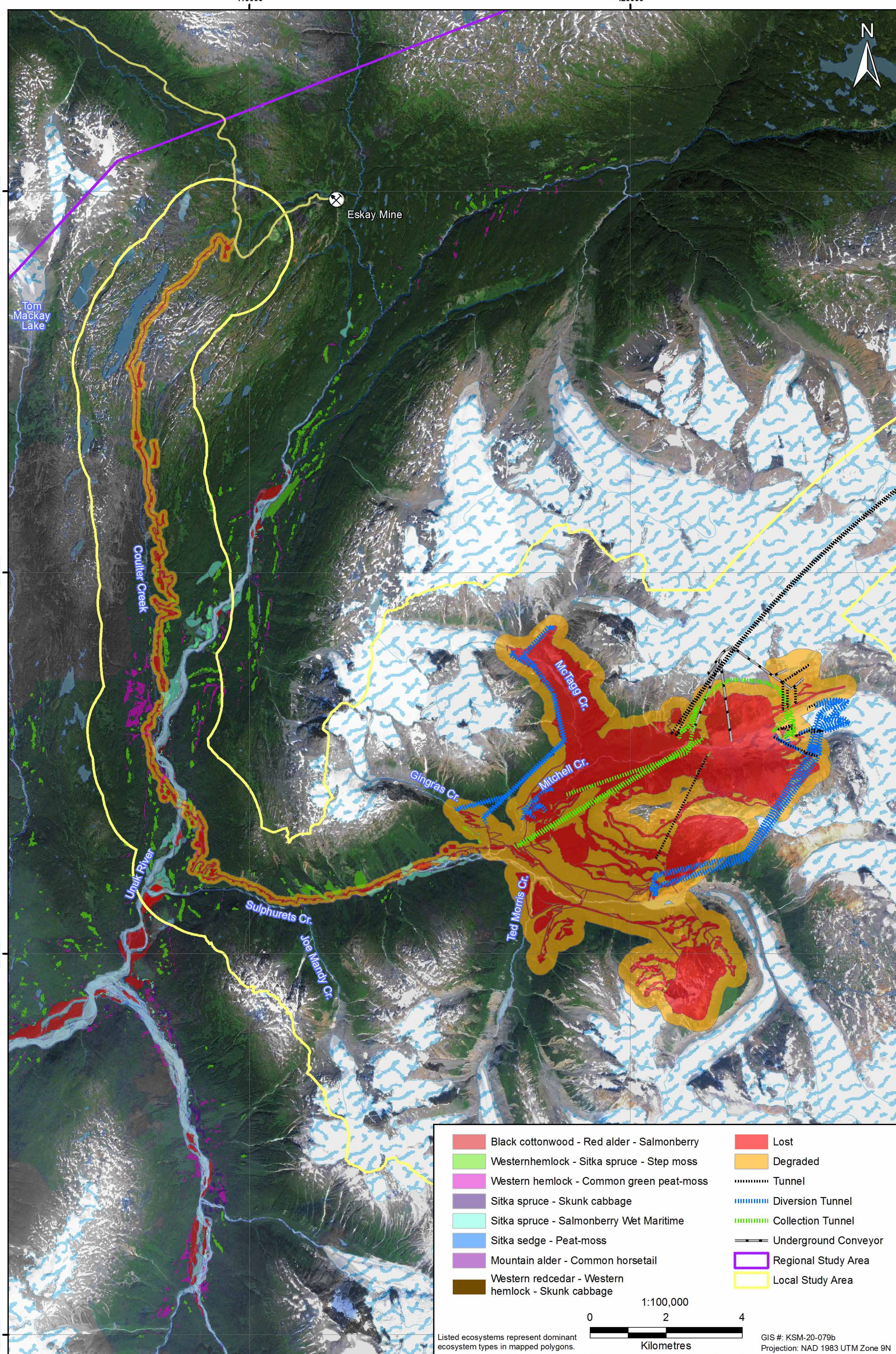

Figure 17.7-6b

Loss and Degradation - Listed Ecosystems: Mine Site and Coulter Creek Access Road

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Table 17.7-8. Listed Ecosystems Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)[1]	Portion (%) of Baseline Area Lost
Treaty	Treaty Creek Access Corridor	7.7	507.4 (263.2)	1.5
Sulphurets	Coulter Creek Access Corridor	7.3	163.6 (163.6)	4.5
Upper Unuk	Coulter Creek Access Corridor	6.8	380.2 (284.2)	1.8
Bell-Irving	Treaty Creek Access Corridor	13.9	n/a[2]	n/a
Teigen	n/a	0.0	246.9 (197.0)	0.0

[1] **PEM data combines CWHwm units (CD/CW and SC/LS) - TEM contributions within parentheses.**
[2] **Baseline ecosystem mapping data not available for the Bell-Irving River watershed.**

Approximately 17 ha (21%) of the listed ecosystems occur in areas with prescribed reclamation. However, as listed ecosystems often represent the late seral (old forest) condition and may be adapted to very particular environmental conditions, such as recurring flooding, which reclamation efforts may not achieve, reclamation will not be considered a possible mitigation, and residual vegetation loss is expected.

17.7.1.6 Riparian and Floodplain Ecosystems (Non-listed): Identification of Potential Residual Effects due to Vegetation Loss

Within the LSA, approximately 550 ha of riparian and floodplain vegetation could be lost by the end of the operation phase (Table 17.7-9; Figures 17.7-7a and 17.7-7b), 15% of the baseline distribution. The majority (87%) of loss is expected within the Teigen and Treaty Creek watersheds (Table 17.7-10) from development of the proposed TMF.

The majority of loss at the Mine Site is expected along the Mitchell and McTagg creeks, within the Sulphurets Creek watershed, from development of the rock storage facilities and diversion of water to the Water Storage Facility and Water Treatment Plant. The riparian systems at these locations do not provide the same habitat function and values as those in the Teigen and Treaty watersheds, as fish are absent. Most of the riparian and floodplain ecosystems occurring within the CWHwm subzone are previously assessed as listed ecosystems.

Figures 17.7-7a and 7b depict 30 m buffers on either side of all creek and river features (total of 1,775 ha), consistent with the riparian zone width within the Fish and Fish Habitat Effects Assessment (Chapter 15). Table 17.7-9 summarizes the areas within the buffers that are mapped as riparian and floodplain ecosystems. TEM polygons are typically delineated at a scale that does not allow for the identification of small linear riparian habitats. Applying a 30 m buffer on all creeks and water features could overestimate the extent of riparian ecosystems, especially on steep or gullied slopes, which can constrain riparian habitat to a narrow channel or gully.

The larger linear developments that will cross streams and rivers, thereby resulting in loss of riparian vegetation, include the Coulter Creek access road; the Treaty Creek access road, Treaty Saddle road, and transmission line; the Sulphurets Valley and explosives access roads; and the Temporary Frank Mackie Glacier access route. The development of smaller roads to access other infrastructure could result in additional loss.

Table 17.7-9. Riparian and Floodplain Ecosystems (Non-listed) Lost at End of Operation – Local Study Area Assessment

BEC Unit / Site Series (TEM Code)	Riparian Type	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
ESSFwv/06 (FD)	Forested (Riparian)	267.4	1,175.1	22.8
ESSFwv/07 (FV)	Forested (Riparian)	155.0	856.8	18.1
MHmm2/07 (YH)	Forested (Riparian)	36.9	370.9	9.9
ESSFwv/09 (FL)	Forested (Riparian)	27.0	71.8	37.6
ESSFwv/00 (FP)	Floodplain (generic unit)	19.1	110.4	17.3
ICHvc/04 (DD)	Forested Floodplain (non-listed)	13.5	228.8[1]	5.9
MHmm2/06 (MD)	Forested (Riparian)	9.7	191.2	5.1
MHmm2/00 (FP)	Floodplain (generic unit)	7.3	39.8	18.3
ICHvc/06 (SH)	Forested (Riparian)	1.5	56.3	2.7
CWHwm/07 (CW)	Forested Floodplain (non-listed)	0.4	47.6	0.8
MHmm2/09 (YC)	Forested (Riparian)	0.0	13.9	0.0
CMAunp (FP)	Floodplain (generic unit)	0.0	4.1	0.0
Total (Non-listed) Riparian / Floodplain Units		**537.8**	**3,166.6**	**17.0**
Sum of Listed Riparian and Floodplain Units[2]		11.4	532.2	2.1
Total Riparian / Floodplain Units		**549.2**	**3,698.8**	**14.8**

[1] Based only on TEM data, as the PEM model grouped this ecosystem with another.
[2] Results from Section 17.7.1.5.

Table 17.7-10. Riparian and Floodplain Ecosystems (Non-listed) Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
Teigen	North Cell TMF	266.0	2,585.0 (2,244)	10.3
Treaty	South Cell TMF, Treaty Creek access road and Treaty Saddle road	210.1	1,485.0 (812)	14.1
Sulphurets	Mine Site	54.4	424.8 (424)	12.8
Upper Unuk	Coulter Creek access road	0.2	1,985.1 (1,364)	0.005
Bell-Irving[2]	Treaty Creek access road	7.4	n/a[1]	n/a[1]

[1] TEM contribution within parentheses.
[2] Baseline ecosystem mapping data not available for Bell-Irving watershed.

The reclamation of vegetated ecosystems will ultimately be guided by the objectives for wildlife habitat and will not attempt to restore vegetation communities to baseline conditions. Although wildlife management objectives include the restoration of riparian habitat within the PTMA at closure (Chapter 27), it is expected that reclaimed areas may be drier than the baseline condition due to the endemic coarse fragment content of subsoils within the area. Reclamation objectives within the Mine Site do not include restoration of riparian habitat and therefore, losses during construction and operation will continue through to closure.

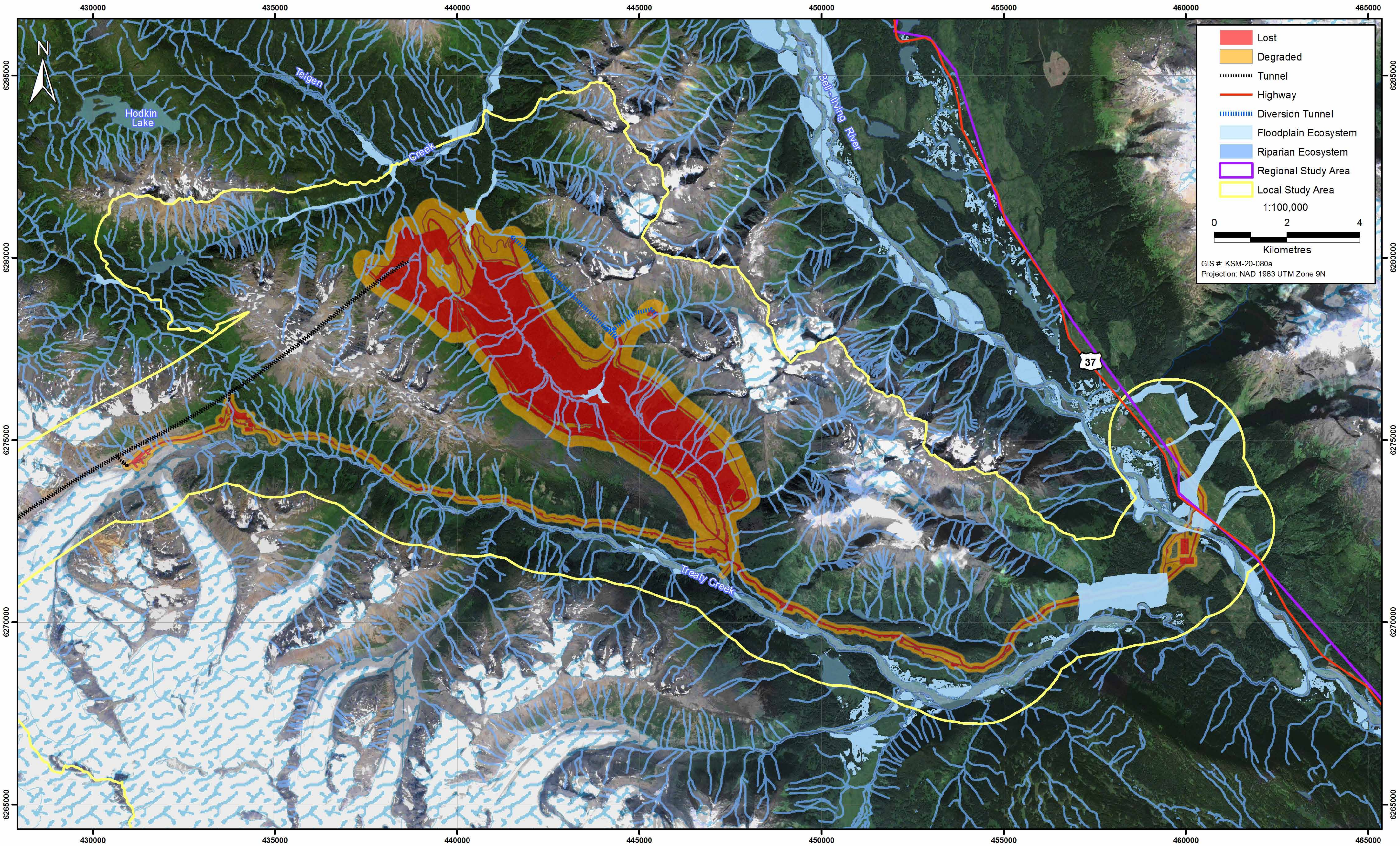

Figure 17.7-7a

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Loss and Degradation - Riparian and Floodplain Ecosystems: PTMA and Treaty Creek Access Road

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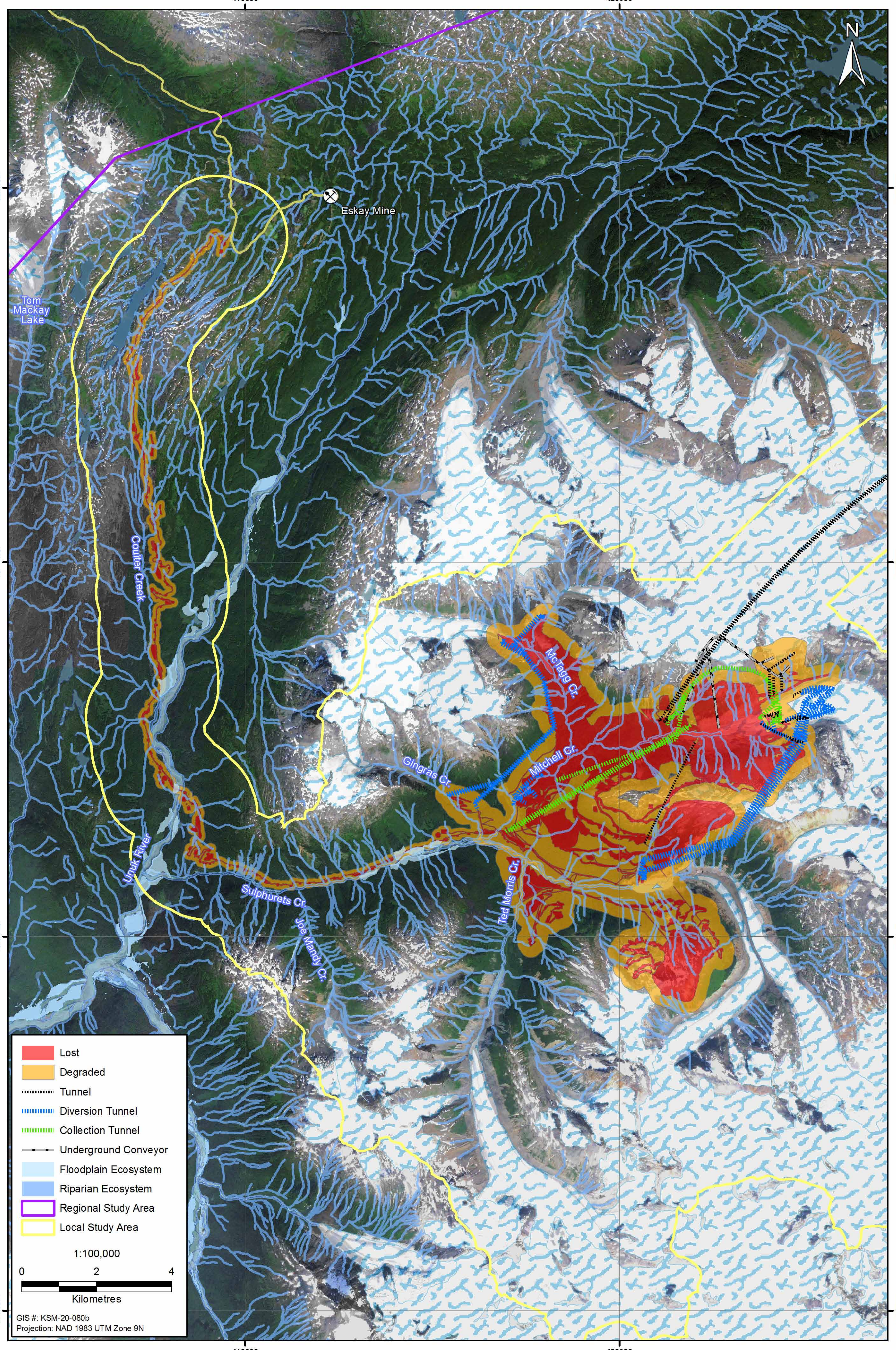

Figure 17.7-7b

Loss and Degradation - Riparian and Floodplain Ecosystems: Mine Site and Coulter Creek Access Road

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Some lost riparian habitat along fish-bearing streams will be compensated, as described within the Fish Habitat Compensation Plans (Appendices 15-Q and 15-R). However, this plan will also necessitate removal of small areas of riparian habitat in itself (e.g., for construction of new channels) and does not account for lost riparian habitat along non-fish bearing streams. The amount of riparian vegetation removed will be very small relative to the amount created, however.

Described in Appendix 16-B, the Wetland Habitat Compensation Plan details the process of compensating the lost wetland area resulting from development of the PTMA of the proposed Project.

As not all of the riparian and floodplain vegetation loss can be mitigated, residual vegetation loss is expected.

17.7.1.7 Alpine and Parkland Ecosystems: Identification of Potential Residual Effects due to Vegetation Loss

Within the LSA, an estimated 411 ha of vegetated alpine and parkland ecosystems could be lost (Table 17.7-11), totalling 5% of the mapped baseline distribution. Often mapped within the lower elevation ESSF and MH BEC zones in TEM projects, the following five ecosystems are included as alpine and parkland ecosystems in the assessment, reflecting the impact of cold air influence in ecosystem development: MP (Mountain-heather Heath), PK (Parkland Forest), KH (Krummholz), CG (Cryptogram – Altai fescue), and FC (Fescue – Lichen). These ecosystems account for a large proportion of the respective ecosystem losses within the MH and ESSF BEC zones. Although no distinction is made between alpine and parkland ecosystems within this assessment, the Parkland Forest (PK) ecosystem represents the patchy treed ecosystem typically associated with high elevation, subalpine areas.

Table 17.7-11. Alpine / Parkland Ecosystems Lost at End of Operation – Local Study Area Assessment

Ecosystem Type (TEM Code)	General Ecosystem Type	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
Mountain-heather Heath (MP)	Mesic Shrub / Herb	163.2[1]	2,125.0	7.7
Krummholz (KH)	Parkland Forest / Krummholz	114.4[1]	2,236.6	5.1
Herbaceous Meadow (AM)	Mesic Herb (Meadow)	57.1	1,302.1	4.4
Cryptogram – Altai fescue (CG)	Drier Herb	32.9[1]	548.7	6.0
Willow Thicket (WT)	Wetter Shrub / Herb	21.7	151.4	14.3
Parkland Forest (PK)	Parkland Forest / Krummholz	13.2[1]	684.1	1.9
Fescue – Lichen (FC)	Drier Herb	8.6[1]	845.6	1.0
Wetland – Fen (Wf)	Wetland Shrub / Herb	0.3	114.5	0.3
Total		**411.4**	**8,008.0**	**5.1**

[1] Includes areas mapped within MH and ESSF BEC zones.

The loss of alpine and parkland ecosystems will occur primarily within the Sulphurets Creek watershed (Table 17.7-12) from development of the proposed Mine Site infrastructure including the Mitchell, Sulphurets, and Kerr pits and the McTagg and Mitchell RSFs. Within the Sulphurets Creek watershed, representing the majority of expected ecosystem loss, an estimated 11.5% of baseline alpine and parkland ecosystems will be lost (Table 17.7-12).

Table 17.7-12. Alpine and Parkland Ecosystems Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Lost
Sulphurets	Mine Site	394.9	3,441.2	11.5
Teigen	PTMA	5.5	3,608.5	0.2
Treaty	Treaty Saddle Area	3.2	2,419.3	0.1
Upper Unuk	Coulter Creek Access Corridor	7.8	5,900.1	0.1

The majority of alpine and parkland ecosystem loss within the proposed PTMA occurs within the Mitchell-Treaty Twinned Tunnels Saddle Area (Figures 17.7-8a and 17.7-8b). Smaller losses are expected from development of the northern portion of the Coulter Creek Access Corridor (east side of Tom McKay Lake).

As neither reclamation nor re-vegetation activities are proposed within alpine and parkland elevations, residual vegetation loss resulting from the construction and operation phases is expected to continue to post-closure.

17.7.1.8 Old Forest Ecosystems: Identification of Potential Residual Effects due to Vegetation Loss

Estimates of old forest loss, based upon the TEM polygons mapped as structural stage 7, are provided within Table 17.7-13 and depicted in Figures 17.7-9a and 17.7-9b. Approximately 345 ha of old forest could be lost, representing 17% of the mapped baseline distribution within the LSA.

Table 17.7-13. Old Forest Ecosystems (TEM Data) Lost at End of Operation – Local Study Area Assessment

Structural Stage	Area Lost (ha)	Baseline Area (ha)	Portion (%) of TEM Baseline Area Lost
7 (Old Forest)	345.4	2,049.7[1]	16.9

[1] **TEM contribution only; PEM combines structural stages 6 (mature forest) and 7 (old forest) into a single map entity.**

The majority of old forest loss (214 ha) is expected within the Sulphurets Creek watershed, representing a loss of 34% of the baseline distribution within this watershed (Table 17.7-14). Smaller losses are expected within the other watersheds, with nearly equal area losses expected within the Teigen and Treaty Creek watersheds. Estimated percentage losses within these two watersheds are 18 and 25% of baseline distributions, respectively.

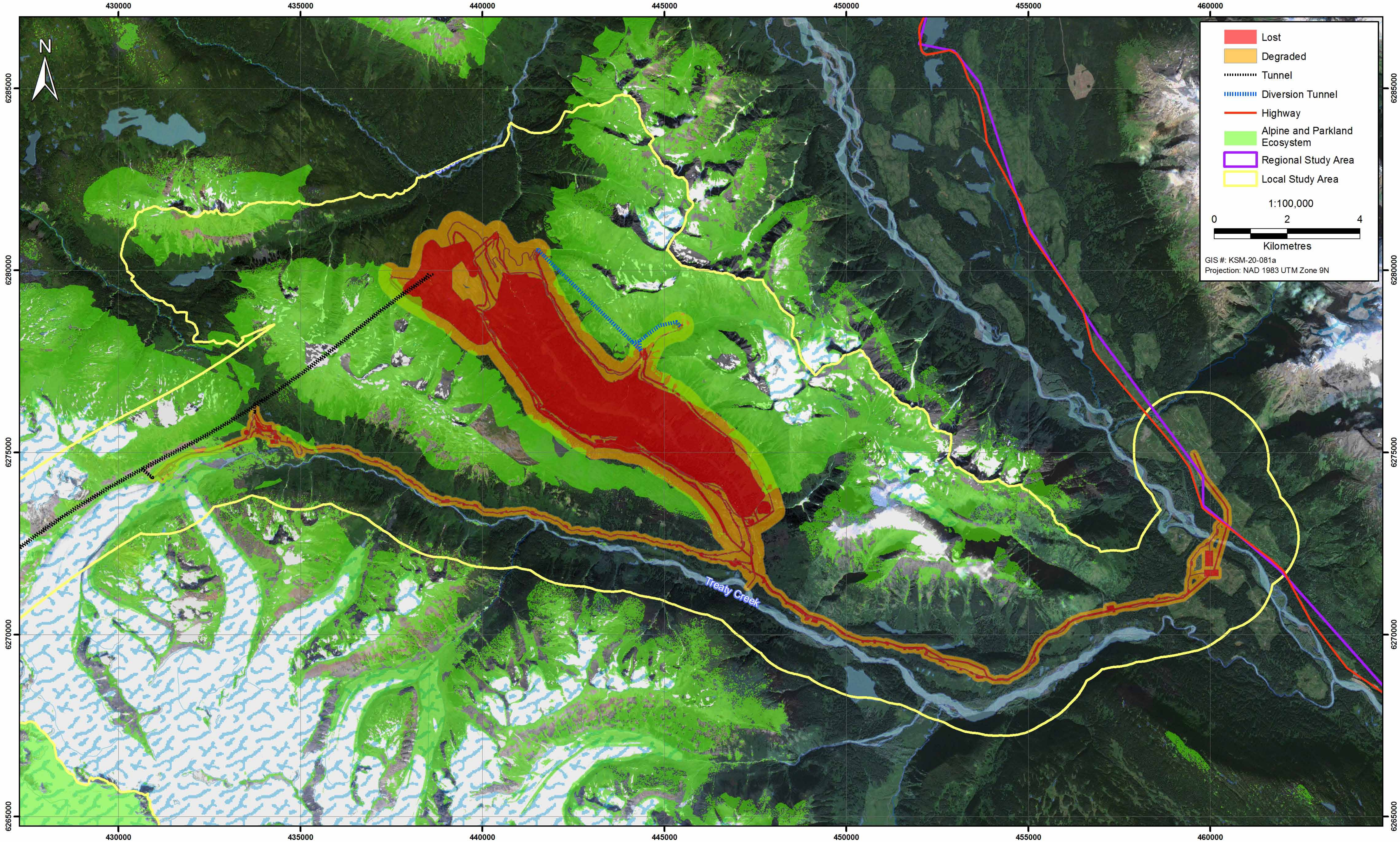

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Figure 17.7-8a

Loss and Degradation - Alpine and Parkland Ecosystems: PTMA and Treaty Creek Access Road

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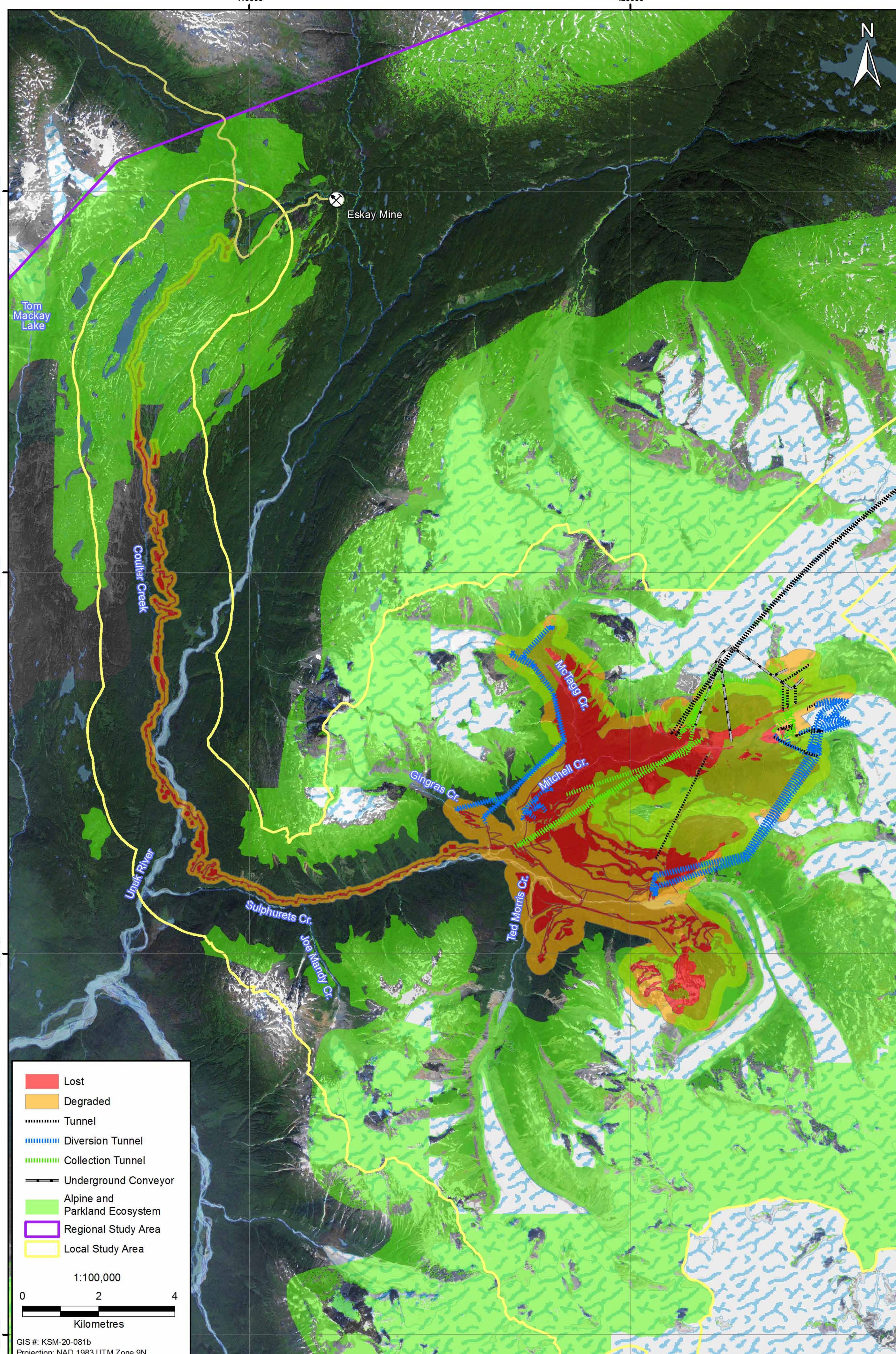

Figure 17.7-8b

Loss and Degradation - Alpine and Parkland Ecosystems: Mine Site and Coulter Creek Access Road

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Figure 17.7-8b

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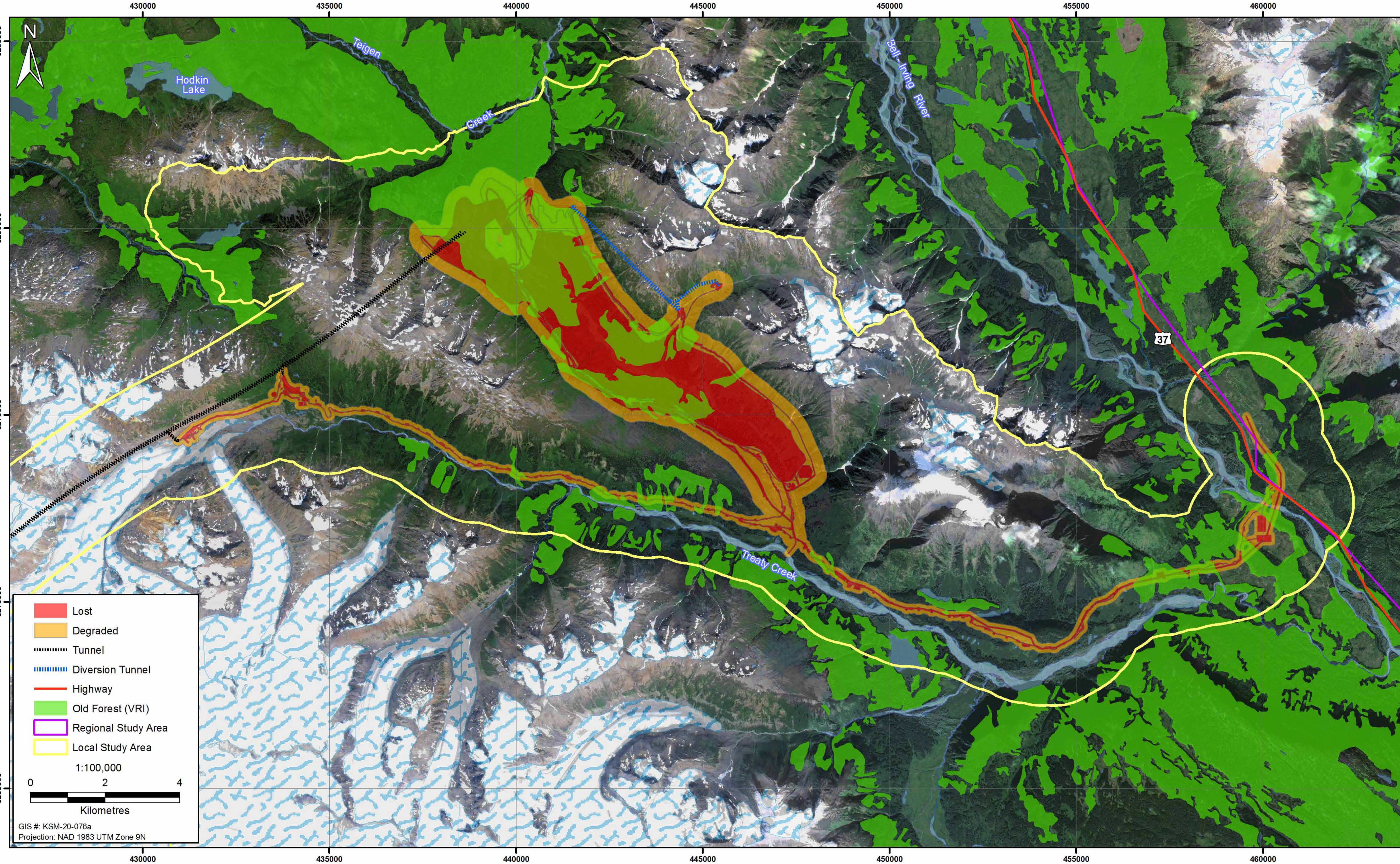

Figure 17.7-9a

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Loss and Degradation - Old Forest Ecosystems (TEM): PTMA and Treaty Creek Access Road

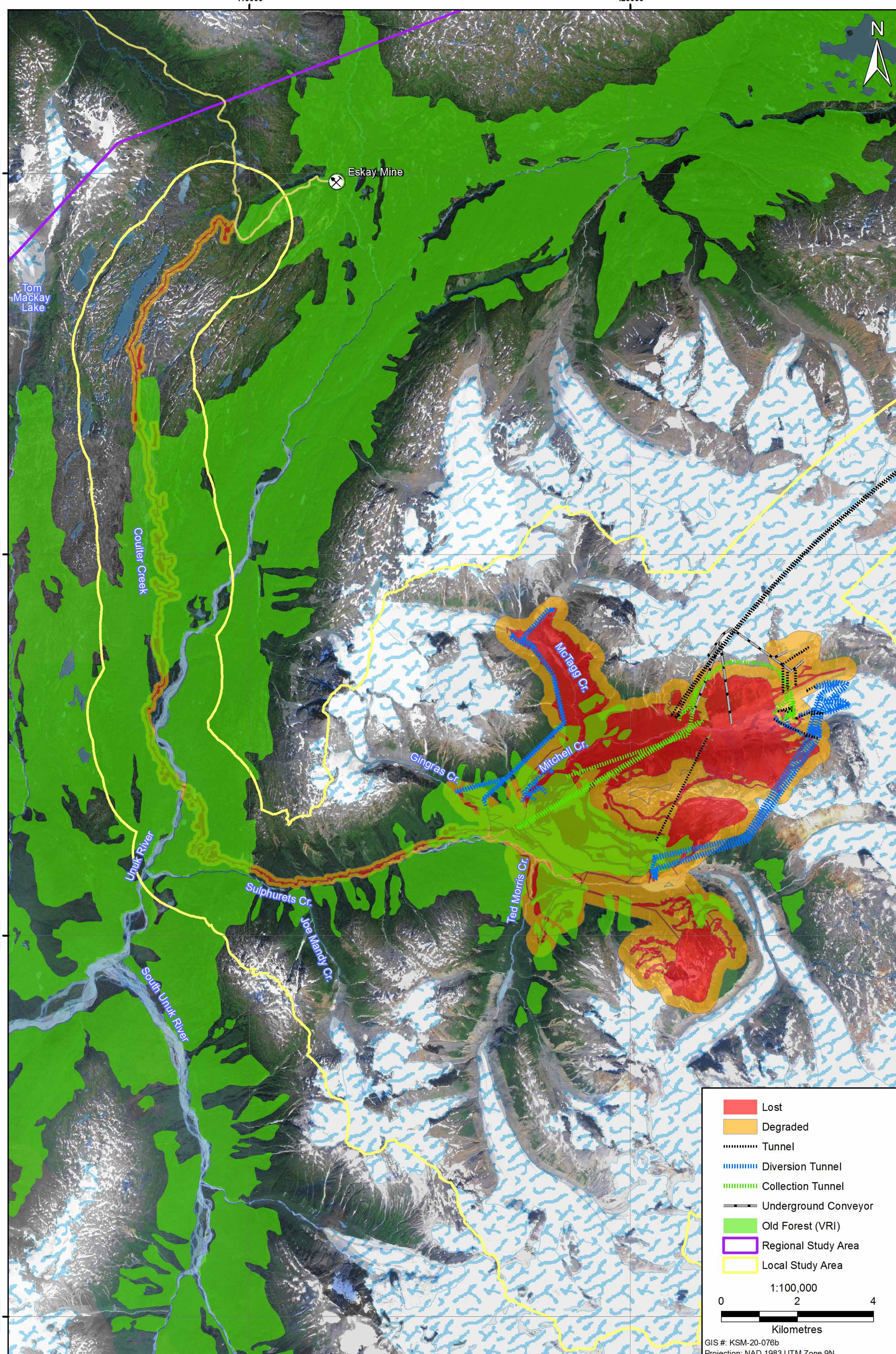

Figure 17.7-9b

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Loss and Degradation - Old Forest Ecosystems (TEM): Mine Site and Coulter Creek Access Road

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Table 17.7-14. Old Forest Ecosystems (TEM Data) Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)[1]	Portion (%) of TEM Baseline Area Lost
Sulphurets	Mine Site	214.0	612.2	34.9
Teigen	TMF	45.7	250.3	18.3
Treaty	TMF, Treaty Creek access road	44.5	179.6	24.8
Upper Unuk	Coulter Creek Access Corridor	28.3	1,078.8	2.6
Bell-Irving[2]	Treaty Creek access road	12.9	n/a	n/a

[1] TEM contribution used for percentage loss estimate.
[2] Baseline ecosystem mapping data not available for Bell-Irving watershed.

TEM-derived results were compared with the old forest information derived from the provincial Vegetation Resources Inventory (VRI) database, which is administered and updated by the Ministry of Forests, Lands and Natural Resource Operations. Having a provincial inventory program that is routinely updated to reflect changes due to harvesting, fire or other catastrophic events enables an independent estimate of old forest ecosystems within the Project area. Although the assessment is based upon the data of most local relevance (TEM), VRI data is included to ensure that other available forest inventory data is recognized and assessed. Within the VRI database, old forest was assumed where the projected age attribute exceeded 250 years. PEM data were not used as a comparison as PEM groups structural stages 6 (mature forest) and 7 (old forest) into a single map entity.

The VRI-derived estimates of old forest loss are provided within Table 17.7-15. The baseline area and loss estimates are much higher than those estimated by the TEM mapping. The VRI data yields an estimated 1,341 ha of old forest loss, representing 12% of the mapped baseline distribution.

Table 17.7-15. Old Forest Ecosystems (VRI Data) Lost at End of Operation – Local Study Area Assessment

Projected Forest Age	Area Lost (ha)	Baseline Area (ha)	Portion (%) of VRI Baseline Area Lost
> 250 years	1,341.3	10,971.5	12.2

In contrast to the TEM results, with the majority of loss estimated within the Sulphurets watershed, the majority of VRI old forest loss (710 ha) is expected within the Teigen Creek watershed, representing a loss of nearly 8% of the baseline distribution (Table 17.7-16). Within the Sulphurets Creek watershed, approximately 470 ha could be lost, representing 17% of the baseline distribution. Much smaller losses are estimated within the Treaty Creek and upper Unuk River watersheds, with percentage losses of 2 and 0.2% of baseline distributions, respectively.

Despite large area (ha) and percentage loss differences at the watershed level when assessing the TEM-derived (Table 17.7-14) versus VRI-derived estimates (Table 17.7-16), the majority of old forest loss in each data set is estimated within the Sulphurets and Teigen Creek watersheds.

Table 17.7-16. Old Forest Ecosystems (VRI Data) Lost at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Lost (ha)	Baseline Area (ha)	Portion (%) of VRI Baseline Area Lost
Teigen	PTMA	709.8	9,345.4	7.6
Sulphurets	Mine Site	469.5	2,738.6	17.1
Treaty	PTMA, Treaty Creek Access Corridor	117.5	5,297.0	2.2
Upper Unuk	Coulter Creek Access Corridor	35.7	15,149.8	0.2

The reclamation of vegetated ecosystems will ultimately be guided by the objectives for wildlife habitat, and reclamation efforts will not attempt to restore vegetation communities to baseline conditions. Although wildlife management objectives include the restoration of forest within portions of the McTagg RSF, Mitchell RSF, and the TMF at closure (Chapter 27), restoration of old forests in reclaimed areas could take hundreds of years and will not reflect the baseline conditions during the Project life.

Residual loss of old forest resulting from the construction and operation phases will continue through to post-closure.

17.7.1.9 Other Terrestrial Ecosystems: Identification of Potential Residual Effects due to Vegetation Loss

Within the LSA, an estimated 1,715 ha of other terrestrial ecosystems could be lost (Table 17.7-17; Figures 17.7-10a and 17.7-10b) during construction and operation of the KSM Project, totalling 11% of the baseline distribution. The majority of loss is expected within the Mesic Forest General Ecosystem Type within the Sulphurets, Teigen, and Treaty Creek watersheds. Estimated losses are largest within the MH and ESSF BEC zones, where the majority of Mine Site and PTMA infrastructure is proposed.

In the Sulphurets Creek watershed, the majority of loss is expected within forested ecosystems in the MHmm2 BEC variant. Smaller losses will occur along lower Sulphurets Creek, within the CWHwm BEC subzone. In the Teigen Creek watershed, the majority of loss will occur from forests within the ESSFwv BEC subzone. In the Treaty Creek watershed, loss will occur from forests within the ESSFwv and ICHvc BEC subzones.

The reclamation of vegetated ecosystems will ultimately be guided by the objectives for wildlife habitat and does not include restoration of terrestrial ecosystems to baseline conditions. As wildlife management objectives include the restoration of some vegetated habitat, but not all, within portions of the Mine Site and PTMA at closure (Chapter 27), residual vegetation loss is expected.

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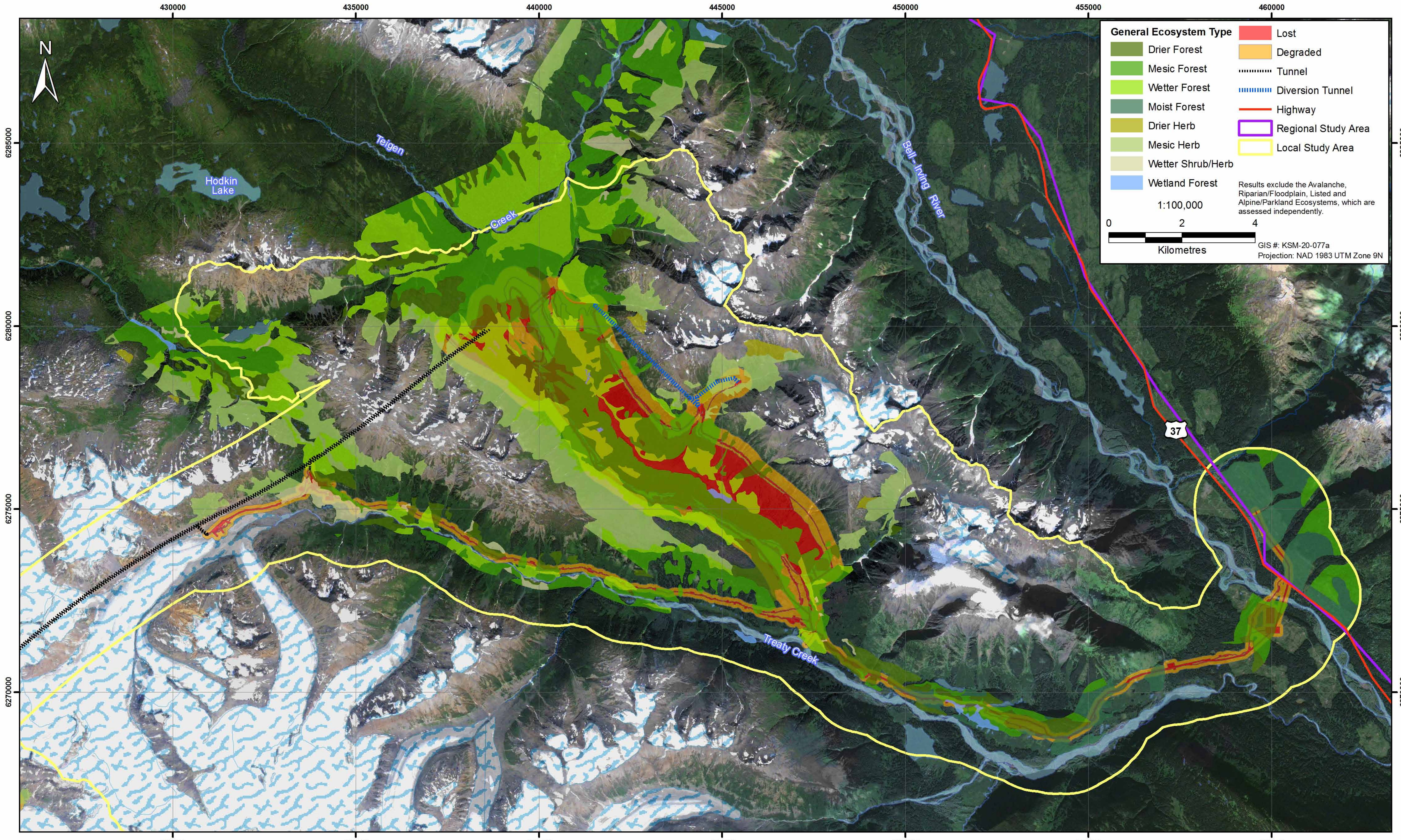

Figure 17.7-10a

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Loss and Degradation - Other Terrestrial Ecosystems: PTMA and Treaty Creek Access Road

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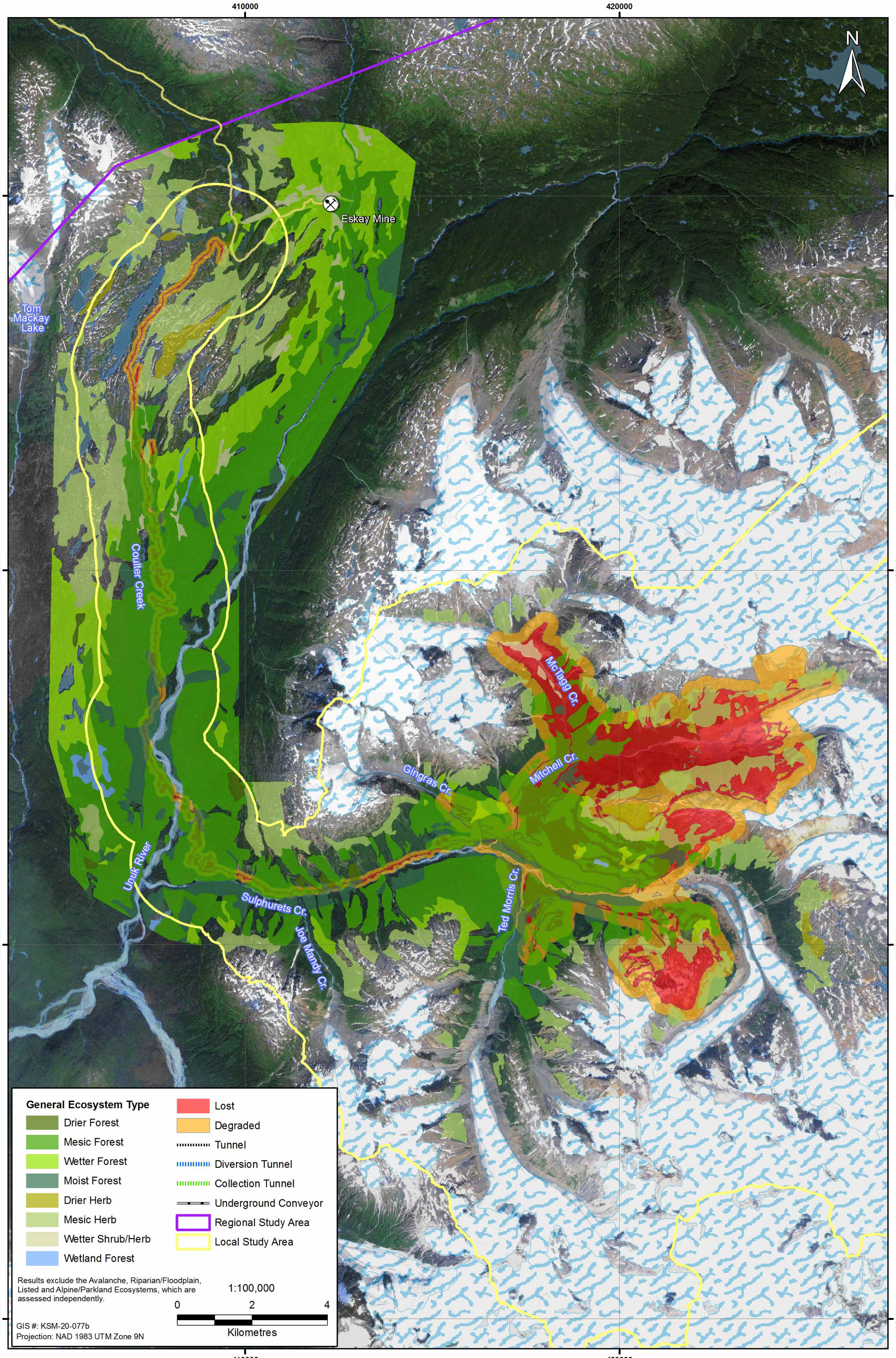

Figure 17.7-10b

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Loss and Degradation - Other Terrestrial Ecosystems: Mine Site and Coulter Creek Access Road

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Table 17.7-17. Other Terrestrial Ecosystems Lost at End of Operation – Local Study Area Assessment

BEC Unit / Site Series (TEM Code)	General Ecosystem Type	Area Lost (ha)	Baseline Area (ha)	Portion (%) of Baseline Lost
CWHwm/01 (HB)	Mesic Forest	19.2	1,269.2	1.5
CWHwm/03 (SO)	Mesic Forest	5.2	201.6	2.6
ICHvc/01 (HD)	Mesic Forest	11.7	1,264.2	0.9
MHmm2/01 (MB)	Mesic Forest	214.0	1,645.1	13.0
MHmm2/03 (MO)	Mesic Forest	230.3	1,207.3	19.1
ESSFwv/01 (FA)	Mesic Forest	287.6	2,051.0	14.0
ESSFwv/04 (MH)	Mesic Forest	12.7	153.8	8.3
ESSFwv/05 (FO)	Mesic Forest	320.6	1,206.7	26.6
		1,101.3	**8,998.9**	**12.2**
ICHvc/02 (HM)	Drier Forest	20.0	330.3	6.1
MHmm2/02 (MM)	Drier Forest	1.7	20.7	8.2
ESSFwv/02 (LC)	Drier Forest	88.8	352.8	25.2
ESSFwv/03 (FF)	Drier Forest	21.4	464.4	4.6
		131.9	**1,168.2**	**11.3**
CWHwm/04 (SD)	Moist Forest	11.1	804.6	1.4
ICHvc/03 (SD)	Moist Forest	25.2	1,095.0	2.3
MHmm2/05 (MT)	Moist Forest	131.3	523.4	25.1
MHmm2/04 (AB)	Moist Forest	29.5	265.9	11.1
		197.1	**2,688.9**	**7.3**
ICHvc/06 (SH)	Wetter Forest	1.5	56.3	2.7
MHmm2/08 (YS)	Wetter Forest	7.9	67.0	11.8
ESSFwv/08 (FH)	Wetter Forest	28.8	72.6	39.7
		38.2	**195.9**	**19.5**
Herbaceous meadow (AM)	Mesic Herb	102.3	1,563.6	6.5
Willow thicket (WT)	Wetter Shrub / Herb	9.9	274.1	3.6
Wetland (Wf, Wm, Ws, WE)	Wetland Shrub / Herb	134.6	900.8	14.9
Other Terrestrial Ecosystems	**Total**	**1,715.3**	**15,790.4**	**10.9**

17.7.2 Vegetation Degradation

The extent of vegetation degradation was calculated within a 100 m buffer surrounding all infrastructure components, with the exception of the larger facilities associated with the proposed Mine Site, Process Plant Site, and TMF, where a 300 m buffer has been applied (in order to accommodate for the effects of increased potential dust). The increased buffer has been applied to recognize the potential for a greater magnitude and extent of degradation effects.

The 100 m buffer width was based on research indicating that windthrow, invasive species, and fugitive dust accumulation are concentrated primarily within 100 m from forest edges

(Section 17.8). In few cases (i.e., the crest position between Sulphurets Pit and the Mitchell RSF), small fragmented patches adjacent to infrastructure but outside of this 100 m buffer were also included in the degraded category. These fragments have a large area of edge relative to interior habitat, suggesting that windthrow and invasive plant species may affect a relatively higher proportion of the areas. Fragmented areas could receive cumulative dusting from the surrounding infrastructure.

During the construction, operation, closure, and post-closure phases, all seven VCs that are adjacent to active infrastructure could be subject to degradation resulting from windthrow, invasive plants, and/or fugitive dust (Table 17.7-18). Each of these effects is discussed in more detail in Section 17.8.

Table 17.7-18. Summary of Project-specific Vegetation Degradation

Valued Component Category	Valued Component	Total Extent (ha) Degraded at End of Operation
Culturally and Ecologically important	Potential pine mushroom habitat	234.7
	Avalanche track ecosystems	652.8
Listed and Culturally Important	Listed ecosystems	145.3
Sensitive and Culturally Important	Riparian and floodplain ecosystems	627.5
	Alpine and parkland ecosystems	838.1
	Old forests	416.5
Other Culturally and Ecologically Important	Other terrestrial ecosystems	2,760

[1] Total lost is not additive because VCs are overlapping.

In order to assess the potential degradation on terrestrial ecosystems during the construction and operation phases, the Project footprint and associated degradation buffer was overlaid on the distribution of each VC. The extent of degradation is based on the footprint at the end of the operation phase, representing the maximum extent of disturbance. Degradation calculations were based on the TEM ecosystem distributions.

17.7.2.1.1 Windthrow

Trees at forest edges are susceptible to windthrow, particularly when those trees have matured within a closed canopy where wind velocities are relatively low and are then exposed to increased wind velocities at forest edges following forest clearing (Saunders, Hobbs, and Margules 1991; Stathers, Rollerson, and Mitchell 1994). As windthrow usually occurs during the first few years after clearing, risk is assumed to be highest during the construction phase and the first few years of operation.

Windthrow can cause tree mortality which, in turn, may cause increased fire hazard and insect epidemics when downed trees are not salvaged (Stathers, Rollerson, and Mitchell 1994). Although windthrow effects in BC have been documented to extend more than 100 m into forest stands (Burton 1991), most windthrow damage is expected within 10 to 20 m of forest edges (Stathers, Rollerson, and Mitchell 1994).

Windthrow hazard depends on a variety of environmental conditions, including wind speed and direction; slope topography; and soil properties and species-dependent differences in rooting depths, height-to-diameter ratios, and height-to-crown length ratios (Stathers, Rollerson, and Mitchell 1994). Windthrow risk is greatest where wind speeds are high and/or where soil and terrain properties do not allow for deep-rooting, such as in wet soils, on steep rocky slopes, or on exposed crests and ridges. For example, in the ESSF BEC zone, frequent storms, shallow and wet soils, and complex topography results in an elevated windthrow risk (Huggard, Klenner, and Vyse 1999).

The updated *BCTS Windthrow Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast* (Zielke et al. 2010), pulls together the significant body of work that has been ongoing throughout BC over the last 20 years. It provides an overview of the windthrow management framework and outlines hazard assessment, windthrow risk, best management practices and monitoring programs. This will guide the development of management and monitoring programs outlined within the Terrestrial Ecosystem Management and Monitoring Plans in Chapter 26.

Project-specific Effect

Windthrow does not represent a risk for much of the proposed Mine Site as the pits and large portions of the RSFs are proposed above the treeline in non-forested areas. Windthrow effects could result where forests are cleared within the PTMA, along the Coulter and Treaty Creek access roads, and along the transmission line right-of-way. Although linear features such as roads and rights-of-way create large amounts of forest edge relative to the area cleared, risk may be minimal as they are usually narrow enough that the wind force on the edges is minimized (BC MOF 2003). However, degradation resulting from windthrow is assumed to represent some risk whenever new forest edges are created.

17.7.2.1.2 Invasive Plants

Invasive plants refer to species (usually non-native or exotic) that can aggressively compete with and replace native vegetation when introduced into natural settings (Haber 1997). Plants introduced to areas beyond their home range often lack competition and other natural balances, which can give them a competitive advantage over native vegetation.

Potential for invasive plant establishment in an area depends on several factors:

- creation of appropriate habitat for the invasive plant, such as freshly exposed mineral soil;
- access to an invasive plant seed source; and
- an invasive plant dispersal mechanism.

Construction and development activities increase the potential for invasive plant introduction and establishment by creating favourable habitat through ground disturbance (Polster 2005). Furthermore, features fundamental to the construction process, namely vehicles and machinery using access roads, provide plant dispersal mechanisms. Invasive plants are often found along road verges and other recently disturbed areas. Once established, they can decrease vegetation biodiversity, forest, and range productivity and ultimately reduce the overall efficacy of reclamation initiatives (Polster 2005). Vehicles and machinery can carry plant propagules in their tires, undercarriages, or in mud on the vehicle, inadvertently transporting them to previously unaffected areas. In addition to roadside ditches and verges, forest edges are susceptible to the introduction of invasive species propagules from adjacent clearings (H. T. Murphy and Lovett-Doust 2004). Research in temperate forests indicates invasive species may dominate the vegetation 10 to 30 m into the forest from an edge, with changes in plant species composition measurable up to 60 m (Fraver 1994; Meiners and Pickett 1999; Honnay, Verheyen, and Hermy 2002; Harper et al. 2005; Flory and Clay 2006).

Project-specific Effect

Although no invasive plant species were found during baseline studies in the LSA, invasive plants could be introduced throughout the construction, operation, and closure phases. In the broader region, an online database from the Invasive Alien Plant Council of BC indicates that some invasive plants are found nearby along Highway 37, including spotted knapweed (*Centaurea maculosa*), common toadflax (*Linaria vulgaris*), Canada thistle (*Cirsium arvense*), perennial sow-thistle (*Sonchus arvensis*), king devil (*Hieracium praealtum*), and oxeye daisy (*Leucanthemum vulgare*). It is important to recognize this list is not an exhaustive list of all the invasive plants that could be introduced into the Project area, but may represent those with higher likelihood of establishing. Of these species, spotted knapweed is considered the largest threat. It is regulated as noxious in all regions of the province and is one of the Northwest Invasive Plant Council's most unwanted weeds due to its highly aggressive spreading capability (NWIPC 2012).

17.7.2.1.3 Fugitive Dust Deposition

Fugitive dust (particulate matter) can have various effects on vegetation depending on the amount and frequency of dusting, the chemical properties of the dust, and the receptor plant species. A buildup of dust over time can alter vegetation growth and reproduction by affecting soil pH and nutrient availability (Walker and Everett 1991; Farmer 1993; Auerbach, Walker, and Walker 1997), leaf temperature (Eller 1977), leaf chemistry (McCune 1991; CEPA/FPAC Working Group 1998; Anthony 2001) and the ability of light and gas to pass through leaves (Thompson et al. 1984; Pyatt and Haywood 1989; Farmer 1993; Environment Australia 1998).

Project-specific Effect

Fugitive dust will be produced during the construction, operation, and closure phases. Expected sources of fugitive dust and particulate matter include gravel roads, blasting and ore processing activities. The dams and beaches of the TMF represent other potential sources of dust. During summer, the tailing will be cycloned with the fine material discharged along the beaches and the coarse material used to build the dams.

Particulate matter can demonstrate different deposition patterns depending on size; large dust particles typically settle near the source (e.g., within 100 m), while finer particles travel much greater distances (US EPA 1995). The moist, humid climate within this region of BC, together with tree canopies that intercept dust, will likely restrict the majority of dustfall to within 100 m of road corridors. Above the treeline, however, dust interception is often reduced and dust could travel greater distances. The wet climate is also expected to regularly wash plant leaves of dust.

Dust or sediment from ore material being transported on haul trucks along roads (e.g., Highway 37) is not expected to contribute additional dust as their loads will be covered to prevent loss of concentrate during transport. The potential effects of dust deposition on vegetation with respect to effects on human health are discussed in Chapter 25.

17.7.2.2 Mitigation for Vegetation Degradation

Mitigation strategies for vegetation and ecosystems are outlined within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26. Mitigation strategies for windthrow, invasive plants and fugitive dust are briefly addressed below.

17.7.2.2.1 Windthrow

To minimize windthrow risk, site-specific windthrow hazards will be assessed prior to the construction phase, and clearing activity in higher-risk areas will be conducted in a manner that mitigates the risk. Mitigation measures could include edge feathering or other stabilization techniques as outlined in the *BCTS Windthrow Management Manual: A Compendium of Information and Tools for Understanding, Predicting and Managing Windthrow on the BC Coast* (Zielke et al. 2010). Monitoring for windthrow effects is proposed within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26.

17.7.2.2.2 Invasive Plants

Comprising a sub-plan within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26, the Invasive Plant Management Plan (Chapter 26.20) addresses mitigation for invasive plants. Preventing the initial establishment of invasive plant species is often the most effective, economic, and ecological approach to managing the problem (Clark 2003; Polster 2005; BC MOFR 2007). Prevention measures include:

- minimizing the dimensions of ground and soil disturbances;
- re-vegetating disturbance areas using an approved weed-free seed mix; and
- monitoring to ensure timely detection and response to any new plant introductions.

Manual, biological, and chemical methods used to respond to invasions and herbicide use, where required, will be conducted in accordance with the *Integrated Pest Management Act* (2003b).

17.7.2.2.3 Fugitive Dust Deposition

Dust production may be minimized through watering and/or use of inert dust suppressants on roads, regularly maintaining road surfaces, and reducing travel speeds during periods of higher risk. Details are provided in the Air Quality Management Plan (Chapter 26.11). In areas of identified sensitive ecosystems, potential for dust can be further reduced by using surfacing material approved or designed to reduce fugitive dust.

The effects of dust deposition on terrestrial vegetation will be assessed through sampling and monitoring of metal concentrations within plant tissues. Detailed in Appendix 17-A and referenced in Chapter 25 (Human Health), 100 plant tissue samples were collected at the proposed KSM Project between July 2008 and September 2009 and analyzed to establish baseline metal concentrations in local vegetation. This included the leaves of willow (*Salix* sp.), red raspberry (*Rubus idaeus*), blueberry (*Vaccinium* spp.), black huckleberry (*Vaccinium membranaceum*) and Sitka valerian (*Valeriana sitchensis*), and the fruits (berries) of blueberry species.

Addressed within the Terrestrial Plant Tissue Metal Concentrations Monitoring Plan (Chapter 26.20.4), additional samples of vegetation will be collected, and metal concentrations monitored. Adaptive mitigation measures may be implemented should metal concentration in plant tissue pose a risk to wildlife and/or human health. Potential effects of chemical hazards on wildlife species are addressed within Chapter 18. Vegetation species chosen for sampling will be those relevant to human and wildlife consumption, and may include plant species analyzed in 2008 and 2009. Sampling will be conducted in areas determined by results from dust deposition modeling and areas that are frequently used by wildlife species and humans. Sampling will begin during the construction phase and continue throughout the operation, closure, and post-closure phases directed by dust deposition rates and metal concentrations in vegetation. Methods for sampling will include those used to assess deposition on vegetation surfaces and uptake into vegetation tissues.

17.7.2.3 Potential for Residual Effects

All terrestrial ecosystem VCs face some risk from degradation caused by windthrow, invasive plants, and/or deposition of fugitive dust. Mitigation will minimize the likelihood and magnitude of degradation but will likely not completely eliminate the risk. Therefore, some residual degradation is expected.

17.7.2.4 Potential Pine Mushroom Habitat: Potential Residual Effects due to Vegetation Degradation

Within the LSA, an estimated 235 ha of potential pine mushroom habitat could be degraded, representing 21% of the baseline distribution (Table 17.7-19). Degradation of mature and old forest ecosystems may occur during the construction and operation phases along portions of the Coulter and Treaty Creek access roads (Table 17.7-20; Figure 17.7-4a) within the upper Unuk River, Sulphurets Creek, and Treaty Creek watersheds.

Table 17.7-19. Potential Pine Mushroom Habitat Degradation at End of Operation – Local Study Area Assessment

Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Degraded
234.7	1,112.7	21.1

Accumulation of fugitive dust and the introduction and spread of invasive plant species are possible effects that can result in the degradation of potential pine mushroom habitat. Effects of windthrow also represent a risk along newly-created edges, although pine mushrooms tend to grow on well-drained soils on which trees are often relatively windfirm (Stathers, Rollerson, and Mitchell 1994; Gamiet, Ridenour, and Philpot 1998; Ehlers, Fredrickson, and Berch 2007).

Table 17.7-20. Potential Pine Mushroom Habitat Degradation at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
Upper Unuk	Coulter Creek Access Corridor, Camp 7: Unuk North Camp	125.0	1,302.8	9.6
Sulphurets	Mitchell Operating Camp and Access Road, McTagg Diversion access road	75.4	256.5	29.4
Treaty Creek	Treaty Creek Access Corridor	34.4	152.9	22.5

Specific mitigation strategies have not been developed for potential pine mushroom habitat. However, adhering to the general management considerations within the Vegetation Clearing Management Plan (Chapter 26.20.1) and adopting the management recommendations within the Air Quality Management Plan (Chapter 26.11) will reduce the likelihood and magnitude of degradation.

Along the Coulter Creek access road (i.e., between the Eskay Creek Mine road and the Unuk River), approximately 35 ha of vegetation loss occur within areas designated for reclamation activity during the construction and operation phases. An additional 0.6 ha of vegetation loss occur within areas designated for reclamation activity during the closure phase. As reclaimed areas are unlikely to restore suitable pine mushroom habitat for many decades into the future and use of the access corridor will continue, residual vegetation degradation is expected. Given the expectation that degradation effects will not occur consistently within the entire buffered area reported in Table 17.7-19, it is expected that effects will be minimal.

17.7.2.5 Avalanche Track Ecosystems: Potential Residual Effects due to Vegetation Degradation

Degradation of avalanche ecosystems can result from the introduction and spread of invasive plant species and accumulation of fugitive dust.

Within the LSA, an estimated 650 ha of avalanche track ecosystems could be degraded by the end of operation (Table 17.7-21), representing 13% of the baseline distribution.

Based on the TEM ecosystem distributions within the Sulphurets Creek watershed, the majority of degradation is related to development and operation of the McTagg and Mitchell RSFs, Water Storage Facility, Mitchell Ore Preparation Complex, and the Mitchell and Kerr pits. Degradation may also result from use of the Coulter Creek Access Corridor (within the Sulphurets watershed) and other roads that access infrastructure, such as the Explosives Manufacturing Facility. Within the PTMA, the majority of degradation will result from development and use of the Treaty Saddle road. Less degradation is expected on the west aspect slopes above the TMF North and South Cells, including the East Catchment Diversion (Figures 17.7-5a and 17.7-5b).

Table 17.7-21. Avalanche Track Ecosystems Degraded at End of Operation – Local Study Area Assessment

BEC Unit / TEM Code	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Area Degraded
ESSFwv/51	302.1	1,472.3	20.5
MHmm2/51	239.9	1,244.7	19.2
CMAunp/51	41.4	238.1	17.4
CWHwm/51	30.0	200.7	14.9
ICHvc/51	19.4	76.0	25.5
ESSFwv/VG	7.7	50.4	15.3
BAFAunp/51	6.9	16.8	41.0
ICHvc/VG	5.6	36.3	15.4
Total	**652.8**	**5,097.4**	**12.8**

The majority of potential degradation is expected within the Sulphurets and Treaty Creek watersheds, with respective degradation estimates of 18.5 and 6.6% of baseline distributions (Table 17.7-22). The management strategies for invasive plants and fugitive dust deposition outlined within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20), the Air Quality Management Plan (Chapter 26.11), and briefly discussed in Section 17.8.3.2, will reduce the likelihood and magnitude of degradation but might not eliminate it altogether; residual effects are possible.

Table 17.7-22. Avalanche Track Ecosystems Degraded at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
Treaty Creek	Treaty Creek access road (incl. Treaty Saddle road), and TMF (South Cell)	270.6	4,078.4	6.6
Sulphurets	Mine Site	311.3	1,695.2	18.4
Teigen Creek	TMF (North Cell)	70.9	3,943.2	1.8
Upper Unuk	n/a	0.0	1,746.7	0

17.7.2.6 Listed Ecosystems: Potential Residual Effects due to Vegetation Degradation

The potential degradation from fugitive dust accumulation, introduction and spread of invasive plants, and windthrow are concentrated along the proposed Coulter Creek and Treaty Creek access roads (Figures 17.7-6a and 6b). Nine of the listed ecosystems mapped in the LSA could be degraded by the Project, with degradation possible within approximately 145 ha (Table 17.7-23). Most of the potential degradation occurs within the Sulphurets and Treaty Creek watersheds (Table 17.7-24). None of the proposed infrastructure overlaps listed ecosystems mapped within the Teigen Creek watershed.

Table 17.7-23. Listed Ecosystems Degraded at End of Operation – Local Study Area Assessment

Listed Ecosystem (TEM Code)	General Ecosystem Type	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
ICHvc/00 (52)	Wetland Shrub/Herb	36.9	182.8	20.1
CWHwm/02 (HM)	Drier Forest	34.9	79.9	43.7
CWHwm/05 (SS)	Floodplain Forest	34.8	213.4	16.3
ICHvc/05 (CD)	Floodplain Forest	21	228.3	9.2
ICHvc/00 (Wf51)	Wetland Shrub/Herb	8.9	53.6	16.6
ICHvc/00 (Fl01)	Wetland Shrub/Herb (Floodplain)	4.8	7.8	61.5
CWHwm/06 (CD)	Floodplain Forest	3.6	29.2	12.3
CWHwm/09 (SC)	Wetland Forest (Riparian)	0.2	14.0	1.4
ICHvc/00 (Fm03)	Floodplain Forest	0.2	39.5	0.5
CWHwm/08 (HS)	Wetter Forest	0	2.0	0
CWHwm/00 (Wf)	Wetland Shrub/Herb	0	0.02	0
ESSFwv/00 (Fm03)	Floodplain Forest	0	26.0	0
Total		**145.3**	**876.5**	**16.6**

[1] **251 ha predicted in PEM.**

Table 17.7-24. Listed Ecosystems Degraded at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
Sulphurets	Coulter Creek Access Corridor	48.9	163.6	29.9
Treaty Creek	Treaty Creek Access Corridor	42.3	533.3	7.9
Teigen Creek	[*none*]	0	246.9	0.0
Upper Unuk	Coulter Creek Access Corridor	24.6	380.2	6.5
Bell-Irving	Treaty Creek Access Corridor	29.3	n/a	n/a

Strategies to mitigate the potential effects of fugitive dust, invasive plants and windthrow are outlined in the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20), the Air Quality Management Plan (Chapter 26.11), and in Section 17.8.4.2. These strategies will reduce the likelihood and magnitude of degradation, but not eliminate it altogether. Therefore, residual effects are possible.

17.7.2.7 Riparian and Floodplain Ecosystems: Potential Residual Effects due to Vegetation Degradation

Harvesting riparian ecosystems can result in edges that are particularly susceptible to degradation from the introduction and spread of invasive plant species because of their linear nature and high edge-to-core ratio (Rollerson and McGourlick 2001; Richardson et al. 2007; Bahuguna, Mitchell, and Miquelajauregui 2010) and from windthrow due to high relative soil moisture. Fugitive dust may also be deposited on riparian vegetation where adjacent to active roads and other facilities generating fugitive dust.

Nearly 630 ha of (unlisted) riparian and floodplain ecosystems (Table 17.7-25) could be degraded as a result of windthrow, fugitive dust accumulation, and introduction and spread of invasive plant species. An estimated 65 ha of riparian and floodplain ecosystems, assessed previously in Section 17.7.2.5 as CDC listed ecosystems, could also be degraded. At the watershed level, nearly 30% of the mapped riparian and floodplain ecosystems in the Sulphurets Creek Watershed occur within the degradation buffer (Table 17.7-26).

Table 17.7-25. Riparian and Floodplain Ecosystems (Non-listed) Degraded at End of Operation – Local Study Area Assessment

BEC Unit / Site Series (TEM Code)	Ecosystem Type	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
ESSFwv/07 (FV)	Forested (Riparian)	210.7	856.8	24.6
ESSFwv/06 (FD)	Forested (Riparian)	190.9	1175.1	16.2
MHmm2/07 (YH)	Forested (Riparian)	72.5	370.9	19.5
ICHvc/04 (DD)	Forested Floodplain (non-listed)	59.9	228.8[1]	26.2
MHmm2/00 (FP)	Floodplain (generic unit)	30.3	39.8	76.1
MHmm2/06 (MD)	Forested (Riparian)	18.7	191.2	9.8
ESSFwv/09 (FL)	Forested (Riparian)	18.7	71.8	26.0
ESSFwv/00 (FP)	Floodplain (generic unit)	14.2	110.4	12.9
CWHwm/07 (CW)	Forested Floodplain (non-listed)	7.9	47.6	16.6
CMAunp/00 (FP)	Floodplain (generic unit)	0.5	4.1	12.2
ICHvc/06 (SH)	Forested (Riparian)	3.2	56.3	5.7
MHmm2/09 (YC)	Forested (Riparian)	0	13.8[1]	0
Total (Non-listed) Riparian / Floodplain Units		**627.5**	**3,166.6**	**19.8**
Sum of Listed Riparian and Floodplain Units[2]		64.6	558.2	11.6
Total Riparian / Floodplain Units		**692.1**	**3,724.8**	**18.6**

[1] **Based only on TEM data as the PEM model grouped this ecosystem with another.**
[2] **Results from Section 17.7.2.5.**

Table 17.7-26. Riparian and Floodplain Ecosystems (Non-listed) Degraded at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
Teigen Creek	North Cell TMF	284.5	2,585.0 (2,244)	11.0
Treaty Creek	South Cell TMF, Treaty Creek Access Corridor	178.9	1,485.0 (812)	12.0
Sulphurets	Mine Site	125.3	424.8 (424)	29.5
Upper Unuk	Coulter Creek Access Corridor	4.2	1,985.1 (1,364)	0.2
Bell-Irving	East of Hwy 37 (Treaty Creek Switching Station)	33.0	n/a	n/a

Management strategies for windthrow, invasive plants, and fugitive dust outlined within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20), the Air Quality Management Plan (Chapter 26.11), and briefly discussed in Section 17.7.2.1, could reduce the likelihood and magnitude of degradation, but not eliminate it altogether. Therefore, residual effects of vegetation degradation could result within riparian and floodplain ecosystems.

17.7.2.8 Alpine and Parkland Ecosystems: Potential Residual Effects due to Vegetation Degradation

Approximately 840 ha of vegetated alpine and parkland ecosystems could be degraded by the Project (Table 17.7-27), with krummholz and mountain-heather heath representing the main ecosystems, followed by herbaceous meadows and parkland forest. Potential degradation is concentrated in the Sulphurets Creek watershed (Table 17.7-28), with some potential along the upper portions of the Coulter Creek access road near the Eskay Creek Mine road (Figure 17.7-8a and 8b). Within the Mine Site, degradation could result from fugitive dust accumulation due to blasting and ore processing, as well as from the introduction and spread of invasive plants. Along road edges, potential effects could result from the introduction and spread of invasive plant species and accumulation of fugitive dust from traffic and machinery. Windthrow risk is considered negligent at parkland and alpine elevations due to the lack of trees and inherent windfirm-ness of parkland trees and krummholz.

Table 17.7-27. Alpine and Parkland Ecosystems Degraded at End of Operation – Local Study Area Assessment

Ecosystem (TEM Code)	General Ecosystem Type	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
Krummholz (KH)	Parkland Forest / Krummholz	240.7[1]	2,236.6	10.8
Mountain-heather Heath (MP)	Mesic Shrub / Herb	236.1[1]	2,125.0	11.1
Herbaceous Meadow (AM)	Mesic Herb (Meadow)	149.3	1,302.1	11.5
Parkland Forest (PK)	Parkland Forest / Krummholz	92.1	684.1	13.5
Cryptogram – Altai fescue (CG)	Drier Herb	63.9[1]	548.7	11.6
Fescue – Lichen (FC)	Drier Herb	39.1[1]	845.6	4.6
Willow Thicket (WT)	Wetter Shrub / Herb	12.4[1]	151.4	8.2
Wetland – Fen (Wf)	Wetland Shrub / Herb	4.5	114.5	3.9
Total Alpine and Parkland Units		**838.1**	**8,008**	**10.5**

[1] Includes areas mapped within MH and ESSF BEC zones.

Table 17.7-28. Alpine and Parkland Ecosystems Degraded at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
Sulphurets	Mine Site	549.2	3,441.2	16.0
Upper Unuk	Camp 3: Eskay Staging Camp	117.5	5,900.1	2.0
Teigen Creek	PTMA	88.7	3,608.5	2.5
Treaty Creek	PTMA	82.6	2,419.3	3.4

Management strategies for fugitive dust and invasive plants outlined in the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20), the Air Quality Management Plan (Chapter 26.11), and briefly discussed in Section 17.7.2.1, will reduce the likelihood and magnitude of vegetation degradation, but might not eliminate it altogether. Residual degradation of alpine and parkland ecosystems is possible.

17.7.2.9 Old Forest Ecosystems: Potential Residual Effects due to Vegetation Degradation

Degradation of old forests may result from the introduction and spread of invasive plant species and dust deposition. They may also be particularly at risk from windthrow, as many trees in old stands have root and butt rot (Stathers, Rollerson, and Mitchell 1994).

TEM-derived estimates of old forest degradation, based upon ecosystems mapped as structural stage 7, are provided within Table 17.7-29 and depicted in Figures 17.7-9a and 17.7-9b. Approximately 417 ha of old forest within the LSA could be degraded, representing 20% of the mapped baseline distribution.

Table 17.7-29. Old Forest Ecosystems (TEM Data) Degraded at End of Operation – Local Study Area Assessment

Structural Stage	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
7 (Old Forest)	416.5	2,049.7	20.3

The greatest potential for old forest degradation (236 ha) occurs within the Sulphurets Creek watershed, representing 38% of the baseline distribution within this watershed (Table 17.7-30). Less degradation is expected within the upper Unuk River and Treaty Creek watersheds, with estimated percentage degradation of 10 and 22% of baseline distributions, respectively.

Table 17.7-30. Old Forest Ecosystems (TEM Data) Degraded at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)[1]	Portion (%) of Baseline Degraded
Sulphurets	Mine Site	236.4	620.9 (612.2)	38.1
Upper Unuk	Coulter Creek Access Corridor	102.9	9,212.9 (1078.8)	9.5
Treaty	TMF, Treaty Creek Access Corridor	39.2	8,016.7 (179.6)	21.8
Teigen	TMF	12.4	4,777.2 (250.3)	5.0
Bell-Irving[2]	Treaty Creek Access Corridor	25.5	n/a	n/a

[1] PEM data combine mature and old forest - TEM contribution within parentheses.
[2] Baseline ecosystem mapping data not available for Bell-Irving watershed.

For comparison, the VRI-derived estimates of old forest degradation are provided within Table 17.7-31. Approximately 1,915 ha of old forest could be degraded within the LSA, representing 18% of the mapped baseline distribution.

Table 17.7-31. Old Forest Ecosystems (VRI Data) Degraded at End of Operation – Local Study Area Assessment

Projected Forest Age	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of VRI Baseline Degraded
> 250 years	1,915.1	10,971	17.5

Consistent with the TEM results, the majority of degradation (951 ha) occurs within the Sulphurets Creek watershed, representing 35% of the baseline distribution (Table 17.7-32). Within the Teigen Creek watershed, nearly 545 ha could be degraded, representing 6% of the baseline distribution. Smaller areas of degradation occur within the upper Unuk River and Treaty Creek watersheds, with percentage degradation estimates of 1.9 and 2.2% of baseline distributions, respectively.

Table 17.7-32. Old Forest Ecosystems (VRI Data) Degraded at End of Operation – Watershed Assessment

Watershed	Infrastructure	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of VRI Baseline Degraded
Sulphurets	Mine Site	950.7	2,738.6	34.7
Teigen	TMF	543.9	9,345.4	5.8
Treaty	TMF, Treaty Creek Access Corridor	117.9	5,297.0	2.2
Upper Unuk	Coulter Creek Access Corridor	291.3	15,149.8	1.9
Bell-Irving	Treaty Creek Access Corridor	n/a	n/a	n/a

Within the LSA at the end of operation, 20% degradation is estimated from the TEM data, slightly higher than the 18% VRI estimate. Although the VRI area degradation estimate in the LSA (1,915 ha) far exceeds the TEM estimate (417 ha), the baseline area of old forest estimated by VRI is also much larger (10,972 ha) than the TEM baseline (2,050 ha). Despite the larger degradation estimate, the VRI percentage degradation estimate within the Sulphurets Creek watershed (35%) is consistent with the TEM estimate of 38%.

The management strategies for windthrow, invasive plants, and fugitive dust outlined within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20), the Air Quality Management Plan (Chapter 26.11), and briefly discussed in Section 17.7.2.1, will reduce the likelihood and magnitude of vegetation degradation, but will not eliminate it altogether. Therefore, residual vegetation degradation is possible.

17.7.2.10 Other Terrestrial Ecosystems: Potential Residual Effects due to Vegetation Degradation

Approximately 2,760 ha of other terrestrial ecosystems could be degraded by the Project (Table 17.7-33 and Figures 17.7-10a and 10b). Forests within the Mesic Forest General Ecosystem Type in the ESSFwv and MHmm2 BEC units will be most affected. Windthrow, introduction and spread of invasive species, and fugitive dust accumulation represent potential degradation risks.

Table 17.7-33. Other Terrestrial Ecosystems Degraded by the Project – Local Study Area Assessment

BEC Unit / Site Series (TEM Code)	General Ecosystem Type	Area Degraded (ha)	Baseline Area (ha)	Portion (%) of Baseline Degraded
ICHvc/01 (HD)	Mesic Forest	67.0	1,264.2	5.3
CWHwm/01 (HB)	Mesic Forest	183.6	1,269.2	14.6
CWHwm/03 (SO)	Mesic Forest	41.4	201.6	20.5
MHmm2/01 (MB)	Mesic Forest	457.2	1,645.1	27.8
MHmm2/03 (MO)	Mesic Forest	363.9	1,207.3	30.1
ESSFwv/01 (FA)	Mesic Forest	278.6	2,051.0	13.6
ESSFwv/04 (MH)	Mesic Forest	18.8	153.8	12.2
ESSFwv/05 (FO)	Mesic Forest	248.1	1,206.7	20.6
		1,658.6	**8,998.9**	**18.4**
ICHvc/02 (HM)	Drier Forest	125.6	330.3	38.0
MHmm2/02 (MM)	Drier Forest	1.7	20.7	8.2
ESSFwv/02 (LC)	Drier Forest	70.3	352.8	20.0
ESSFwv/03 (FF)	Drier Forest	96.8	464.4	20.8
		294.4	**1,168.2**	**25.2**
ICHvc/03 (SD)	Moist Forest	98.6	1,095.0	9.0
CWHwm/04 (SD)	Moist Forest	106.1	804.6	13.2
MHmm2/04 (AB)	Moist Forest	48.6	265.9	18.3
MHmm2/05 (MT)	Moist Forest	143.5	523.4	27.4
		396.8	**2,688.9**	**14.8**
ICHvc/06 (SH)	Wetter Forest	50.1	56.3	89.0
MHmm2/08 (YS)	Wetter Forest	16.3	67.0	24.3
ESSFwv/08 (FH)	Wetter Forest	2.1	72.6	2.9
		68.5	**195.9**	**35.0**
Herbaceous meadow (AM)	Mesic Herb	218.7	1,563.6	14.0
Willow thicket (WT)	Wetter Shrub / Herb	52.6	274.1	19.2
Wetland (Wf, Wm, WE)	Wetland Shrub / Herb	108.9	900.8	12.1
Other Terrestrial Ecosystems	**Total**	**2,760**	**15,790.3**	**17.5**

The management strategies for windthrow, invasive species, and fugitive dust outlined in the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20), the Air Quality Management Plan (Chapter 26.11), and briefly discussed in Section 17.8.3.5, will reduce the likelihood and magnitude of degradation, but might not eliminate it altogether. Therefore, residual degradation is possible.

17.8 Significance of Residual Effects for Terrestrial Ecosystems

Despite mitigation, residual vegetation loss and degradation effects are expected within each of the seven terrestrial ecosystem VCs.

17.8.1 Residual Effect Descriptors for Terrestrial Ecosystems

The potential residual effect on each VC was characterized in terms of six key descriptors: magnitude, spatial extent, duration, frequency, reversibility, and context (resiliency; Table 17.8-1). These descriptors refer to the effect itself (e.g., vegetation loss) and not the action that causes the effect (e.g., vegetation clearing). The definitions of these descriptors are common to all sections of the Application/EIS, with the exception of magnitude and spatial extent, which are tailored to the terrestrial ecosystems effects assessment, as discussed below.

Table 17.8-1. Definitions of Significance Criteria for Terrestrial Ecosystems Residual Effects

Descriptor	Ranking	Definition
Magnitude	Negligible	No detectable change from baseline conditions.
	Low	Differs from the average value for baseline conditions to a small degree. Less than 20% of baseline distribution in any local watershed is lost or degraded.
	Medium	Noticeably different from baseline. Between 20 and 30% of baseline distribution in any local watershed is lost or degraded.
	High	Differs substantially from baseline conditions. More than 30% of the baseline distribution in any local watershed is lost or degraded.
Spatial Extent	Local	Effect is limited to the immediate Project footprint and degradation buffer.
	Landscape	Effect extends beyond the footprint but is constrained within the local watershed.
	Regional	Effect extends across the broader region.
	Beyond Regional	Effect extends beyond the region and may extend across or beyond the province.
Duration	Short-term	Effect lasts approximately one year or less.
	Medium-term	Effect lasts from one to five years.
	Long-term	Effect lasts between 6 to 40 years.
	Far Future	Effect lasts more than 40 years.
Frequency	One Time	Effect is confined to one discrete period in time during the life of the Project.
	Sporadic	Effect occurs rarely and at sporadic intervals.
	Regular	Effect occurs on a regular basis and potentially beyond the life span of the Project.
	Continuous	Effect occurs constantly during, and potentially beyond, the life of the Project.

(continued)

Table 17.8-1. Definitions of Significance Criteria for Terrestrial Ecosystems Residual Effects (completed)

Descriptor	Ranking	Definition
Reversibility	Reversible short-term	Effect can be reversed relatively quickly.
	Reversible long-term	Effect can be reversed over many years.
	Irreversible	Effect cannot be reversed.
Context (Resiliency)	High	The receiving ecosystems have a high natural resilience to imposed stresses and can respond and adapt to the effect.
	Neutral	The receiving ecosystems have a neutral resilience to imposed stresses and may be able to respond and adapt to the effect.
	Low	The receiving ecosystems have a low resilience to imposed stresses and will not easily adapt to the effect.
Probability	High	Effect is highly likely to occur.
	Medium	Effect is likely but may not occur.
	Low	Effect is unlikely but could occur.
Confidence Level	High	A good understanding of the cause-effect relationship and all necessary data are available for the Project area. A low degree of uncertainty and variation from the predicted effect is expected to be low; greater than 80% confidence.
	Medium	Cause-effect relationships are not fully understood, there are a number of unknown external variables, or data for the Project area are incomplete. There is a moderate degree of uncertainty; while results may vary, predictions are relatively confident: 40 to 80% confidence.
	Low	Cause-effect relationships are poorly understood, there are a number of unknown external variables, and data for the Project area are incomplete. High degree of uncertainty and final results may vary considerably; less than 40% confidence.

For each VC, the probability of the residual effect being assessed and confidence in the assessment is also discussed. Probability refers to the likelihood of occurrence, and confidence rates the level of uncertainty (e.g., in the data, models, or possible outcomes). Scientific uncertainty estimates address the available information and methods used to predict the potential and residual effects.

Magnitude was assessed in terms of the estimated percentage of a given VC's baseline distribution within any local watershed that would be affected. Watershed boundaries constitute a logical local spatial boundary within which to assess the effects of loss since, unlike the LSA, which was defined by the Project footprint, ecological processes (e.g., fluvial, geomorphic) that affect the distribution of ecosystems occur within watershed boundaries.

There are no standardized provincial or federal magnitude thresholds against which to assess the potential effects on the plant species and structure of terrestrial ecosystems (the exception is federally listed plant species, none of which were identified in the LSA and RSA). In the Nass South SRMP, however, it is recommended that no more than 30% of a blue-listed ecosystem within a cutblock is lost (BC ILMB 2012). This value was used as a stepping point for developing the definitions of magnitude used in this assessment.

Loss and degradation estimates were considered of medium magnitude if greater than 20% of a given VC's baseline distribution within any local watershed would be affected and high magnitude if greater than 30% within any watershed would be affected. The thresholds are based on values defined in terms of hydrologic and wildlife habitat integrity. Although hydrologic and wildlife habitat integrity are not explicitly assessed here, they represent functions provided by vegetation, and thus represent logical thresholds to use in the absence of vegetation-specific thresholds.

The threshold value of 20% for medium magnitude was selected based on the concept of Equivalent Clear-cut Area (ECA) and the allowed ECA of 20% in the SRMP (BC ILMB 2012). The ECA is a forestry index that considers the size of a clear-cut area and its degree of recovery. It is a common index used to set thresholds for a maximum clear-cut allowed to maintain hydrological integrity.

The value of 30% is adapted from scientific research and reviews on ecological thresholds. Research has indicated that, as total habitat declines, both population size and the number of wildlife species decline (not necessarily in a linear relationship) and that thresholds for wildlife often occur somewhere between 30 and 70% of habitat loss, depending on the ecosystem and wildlife species of interest (Mace et al. 1996; Mace and Waller 1997; Mace 2004; Schwartz et al. 2006; Interagency Conservation Strategy Team 2007; Price, Holt, and Kremsater 2007).

The definitions of spatial extent were tailored to fit the spatial boundaries used in the assessment (Section 17.4.1). Specifically, a "local" extent included the 100 m and 300 m disturbance buffers and the "landscape" extent was based on watershed boundaries. Tables 17.8-2 through 17.8-8 summarize the potential residual effects of vegetation loss and degradation and provide an overall residual effect for each VC.

17.8.2 Residual Effects Assessment for Potential Pine Mushroom Habitat

A summary of the potential residual effects for potential pine mushroom habitat is presented in Table 17.8-2.

17.8.2.1 Vegetation Loss

In the LSA, approximately 6% of the potential pine mushroom habitat that was mapped will be lost at the end of operation and is therefore considered a low magnitude effect. The effect is local in extent as it occurs directly under the Project footprint. The loss occurs at one point in time, during land clearing for a given infrastructure feature, and will extend into the far-future. The effect is irreversible where infrastructure is permanent, but could be reversible in the long term in areas restored to coniferous forest. Pine mushroom habitat is assumed to have a neutral resiliency, as it might be able to recover in some areas through natural succession.

The probability that loss of potential pine mushroom habitat will occur is medium due to medium confidence in the models of potential pine mushroom habitat. Some research suggests that ecosystem mapping does not currently provide the accuracy required for pine mushroom habitat identification at finer spatial scales (Ehlers, Fredrickson, and Berch 2007). In summary, this potential residual effect is **not significant (minor)**.

17.8.2.2 Vegetation Degradation

Degradation of potential pine mushroom habitat is rated as medium in magnitude at both the LSA level (21%) and individual watershed level, with 29% degradation within the Sulphurets watershed and 21% within the Treaty Creek watershed.

Degradation is local in extent because it occurs directly adjacent to the footprint (within the 100 m access road degradation buffer). Windthrow could occur sporadically for the first few years after vegetation clearing, but downed trees and structural changes along forest edges would last considerably longer. The potential for introduction and spread of invasive plant species will also occur sporadically; they could be introduced in different places and at different times depending on when and where machinery and vehicles are working. Although production of fugitive dust will occur regularly throughout the lifetime of the Project due to blasting, processing, and traffic on unpaved roads, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will be short-lived because of the frequent rain.

Degradation effects are generally reversible in the far future (e.g., after construction, closure, and post-closure activities are complete). An exception to reversibility could occur in areas adjacent to the portion of the Coulter Creek access road which will not be reclaimed, as continued use of this road can degrade adjacent vegetation. As there is currently no information to indicate otherwise, pine mushroom habitat is assumed to have a neutral resiliency to degradation effects.

The probability that some degradation will occur in pine mushroom habitat is medium, as the modelled habitat might over- or underestimate the true extent, and uncertainties exist with respect to where the degradation effects will occur, and to what degree. However, it is expected that degradation will not occur uniformly throughout the buffer, resulting in an overestimation of potential effects. The potential effects from windthrow, fugitive dust, and invasive species will be minimized through adherence to the mitigation and management strategies outlined within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11). However, the maximum extent that can be degraded has been assessed and reported as a precautionary approach.

In summary, this potential residual effect is considered **not significant (minor)**.

17.8.2.3 Overall Effect on Potential Pine Mushroom Habitat

The overall effect assessment of potential pine mushroom habitat includes the residual effects of vegetation loss and degradation. Despite a medium magnitude effect for vegetation degradation, the overall rating is considered to be of low magnitude, given that degradation effects are not likely to be evenly distributed throughout the buffer. High-quality mushroom habitat in northwestern BC occurs south of the Project area, along the Nass River within a warmer climatic region. Much of the potential pine mushroom habitat identified is marginal for pine mushrooms, as both tree species composition and age are not comparable to species composition and age associated with high-quality pine mushroom habitat. The potential degradation effects from windthrow, fugitive dust, and invasive species will be minimized by applying the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11). The overall effect on potential pine mushroom habitat is considered **not significant (minor)**.

Table 17.8-2. Summary of Residual Effects on Potential Pine Mushroom Habitat

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects: Probability	Likelihood of Effects: Confidence Level	Significance Determination	Follow-up Monitoring
Vegetation Loss	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Construction	Low	Local	Far future	One-time	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Not Required
	Camp 7: Unuk North Camp	Construction										
	Mitchell Operating Camp	Construction										
Vegetation Degradation	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Construction	Medium	Local	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Not Required
	Camp 7: Unuk North Camp	Construction										
	Mitchell Operating Camp	Construction										
Overall Residual Effect	All	Post-closure	Low	Local	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Not Required

17.8.3 Residual Effects Assessment for Avalanche Track Ecosystems

A summary of the residual effects with potential to be significant for avalanche track ecosystems is presented in Table 17.8-3.

17.8.3.1 Vegetation Loss

The residual effect of lost avalanche track vegetation is of medium magnitude, as an estimated 27% of the mapped avalanche track area within the most affected watershed (Sulphurets Creek) will be lost at closure (Table 17.7-6). Loss estimates within the other watersheds are less than 5% of their respective baseline distributions. Within the LSA, an estimated 13% of the mapped avalanche ecosystems will be lost. Loss of avalanche track ecosystems, local in extent because it occurs directly under the footprint, will extend into the far-future and is considered irreversible, given that the wildlife habitat objectives within the Closure Plan (Ch. 27) do not include restoration of avalanche ecosystems.

The loss occurs at one point in time, during clearing of vegetation during the construction and operation phases. Avalanche tracks have a neutral resiliency because although the vegetation could recover quickly from disturbance, their development is dependent on specific environmental processes.

The probability that loss of avalanche track vegetation will occur is high. Confidence in the mapping of avalanche tracks, and thus, the assessment of their loss is also high because avalanche tracks are easily recognizable features on imagery.

In summary, this potential residual effect is **not significant (moderate).**

17.8.3.2 Vegetation Degradation

Vegetation degradation is rated low in magnitude, as the Sulphurets Creek watershed, where effects are concentrated, has a degradation estimate of 18% of baseline distribution. The potential degradation effects from fugitive dust and invasive plants will be minimized through adherence to the mitigation and management strategies outlined within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11). Windthrow is unlikely to degrade avalanche track ecosystems, which are largely dominated by deciduous shrub and herbaceous plant species.

Degradation is local in extent, as it occurs directly adjacent to the footprint, within the degradation buffer. The potential for introduction and spread of invasive plant species will also occur sporadically; they could be introduced in different places, and at different times, depending on when and where machinery and vehicles are working. Although production of fugitive dust will occur regularly throughout the lifetime of the Project due to blasting, processing, and traffic on unpaved roads, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will be short-lived because of the frequent rain. As avalanche tracks are assumed to have neutral resiliency, the effects of degradation are generally reversible in the far-future (e.g., after construction, closure, and post-closure activities are complete). Degradation is irreversible in areas adjacent to infrastructure that is not reclaimed, as continued use can degrade adjacent vegetation.

The probability that some degradation will occur adjacent to Project infrastructure is medium. Although the non-treed nature of avalanche track ecosystems can make them more suitable habitat for invasive plant species than adjacent forested areas, introduced plants might not persist for long, depending on success of management treatments or other natural, competitive, forces. Uncertainties exist with respect to where degradation will occur, and to what degree.

It is assumed degradation will not occur uniformly throughout the degradation buffer, and as a result, the extent of potential effects is likely overestimated. However, the maximum extent that may be degraded has been assessed as a precautionary approach.

In summary, this potential residual effect is **not significant (minor)**.

17.8.3.3 Overall Effect on Avalanche Track Ecosystems

The overall effect on avalanche track ecosystems considers the residual effects of vegetation loss and degradation. With a medium magnitude effect for vegetation loss, the overall rating is also considered to be of medium magnitude. Given the extent of these ecosystems throughout most steep valleys throughout the LSA and RSA, this potential residual effect is **not significant (moderate).**

17.8.4 Residual Effects Assessment for Listed Ecosystems

A summary of the potential residual effects on listed ecosystems is presented in Table 17.8-4

17.8.4.1 Vegetation Loss

The residual effect of loss of listed ecosystems is rated low magnitude, as less than 5% of the baseline distribution in any of the watersheds will be lost (Table 17.7-8) at closure. The maximum watershed-level effect on listed ecosystems occurs within the Sulphurets Creek watershed, with a 4.5% loss of the baseline distribution. The effect is local in extent, as it occurs directly under the Project footprint. The loss occurs at one point in time, during clearing of vegetation during the construction and operation phases, and will extend into the far future. The effect is considered irreversible, as most of the provincially listed forest ecosystems are identified on the basis of their late seral (old forest) stage. The listed ecosystems are considered to have low resiliency because many, especially the riparian and floodplain communities, are adapted to very specific environmental conditions, such as flooding return intervals. If the soil moisture and nutrient regime, tree species, canopy cover, etc. were to change, the ecosystem might not support the plant communities previously identified within the listed ecosystems.

The probability that listed ecosystems will be lost is medium as the confidence in their mapped distribution is medium. In general, ecosystem mapping is considered better able to accurately identify ecosystems that are common on the landscape than the rarer elements (Smith et al. 2002; Smith et al. 2003). Despite this, there is high confidence in the mapping of listed ecosystems present within the infrastructure areas, as these have been heavily ground-truthed.

In summary, this potential residual effect is **not significant (minor).**

Table 17.8-3. Summary of Residual Effects on Avalanche Track Ecosystems

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Vegetation Loss	Kerr Pit, Mitchell Pit, and Mitchell Ore Preparation Complex	Construction	Medium	Local	Far future	One-time	Irreversible	Neutral	High	High	Not Significant (Moderate)	Not Required
	Water Storage Facility	Construction										
	Coulter Creek Access Corridor (within Sulphurets watershed)	Construction										
	Explosives Manufacturing Facility	Construction										
	Temporary Frank Mackie Glacier access route	Construction										
	North Cell TMF	Construction										
	East Catchment Diversion	Construction										
	Water Treatment and Energy Recovery Area	Construction										
	Mitchell Rock Storage Facility	Construction										
	McTagg Rock Storage Facility	Operation										
	South Cell TMF	Operation										
Vegetation Degradation	Kerr Pit, Mitchell Pit and Mitchell Ore Preparation Complex	Construction	Low	Local	Far future	Sporadic	Reversible long-term	Neutral	Medium	Medium	Not Significant (Minor)	Not Required
	Water Storage Facility	Construction										
	Coulter Creek Access Corridor (within Sulphurets watershed)	Construction										
	Explosives Manufacturing Facility	Construction										
	Temporary Frank Mackie Glacier access route	Construction										
	North Cell TMF	Construction										
	East Catchment Diversion	Construction										
	Water Treatment and Energy Recovery Area	Construction										
	Mitchell Rock Storage Facility	Construction										
	McTagg Rock Storage Facility	Operation										
	South Cell TMF	Operation										
Overall Residual Effect	All	Post-closure	Medium	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not Significant (Moderate)	Not Required

Table 17.8-4. Summary of Residual Effects on Listed Ecosystems

Description of Residual Effect	Project component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Vegetation Loss	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Construction	Low	Local	Far future	One-time	Irreversible	Low	Medium	Medium	Not Significant (Minor)	Not Required
	Camp 7: Unuk North Camp	Construction										
	Camp 8: Unuk South Camp	Construction										
Vegetation Degradation	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Construction	Medium	Local	Far future	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Not Required
	Camp 7: Unuk North Camp	Construction										
	Camp 8: Unuk South Camp	Construction										
Overall Residual Effect	All	Post-closure	Low	Local	Far future	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Not Required

17.8.4.2 Vegetation Degradation

Vegetation degradation is rated medium magnitude for listed ecosystems due to the estimated 29.9% degradation effect within the Sulphurets Creek watershed (Table 17.7-24). However, the potential effects of windthrow, fugitive dust, and invasive plant species will be minimized through adherence to the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11).

Degradation is local in extent as it occurs adjacent to the footprint, within the degradation buffer. Windthrow effects could occur sporadically for several years after vegetation clearing, but downed trees and structural changes along forest edges would last considerably longer. The potential for introduction and spread of invasive plant species will also occur sporadically; they may be introduced in different places, and at different times, depending on when and where machinery and vehicles are working.

Although production of fugitive dust may occur regularly throughout the Project life largely due to vehicle and machinery traffic on unpaved roads, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will likely be short-lived because of the frequent rain. Degradation effects are considered reversible in the far-future (e.g., after construction, closure, and post-closure activities are complete). Exceptions to reversibility occur within areas adjacent to infrastructure, such as roads and transmission lines, which are not reclaimed, as continued use of these features can degrade adjacent vegetation.

The probability that some degradation will occur in listed ecosystems is medium because the confidence in the distribution of these ecosystems is medium and uncertainty exists with respect to where effects could occur, and to what degree. It is expected that degradation will not occur uniformly throughout the buffer, resulting in an overestimation of potential effects. However, the maximum extent of these ecosystems that may be degraded has been assessed as a precautionary approach. In summary, this potential residual effect is considered **not significant (minor).**

17.8.4.3 Overall Effect on Listed Ecosystems

The overall effect on listed ecosystems considers the residual effects of vegetation loss and degradation. Despite a medium magnitude effect for degradation, the overall rating is considered low magnitude, given that potential effects from windthrow, fugitive dust, and invasive plants will be minimized by applying the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11). The overall effect on listed ecosystems is considered **not significant (minor)**.

17.8.5 Residual Effects Assessment for Riparian and Floodplain Ecosystems

A summary of the residual effects with potential to be significant for riparian and floodplain ecosystems is presented in Table 17.8-5.

17.8.5.1 Vegetation Loss

The residual effect of riparian and floodplain vegetation loss (for the non-listed ecosystems) is rated low magnitude at closure, as less than 15% within any local watershed will be lost (Table 17.7-10), and because additional area will be compensated through the Fish Habitat Compensation Plans (Appendices 15-Q and 15-R) and Wetland Habitat Compensation Plan (Appendix 16-B). The effect is local in extent as it occurs directly under the Project footprint. The loss occurs at one point in time, during clearing of vegetation during the construction and operation phases, and will extend into the far future. The effect is considered irreversible where infrastructure is permanent but may be reversible in the long term within portions of the TMF that will be reclaimed as riparian habitat. Being naturally dynamic, frequently disturbed ecosystems, riparian and floodplain ecosystems are inherently resilient to a level of disturbance. However, this resilience does not necessarily apply to anthropogenic disturbances to which ecosystems are not naturally accustomed. In that regard, riparian and floodplain ecosystems have low resiliency as they are reliant on specific environmental conditions, such as flooding and soil moisture regimes, which, if altered, have potential to greatly alter their baseline structure and function.

The probability that loss of riparian and floodplain ecosystems will occur is high, especially within the TMF and McTagg and Mitchell RSFs. In some areas, the exact amount lost remains uncertain, as the footprint may not affect the riparian component, where it occurs within a TEM polygon mapped with two or three different ecosystems. In summary, this potential residual effect is considered **not significant (minor).**

17.8.5.2 Vegetation Degradation

Nearly 30% of riparian and floodplain ecosystems in the Sulphurets Creek watershed (17% within the LSA, Table 17.7-9) could be degraded at closure, a medium magnitude effect. However, the potential effects from windthrow, fugitive dust, and invasive species will be minimized through application of the mitigation and management strategies outlined within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11).

Degradation is local in extent as it occurs directly adjacent to the footprint, within the degradation buffer. Windthrow may occur sporadically for several years after vegetation clearing, but downed trees and structural changes along forest edges would last considerably longer. The potential for introduction and spread of invasive plant species will also occur sporadically; they may be introduced in different places, and at different times, depending on when and where machinery and vehicles are working. Although production of fugitive dust may occur regularly throughout the Project life due to ongoing blasting, processing, and use of vehicles and machinery on unpaved roads, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will be short-lived because of the frequent rain. Degradation effects are generally reversible in the far future (e.g., after construction, closure, and post-closure activities are complete), with the exception of infrastructure such as roads and transmission lines that are not reclaimed; the continued use may degrade adjacent vegetation. Riparian zones with a sparse cover of invasive plants, or with a recent dense cover, may be restored to baseline condition through removal of invasive species, but this may be more difficult if the natural hydrology has been altered (Richardson et al. 2007).

Table 17.8-5. Summary of Residual Effects on Riparian and Floodplain Ecosystems

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Vegetation Loss	Access roads: Coulter Creek, Treaty Creek, Treaty Saddle, Sulphurets Valley, and explosives access roads	Construction	Low	Local	Far future	One-time	Irreversible	Low	High	Medium	Not Significant (Minor)	Not Required
	North, Centre, and South Cell TMF	Construction										
	Kerr, Sulphurets, and Mitchell Pits	Construction										
	McTagg and Mitchell Rock Storage Facilities	Construction										
	Sulphurets laydown area	Construction										
	Water Storage Facility	Construction										
Vegetation Degradation	Access roads: Coulter Creek, Treaty Creek, Treaty Saddle, Sulphurets Valley, and explosives access roads	Construction	Medium	Local	Far future	Sporadic	Reversible long-term	Low	High	Medium	Not Significant (Minor)	Not Required
	North, Centre, and South Cell TMF	Construction										
	Kerr, Sulphurets, and Mitchell Pits	Construction										
	McTagg and Mitchell Rock Storage Facilities	Construction										
	Sulphurets laydown area	Construction										
	Water Storage Facility	Construction										
Overall Residual Effect	All	Post-closure	Low	Local	Far future	Sporadic	Irreversible	Low	High	Medium	Not Significant (Minor)	Not Required

The probability that some degradation will occur adjacent to infrastructure is high. The high edge-to core ratio of linear riparian and floodplain ecosystems makes them more susceptible to effects of windthrow and invasive plants. Their dynamic nature, and the fact that watercourses act as conduits for plant propagules, also increases their susceptibility to invasive plants (Richardson et al. 2007).

Although the maximum degradation extent has been assessed as a precautionary approach, it is expected that effects will not occur uniformly throughout the buffer, resulting in an overestimation of potential effects.

In summary, this potential residual effect is considered **not significant (minor).**

17.8.5.3 Overall Effect on Riparian and Floodplain Ecosystems

The overall effect on riparian and floodplain ecosystems considers the residual effects of vegetation loss and degradation. Despite a medium magnitude degradation estimate, the overall rating is considered low magnitude, given that potential effects from windthrow, fugitive dust, and invasive species will be minimized through application of the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11).

The overall effect on riparian and floodplain ecosystems is considered **not significant (minor)**.

17.8.6 Residual Effects Assessment for Alpine and Parkland Ecosystems

A summary of the potential residual effects on alpine and parkland ecosystems is presented in Table 17.8-6.

17.8.6.1 Vegetation Loss

The residual effect of alpine and parkland vegetation loss is of low magnitude, as an estimated 12% of baseline ecosystems in the Sulphurets Creek watershed may be lost at closure (Table 17.7-12). Smaller losses (typically less than 1% of their respective baseline distributions) are expected within each of the other watersheds. The effect is local in extent, as it occurs directly under the footprint. The loss occurs at one point in time, during clearing of vegetation during the construction and operation phases, and will extend into the far future. Alpine and parkland ecosystems have a low resilience, because the harsh environment results in very slow vegetation growth (see Section 17.5.1). The loss of alpine and parkland vegetation is considered irreversible; no reclamation activity is proposed within alpine and parkland ecosystems.

The probability that loss of alpine and parkland vegetation will occur is high, although uncertainty exists around the precise type of vegetation communities affected, as much of the low-growing, sparse vegetation can be difficult to accurately identify from aerial imagery.

Given the effect is localized within a single watershed (Sulphurets Creek) and is within the range of a low magnitude effect, the potential residual effect is considered **not significant (minor)**.

17.8.6.2 Vegetation Degradation

Alpine and parkland ecosystems have a low resilience to vegetation degradation effects, because the harsh environment inherently places large constraints on ecosystems, resulting in very slow vegetation growth.

Vegetation degradation is rated low in magnitude, as an estimated 16% of the mapped alpine and parkland ecosystems in the Sulphurets Creek watershed could be degraded (below the threshold for a medium magnitude effect). The effects from invasive species and dust will be minimized through adherence to the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11).

Degradation is local in extent as it occurs directly adjacent to the footprint, within the degradation buffer. The potential for introduction and spread of invasive plant species will also occur sporadically; they may be introduced in different places, and at different times, depending on when and where machinery and vehicles are working. Although production of fugitive dust will occur regularly due to blasting, processing, and traffic on unpaved roads, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will likely be short-lived because of the frequent rain. The effects of degradation are generally reversible in the far-future (e.g., after construction, closure, and post-closure activities are complete), except where adjacent to infrastructure that is not reclaimed. Although it is expected that effects will not occur uniformly throughout the degradation buffer, uncertainty exists with respect to where, and to what degree, degradation may occur. As a result, there is medium probability that some degradation will occur within alpine and parkland ecosystems. As the maximum degradation extent has been assessed as a precautionary approach, the estimated effects are likely overestimated.

In summary, this potential residual effect is **not significant (minor)**.

17.8.6.3 Overall Effect on Alpine and Parkland Ecosystems

The overall effect assessment of alpine and parkland ecosystems includes residual effects of vegetation loss and degradation. With low magnitude estimates for each potential effect, the overall rating is also considered low magnitude. Potential effects from windthrow, fugitive dust, and invasive plants will be minimized through adherence to the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11). The overall effect on alpine and parkland ecosystems is considered **not significant (minor).**

17.8.7 Residual Effects Assessment for Old Forest Ecosystems

A summary of residual effects with potential to be significant for old forests is presented in Table 17.8-7. Residual effects of old forest loss and degradation are estimated using TEM-derived results, as the field surveys provide the best source of local stand age and structure information.

Table 17.8-6. Summary of Residual Effects on Alpine and Parkland Ecosystems

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects: Probability	Likelihood of Effects: Confidence Level	Significance Determination	Follow-up Monitoring
Vegetation Loss	Camp 3: Eskay Staging Camp	Construction	Low	Local	Far future	One-time	Irreversible	Low	High	Medium	Not Significant (Minor)	Not Required
	Coulter Creek Access Corridor	Construction										
	Mitchell Rock Storage Facility	Construction										
	Mine Site Avalanche Control	Construction										
	Kerr, Sulphurets, and Mitchell Pits	Construction										
	Sulphurets Laydown Area	Construction										
	Temporary Frank Mackie Glacier access route	Construction										
	Construction Access Adit	Construction										
	Mitchell-Treaty Saddle Area	Construction										
	McTagg Rock Storage Facility and Diversion Tunnels	Operation										
	Kerr Rope Conveyor	Operation										
Vegetation Degradation	Camp 3: Eskay Staging Camp	Construction	Low	Local	Far future	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Not Required
	Coulter Creek Access Corridor	Construction										
	Mitchell Rock Storage Facility	Construction										
	Mine Site Avalanche Control	Construction										
	Kerr, Sulphurets, and Mitchell Pits	Construction										
	Sulphurets laydown area	Construction										
	Temporary Frank Mackie Glacier access route	Construction										
	Construction Access Adit	Construction										
	Mitchell-Treaty Saddle Area	Construction										
	McTagg Rock Storage Facility and Diversion Tunnels	Operation										
	Kerr Rope Conveyor	Operation										
Overall Residual Effect	All	Post-closure	Low	Local	Far future	Sporadic	Irreversible	Low	High	Medium	Not Significant (Minor)	Not Required

Table 17.8-7. Summary of Residual Effects on Old Forest Ecosystems

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects: Probability	Likelihood of Effects: Confidence Level	Significance Determination	Follow-up Monitoring
Vegetation Loss	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Construction	High	Local	Far future	One-time	Irreversible	Low	High	Medium	Not Significant (Moderate)	Not Required
	Camp 7: Unuk North Camp	Construction										
	Mitchell Operating Camp	Construction										
	Explosives Manufacturing Facility	Construction										
	Camp 2: Ted Morris Camp	Construction										
	Sulphurets access road	Construction										
	Sulphurets laydown area	Construction										
	Water Treatment and Energy Recovery Area	Construction										
	Mitchell Rock Storage Facility	Construction										
	Water Storage Facility	Construction										
	South, Centre and North Cell TMF	Construction										
	Saddle Dam, Splitter Dam, North Dam	Construction										
Vegetation Degradation	Coulter Creek Access Corridor; Treaty Creek Access Corridor	Construction	High	Local	Far future	Sporadic	Reversible long-term	Low	Medium	Medium	Not Significant (Minor)	Not Required
	Camp 7: Unuk North Camp	Construction										
	Mitchell Operating Camp	Construction										
	Explosives Manufacturing Facility	Construction										
	Camp 2: Ted Morris Camp	Construction										
	Sulphurets access road	Construction										
	Sulphurets laydown area	Construction										
	Water Treatment and Energy Recovery Area	Construction										
	Mitchell Rock Storage Facility	Construction										
	Water Storage Facility	Construction										
	South, Centre, and North Cell TMF	Construction										
	Saddle Dam, Splitter Dam, North Dam	Construction										
Overall Residual Effect	All	Post-closure	High	Local	Far future	Sporadic	Irreversible	Low	High	Medium	Not Significant (Moderate)	Not Required

17.8.7.1 Vegetation Loss

An estimated 35% of the baseline (TEM) old forests could be lost from the Sulphurets Creek watershed, a high magnitude effect. A medium magnitude loss (25% of baseline) could result within the Treaty Creek watershed. The effect is local in extent as it occurs directly under the footprint, with loss occurring at one point in time, during clearing of vegetation during the construction and operation phases. Losses will extend into the far future, and are considered since old forests, even where reclamation objectives include the restoration of coniferous forest, could take hundreds of years to re-establish. This lengthy recovery period is the reason for the low resiliency determination.

The probability that old forests will be lost is high, although the confidence in the amount that will be lost is medium, as old forests can be difficult to distinguish from mature forests when attributing TEM polygons. The much greater area of old forests mapped by the provincial VRI forest inventory program, resulting in low magnitude effects at the LSA and individual watershed scales, suggests that their extent could be much greater than the TEM estimate. Given the infrequency of large scale disturbances within this cool, wet region of the province, old forest ecosystems may be underestimated in the TEM data.

In summary, this potential residual effect is **not significant (moderate)**.

17.8.7.2 Vegetation Degradation

Vegetation degradation is rated high in magnitude within the Sulphurets Creek watershed, with an estimated 38% of the baseline distribution degraded. Moderate magnitude degradation (22% of baseline) is estimated within the Treaty Creek watershed. Degradation is local in extent, as it occurs directly adjacent to the Project footprint, within the degradation buffer. Windthrow may occur sporadically for several years after vegetation clearing, but the downed trees and structural changes along forest edges would last considerably longer. The potential for introduction and spread of invasive plant species will also occur sporadically; they may be introduced in different places, and at different times, depending on when and where machinery and vehicles are working. Although production of fugitive dust may occur regularly throughout the lifetime of the Project due to blasting, processing, and use of vehicles and machinery, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will likely be short-lived because of the frequent rain. Degradation effects are considered reversible in the far future (e.g., after construction, closure and post-closure activities are complete), except where infrastructure, such as roads and transmission lines, are not reclaimed; continued use may degrade adjacent old forests.

The much greater area of old forests mapped by VRI, results in an estimated low magnitude effect at the LSA scale. However, similar to the TEM data, a high magnitude effect is estimated within the Sulphurets Creek watershed. Given the infrequency of large scale disturbances within this cool, wet region of the province, old forest ecosystems are likely more common than indicated by the TEM data. Effects will likely not occur uniformly throughout the degradation buffer, and uncertainty exists with respect to exactly where, and to what degree, degradation could occur. As a result, there is medium probability that some degradation will occur within old forest ecosystems. As the maximum extent that may be degraded has been assessed as a precautionary approach, the extent of these effects could be overestimated.

In summary, this potential residual effect is **not significant (minor).**

17.8.7.3 Overall Effect on Old Forest Ecosystems

The overall effect on old forest ecosystems considers the residual effects of vegetation loss and degradation. With high magnitude effects for vegetation loss and degradation within the Sulphurets Creek watershed, the overall rating is also considered high magnitude. However potential degradation effects from windthrow, fugitive dust, and invasive plants will be minimized by adhering to the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11).

Large differences exist between the baseline old forest distributions within the LSA, with the provincial VRI forest inventory estimate more than five times greater than the TEM-derived estimate. This suggests the true old forest area could be greater than the TEM estimate.

The overall effect on old forest ecosystems is considered **not significant (moderate)**.

17.8.8 Residual Effects Assessment for Other Terrestrial Ecosystems

A summary of the residual effects with potential to be significant for other terrestrial ecosystems is presented in Table 17.8-8.

17.8.8.1 Vegetation Loss

The residual effect of vegetation loss within other terrestrial ecosystems is rated low magnitude as an estimated 11% of baseline ecosystems could be lost within the LSA (Table 17.7-17), primarily within the Teigen Creek, Treaty Creek, and Sulphurets Creek watersheds.

The effect is local in extent because it occurs directly under the footprint. The loss occurs at one point in time, during vegetation clearing during the construction and operation phases. The loss will extend into the far future and is irreversible where infrastructure is permanent, but reversible in the long term in areas re-vegetated during reclamation. Other terrestrial ecosystems have a neutral resiliency and, over time, may return to functioning ecosystems comprising largely native species. However, the restoration of ecosystems to baseline conditions depends on reclamation success and a variety of site and soil characteristics including depth and texture of surficial material and soil and the relative moisture and nutrient regimes.

The probability of vegetation loss within other ecosystems is high, but the confidence in the amount that will be lost is medium. Ecosystem maps inherently contain some error, as the entire map cannot be ground-truthed and subjective estimates are necessary during mapping. However, because of the range of data used by the mappers to increase knowledge of the area (e.g., provincial forest inventory data and cutblock data), the high spatial resolution of the aerial photographs that were interpreted, and because the map was refined following two seasons of field surveys, the mapping is assumed to be sufficiently accurate to make this determination.

In summary, this potential residual effect is **not significant (minor)**.

Table 17.8-8. Summary of Residual Effects on Other Terrestrial Ecosystems

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects		Significance Determination	Follow-up Monitoring
									Probability	Confidence Level		
Vegetation Loss	Most Project Areas / Components	Construction	Low	Local	Far future	One-time	Irreversible	Neutral	High	Medium	Not Significant (Minor)	Not Required
Vegetation Degradation	Most Project Areas / Components	Construction	Low	Local	Far future	Sporadic	Reversible long-term	Neutral	High	Medium	Not Significant (Minor)	Not Required
Overall Residual Effect	All	Post-closure	Low	Local	Far future	Sporadic	Reversible long-term	Neutral	High	Medium	Not Significant (Minor)	Not Required

17.8.8.2 Vegetation Degradation

Vegetation degradation is rated low in magnitude as less than 20% of vegetation within any local watershed will be affected. In addition, the potential effects from windthrow, fugitive dust, and invasive species will be minimized through adherence to the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11).

Degradation is local in extent as it occurs directly adjacent to the footprint, within the degradation buffer. Windthrow may occur sporadically for several years after vegetation clearing, but the downed trees and structural changes along forest edges would last considerably longer. The potential for the introduction and spread of invasive plants will also occur sporadically; they may be introduced in different places, and at different times, depending on when and where machinery and vehicles are working. Although production of fugitive dust may occur regularly due to blasting, processing, and use of vehicles and machinery on unpaved roads, deposition on vegetation, both temporally and spatially, is considered sporadic. Dust accumulation on vegetation will likely be short-lived because of the frequent rain. The effects of degradation are generally reversible in the far-future (e.g., after construction, closure, and post-closure activities are complete), except where infrastructure such as roads and transmission lines are not reclaimed; continued use may degrade adjacent ecosystems. Other terrestrial ecosystems have a neutral resiliency but are not immune to degradation effects and can take time to recover.

Although it is expected that effects will not occur uniformly throughout the degradation buffer, uncertainty exists with respect to where and to what degree degradation may occur. As a result, there is medium probability that some degradation will occur within other ecosystems. As the maximum extent that may be degraded has been assessed as a precautionary approach, the extent of these effects is likely overestimated. In summary, this potential residual effect is **not significant (minor)**.

17.8.8.3 Overall Effect on Other Terrestrial Ecosystems

The overall effect on other terrestrial ecosystems considers residual effects of vegetation loss and degradation. The effects are considered low magnitude. Potential degradation effects from windthrow, fugitive dust, and invasive species will be minimized by adhering to the mitigation and management strategies described within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26.20) and the Air Quality Management Plan (Chapter 26.11). The overall effect on other terrestrial ecosystems is considered **not significant (minor).**

17.9 Potential Cumulative Effects for Terrestrial Ecosystems

The KSM Project may result in residual effects of vegetation loss and vegetation degradation (summarized in Table 17.9-1). Due to the potential for residual effects, a cumulative effects assessment is required.

Direct loss of terrestrial ecosystems will result from vegetation clearing during the construction, operation, and in a few instances, closure phases. The majority of losses are expected within the proposed Mine Site, PTMA, and access roads.

Table 17.9-1. Summary of Potential Linkages between KSM Project and Other Human Actions in Regards to Terrestrial Ecosystems

Action/Project	Past	Present	Future
Past Projects			
Eskay Creek Mine	X; vegetation loss and degradation	NL	X; vegetation degradation
Granduc Mine	X; vegetation loss and degradation	NL	NL
Johnny Mountain Mine	X; vegetation loss and degradation	NL	NL
Snip Mine	X; vegetation loss and degradation	NL	NL
Sulphurets Project	X; vegetation loss and degradation	NL	NL
Kitsault Mine (Closed)	NL	NL	NL
Swamp Point Aggregate Mine	NL	NL	NL
Present Projects			
Forrest Kerr Hydroelectric	NL	X; vegetation loss and degradation	X; vegetation degradation
Long Lake Hydroelectric	NL	X; vegetation loss and degradation	X; vegetation degradation
Northwest Transmission Line (NTL)	NL	X; vegetation loss and degradation	X; vegetation degradation
Red Chris Mine	NL	NL	NL
Wolverine Mine	NL	NL	NL
Future Projects			
Arctos Anthracite Coal Mine	NL	NL	NL
Bronson Slope Mine	NL	NL	X; vegetation loss and degradation
Brucejack Mine	NL	NL	X; vegetation loss and degradation
Galore Creek Mine	NL	NL	X; vegetation loss and degradation
Granduc Copper Mine	NL	NL	X; vegetation loss and degradation
McLymont Creek Hydroelectric	NL	NL	X; vegetation loss and degradation
Snowfield Project	NL	NL	X; vegetation loss and degradation
Treaty Creek Hydroelectric (three proposed sites)	NL	NL	X; vegetation loss and degradation
Kitsault Mine	NL	NL	NL
Kutcho Mine	NL	NL	NL
Schaft Creek Mine	NL	NL	NL

(continued)

Table 17.9-1. Summary of Potential Linkages between KSM Project and Other Human Actions in Regards to Terrestrial Ecosystems (completed)

Action/Project	Past	Present	Future
Storie Moly Mine	NL	NL	NL
Turnagain Mine	NL	NL	NL
Bear River Gravel	NL	NL	NL
Land Use Activities			
Agricultural Resources	NL	NL	NL
Fishing (commercial, recreational)	NL	NL	NL
Guide Outfitting	NL	NL	NL
Aboriginal Harvest (fishing, hunting/trapping, and plant harvest)	NL	NL	NL
Resident Trapping	NL	NL	NL
Mineral and Energy Resource Exploration	X; vegetation loss and degradation	X; vegetation loss and degradation	X; vegetation loss and degradation
Recreation and Tourism (parks and commercial tenures)	NL	NL	NL
Timber Harvesting (forestry)	X; vegetation loss and degradation	NL	X; vegetation loss and degradation
Traffic and Roads	X; vegetation loss and degradation	X; vegetation degradation	X; vegetation loss and degradation

Note: X = potential linkage with Project or activity; NL = no linkage with Project or activity.

Degradation of terrestrial ecosystems, expected to occur within, but not evenly throughout, the degradation buffer, can result from the accumulation of dust along roads due to traffic and near blasting and ore processing facilities. Potential degradation effects also include the introduction and spread of invasive plants and windthrow of trees adjacent to new clearings in forested ecosystems. Degradation effects that alter the structure and function of ecosystems may result from changes to natural hydrology patterns, especially for riparian and floodplain ecosystems; the potential effects resulting from hydrologic changes are assessed within the Fish and Aquatic Habitat Effects Assessment (Chapter 15).

Potential losses resulting from development of the proposed KSM Project are expected within each of the terrestrial ecosystem VCs:

- potential pine mushroom habitat;
- avalanche track ecosystems;
- riparian and floodplain ecosystems;
- alpine and parkland ecosystems;
- old forest ecosystems;
- listed ecosystems (BC CDC red- and blue-listed); and
- other terrestrial ecosystems.

Mitigation has previously occurred throughout the Project design phase. For example, road and transmission line corridors have been modified through ground verification to minimize potential losses within several sensitive and potentially listed ecosystems. Reclamation objectives, based upon wildlife habitat considerations after closure, do not include restoration of sites to pre-development (baseline) conditions. In the far future (e.g., many decades from now), many re-vegetated areas are likely to differ from baseline conditions due to alteration of topography (slope and aspect), surficial materials (type and texture), and other soil properties (depth and physical/chemical composition) affecting vegetation establishment. For these reasons, reclamation will not mitigate the loss of terrestrial ecosystems resulting from construction and operation activities.

17.9.1 Scoping of Cumulative Effects

17.9.1.1 Spatial Linkages with Other Projects and Human Actions

Other projects and land use activities with potential to result in additive or synergistic effects are proposed within or near the proposed KSM Project. Vegetation loss and degradation associated with each of the projects and activities has potential to increase the cumulative level of residual effect expected from this Project alone.

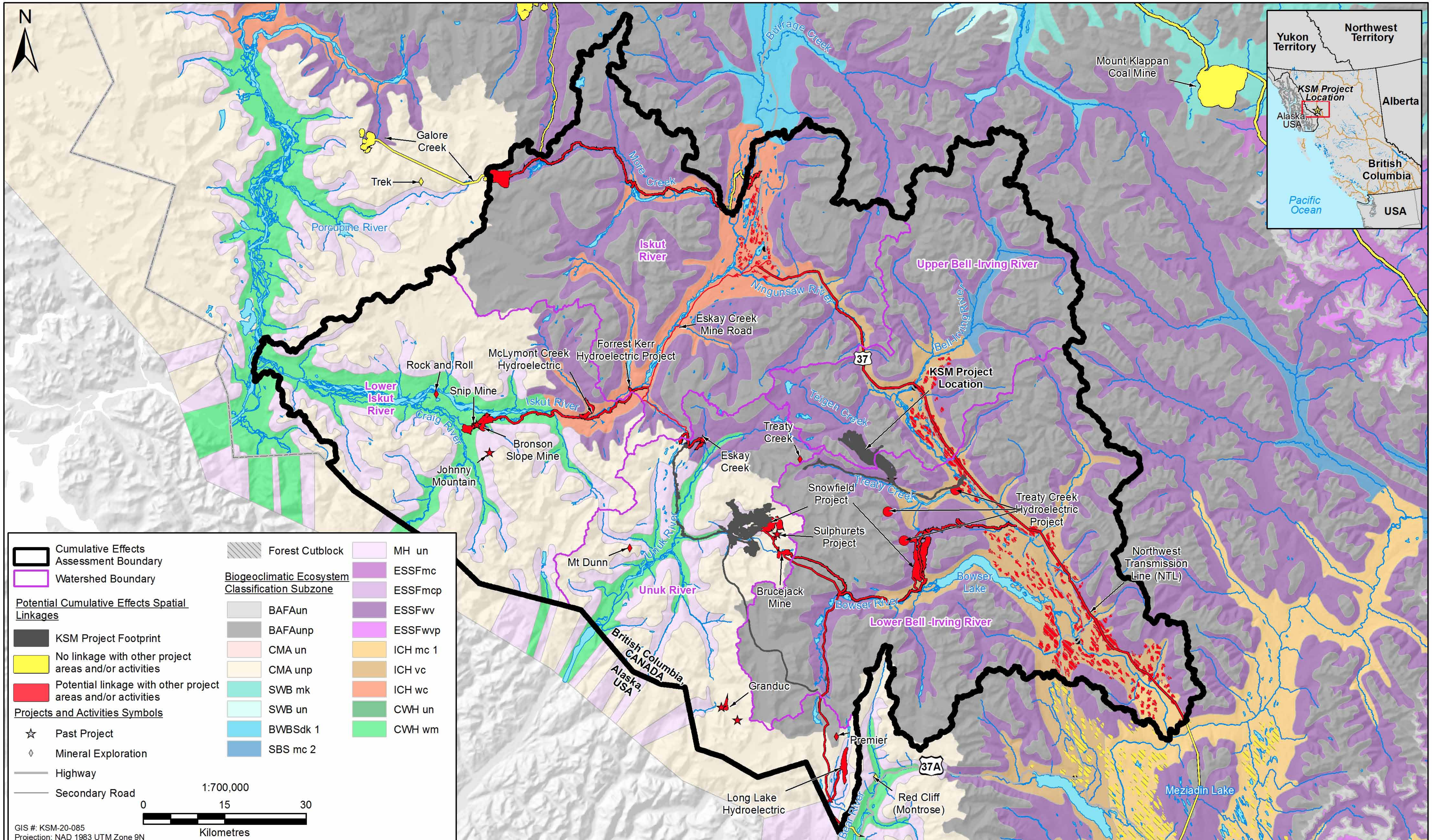
A Terrestrial Ecosystems CEA boundary (Figure 17.9-1) was developed to identify other projects and land use activities with potential spatial and/or temporal linkage with the KSM Project. Consistent with the approach of adopting watersheds as the assessment area of residual effects of the Project on VCs, the CEA boundary also retains a watershed-based approach, albeit incorporating higher-order watersheds. Watersheds that overlapped any Project infrastructure or roads required to access the infrastructure (such as the Eskay Creek Mine road), were included in the CEA boundary. Watersheds comprising the CEA boundary include the Upper Bell-Irving River, Lower Bell-Irving River, Iskut River, Lower Iskut River, and Unuk River. This 1,300,000 ha CEA boundary outlines a sustainable area of terrestrial ecosystems in which the proposed KSM Project is situated.

All past, present, and reasonably foreseeable future projects, as well as other land use activities, with potential to result in additional loss or degradation of the terrestrial ecosystem VCs were assessed.

17.9.1.2 Temporal Linkages with other Projects and Human Actions

Chapter 5 (Section 5.3.2) defines temporal boundaries for use in the cumulative effects assessment as:

- Past – 1964 to 2008: coinciding with the development of the Granduc copper-gold mine, which influenced the growth of the community of Stewart and other human activities in the area;
- Present – 2008 to 2013: from the start of KSM baseline studies to the completion of the environmental effects assessment; and
- Future – variable according to the time estimated for VCs to recover to baseline conditions.



SEABRIDGE GOLD
KSM PROJECT

Rescan Engineers & Scientists

Figure 17.9-1

KSM Cumulative Effects Issue Scoping: Potential Spatial Linkages for Terrestrial Ecosystems

Table 17.9-1 summarizes the human actions, including past, present, and reasonably foreseeable future projects and other land use activities with potential to result in additional loss, degradation, or alteration of terrestrial ecosystem VCs. Summary information for each project is provided within Chapter 5 (Section 5.3), including details (as available) on the production, lifespan, footprint, access and roads, traffic, tailing storage, water use, and employment. Projects identified with "NL," meaning no linkage, are assumed to have no potential for linkage within the respective temporal boundary (Past, Present, Future). The Eskay Creek Mine, closed in 2008, is assessed as a past linkage to the KSM Project. The Eskay Creek Mine road remains a key access corridor for the proposed KSM Project.

Despite having potential for cumulative loss and degradation effects, several mineral and energy resource exploration activities identified within the CEA boundary, including the Rock and Roll, Mt. Dunn, Treaty Creek, and Premier projects are not assessed further given their small footprint, lack of available ecological information, and expectation that effects will be of nil to low magnitude within the CEA boundary.

Similarly, potential effects of other land use activities associated with Aboriginal harvesting (of plants, mushrooms, fish, and wildlife species), resident trapping, and recreation and tourism are expected to be of nil to low magnitude at the assessment scale and are not assessed further. Many of the projects identified as "NL" occur outside of the CEA boundary.

17.9.2 Cumulative Effects Assessment for Potential Pine Mushroom Habitat

To best estimate potential pine mushroom habitat, the completion of detailed terrain and ecosystem mapping is required. However, some research suggests that ecosystem mapping may not currently provide the accuracy required for pine mushroom habitat identification at finer spatial scales (Ehlers, Fredrickson, and Berch 2007). Within the Project area, the mapped potential mushroom habitat was limited to the CWHwm and ICHvc BEC subzones as the higher elevation forested BEC zones (MH and ESSF) were considered unsuitable, due to their cold and wet climates.

Based on the presence of current or proposed infrastructure within the ICH or CWH BEC zones, Table 17.9-2 summarizes those past, present, and future projects and/or land use activities with potential to cumulatively interact with the residual effects estimated for the KSM Project.

17.9.2.1 Project-specific Residual Effects on Potential Pine Mushroom Habitat Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of potential pine mushroom habitat have the potential to result from one or more of the project activities identified in Table 17.9-2. Projects identified with "NL" are assumed to have no past, present, or future linkage.

17.9.2.2 Cumulative Effect of Vegetation Loss

Direct loss of potential pine mushroom habitat could have resulted from vegetation clearing during construction of Highway 37 and from previous timber harvesting activities at low elevations near the highway. Given the preponderance of high coarse fragment glacial fluvial deposits along Highway 37, it is possible that some high-quality pine mushroom habitat was lost. However, this cannot be quantified, as mapping of potential mushroom habitat is not available.

Table 17.9-2. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Potential Pine Mushroom Habitat

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities					
	Timber Harvesting – Forestry	Traffic and Roads	Eskay Creek Mine	Forrest Kerr Hydroelectric	Northwest Transmission Line	Brucejack Mine
Vegetation Loss	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities				
	Snowfield Project	McLymont Creek Hydroelectric	Treaty Creek Hydroelectric	Galore Creek Mine	Bronson Slope Mine
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

No information is available on potential habitat loss from past projects, including Eskay Creek Mine, the Sulphurets Project, or for either of the Johnny Mountain or Snip Mines, each located within the Iskut River drainage approximately 50 km northwest of the Eskay Creek Mine road. The Eskay Creek, Johnny Mountain, and Sulphurets projects are likely at elevations too high for pine mushrooms. Known harvesting locations presently exist along portions of the Eskay Creek Mine road within the ICHwc subzone.

Further loss may have resulted from each of the projects identified as a present linkage, all of which are presently under development. The Forrest Kerr Hydroelectric Project application, which addressed the residual cumulative effects of forest clearing, did not specifically assess pine mushroom as a VC. However, in their Application for an Environmental Assessment Certificate, Coast Mountain Hydro Corp. recognized the local cultural and economic importance of mushroom harvesting in the immediate vicinity of the proposed access road and development sites, including along the Eskay Creek Mine road. Through collaboration with First Nations (Iskut Band) and other local mushroom harvesters, Coast Mountain Hydro Corp. ensured that the proposed alignment of the final access road and transmission line poles minimized impact on known harvest sites. The Forrest Kerr Project was expected to result in little effect on mushroom harvesting (Coast Mountain Hydro Corp. 2002).

Pine mushrooms were assessed as a VC, under the species or groups of cultural, social, or economic importance, in the Northwest Transmission Line (NTL) Project EA. The residual effect of permanent alteration of mushroom habitat was considered of low magnitude given that 360 ha, a small portion of available mushroom habitat, was likely to be lost (Rescan 2010), primarily from the ICHmc1 BEC variant to the south of Meziadin Lake beyond the KSM CEA boundary area.

Each of the identified future projects has potential to remove additional pine mushroom habitat, especially where infrastructure requires forest clearing in low elevation CWH and ICH BEC zones.

Pine mushrooms were assessed as a valued economic component in the McLymont Creek Hydroelectric Project EA Application. Based on ecosystem mapping, guided by known harvesting locations provided by representatives of the Tahltan Nation, potential habitat was mapped on the south side of Iskut River. A total of 264 ha were mapped as potential habitat, including 164 ha and 100 ha to the east and west of Jennifer Creek, respectively. However, as described within the EA Application, the Tahltan Heritage Resources Environmental Assessment Team (THREAT) indicated limited harvesting opportunity in areas beyond the gated Eskay Creek Mine road. Development of the proposed McLymont Creek Project infrastructure will result in an estimated loss of 7.3 ha of potential habitat, although it may increase opportunities to harvest areas west of Jennifer Creek, which are presently difficult to access. A positive effect on pine mushroom harvesting was estimated due to the small area of habitat loss compared with the potential for other habitat to be accessed (Hemmera 2011).

Although the Galore Creek Mine EA Application did not assess pine mushroom habitat as a VC, portions of the access road developed from Highway 37 along More Creek, especially within the low elevation ICHwc BEC variant, may overlap areas of suitable habitat. As addressed in the McLymont Creek Application (Hemmera 2011), known habitat and harvesting locations exist within this same BEC variant along the Eskay Creek Mine road, approximately 20 km to the south.

Other future projects that could result in loss of potential pine mushroom habitat include the Brucejack and Snowfield projects (access roads), Bronson Slope Mine (mine site and access road), and Treaty Creek Hydroelectric Project (facility and access roads). Each of these projects has infrastructure proposed within low elevation ICH and CWH BEC subzones, which currently provide the majority of known habitat. A conceptual design for an access road to the Bronson Slope Mine from the Eskay Creek Mine road was developed in the 1990s by a group of exploration companies and the provincial and federal governments. Given the general similarity in ecosystems and topography to the KSM Project, it is expected that access roads for the future projects could result in a similar low magnitude residual effect upon potential pine mushroom habitat.

17.9.2.2.1 Project-specific Cumulative Effects Mitigation for Vegetation Loss

No specific mitigation has been developed to minimize loss of potential pine mushroom habitat, as the footprint does not overlap any presently known pine mushroom harvesting locations and high quality areas are often site-specific and not reliably estimated based on TEM attributes.

General management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize the loss of vegetated ecosystems, including potential pine mushroom habitat. They include minimizing all clearing dimensions and preferentially retaining areas of mature and old forest, where the option exists to remove younger stands.

17.9.2.2.2 Other Project/Activity Mitigation to Address Vegetation Loss

Apart from identifying known harvesting locations and collaborating with local Aboriginal groups and other resource users to minimize potential impacts, mitigation measures specific to minimizing loss of pine mushroom habitat were not provided within any of the past or present projects.

Given the high importance to the culture and economies of the local Aboriginal groups and other residents, it is assumed that future projects proposed within potential mushroom habitat will make appropriate efforts to identify the location of known pine mushroom harvesting sites early in the planning phases. It is expected that all future developments will continue to adopt or develop appropriate management and monitoring strategies to minimize potential effects from vegetation loss.

17.9.2.2.3 Determination of Potential for Residual Cumulative Effect and Significance

Despite application of the general mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, there remains potential for cumulative loss of pine mushroom habitat.

In addition to the estimated 66 ha of potential pine mushroom habitat loss from the KSM Project, further cumulative loss of 367 ha may result from the NTL and future McLymont Creek Hydroelectric projects, although most habitat loss is associated with potential effects from the NTL Project south of the CEA boundary. Each project estimated a low magnitude residual effect on potential mushroom habitat, and neither is expected to appreciably increase the magnitude of the potential effect expected from the KSM Project. Potential loss from other projects and land use activities, including timber harvesting within the low elevation ICH BEC units, were not assessed and remain unknown.

Summarized in Table 17.9-3, the residual cumulative effect of habitat loss represents a regional effect that is expected to last into the far future, with sporadic losses resulting from clearing associated with the respective developments. The effects will be irreversible where infrastructure is permanent but may be reversible in the long term where reclamation objectives include the restoration of coniferous forest. Given that ecosystem mapping, required for all developments, may not reliably predict pine mushroom habitat without incorporating local knowledge of mushroom presence, distribution, and harvesting locations, the probability that effects from other developments will occur is medium and the confidence level is medium.

Given that the present and proposed developments have identified small areas of potential habitat loss, estimated nil to low magnitude effects, and incorporated design changes to accommodate known areas of habitat and use, the residual cumulative effect is expected to be **not significant (minor).**

17.9.2.3 Cumulative effect of Vegetation Degradation

Degradation of potential pine mushroom habitat was estimated within a 100 m buffer surrounding the proposed Treaty Creek and Coulter Creek access roads and associated infrastructure. Vegetation degradation, through the introduction and spread of invasive species, deposition of fugitive dust, or windthrow effects could have resulted from the construction of Highway 37 and previous timber harvesting activity at low elevations near the highway. Mapping of potential mushroom habitat is not available to quantitatively assess the potential effect.

Further degradation may have resulted from each of the projects with a present linkage, all of which are presently under development. By using a buffer approach to estimate degradation (i.e., within a buffer surrounding the footprint), the area potentially degraded is directly linked to the area lost. Therefore, respective losses of potential mushroom habitat described for other past, present, and reasonably foreseeable future projects (Section 17.9.2.2) also provide an indication of potential degradation. Effects, especially along road edges, are likely correlated to the extent of road use and may not occur evenly throughout the buffer.

Present projects each estimate low magnitude effects on potential pine mushroom habitat. The Forrest Kerr Hydroelectric Project EA Application estimated little residual effect on mushroom harvesting) with a potential benefit of improved accessing to previously inaccessible habitat (Coast Mountain Hydro Corp. 2002). The NTL Project EA Application estimated the residual effect of permanent alteration of mushroom habitat to be low magnitude in comparison to the availability of mushroom habitat (Rescan 2010). The future McLymont Creek Hydroelectric Project EA Application also estimated the potential for a positive effect on pine mushroom harvesting due to the small area of habitat loss compared with the newly accessible habitat (Hemmera 2011). It is assumed that degradation associated with each project will constitute a similar low magnitude effect, given the small respective areas of loss and potential improvement in access for harvesting.

Other future projects (and infrastructure) with potential to result in degradation of potential pine mushroom habitat include the Galore Creek Mine (access road), Brucejack and Snowfield projects (access roads), Bronson Slope Mine (access road), and the Treaty Creek Hydroelectric Project (facilities and access roads).

Given the similarity in ecosystems and topography to the KSM Project, it is expected that the access roads for the future projects could each result in a similar low magnitude residual effect on potential pine mushroom habitat.

17.9.2.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

No specific mitigation has been developed to minimize loss of potential pine mushroom habitat, as the footprint does not overlap any presently known pine mushroom harvesting locations and high-quality areas are often very site-specific. General management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26) will minimize the degradation of vegetated ecosystems, including potential pine mushroom habitat. They include adopting management and monitoring programs to minimize erosion and windthrow effects and re-vegetating or re-seeding as soon as possible after clearing to minimize potential for introduction and spread of invasive plant species.

17.9.2.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Given the high importance to the culture and economies of the local Aboriginal groups and other residents, it is assumed that future projects proposed within potential mushroom habitat will make efforts to identify the location of known pine mushroom-harvesting sites early in the planning phases. It is expected all future developments will continue to adopt or develop appropriate management and monitoring strategies to minimize potential effects from vegetation degradation.

17.9.2.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the general mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, there remains potential for cumulative degradation of pine mushroom habitat.

In addition to the 235 ha of potential degradation estimated from the KSM Project, further degradation may result from the identified present or future projects. As each project identifies a low magnitude residual effect on potential mushroom habitat due to habitat loss, it is assumed degradation will represent a similar low magnitude effect.

Summarized in Table 17.9-3, the residual cumulative effect of habitat degradation represents a regional effect that is expected to last into the far future, with regular effects resulting from the clearing and continued use of infrastructure located within or adjacent to pine mushroom habitat. The effects will be reversible in the long term where infrastructure, such as access roads, are removed or no longer used, and assuming the respective vegetation management and monitoring recommendations are adopted. Given that ecosystem mapping, required for all developments, may not reliably predict pine mushroom habitat without incorporating local knowledge of mushroom presence, distribution, and harvesting locations, the probability that effects from other developments will occur is medium and the confidence level is medium.

Given that prime pine mushroom habitat occurs outside of the CEA boundary and that the present and proposed developments have identified small areas of potential habitat, estimated nil to low magnitude effects, and incorporated design changes to accommodate known habitat and use, the residual cumulative effect of degradation is expected to be **not significant (minor).**

Table 17.9-3. Summary of Residual Cumulative Effects on Potential Pine Mushroom Habitat

															Likelihood of Effects							
Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Probability	Probability Adjusted for CE	Confidence Level	Confidence Adjusted for CE	Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted for CE
Vegetation Loss		Construction	Low	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
	Eskay Creek Mine																					
	Forrest Kerr Hydroelectric																					
	Northwest Transmission Line																					
	Brucejack Mine																					
	Snowfield Project																					
	McLymont Creek Hydroelectric																					
	Treaty Creek Hydroelectric																					
	Galore Creek Mine																					
	Bronson Slope Mine																					
	Timber Harvesting - Forestry																					
	Traffic and Roads																					
Vegetation Degradation		Construction	Medium	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
	Eskay Creek Mine																					
	Forrest Kerr Hydroelectric																					
	Northwest Transmission Line																					
	Brucejack Mine																					
	Snowfield Project																					
	McLymont Creek Hydroelectric																					
	Treaty Creek Hydroelectric																					
	Galore Creek Mine																					
	Bronson Slope Mine																					
	Timber Harvesting - Forestry																					
	Traffic and Roads																					
Overall Effect	All	Post-closure	Low	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

Note:

CE = Cumulative Effect

17.9.2.4 Overall Cumulative Effect on Potential Pine Mushroom Habitat

Considering the potential for cumulative loss and degradation effects on potential pine mushroom habitat, the cumulative overall effect, summarized in Table 17.9-3, is expected to be **not significant (minor).**

17.9.3 Cumulative Effects Assessment for Avalanche Track Ecosystems

Cumulative effects on avalanche track ecosystems are best assessed using ecological inventories such as TEM and PEM, which delineate avalanche ecosystems as distinct ecosystems and enable the quantification of potential effects. The provincial VRI database was deemed unsuitable for use in this assessment as avalanche ecosystems are not delineated as distinct polygons.

Past, present, and future projects with developed or proposed infrastructure within mountainous terrain at middle to high elevations (i.e., within and above the MH and ESSF BEC zones) have highest potential to result in additional loss of avalanche track ecosystems. Although some tracks may extend to the lower elevation CWH and ICH BEC zones within steep, narrow valleys, the vast majority (98%) of the loss estimated from the KSM Project occurs within the MH and ESSF BEC zones.

Table 17.9-4 summarizes the past, present, and future projects and land use activities with potential to cumulatively interact with the residual effects estimated for the KSM Project:

17.9.3.1 Project-specific Residual Effects on Avalanche Track Ecosystems Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of avalanche track ecosystems may result from one or more of the Project activities identified in Table 17.9-4.

17.9.3.2 Cumulative Effect of Vegetation Loss

Information on avalanche ecosystems is not available for the closed Johnny Mountain or Snip mines, each of which were fly-in/fly-out operations located within the Iskut River drainage, approximately 50 km northwest of the Eskay Creek Mine road. Similarly, no information is available for the closed Eskay Creek and Sulphurets projects, the present Long Lake Hydroelectric Project, and proposed Granduc Copper Mine. Although no information is available, past road construction (including Highway 37) and timber harvesting activities are concentrated at low elevations within the Bell-Irving River watershed and are unlikely to have resulted in the loss of avalanche track ecosystems.

None of the projects with a present linkage assessed effects on avalanche track ecosystems. The Forrest Kerr Hydroelectric Project facilities and associated access road are situated at low elevations within the Iskut River drainage and do not overlap avalanche ecosystems. Although the 188 km transmission line, proposed between the Forrest Kerr powerhouse and Meziadin Junction, may cross areas of avalanche terrain along the 142 km unburied length between Bob Quinn Lake and the Meziadin substation, no potential effects were identified. Similarly, the NTL Project EA Application neither identified nor assessed potential effects on avalanche track ecosystems.

Table 17.9-4. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Avalanche Track Ecosystems

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities				
	Snip Mine	Eskay Creek Mine	Sulphurets Project	Long Lake Hydroelectric	Granduc Copper Mine
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	No Interaction	No Interaction	No Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities				
	Galore Creek Mine	Snowfield Project	Brucejack Mine	Treaty Creek Hydroelectric	Bronson Slope Mine
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Several future projects have potential to result in additional loss where infrastructure requires clearing within avalanche track ecosystems. As the projects are in early planning phases, the assessment was completed using pre-feasibility footprint information, which may change as planning progresses. Within the Galore Creek Mine EA Application, avalanches were identified as a geohazard along the access corridor, extending down to 200-m elevation within the middle and lower reaches of Sphaler Creek. Snow avalanche hazard was estimated along 22.9 km of the proposed access road, 17.8% of its total length. Although many of the mine site facilities are proposed in areas subject to avalanche activity (i.e., the West Fork Pit overlaps runout zones of two avalanche paths), avalanche ecosystems were not assessed as a VC (Rescan 2006).

The assessment of cumulative effects utilized available PEM data within the KSM RSA, which encompasses the complete footprints for the proposed Snowfield and Brucejack mines. Each of these future projects proposes access roads and infrastructure within mountainous terrain that is ecologically similar and immediately adjacent to the proposed KSM Project. The proposed footprints overlap 183 ha of avalanche track ecosystems, 172 ha (94%) from Snowfield infrastructure and 11 ha (6%) from Brucejack infrastructure. An estimated 105 ha occurs within the ICHvc subzone and 78 ha within the ESSFwv subzone. An estimated 38,800 ha of avalanche track ecosystems were mapped within the KSM Project RSA.

Much of the Brucejack Mine infrastructure is proposed to be located within the Sulphurets Creek watershed, which has an estimated residual loss of 27% from the KSM Project, an effect considered of medium magnitude at the watershed level. No further loss of avalanche ecosystems is expected within the Sulphurets Creek watershed.

17.9.3.2.1 Project-specific Cumulative Effects Mitigations for Vegetation Loss

No mitigation has been developed specific to minimizing loss of avalanche track ecosystems. The general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26, such as minimizing all clearing dimensions, will minimize loss of avalanche tracks.

17.9.3.2.2 Other Project/Activity Mitigations to Address Vegetation Loss

Although not specific to avalanche track ecosystems, most of the present projects outline mitigation activities within their EA Applications to minimize effects of vegetation loss. These range from general statements, such as “limit the extent of clearing,” to detailed management plans.

Given the regional importance of avalanche ecosystems as wildlife habitat, especially as food and shelter for grizzly bears, and as habitat for plant species valued by local Aboriginal groups, it is expected that future projects proposed in similar terrain will also include avalanche ecosystems as a VC and will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.3.2.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite the application of the general mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, there remains potential for cumulative loss of avalanche track ecosystems.

In addition to the loss estimate of 670 ha of avalanche track ecosystems from the KSM Project, the majority within the Sulphurets and Treaty Creek watersheds, further cumulative loss of 183 ha may result from the development of the future Snowfield and Brucejack mines. No further loss is expected within the Sulphurets watershed, however. The cumulative loss of 853 ha is equivalent to 2.2% of the 38,800 ha of avalanche track ecosystems mapped within the KSM Project RSA. Although it cannot be quantified without ecosystem mapping information, the total area of avalanche ecosystems is likely far greater within the CEA boundary.

Summarized in Table 17.9-5, the residual cumulative effect of avalanche track vegetation loss represents a regional effect that is expected to last into the far future, with sporadic losses resulting from clearing associated with the respective developments. The effects will be irreversible where infrastructure is permanent but may be reversible in the long term should reclamation objectives include the restoration of baseline conditions. As avalanche tracks are typically reliably mapped (TEM) or predicted (PEM), the probability that effects from future developments will occur is considered high with a high confidence level, especially for the proposed Brucejack and Snowfield projects, which are situated in mountainous, avalanching terrain adjacent to the KSM Project.

As incremental loss is not expected within the Sulphurets Creek watershed, deemed most sensitive to cumulative effects given the medium magnitude effect estimated for the KSM Project, the residual cumulative effect is expected to be **not significant (minor)**, consistent with the KSM Project residual effect determination. Losses in other watersheds are expected to be of low magnitude.

17.9.3.3 Cumulative Effects of Vegetation Degradation

Information is not available for either the proposed Granduc Copper Mine or Long Lake Hydroelectric Project to enable the assessment of potential degradation effects upon avalanche track ecosystems. None of the project Applications with a present linkage assessed potential effects on avalanche track ecosystems, suggesting that the effects could be of nil to low magnitude. The Forrest Kerr Hydroelectric Project facilities and associated access road are situated at low elevations within the Iskut River drainage. Although the 188 km transmission line, proposed between the Forrest Kerr powerhouse and Meziadin Junction, may cross some areas of avalanche terrain along the 142 km unburied length between Bob Quinn Lake and the Meziadin substation, no potential effects were identified. Similarly, the NTL Project EA Application neither identified nor assessed effects on avalanche track ecosystems.

Several future projects within the CEA boundary have potential to result in additional degradation where infrastructure is developed or operated within or adjacent to avalanche track ecosystems. As the projects are in early planning phases, the assessment was completed using the pre-feasibility footprint information (October 2012), which may be subject to change.

Based on PEM data within the KSM RSA, further loss of avalanche track ecosystems within the ICHvc and ESSFwv subzones is estimated from development of the proposed Snowfield and Brucejack mines. Consequently, incremental degradation may also result from the introduction and spread of invasive plants, deposition of fugitive dust, and effects of windthrow, where adjacent to new forest clearings.

Table 17.9-5. Summary of Residual Cumulative Effects on Avalanche Track Ecosystems

Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted for CE
															Probability	Probability Adjusted for CE	Confidence Level	Confidence Adjusted for CE				
Vegetation Loss	Snip Mine Eskay Creek Mine Sulphurets Project Long Lake Hydroelectric Granduc Copper Mine Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine	Construction	Medium	Medium	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	High	High	High	High	Not Significant (Moderate)	Not Significant (Minor)	Not Required	Not Required
Vegetation Degradation	Snip Mine Eskay Creek Mine Sulphurets Project Long Lake Hydroelectric Granduc Copper Mine Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Overall Effect	All	Post-closure	Medium	Medium	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	High	High	High	High	Not Significant (Moderate)	Not Significant (Minor)	Not Required	Not Required

Note:

CE = Cumulative Effect

17.9.3.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

Specific mitigation to minimize degradation of avalanche track ecosystems has not been proposed. General management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize the degradation of vegetated ecosystems, including avalanche track ecosystems. They include adopting management and monitoring programs to minimize erosion and windthrow effects and re-vegetating or re-seeding as soon as possible after clearing to minimize potential for introduction and spread of invasive plant species.

17.9.3.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Although not specific to avalanche track ecosystems, most of the EA Applications for the present projects outline mitigation activities to address and minimize effects of degradation due to disturbance and other secondary effects. These range from general statements, such as “limit the extent of clearing,” to detailed management plans that minimize disturbance and other secondary effects, including disturbance from invasive plant species and windthrow along new edges. Specific management activities include implementing rehabilitation measures to limit suitable habitat for invasive plants and monitoring for effects of windthrow (including hazard trees) and invasive plants.

Given the regional importance of avalanche ecosystems as wildlife habitat, especially as food and shelter for grizzly bears, and as habitat providing plant species valued by local Aboriginal groups, it is expected that future projects in similar terrain will also include avalanche ecosystems as a VC and will adopt or develop appropriate management and monitoring strategies to minimize potential degradation.

17.9.3.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the general mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative degradation of avalanche track ecosystems remains.

In addition to the degradation estimate of 650 ha from the KSM Project, mainly within the Sulphurets Creek and Treaty Creek watersheds, further cumulative degradation within the ICHvc and ESSFwv subzones may result from development of the identified future projects.

Summarized in Table 17.9-5, the residual cumulative effect of vegetation degradation represents a regional effect that is expected to last into the far future, with sporadic effects resulting from development or operation of infrastructure located within, or adjacent to, avalanche track ecosystems. The effects will be reversible in the long-term where infrastructure, such as access roads, is removed, and assuming the respective vegetation management and monitoring recommendations are adopted. The probability that effects from future developments will occur is considered medium with a medium confidence level. The residual cumulative effect is expected to be **not significant (minor).**

17.9.3.4 Overall Cumulative Effects on Avalanche Track Ecosystems

Considering potential for cumulative loss and degradation effects on avalanche track ecosystems, the overall cumulative effect, summarized in Table 17.9-5, is expected to be **not significant (minor).** No further loss or degradation is expected within the Sulphurets Creek watershed, deemed most sensitive to cumulative effects given the concentration of Project-related degradation effects.

17.9.4 Cumulative Effects Assessment for Listed Ecosystems

Cumulative effects on provincial red- and blue-listed ecosystems are best assessed using available inventories such as TEM and PEM, which enable a quantitative assessment of potential effects. Listed ecosystems are often assessed as a VC in current development applications, reflecting the ecological importance of maintaining biodiversity and protecting rare and potentially threatened ecosystems. Maintaining listed ecosystems represents an objective within both the Nass South SRMP (BC ILMB 2012) and the Cassiar Iskut-Stikine LRMP (BC ILMB 2000). As ecosystem maps are more accurate with regards to ecosystems that are more common on the landscape and less accurate with regards to the rarer elements (Smith et al. 2002; Smith et al. 2003), mapped listed ecosystems typically require field confirmation to increase the confidence in mapping.

Table 17.9-6 summarizes the past, present, and future projects and land use activities with potential to cumulatively interact with the residual effects estimated for the KSM Project.

17.9.4.1 Project-specific Residual Effects on Listed Ecosystems Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of listed ecosystems may result from one or more of the Project activities identified in Table 17.9-6. As a result, they are included in the cumulative effects assessment.

17.9.4.2 Cumulative Effect of Vegetation Loss

Although loss of listed ecosystems may have resulted from vegetation clearing during construction of Highway 37 and from previous timber harvesting at low elevations throughout the Bell-Irving River watershed, it cannot be quantified. No information of relevance to listed ecosystems is available for the closed Johnny Mountain or Snip mines, each of which were fly-in/fly-out operations located within the Iskut River drainage. Similarly, no information is available for the closed Eskay Creek and Sulphurets projects, the present Long Lake Hydroelectric Project, and the proposed Granduc Copper Mine. However, as most listed ecosystems in the assessment area are low elevation floodplain ecosystems, high elevation mines, including the Granduc Copper, Sulphurets, and Johnny Mountain mines, are unlikely to have resulted in any loss.

Approximately 36 ha (4% of baseline distribution) of loss could result from the KSM Project, most from proposed access roads within low-elevation (ICHvc and CWHwm) floodplain forests and wetlands in the Treaty Creek, Sulphurets Creek, and Bell-Irving River watersheds. Further loss could also result from each of the projects with a present linkage, all of which are presently in development.

The NTL Project EA Application assessed listed ecosystems as a VC and estimated up to 245 ha of permanent alteration (loss) due to right-of-way clearing during construction (Rescan 2010). Most of the ecosystems consisted of moist forests (considered locally common) towards the southern end of the alignment, within the CWHms1 variant outside of the CEA boundary. Given that listed floodplain forest communities in the NTL area were less common, with less forestry-related pressure, they were the focus of the NTL Project cumulative assessment. No listed floodplain forest communities or other listed ecosystems overlapped the CEA boundary.

Table 17.9-6. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Listed Ecosystems

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities				
	Timber Harvesting - Forestry	Traffic and Roads	Snip Mine	Eskay Creek Mine	Long Lake Hydroelectric
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	No Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities				
	Galore Creek Mine	Snowfield Project	Brucejack Mine	Treaty Creek Hydroelectric	Bronson Slope Mine
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Although the Forrest Kerr Hydroelectric Project EA Application, which addressed residual cumulative effects of forest clearing, did not assess listed ecosystems as a VC, the residual effects of general vegetation loss during construction of generating facilities, access road and buried transmission line, and the Highway 37 transmission line ranged from low to moderate magnitude (Coast Mountain Hydro Corp. 2002).

Each of the future projects has potential to result in further loss of listed ecosystems. The McLymont Creek Hydroelectric Project EA Application assessed at-risk plant communities (ecosystems) as a VC. The project footprint results in an estimated loss of 0.93 ha within a single blue-listed ecosystem (ICHwc/06). The footprint may not affect this particular ecosystem, however, as it constitutes just 20% of the baseline TEM polygon. The residual effect is considered not significant, given the potential loss represents 3% of the listed ecosystem area mapped within the McLymont Project LSA (Hemmera 2011).

Although not assessed as a VC, mapping for the Galore Creek Mine identified six listed ecosystems overlapping the filter plant and access corridor (Rescan 2006). Similar to the KSM Project, most listed ecosystems were located within the CWHwm subzone, with the exception of a single floodplain ecosystem within the ICHwc subzone, which was also considered rare due to similarity with a listed CWHwm ecosystem. No listed ecosystems were identified within the proposed Mine Site.

Future projects with greatest potential to result in incremental loss of listed ecosystems include the Brucejack and Snowfield projects and the Treaty Creek Hydroelectric facilities, each of which has potential to result in loss of floodplain and wetland ecosystems within the ICHvc subzone. Proposed infrastructure along valley bottoms includes hydro generation facilities and transmission lines, access corridors, and tailing management facilities. Given the similarity in ecosystems and topography to the KSM Project, the access roads and facilities may result in a low magnitude residual effect, similar to the potential effects from the KSM Project within the Treaty Creek and Bell-Irving watersheds.

Similarly, loss of listed ecosystems may result from developing the proposed Bronson Slope Mine access road, as many of the valley bottom riparian and floodplain ecosystems within the CWHwm subzone are presently blue-listed. As identified by Keystone Wildlife Research Ltd. and Oikos Ecological Services Ltd. (1997) within Hemmera (2011), although the ICHwc/06 ecosystem identified in the McLymont Creek Hydroelectric assessment was identified along the previously proposed road, it is unlikely that the alignment would affect it given its inherent dynamism and lack of suitability for construction.

17.9.4.2.1 Project-specific Cumulative Effects Mitigation for Vegetation Loss

Project infrastructure was revised during infrastructure design to avoid several areas mapped as potentially sensitive or listed ecosystems. No further mitigation specific to listed ecosystems is proposed, as general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize losses. They include minimizing all clearing dimensions and preferentially retaining areas of mature and old forest (most likely to support listed plant communities), where the option exists to remove younger forests.

17.9.4.2.2 Other Project/Activity Mitigation to Address Vegetation Loss

Each of the present projects outlines mitigation activities to address and minimize the effects of vegetation loss. For example, avoidance of rare ecosystems during Project design has resulted in the Forrest Kerr Project overlapping a single polygon mapped as a listed ecosystem. Specific mitigations for this polygon include flagging the boundary on construction maps and on the ground to prevent accidental encroachment. Other mitigation measures include further limiting the spatial extent of clearing through a variety of design considerations, such as designing spoil areas to maximum safe height to reduce footprint needs, incorporating different infrastructure within rights-of-way, and placing temporary construction areas in sites required during operations (Coast Mountain Hydro Corp. 2002). Most projects adopt minimizing spatial footprint extent as a mitigation to reduce loss of vegetation.

Provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining listed ecosystems in achieving regional scale biodiversity objectives. It is expected that EAs for all future projects with potential to remove any provincially-listed ecosystem will assess them as a VC and will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.4.2.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative loss of listed ecosystems remains.

In addition to the 36 ha (less than 2% of the baseline distribution) of loss estimated from the KSM Project, largely associated with proposed development of access corridors within the low elevation (CWH and ICH) BEC zones, further cumulative loss of listed ecosystems may result from development of the present and future projects. A lack of information on potential losses resulting from past projects or land use activities, including previously-closed mines within the Iskut River drainage, timber harvesting, and development of Highway 37 prohibits a quantitative assessment of potential effects. Where the present assessed projects listed ecosystems as a VC, including the NTL and McLymont Creek Hydroelectric projects, little to no residual effects were estimated. The highest potential for cumulative effects is likely associated with development of the proposed Brucejack Mine, Snowfield Project, and Treaty Creek Hydroelectric Project. Given the proximity to the KSM Project and similarity in BEC classification and topography, the loss of low elevation floodplain ecosystems may result.

Summarized in Table 17.9-7, the residual cumulative effect of vegetation loss represents a regional effect that is expected to last into the far future, with sporadic losses resulting from clearing associated with the respective developments. The effects are considered irreversible given the sensitive nature of listed ecosystems and the long period required for reestablishment. As footprint designs are subject to change, the probability that effects from future developments will occur is medium, with medium confidence.

Given that present and proposed developments have identified small areas of potential vegetation loss, estimated nil to low magnitude effects, and incorporated mitigations such as identifying known locations on the ground and construction maps, the residual cumulative effect is expected to be **not significant (minor).**

17.9.4.3 Cumulative Effects of Vegetation Degradation

Although degradation of listed ecosystems may have occurred during construction of Highway 37 and from previous timber harvesting activity at low elevations within the Bell-Irving River watershed, it cannot be quantified. No information of relevance to listed ecosystems is available for the closed Johnny Mountain or Snip mines, each of which were fly-in/fly-out operations located within the Iskut River drainage. Similarly, no information is available for the closed Eskay Creek and Sulphurets projects, the present Long Lake Hydroelectric Project, and the proposed Granduc Copper Mine. However, as most listed ecosystems in the assessment area are associated with low elevation floodplain ecosystems, high elevation mines including the Granduc Copper, Sulphurets, and Johnny Mountain mines are unlikely to have resulted in degradation.

Approximately 145 ha of degradation are estimated from the KSM Project, most within low-elevation floodplain forests and shrub or herb wetlands in the ICHvc and CWHwm subzones. Further degradation has likely resulted from each of the projects identified as a present linkage, all of which are in development.

The NTL Project EA Application assessed rare ecosystems as a VC and evaluated degradation potential resulting from effects and invasive species introduction (Rescan 2010). Most of the ecosystems consisted of moist forests (considered locally common) towards the southern end of the alignment, within the CWHms1 variant and outside of the CEA boundary. Windthrow and other edge-related effects were considered of low magnitude and not significant. Given that listed floodplain forest communities in the NTL area were less common, with less forestry-related pressure, they were the focus of the NTL cumulative assessment. No listed floodplain forest communities or other listed ecosystems overlapped the KSM LSA or RSA.

Each of the future projects has potential to further degrade listed ecosystems. The EA Application for the McLymont Creek Hydroelectric Project (Hemmera 2011) assessed at-risk plant communities (listed ecosystems) as a VC, including potential effects from non-native invasive plant species. As mitigation measures were considered sufficient to eliminate potential for effects, no residual effects were expected on listed ecosystems due to invasive species establishment. Potential edge effects due to increased light and moisture were considered negligible to low magnitude, with effects likely evident within approximately 10 m from cleared edges.

Future projects with greatest potential to result in degradation of listed ecosystems include the Brucejack and Snowfield projects and the Treaty Creek Hydroelectric facilities, each of which has potential to degrade floodplain and wetland ecosystems within the ICHvc subzone. Proposed infrastructure along valley bottoms includes hydro generation facilities and transmission lines, access corridors, and tailing management facilities. Given the similarity in ecosystems and topography to the KSM Project, the access roads and facilities may result in a low magnitude residual effect, similar to the estimated KSM Project effects within the Treaty Creek and Bell-Irving River watersheds. Additional degradation may result from the introduction and spread of invasive plant species, deposition of fugitive dust and windthrow along new forest clearings.

Table 17.9-7. Summary of Residual Cumulative Effects on Listed Ecosystems

Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted for CE
															Probability	Probability Adjusted for CE	Confidence Level	Confidence Adjusted for CE				
Vegetation Loss	Snip Mine Eskay Creek Mine Long Lake Hydroelectric Granduc Copper Mine Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine Timber Harvesting - Forestry Traffic and Roads	Construction	Low	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Irreversible	Irreversible	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Vegetation Degradation	Snip Mine Eskay Creek Mine Long Lake Hydroelectric Granduc Copper Mine Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine Timber Harvesting - Forestry Traffic and Roads	Construction	Medium	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Overall Effect	All	Post-closure	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

Note:

CE = Cumulative Effect

Additional degradation of listed ecosystems may result from development of the proposed Bronson Slope Mine access road, as many of the valley-bottom riparian and floodplain ecosystems within the CWHwm subzone are currently blue-listed. As identified by Keystone Wildlife Research Ltd. and Oikos Ecological Services Ltd. (1997) within Hemmera (2011), although the ICHwc/06 ecosystem identified in the McLymont Creek Hydroelectric assessment was identified along the previously proposed access road, it is unlikely that the alignment would affect it, given its inherent dynamism and lack of suitability for construction.

17.9.4.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

Project infrastructure was revised during the infrastructure design phase to avoid several areas mapped as potentially sensitive or listed ecosystems. No further mitigations have been developed specific to minimizing degradation of listed ecosystems, as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize degradation.

17.9.4.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Each of the present project EA Applications outlines mitigation activities to address and minimize the effects of degradation due to disturbance and other secondary effects. These range from general statements, such as “limit the extent of clearing,” to detailed management plans that minimize disturbance and other secondary effects, including from invasive plant species and windthrow along new edges. Specific management activities include the marking of listed ecosystems on maps and in the field, implementing immediate rehabilitation measures to limit suitable habitat for invasive plant species, and monitoring for effects of windthrow (including hazard trees) and invasive species (with follow-up management as required).

As most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining listed ecosystems in achieving biodiversity objectives, it is expected that all future projects overlapping or with potential to degrade any provincially listed ecosystem will assess them as a VC and adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.4.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, there remains potential for cumulative degradation of listed ecosystems. A lack of information on past projects or land use activities, including previously closed mines within the Iskut River drainage, timber harvesting, and development of Highway 37, prohibits a quantitative assessment of potential effects.

The present projects’ EAs that specifically assessed listed ecosystems as a VC, including those for the NTL and McLymont Creek Hydroelectric projects, estimated little to no degradation effects. The highest potential for cumulative effects is likely associated with development of the proposed Brucejack Mine, Snowfield Project, and Treaty Creek Hydroelectric Project. Given the close proximity to the KSM Project and similarity in BEC classification and topography, effects from development and use of roads may be similar to those expected within the ICHvc subzone from development within the Treaty Creek watershed, with a degradation estimate of approximately 8% of the baseline distribution.

Continued use of the Eskay Creek Mine road, between Highway 37 and the present and proposed projects along the Iskut River, has potential to result in roadside vegetation degradation, primarily from the introduction and spread of invasive plant species or windthrow where new access roads and facilities are constructed.

Summarized in Table 17.9-7, the residual cumulative effect of vegetation degradation represents a regional effect that is expected to last into the far future, with sporadic effects resulting from the clearing and continued use of infrastructure located within or adjacent to listed ecosystems. The effects will be reversible in the long term where infrastructure such as access roads are removed or no longer used, assuming the respective vegetation management and monitoring recommendations are adopted. The probability that effects from future developments will occur is considered medium with a medium confidence level. The residual cumulative effect is expected to be **not significant (minor)**.

17.9.4.4 Overall Cumulative Effects on Listed Ecosystems

Considering potential for cumulative loss and degradation effects on listed ecosystems, the cumulative overall effect, summarized in Table 17.9-7, is expected to be **not significant (minor).**

17.9.5 Cumulative Effects Assessment for Riparian and Floodplain Ecosystems

Riparian and floodplain ecosystems are commonly assessed as a VC in many current assessment applications, reflecting the ecological importance of maintaining riparian ecosystems for biodiversity, fish habitat, and wildlife habitat objectives. Furthermore, the *Fisheries Act* (1985) requires riparian areas to be protected, and the *Canadian Environmental Assessment Act* (1992) requires that they be considered in an EA. These ecosystems have also been recognized within both the Nass South SRMP and Cassiar Iskut-Stikine LRMP as important ecosystems to manage well (BC ILMB 2000, 2012).

It is anticipated that each past, present, and future development and most land-use activities have potential to cumulatively interact with the residual effects estimated for the KSM Project. Table 17.9-8 summarizes the past, present, and future projects and land-use activities with potential to cumulatively interact with the residual effects estimated for the KSM Project.

17.9.5.1 Project-specific Residual Effects on Riparian and Floodplain Ecosystems Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of riparian and floodplain ecosystems may result from one or more of the project activities identified in Table 17.9-8. As a result, they are included in the assessment of cumulative effects.

17.9.5.2 Cumulative Effect of Vegetation Loss

Although loss of riparian and floodplain ecosystems has likely resulted from vegetation clearing during construction of Highway 37 and from previous timber harvesting activities at low elevations near the highway, it cannot be quantified. No information regarding potential effects on these ecosystems is available for the closed Johnny Mountain or Snip mines, which were fly-in/fly-out operations within the Iskut River drainage.

Table 17.9-8. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Riparian and Floodplain Ecosystems

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities								
	Timber Harvesting – Forestry	Traffic and Roads	Eskay Creek Mine	Granduc Mine	Johnny Mountain Mine	Snip Mine	Sulphurets Project	Forrest Kerr Hydroelectric	Long Lake Hydroelectric
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities								
	Long Lake Hydroelectric	Northwest Transmission Line	Bronson Slope Mine	Brucejack Mine	Galore Creek Mine	Granduc Copper Mine	McLymont Creek Hydroelectric	Snowfield Project	Treaty Creek Hydroelectric
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

In total, including the listed riparian and floodplain ecosystems, an estimated 550 ha (15% of baseline distribution) of loss could result from the KSM Project, the majority (87%) within the Teigen and Treaty Creek watersheds. Most of the riparian and floodplain ecosystems within the upper Unuk watershed, upstream of the Sulphurets confluence, occur within the CWHwm subzone and are assessed separately as listed ecosystems. Further loss has likely resulted from each of the projects identified as a present linkage, all of which are presently in development.

The NTL Project EA Application assessed riparian areas and floodplain forests as independent VCs. For riparian areas, up to 930 ha of alteration was estimated due to the right-of-way (303 ha) and one-time clearing areas (628 ha), respectively (Rescan 2010). As road locations were not available, alteration due to road construction was excluded. Permanent loss is assumed to apply to just the right-of-way area (303 ha) and not the one-time clearing area. The potential effect was considered medium magnitude, given the ecological importance and large area potentially affected. As the sustainability of riparian ecosystems was not considered threatened, loss was considered not significant. A loss of 93 ha (3% of baseline distribution) of floodplain forest areas was estimated due to right-of-way clearing associated with the NTL Project. The potential effect was considered of medium magnitude, but not significant (Rescan 2010).

The Forrest Kerr Hydroelectric Project EA Application, which addressed the residual cumulative effects of forest clearing, did not assess riparian ecosystems as a VC. However, potential effects on riparian areas due to construction of infrastructure, including intake and tailrace, diversion reach, and access roads were identified and considered to be very minor. Riparian areas along the transmission line were identified primarily as cottonwood habitats along creeks and rivers. Potential impacts were assumed to be largely mitigated through compliance with provincial and federal regulations for working in and around watercourses. General residual effects of vegetation loss during construction of generating facilities, access road and buried transmission line, and the Highway 37 transmission line ranged from low to moderate magnitude (Coast Mountain Hydro Corp. 2002).

Each of the future projects has potential to result in incremental loss of riparian and floodplain ecosystems. Aside from wetlands (with no estimated potential effects), the McLymont Creek Hydroelectric Project EA Application did not assess riparian ecosystems as a VC. Described within the listed ecosystems section, the McLymont Project footprint overlaps an estimated 0.93 ha within the ICHwc/06 ecosystem, a middle-bench, forested floodplain ecosystem. The footprint may not affect this particular ecosystem, however, as it constitutes a minor portion of the TEM polygon. The residual effect on this ecosystem is considered not significant, given the potential loss represents 3% of the area mapped within the LSA (Hemmera 2011).

Future projects with greatest potential to result in loss of riparian and floodplain ecosystems include the Brucejack Gold Mine project and the Treaty Creek Hydroelectric facilities. As proposed, these developments would result in loss of riparian, floodplain, and wetland ecosystems along Treaty Creek, Todedada Creek, Scott Creek, Bowser River, and at high elevations in the headwaters of Sulphurets Creek. Proposed infrastructure includes hydro generation facilities and transmission lines, access corridors, mine sites, and tailing management facilities. Given the similarity in ecosystems and topography to the KSM Project, the access roads and facilities proposed for the Brucejack Mine, Snowfield Project, and Treaty Creek Hydroelectric

Project could result in a low magnitude residual effect, similar to the potential effects from the KSM Project. Potential effects from additional development within the Sulphurets and Treaty Creek watersheds may add to the effects on riparian and floodplain ecosystems estimated from the KSM Project (13 and 14% of baseline distributions, respectively).

Loss of riparian and floodplain ecosystems may also result from development of the access road proposed for the Bronson Slope Mine along the Iskut River. As identified by Keystone Wildlife Research Ltd. and Oikos Ecological Services Ltd. (1997) within Hemmera (2011), although a forested floodplain (ICHwc/06) ecosystem identified in the McLymont Creek Hydroelectric assessment was identified along the previously proposed road, it is unlikely that the alignment would affect the ecosystem given its inherent dynamism and lack of suitability for construction.

17.9.5.2.1 Project-specific Cumulative Effects Mitigation for Vegetation Loss

Project infrastructure, including the Coulter Creek and Treaty Creek access roads, was revised during infrastructure design to avoid several areas mapped as potentially sensitive riparian and wetland ecosystems. General mitigation measures to minimize the loss of riparian and floodplain ecosystems include ensuring riparian setbacks and work practices proceed in accordance with legislated reserve and/or management zone widths. No further mitigation measures have been developed specific to minimizing losses of riparian ecosystems, as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize losses.

The creation of riparian and wetland habitat under the Fish Habitat Compensation Plans (Appendices 15-Q and 15-R) and Wetland Habitat Compensation Plan (Appendix 16-B) further mitigates some of the vegetation loss resulting from the Project.

17.9.5.2.2 Other Project/Activity Mitigation to Address Vegetation Loss

Each of the present projects outlines a variety of mitigation activities to address and minimize the effects of vegetation loss. These range from general statements, such as "limiting the extent of clearing," to detailed vegetation management plans for working in and around watercourses. For example, the Forrest Kerr Project (Coast Mountain Hydro Corp. 2002) references the Riparian Assessment and Prescription Procedures – Field Guide (McLennan and Johnson 1997) and outlines numerous detailed management recommendations for in-stream work, many directly related to riparian vegetation.

As most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining riparian and floodplain ecosystems in achieving biodiversity and fish and wildlife habitat objectives, EAs for all future projects with potential to result in such ecosystem loss are expected to assess these ecosystems as VCs and adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.5.2.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative loss of riparian and floodplain ecosystems remains.

In addition to the 550 ha of potential loss estimated from the KSM Project, largely associated with proposed development of the RSFs and TMF, further cumulative loss of riparian and floodplain ecosystems may result from the development of the present or future projects. A lack of information on past projects or land use activities, including previously closed mines within the Iskut River drainage, timber harvesting, and development of Highway 37, prohibits a quantitative assessment of potential effects. The expectation, however, is that projects would have adhered to regulations associated with their respective developments.

Where the present project EA Applications specifically assessed riparian and floodplain ecosystems as a VC (e.g., the NTL Project) or qualitatively addressed them (Forrest Kerr and McLymont Creek Hydroelectric projects), nil to medium magnitude effects (not significant) were estimated. The highest potential for cumulative effects is associated with the development of the proposed Brucejack Mine, Snowfield Project, and Treaty Creek Hydroelectric Project. Given the close proximity to the KSM Project and similarity in BEC classification and topography, effects may be similar to those expected from development within the Treaty and Sulphurets creeks watersheds.

Summarized in Table 17.9-9, the residual cumulative effect of vegetation loss represents a regional effect that is expected to last into the far future, with sporadic losses resulting from clearing associated with the respective developments. The effects are considered irreversible where infrastructure is permanent but may be reversible in the long term where reclamation objectives include re-establishing riparian and floodplain ecosystems. Although footprint designs are subject to change, the probability that loss of riparian and/or floodplain ecosystems will result from future developments is high and the confidence is medium. Given that present and proposed developments have identified small areas of potential vegetation loss and estimated nil to low magnitude effects, the residual cumulative effect is expected to be **not significant (minor)**.

17.9.5.3 Cumulative Effects of Vegetation Degradation

Although degradation of riparian and floodplain ecosystems may have resulted during construction of Highway 37 and from previous timber harvesting activities at low elevations near the highway, it cannot be quantified. No information about potential effects is available for the Johnny Mountain or Snip mines, which were fly-in/fly-out operations within the Iskut River drainage.

Approximately 690 ha of degradation may result from the KSM Project, most within the Teigen, Treaty, and Sulphurets creeks watersheds. Further degradation has likely resulted from each of the projects with a present linkage, all of which are presently in development.

The NTL Project EA Application independently assessed riparian areas and floodplain forests as sensitive VCs. Listed floodplain ecosystems are addressed within the listed ecosystems section. For riparian areas, up to 930 ha of alteration was estimated due to the right-of-way (303 ha) and one-time clearing areas (628 ha), respectively (Rescan 2010). As road locations were not available, alteration from road construction or use was not included. The potential edge effects from windthrow and changes to physical environment were considered of low magnitude and not significant.

Table 17.9-9. Summary of Residual Cumulative Effects on Riparian and Floodplain Ecosystems

															Likelihood of Effects							
Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Probability	Probability Adjusted for CE	Confidence Level	Confidence Adjusted for CE	Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted for CE
Vegetation Loss	Snip Mine Eskay Creek Mine Granduc Mine Johnny Mountain Mine Sulphurets Project Forrest Kerr Hydroelectric Northwest Transmission Long Lake Hydroelectric Granduc Copper Mine McLymont Creek Hydroelectric Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine Timber Harvesting - Forestry Traffic and Roads	Construction	Low	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Low	Low	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Vegetation Degradation	Snip Mine Eskay Creek Mine Granduc Mine Johnny Mountain Mine Sulphurets Project Forrest Kerr Hydroelectric Northwest Transmission Line Long Lake Hydroelectric Granduc Copper Mine McLymont Creek Hydroelectric Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine Timber Harvesting - Forestry Traffic and Roads	Construction	Medium	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Overall Effect	All	Post-closure	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

Note:

CE = Cumulative Effect

The Forrest Kerr Hydroelectric Project EA Application, which addressed the residual cumulative effects of forest clearing, did not assess riparian ecosystems as a VC. However, potential effects on riparian areas due to construction of infrastructure, including intake and tailrace, diversion reach, and access road were identified and considered very minor. It was assumed that potential impacts would be mitigated through compliance with provincial and federal regulations for working in and around watercourses (Coast Mountain Hydro Corp. 2002).

Each of the future projects has potential to degrade additional riparian and floodplain ecosystems. Aside from wetlands (with no estimated potential effects), the McLymont Creek Hydroelectric Project EA Application did not assess riparian ecosystems as a VC. Described within the listed ecosystems section, the project footprint results in an estimated loss of 0.93 ha within the ICHwc/06 ecosystem, a middle-bench, forested floodplain ecosystem. The residual effect on this ecosystem is considered not significant, given the potential loss represents 3% of the area mapped within the McLymont LSA (Hemmera 2011).

Future projects with greatest potential to result in degradation of riparian and floodplain ecosystems include the Brucejack Mine and Snowfield Project and the Treaty Creek Hydroelectric facilities. These have potential to degrade floodplain and wetland ecosystems along Treaty Creek, Todedada Creek, Scott Creek, the Bowser River, and at high elevations in the headwaters of Sulphurets Creek. Proposed infrastructure includes hydro generation facilities, access corridors, mine sites, and tailing management facilities. Given the similarity in ecosystems and topography to the KSM Project, the access roads and facilities proposed for the Brucejack Mine, Snowfield Project, and Treaty Creek Hydroelectric Project could result in a medium magnitude residual effect, similar to the potential effects from the KSM Project. Potential effects from further development within the Sulphurets and Treaty watersheds may add to the estimated degradation effects on riparian and floodplain ecosystems from the KSM Project (30 and 12% of baseline distributions, respectively). The estimated 30% degradation within the Sulphurets watershed, a borderline high magnitude effect, is expected to represent a maximum effect as degradation might not occur uniformly throughout the degradation buffer.

Degradation of riparian and floodplain ecosystems may also result from development of the access road proposed for the Bronson Slope Mine along the Iskut River. As identified by Keystone Wildlife Research Ltd. and Oikos Ecological Services Ltd. (1997) within Hemmera (2011), although a forested floodplain (ICHwc/06) ecosystem identified in the McLymont Creek Hydroelectric assessment was identified along the previously proposed road, it is unlikely that the alignment would affect it given its inherent dynamism and lack of suitability for construction.

17.9.5.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

Project infrastructure, including the Coulter Creek and Treaty Creek access roads, was revised during the design phase to avoid several areas mapped as potentially sensitive riparian ecosystems. Other mitigations specific to minimizing degradation of riparian and floodplain ecosystems are provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26. General mitigation measures to minimize the degradation of riparian and floodplain ecosystems include ensuring riparian setback requirements and work practices proceed in accordance with the legislated reserve and/or management zone widths.

The creation of riparian and wetland habitat under the Fish Habitat Compensation Plans (Appendices 15-Q and 15-R) and Wetland Habitat Compensation Plan (Appendix 16-B) further mitigates some of the vegetation degradation resulting from the Project.

17.9.5.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Each of the present project EA Applications outlines mitigation activities to address and minimize the effects of degradation due to disturbance and other secondary effects. These range from general statements, such as "limiting the extent of clearing," to detailed management plans that minimize disturbance and other secondary effects, including from invasive plant species and windthrow along new edges. Specific management activities include implementing immediate rehabilitation measures to limit suitable habitat for invasive plant species and monitoring for effects of windthrow (including hazard trees) and invasive species.

Most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining riparian and floodplain ecosystems in achieving biodiversity and fish and wildlife habitat objectives. It is therefore expected that all future projects overlapping or with potential to degrade riparian and floodplain ecosystems will assess them as a VC and adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.5.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative degradation of riparian and floodplain ecosystems remains.

In addition to the 690 ha of potential degradation estimated from the KSM Project, largely associated with proposed development of the RSFs and the TMF, further cumulative degradation of riparian and floodplain ecosystems may result from development of the identified present or reasonably foreseeable future projects. A lack of information on past projects or land use activities, including previously closed mines within the Iskut River drainage, timber harvesting, and development of Highway 37, prohibits a quantitative assessment of potential effects. The expectation is that the developments would have adhered to the riparian regulations in place during development.

Whether present project EAs specifically assessed riparian and floodplain ecosystems as a VC (e.g., the NTL Project) or qualitatively addressed them (e.g., Forrest Kerr and McLymont Creek Hydroelectric Projects), nil to low magnitude effects (not significant) were estimated. The highest potential for cumulative effects is associated with development of the proposed Brucejack Mine, Snowfield Project, and Treaty Creek Hydroelectric Project. Given the proximity to the KSM Project and similarity in BEC classification and topography, it is assumed effects may be similar to those expected from development within the Treaty Creek and Sulphurets Creek watersheds.

Summarized in Table 17.9-9, the residual cumulative effect of vegetation degradation represents a regional effect that is expected to last into the far-future, with sporadic effects resulting from the clearing and continued use of infrastructure located within or adjacent to riparian and floodplain ecosystems. The effects will be reversible in the long term where infrastructure, such as access roads, is removed and assuming the respective vegetation management and monitoring recommendations are adopted. The probability that effects from future developments will occur is considered high with a medium confidence level. The residual cumulative effect is expected to be of low or medium magnitude, but **not significant (minor)**.

17.9.5.4 Overall Cumulative Effect on Riparian and Floodplain Ecosystems

Considering potential for cumulative loss and degradation effects on riparian and floodplain ecosystems, the cumulative overall effect, summarized in Table 17.9-9, is expected to be **not significant (minor)**.

17.9.6 Cumulative Effects Assessment for Alpine and Parkland Ecosystems

The assessment of cumulative effects on alpine and parkland ecosystems typically requires the availability of ecosystem mapping inventories, such as TEM and PEM, which identify the spatial distribution of terrestrial ecosystems on the landscape. Alpine and parkland ecosystems often provide habitat characteristics of importance for wildlife species and are assessed as a VC in many developments with infrastructure proposed near and above treeline. Described within the Cassiar Iskut-Stikine LRMP (BC ILMB 2000), within the Unuk River zone, south of Sulphurets Creek, subalpine parkland meadows represent critical patch habitats for grizzly bears (BC ILMB 2000).

Based on the extent of alpine and parkland within the BEC version (2008) used for the KSM ecosystem mapping and effects assessment, Table 17.9-10 summarizes the past, present, and future projects and land use activities with potential to cumulatively interact with the residual effects estimated for the KSM Project.

17.9.6.1 Project-specific Residual Effects on Alpine and Parkland Ecosystems Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of alpine and parkland ecosystems may result from one or more of the project activities identified in Table 17.9-10. As a result, they are included in the assessment of cumulative effects.

17.9.6.2 Cumulative Effect of Vegetation Loss

Previous loss of alpine and parkland ecosystems is not expected from past low elevation developments and land use activities, including the Snip Mine, Highway 37, and timber harvesting, most of which has occurred within the ICH BEC zone near the Bell-Irving River. Although their elevations suggest a likely effect, no information is available regarding the extent of effects on alpine and parkland ecosystems for either the Granduc or Johnny Mountain Mines, which closed in 1984 and 1993, respectively. Approximately 33 ha of the recently closed Eskay Creek Mine overlaps the CMAunp (27.5 ha) and BAFAunp (5.5 ha) BEC units.

An estimated loss of 411 ha of vegetated alpine and parkland ecosystems could result from developing the KSM Project. No loss is likely to be incurred from developing any of the present projects as they occur predominantly at lower elevations.

Table 17.9-10. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Alpine and Parkland Ecosystems

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities						
	Eskay Creek Mine	**Long Lake Hydroelectric**	**Galore Creek Mine**	**Snowfield Project**	**Brucejack Mine**	**Granduc Copper Mine**	**Bronson Slope Mine**
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Based on an overlay with the 2008 BC MOFR BEC lines, future projects with greatest potential to result in cumulative loss of alpine and parkland ecosystems include the Snowfield Project (498 ha), Galore Creek Mine (356 ha), and Brucejack Mine (225 ha). Smaller losses are estimated from development of the Granduc Copper Mine (66 ha) and the Long Lake Hydroelectric Project (4 ha).

In addition to the estimated loss (395 ha) expected within the Sulphurets Creek watershed from the KSM Project (11% of the baseline watershed distribution), development of the proposed Brucejack Mine and Snowfield Project could result in cumulative loss within this watershed. Approximately 645 ha of the infrastructure proposed for the Snowfield and Brucejack mines overlap the CMAunp BEC unit in the Sulphurets watershed. Of this, 344 ha are vegetated ecosystems, including 270 ha from the Snowfield infrastructure and 77 ha from the Brucejack infrastructure.

Including the KSM Project, a cumulative loss of 1,594 ha could result, a small percentage (0.2%) of the total area (640,575 ha) within the CEA boundary that is presently mapped as parkland and alpine ecosystems within the provincial BEC coverage. However, without TEM or PEM available, it is unknown what percentage of the lost and baseline areas consist of vegetated ecosystems.

17.9.6.2.1 Project-specific Cumulative Effects Mitigation for Vegetation Loss

Loss of alpine and parkland ecosystems will be minimized by ensuring clearing of vegetation occurs only where necessary. No further mitigation has been developed specifically to minimize losses of alpine and parkland ecosystems, as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize losses. No reclamation activity is proposed within alpine and parkland ecosystems.

17.9.6.2.2 Other Project/Activity Mitigation to Address Vegetation Loss

No mitigations specific to alpine and parkland ecosystems are provided in publically available sources for present projects, although each of the present projects outlines general mitigation activities to address and minimize the effects of vegetation loss.

As provincial land and resource management plans, and other land development guidelines or best management practices, recognize the importance of maintaining alpine and parkland ecosystems in achieving biodiversity and wildlife habitat objectives, it is expected that EAs for future projects with potential to result in their loss will assess them as a VC and will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.6.2.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, there remains potential for cumulative loss of alpine and parkland ecosystems.

In addition to the estimated 411 ha loss from the KSM Project, largely associated with proposed development of the pits, RSFs and related infrastructure within the Sulphurets Creek watershed, further cumulative loss of alpine and parkland ecosystems may result from development of the identified future projects. The highest potential for cumulative effects is associated with development of the proposed Brucejack Mine and Snowfield Project, given their proximity to the KSM Project and incremental effects within the Sulphurets Creek watershed. The estimated cumulative loss of 740 ha for vegetated alpine and parkland ecosystems represents approximately 22% of the baseline distribution in the Sulphurets Creek watershed, a medium magnitude effect.

Summarized in Table 17.9-11, the residual cumulative effect of vegetation loss represents a regional effect that is expected to last into the far-future, with sporadic losses resulting from clearing associated with the respective developments. The effects are considered irreversible given that re-vegetation at high elevations, should it be a reclamation objective, will take many decades and may not be successful. The probability that effects from future developments will occur is high, with medium confidence. The residual cumulative effect, considered **not significant (minor)**, is expected to be medium magnitude within the Sulphurets Creek watershed and low magnitude within the CEA boundary.

17.9.6.3 Cumulative Effects of Vegetation Degradation

Potential degradation of alpine and parkland ecosystems is not expected from past low elevation developments and land use activities, including the Snip Mine, Highway 37, and timber harvesting, most of which has occurred within the ICH BEC zone near the Bell-Irving River. Although their elevations suggest a likely effect, no information is available regarding potential degradation on alpine and parkland ecosystems resulting from either the Granduc or Johnny Mountain mines, which closed in 1984 and 1993, respectively.

An estimated 840 ha of (vegetated) alpine and parkland ecosystems may be degraded from the KSM Project. No degradation has likely resulted from any of the present projects, as they occur predominantly at low elevations.

Based on an overlay with the 2008 BEC lines, the future projects with greatest potential to result in cumulative degradation of alpine and parkland ecosystems include the Snowfield Project, Galore Creek Mine, and Brucejack Mine. Smaller losses are estimated from development of the Granduc Copper Mine and Long Lake Hydroelectric Project.

In addition to the estimated degradation (550 ha) expected within the Sulphurets Creek watershed from the KSM Project (16% of baseline distribution), development of the proposed Brucejack Mine and Snowfield Project would result in further degradation within this watershed. As approximately 670 ha of the infrastructure proposed for the Snowfield and Brucejack infrastructure occurs within the CMAunp BEC unit in the Sulphurets watershed, additional degradation may result.

17.9.6.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

Degradation of alpine and parkland ecosystems will be minimized by including the ecosystems in monitoring strategies to assess for degradation from dust deposition, invasive species, or erosion. No further mitigation measures have been developed specific to minimizing alpine and parkland ecosystems degradation, as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize effects.

Table 17.9-11. Summary of Residual Cumulative Effects on Alpine and Parkland Ecosystems

Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects: Probability	Likelihood of Effects: Probability Adjusted for CE	Likelihood of Effects: Confidence Level	Likelihood of Effects: Confidence Adjusted for CE	Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted for CE
Vegetation Loss	Eskay Creek Mine Long Lake Hydroelectric Granduc Copper Mine Galore Creek Mine Brucejack Mine Snowfield Project														High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Vegetation Degradation	Eskay Creek Mine Long Lake Hydroelectric Granduc Copper Mine Galore Creek Mine Brucejack Mine Snowfield Project														Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Overall Effect	All														High	High	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

Note:
CE = Cumulative Effect

17.9.6.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Although each of the present projects outlines general mitigation activities to address and minimize potential effects of vegetation degradation, no mitigation specific to alpine and parkland ecosystems are provided.

As provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining alpine and parkland ecosystems in achieving biodiversity and wildlife habitat objectives, it is expected that EAs for future projects with potential to result in their degradation will assess these ecosystems as VCs and will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.6.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative degradation of alpine and parkland ecosystems remains.

In addition to the 840 ha of potential degradation estimated from the KSM Project, largely associated with proposed development of the pits, RSFs and related infrastructure within the Sulphurets Creek watershed, further cumulative degradation of alpine and parkland ecosystems may result from development of the future projects. Information was not available on past projects or land use activities, and the present projects currently under development are located at lower elevations.

The highest potential for cumulative effects is associated with development of the proposed Brucejack Mine and Snowfield Project, given their proximity to the KSM Project. Both projects have infrastructure proposed within the Sulphurets Creek watershed, although much is expected to overlap non-vegetated ecosystems. With the large area presently mapped as parkland and alpine throughout the cumulative effects assessment area, the estimated cumulative degradation is considered of low magnitude.

Summarized in Table 17.9-11, the residual cumulative effect of vegetation degradation represents a regional effect that is expected to last into the far future, with sporadic effects resulting from the clearing and continued use of infrastructure located within or adjacent to alpine and parkland ecosystems. The effects will be reversible in the long term where infrastructure, such as access roads, is removed, assuming the respective vegetation management and monitoring recommendations are adopted. The probability that effects from future developments will occur is considered medium with a medium confidence level. The residual cumulative effect is expected to be of low magnitude and **not significant (minor).**

17.9.6.4 Overall Cumulative Effects on Alpine and Parkland Ecosystems

Considering potential for cumulative loss and degradation effects on alpine and parkland ecosystems, the overall cumulative effects, summarized in Table 17.9-11, are expected to be **not significant (minor).**

17.9.7 Cumulative Effects Assessment for Old Forest Ecosystems

The assessment of cumulative effects on old forest ecosystems requires the availability of forest inventories to identify the spatial distribution of old forests on the landscape. Old forest ecosystems are often assessed as a VC in developments with proposed infrastructure near or above the treeline. Strategies to ensure the maintenance of landscape connectivity within mature and old forest ecosystems are outlined within the Cassiar Iskut-Stikine LRMP (BC ILMB 2000) as management objectives for endangered plants and animals. Similarly, the Nass South SRMP (BC ILMB 2012) outlines several biodiversity-related goals for the maintenance of habitat connectivity, OGMAs, and interior forest conditions for old-growth dependent species.

Using the current provincial VRI database within the cumulative effects assessment area, Table 17.9-12 summarizes the past, present, and future projects and land use activities overlapping forest inventory polygons with projected age exceeding 250 years.

17.9.7.1 Project-specific Residual Effects on Old Forest Ecosystems Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of old forest ecosystems may result from one or more of the project activities identified in Table 17.9-12. As a result, they are included in the assessment of cumulative effects.

17.9.7.2 Cumulative Effects of Vegetation Loss

Although direct loss of old forest ecosystems may have resulted from vegetation clearing during construction of Highway 37 and from previous timber harvesting activities at low elevations near the highway, it cannot be quantified. No information regarding potential effects on old forest ecosystems is available for the closed Johnny Mountain or Snip mines, which were fly-in/fly-out operations within the Iskut River drainage. At present, approximately 16,200 ha have been logged within the assessment area, primarily within the low elevation ICHwc and ICHvc BEC subzones in the Bell-Irving and Upper Iskut River watersheds. It is assumed that much of the logged area was previously old forest.

Based on current VRI data, 1,340 ha (12% of baseline distribution) of loss may result from the KSM Project, primarily from proposed development of infrastructure within the Sulphurets and Teigen Creek watersheds. Further loss may result from each of the projects identified as a present linkage, as all of them are in development.

The NTL Project EA Application assessed old forests as a sensitive VC and estimated a maximum alteration of 863 ha due to the right-of-way (411 ha) and one-time clearing areas (452 ha), respectively. Estimated losses were highest within proposed transmission line segments 10, 12, and 14. Within segments 12 through 15 (the segments within the CEA boundary), loss of 352 ha was estimated due to the right-of-way (166 ha) and one-time clearing areas (186 ha), respectively. As road locations were not available, alteration from road construction was excluded. Permanent loss is assumed to apply to the full 352 ha, given the length of time required to replace old forests. The potential effect was considered of medium magnitude, given the ecological importance of old forests and their importance to local communities. As the sustainability of old forest ecosystems was not considered threatened, loss was considered not significant (Rescan 2010).

Table 17.9-12. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Old Forest Ecosystems

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities						
	Timber Harvesting – Forestry	Northwest Transmission Line	Long Lake Hydroelectric	Brucejack Mine	Snowfield Project	Bronson Slope Mine	Galore Creek Mine
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Based on current VRI data, the Forrest Kerr Hydroelectric Project infrastructure does not overlap any old forest area. Although the Forrest Kerr Hydroelectric Project EA, which addressed the residual cumulative effects of forest clearing, did not assess old forest ecosystems as a VC, the residual effects of general vegetation loss during construction of generating facilities, access road and buried transmission line, and the Highway 37 transmission line ranged from low to moderate magnitude (Coast Mountain Hydro Corp. 2002). The Long Lake Hydroelectric Project overlaps approximately 66 ha of old forest.

Each of the identified future projects has potential to lose additional areas of old forest. The McLymont Creek Hydroelectric Project EA Application did not assess old forest as a specific VC. However, the at-risk (listed) ecosystems were identified as being primarily old forest ecosystems, which were not considered limiting (Hemmera 2011). Based on current VRI data, the McLymont Creek Hydroelectric Project overlaps approximately 31 ha of old forest.

Other future projects with potential to result in incremental loss of old forest ecosystems include the Snowfield Project (726 ha), Bronson Slope Mine (408 ha), Brucejack Mine (56 ha), and Galore Creek Mine (23 ha). It is assumed that planning of future forest harvesting activity, potentially a large contributor to future old forest loss, will proceed in accordance with regional- and landscape-level objectives established within the respective land and sustainable resource management plans.

17.9.7.2.1 Project-specific Cumulative Effects Mitigation for Vegetation Loss

Loss of old forest ecosystems will be minimized by ensuring clearing of vegetation occurs only where necessary and, where the option exists, patches of old forest are retained in lieu of younger stands. No further mitigation measures have been developed to minimize losses of old forest ecosystems, as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26) will minimize losses.

17.9.7.2.2 Other Project/Activity Mitigation to Address Vegetation Loss

Although each of the present projects outlines general mitigation activities to address and minimize the effects of vegetation loss, no mitigation measures specific to old forest ecosystems are provided.

As most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining old forest ecosystems in achieving biodiversity objectives, it is expected that EAs for all future projects with potential to result in loss of old forest ecosystems will assess them as a VC and adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.7.2.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative loss of old forest ecosystems remains.

In addition to the 1,340 ha of potential loss estimated from the KSM Project at end of operation, largely associated with development of infrastructure within the Sulphurets and Teigen Creek watersheds, further cumulative loss of 1,662 ha of old forest ecosystems may result from development of the present and future projects, primarily (43%) due to development of the Snowfield Project. With the exception of forest harvesting, information was not available to quantify the extent of loss resulting from most past projects and land use activities.

Given the extent of VRI old forest mapped within the CEA boundary (193,500 ha), the estimated total cumulative loss, 1.6% of existing baseline area, is considered of low magnitude. Cumulative losses, expected to be greatest within the Unuk River, Upper Bell-Irving, and Lower Bell-Irving watersheds, represent a very small percentage of current baseline distributions, which range from 34,000 to 60,000 ha. Including all previously harvested cutblocks (16,200 ha), the cumulative loss is 19,200 ha, approximately 10% of the old forest currently estimated (VRI database) within the CEA boundary.

Summarized in Table 17.9-13, the residual cumulative effect of vegetation loss represents a regional effect that is expected to last into the far future, with sporadic losses resulting from clearing associated with the respective developments. The effects are considered irreversible given the long time period required to replace old forests. The probability that effects from future developments will occur is high, with medium confidence. The residual cumulative effect is expected to be low magnitude and **not significant (minor)**.

17.9.7.3 Cumulative Effects of Vegetation Degradation

Although degradation of old forest ecosystems may have resulted from the construction and use of Highway 37, as well as from previous timber harvesting activities at low elevations near the highway, it cannot be quantified. No information regarding potential effects on old forest ecosystems is available for the closed Johnny Mountain or Snip mines.

Based on current provincial VRI data, 1,915 ha (18% of baseline distribution) of degradation may result from the KSM Project, most associated with development and use of infrastructure within the Sulphurets and Teigen Creek watersheds. Further degradation may result from each of the projects presently under development.

The NTL Project EA Application assessed old forests as a sensitive VC and estimated 352 ha of alteration due to the right-of-way (166 ha) and one-time clearing areas (186 ha), respectively (Rescan 2010). Potential degradation effects from invasive species, increased fire risk, and edge effects were estimated as low magnitude and not significant, given the sustainability of old forest ecosystems was not considered threatened.

As the Long Lake Hydroelectric Project overlaps an estimated 66 ha of old forest in the VRI database, it is assumed degradation may also occur. Although the Forrest Kerr Hydroelectric Project EA Application, which addressed the residual cumulative effects of forest clearing, did not assess old forest ecosystems as a VC, the residual effects of habitat (vegetation) loss and alteration during construction of generating facilities, access road, buried transmission line, and the Highway 37 transmission line ranged from low to moderate magnitude (Coast Mountain Hydro Corp. 2002). No further loss or degradation of old forests is expected, based on VRI data.

Each of the identified future projects has potential to further degrade old forests. The EA Application for the McLymont Creek Hydroelectric Project did not specifically assess old forest as a VC. However, at-risk (listed) ecosystems were identified as being primarily old forest ecosystems that were not considered limiting (Hemmera 2011), as the McLymont Creek Hydroelectric Project overlaps an estimated 31 ha of old forest in the VRI database, some degradation may occur.

Other future projects with potential to result in incremental degradation of old forest ecosystems include the Snowfield Project, Bronson and Snip mines, Brucejack Mine, and Galore Creek Mine. It is assumed that planning of future forest harvesting activity, potentially a large contributor to future old forest loss and degradation, will proceed in accordance with regional- and landscape-level objectives established within the respective land and sustainable resource management plans.

17.9.7.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

Degradation of old forest ecosystems will be minimized by including the ecosystems in monitoring strategies to assess for degradation from invasive species or windthrow effects. No further mitigation measures have been developed to minimize degradation of old forest ecosystems as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans (Chapter 26) will minimize effects.

17.9.7.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Although each of the present projects outlines general mitigation activities to address and minimize the effects of vegetation degradation, no mitigation measures are provided specific to old forest ecosystems.

As most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining old forest ecosystems in achieving biodiversity objectives, it is expected that EAs for future projects with potential to result in their degradation will assess them as a VC and will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.7.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative degradation of old forest ecosystems remains.

In addition to the 1,915 ha of potential degradation estimated from the KSM Project, largely associated with development of infrastructure within the Sulphurets and Teigen Creek watersheds, further cumulative degradation of old forest ecosystems may result from development of the identified present and future projects. Information was not available on past projects or land use activities. An alteration of approximately 352 ha of was estimated from development of the NTL Project, and losses of 1,334 ha are estimated from development of the other projects.

The highest potential for cumulative effects is associated with development of the infrastructure proposed for the Snowfield Project. Given the extent of VRI old forest mapped within the CEA boundary (193,500 ha), the estimated cumulative degradation is considered of low magnitude.

Summarized in Table 17.9-13, the residual cumulative effect of vegetation degradation represents a regional effect that is expected to last into the far future, with sporadic effects resulting from the clearing and continued use of infrastructure located within or adjacent to old forest ecosystems. The effects may be reversible in the long term where infrastructure, such as access roads, are removed or no longer used, assuming the respective vegetation management and monitoring recommendations are adopted. The probability that effects from future developments will occur is considered medium with a medium confidence level. Degradation estimates using defined buffer widths are often exaggerated as effects are likely to occur sporadically throughout the buffer. The residual cumulative effect of old forest vegetation degradation is expected to be of low magnitude and **not significant (minor).**

17.9.7.4 Overall Cumulative Effects on Old Forest Ecosystems

Considering potential for cumulative loss and degradation effects on old forest ecosystems, the cumulative overall effect, summarized in Table 17.9-13, is expected to be **not significant (minor).**

17.9.8 Cumulative Effects Assessment for Other Terrestrial Ecosystems

Other terrestrial ecosystems include all other ecosystems not identified as an individual VC. They are included as a VC to assess potential effects on all other ecosystems that are not associated with the other VCs. Maintaining a diversity of these ecosystems, which support many different tree and understory plant species across a range of natural seral stages, is important in the maintenance of biodiversity and have been recognized within both the Nass South SRMP and Cassiar Iskut-Stikine LRMP as management objectives (BC ILMB 2000, 2012).

Each past, present, and future development and most land-use activities have potential to cumulatively interact with the residual effects on other terrestrial ecosystems of the KSM Project. Table 17.9-14 summarizes the past, present, and future projects and land use activities.

17.9.8.1 Project-specific Residual Effects on Other Terrestrial Ecosystems Not Likely to Result in Cumulative Effects

Cumulative effects of vegetation loss and/or degradation of other ecosystems could result from one or more of the project activities identified in Table 17.9-14. As a result, they are included in the assessment of cumulative effects.

17.9.8.2 Cumulative Effects of Vegetation Loss

Although direct loss of other ecosystems resulted from vegetation clearing during Highway 37 construction and previous timber harvesting activities at low elevations near the highway, it cannot be quantified. No information regarding potential effects on ecosystems is available for the closed Johnny Mountain or Snip mines, which were fly-in/fly-out operations within the Iskut River drainage.

Approximately 1,715 ha (11% of baseline distribution) of other terrestrial ecosystem loss was estimated for the KSM Project, the majority within the Teigen, Treaty, and Sulphurets watersheds within the MHmm2 and ESSFwv BEC units. Further loss has resulted from each of the projects identified as a present linkage, all of which are presently in development.

The NTL Project EA Application assessed unlisted terrestrial ecosystems as a VC. This collective group of ecosystems, including all ecosystems not assessed as specific VCs, was considered of importance to wildlife, forestry and a variety of resource and recreation uses (Rescan 2010). Within transmission line route segments 12 through 15, occurring within the CEA boundary, permanent alteration was estimated within 430 ha, which is 20% of the total alteration area estimated for the NTL Project. Of this area, approximately 40% occurs within mesic forest ecosystems in the ICHvc subzone.

At baseline, 19,280 ha of unlisted ecosystems were mapped within route segments 12 through 15. The potential residual effect was considered of medium magnitude for permanently altered areas, given the irreversible nature of alteration, the lack of specific mitigation, and potential for a large affected area (at the scale of the Project), much of which is outside of the CEA boundary. The potential cumulative effect of permanent alteration was considered of moderate magnitude, but not significant, primarily due to the low relative proportion of permanent alteration and the ecosystems' relatively high level of resilience compared to sensitive or listed ecosystems (Rescan 2010).

Clearing of forests for logging, mining, and road-building was the focus of the cumulative effects assessment for the Forrest Kerr Hydroelectric Project. The general residual effects of vegetation loss during construction of the generating facilities, 8-km access road extension and buried transmission line, and the Highway 37 transmission line ranged from low to moderate magnitude. The amount of clearing for the Forrest Kerr Project was deemed insignificant relative to the extent of plant communities in the general area, although high magnitude cumulative effects for vegetation were identified within their assessment for past, on-going, and future projects as well as actions related to development of Nisga'a villages and logging activity. Despite a moderate ranking for the sum of cumulative effects, the incremental effect from the Forrest Kerr Hydroelectric Project was considered low magnitude (Coast Mountain Hydro Corp. 2002).

Given that mines typically have much larger footprints than hydroelectric facilities, the future projects with greatest potential to result in incremental loss of other terrestrial ecosystems include the proposed Galore Creek, Snowfield, and Bronson Slope projects. The majority of the proposed Brucejack Mine site is located within parkland and alpine BEC units. Infrastructure associated with the proposed developments within the CEA boundary includes linear access and transmission line corridors, mine sites, and tailing management facilities. Given the similarity in ecosystems and topography to the KSM Project, the access roads and facilities proposed for the Brucejack Mine and Snowfield Project could result in a low magnitude residual effect, similar to the potential effects estimated from the KSM Project.

17.9.8.2.1 Project-specific Cumulative Effects Mitigation for Vegetation Loss

Loss of other terrestrial ecosystems will be minimized by ensuring clearing of vegetation occurs only where necessary. The general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize vegetation loss.

17.9.8.2.2 Other Project/Activity Mitigation to Address Vegetation Loss

Each of the present projects outlines general mitigation activities to address and minimize the effects of vegetation loss. Most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining ecosystem biodiversity.

Table 17.9-13. Summary of Residual Cumulative Effects on Old Forest Ecosystems

Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects: Probability	Likelihood of Effects: Probability Adjusted for CE	Likelihood of Effects: Confidence Level	Likelihood of Effects: Confidence Adjusted for CE	Significance	Significance Adjusted for CE	Follow up Monitoring	Follow up Monitoring Adjusted for CE
Vegetation Loss	Northwest Transmission Long Lake Hydroelectric Brucejack Mine Snowfield Project Bronson Slope Mine Galore Creek Mine Timber Harvesting - Forestry Traffic and Roads	Construction	High	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Irreversible	Irreversible	Low	Low	High	Medium	High	Medium	Not Significant (Moderate)	Not Significant (Minor)	Not Required	Not Required
Vegetation Degradation	Northwest Transmission Long Lake Hydroelectric Brucejack Mine Snowfield Project Bronson Slope Mine Galore Creek Mine Timber Harvesting - Forestry Traffic and Roads	Construction	High	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Low	Low	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Overall Effect	All	Post-closure	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Irreversible	Irreversible	Low	Low	High	Medium	High	Medium	Not Significant (Moderate)	Not Significant (Minor)	Not Required	Not Required

Note:
CE = Cumulative Effect

Table 17.9-14. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Other Terrestrial Ecosystems

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities								
	Timber Harvesting – Forestry	Traffic and Roads	Eskay Creek Mine	Granduc Mine	Johnny Mountain Mine	Snip Mine	Sulphurets Project	Forrest Kerr Hydroelectric	Long Lake Hydroelectric
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

Description of KSM Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities							
	Northwest Transmission Line	Bronson Slope Mine	Brucejack Mine	Galore Creek Mine	Granduc Copper Mine	McLymont Creek Hydroelectric	Snowfield Project	Treaty Creek Hydroelectric
Vegetation Loss	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction
Vegetation Degradation	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

As such, it is expected that future projects will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.8.2.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative loss of other terrestrial ecosystems remains.

In addition to the 1,715 ha of potential loss estimated from the KSM Project at end of operation, largely associated with development of infrastructure within the Sulphurets and Teigen Creek watersheds, further cumulative loss of other terrestrial ecosystems would result from development of each of the present and future projects. Within the CEA boundary, an estimated 430 ha of loss would result from the NTL Project and smaller losses from the Forrest Kerr Hydroelectric Project.

Further incremental loss would result from development of the proposed mines and hydroelectric facilities. However, given the extent of vegetated ecosystems throughout the CEA boundary, the estimated total cumulative loss is considered of low magnitude. Cumulative losses, expected to be greatest within the Upper Bell-Irving, Lower Bell-Irving, Iskut, and Lower Iskut River watersheds likely represent a very small percentage of current baseline distributions of other terrestrial ecosystems.

Summarized in Table 17.9-15, the residual cumulative effect of vegetation loss represents a regional effect that is expected to be reversible in the long term, with sporadic losses resulting from clearing associated with the respective developments. The probability that effects from future developments will occur is high, with high confidence. The residual cumulative effect is expected to be low magnitude and **not significant (minor).**

17.9.8.3 Cumulative Effects of Vegetation Degradation

Although degradation of other terrestrial ecosystems may have resulted from the construction and use of Highway 37, as well as from previous timber harvesting activities at low elevations near the highway, it cannot be quantified. No information regarding potential effects on other ecosystems is available for the closed Johnny Mountain or Snip mines.

Approximately 2,760 ha (18% of baseline distribution) of other terrestrial ecosystem degradation was estimated for the KSM Project, the majority within the Teigen, Treaty, and Sulphurets Creek watersheds. Further degradation could have resulted from each of the projects identified as a present linkage, all of which are presently in development.

The NTL Project EA Application assessed unlisted terrestrial ecosystems as a VC (Rescan 2010). Within transmission line route segments 12 through 15, occurring within the CEA boundary, temporary alteration was estimated within 438 ha or 20% of total area of alteration estimated for the Project. Of this, approximately 45% occurs within mesic forest ecosystems in the ICHvc subzone. At baseline, 19,280 ha of unlisted ecosystems were mapped within route segments 12 through 15. Potential effects of degradation from invasive species, increased fire risk, and edge effects were estimated as low magnitude and not significant, given that the sustainability of old forest ecosystems was not considered threatened.

Table 17.9-15. Summary of Residual Cumulative Effects on Other Terrestrial Ecosystems

Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Likelihood of Effects				Significance Determination	Significance Determination Adjusted for CE	Follow-up Monitoring	Follow-up Monitoring Adjusted for CE
															Probability	Probability Adjusted for CE	Confidence Level	Conf. Level Adjusted for CE				
Vegetation Loss	Snip Mine Eskay Creek Mine Granduc Mine Johnny Mountain Mine Sulphurets Project Forrest Kerr Hydroelectric Northwest Transmission Line Long Lake Hydroelectric Granduc Copper Mine McLymont Creek Hydroelectric Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine Timber Harvesting - Forestry Traffic and Roads	Construction	Low	Low	Local	Regional	Far future	Far future	One-time	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	High	High	High	High	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

(continued)

Table 17.9-15. Summary of Residual Cumulative Effects on Other Terrestrial Ecosystems (completed)

															Likelihood of Effects							
Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Probability	Probability Adjusted for CE	Confidence Level	Conf. Level Adjusted for CE	Significance Determination	Significance Determination Adjusted for CE	Follow-up Monitoring	Follow-up Monitoring Adjusted for CE
Vegetation Degradation	Snip Mine Eskay Creek Mine Granduc Mine Johnny Mountain Mine Sulphurets Project Forrest Kerr Hydroelectric Northwest Transmission Line Long Lake Hydroelectric Granduc Copper Mine McLymont Creek Hydroelectric Galore Creek Mine Brucejack Mine Snowfield Project Treaty Creek Hydroelectric Bronson Slope Mine Timber Harvesting - Forestry Traffic and Roads	Construction	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	Medium	Medium	Medium	Medium	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required
Overall Effect	All	Post-closure	Low	Low	Local	Regional	Far future	Far future	Sporadic	Sporadic	Reversible long-term	Reversible long-term	Neutral	Neutral	High	High	High	High	Not Significant (Minor)	Not Significant (Minor)	Not Required	Not Required

Note: CE = Cumulative Effect.

Although the Forrest Kerr Hydroelectric Project EA Application, which addressed the residual cumulative effects of forest clearing, did not assess other ecosystems as a VC, the residual effects of habitat (vegetation) loss and alteration during construction of generating facilities, access road and buried transmission line, and the Highway 37 transmission line ranged from low to moderate magnitude (Coast Mountain Hydro Corp. 2002).

Each of the identified future projects has potential to further degrade other ecosystems. The EA Application for the McLymont Creek Hydroelectric Project (Hemmera 2011) did not specifically assess other ecosystems as a VC.

All future projects with infrastructure proposed below alpine and parkland elevations have some potential to result in incremental degradation of other terrestrial ecosystems. It is assumed that planning of future forest harvesting activity, potentially a large contributor to the future loss and degradation of other ecosystems, will proceed in accordance with regional- and landscape-level objectives established within the respective land and sustainable resource management plans.

17.9.8.3.1 Project-specific Cumulative Effects Mitigation for Vegetation Degradation

Degradation of other terrestrial ecosystems will be minimized by including the ecosystems in monitoring strategies to assess for degradation resulting from invasive species or windthrow effects. No further mitigation measures have been developed to minimize degradation, as the general management measures provided within the Terrestrial Ecosystems Management and Monitoring Plans in Chapter 26 will minimize effects. These measures include adopting management and monitoring programs to minimize erosion and windthrow effects and re-vegetating or re-seeding as soon as possible after clearing to minimize potential for introduction and spread of invasive plant species.

17.9.8.3.2 Other Project/Activity Mitigation to Address Vegetation Degradation

Although each of the present projects outlines general mitigation activities to address and minimize the effects of vegetation degradation, no specific mitigation measures are provided for other terrestrial ecosystems.

As most provincial land and resource management plans and other land development guidelines or best management practices recognize the importance of maintaining ecosystem biodiversity, it is expected that future projects with potential to result in degradation of other ecosystems will adopt or develop appropriate management and monitoring strategies to minimize potential effects.

17.9.8.3.3 Determination of Potential for Residual Cumulative Effects and Significance

Despite application of the mitigation and monitoring strategies recommended for the KSM Project and the other projects and land use activities, potential for cumulative degradation of other terrestrial ecosystems remains.

In addition to the 2,760 ha of potential degradation estimated from the KSM Project at end of operation, largely associated with development of infrastructure within the Sulphurets and Teigen Creek watersheds, further cumulative degradation of other terrestrial ecosystems could result from development of each of the present and future projects. Within the CEA boundary, an estimated 438 ha of alteration would result from the NTL Project, with much smaller effects from the Forrest Kerr Hydroelectric Project.

Further incremental degradation could result from development of the proposed mines and hydroelectric facilities. However, given the extent of vegetated ecosystems throughout the CEA boundary, the estimated total cumulative degradation is considered of low magnitude. Cumulative degradation, expected to be greatest within the Upper Bell-Irving, Lower Bell-Irving, Iskut, and Lower Iskut River watersheds represent a very small percentage of current baseline distributions of other terrestrial ecosystems.

Summarized in Table 17.9-15, the residual cumulative effect of vegetation degradation represents a regional effect that is expected to last into the far future, with sporadic effects resulting from the clearing and continued use of infrastructure located within or adjacent to other terrestrial ecosystems. The effects may be reversible in the long term where infrastructure, such as access roads, is removed, assuming the respective vegetation management and monitoring recommendations are adopted. The probability that effects from future developments will occur is considered medium with a medium confidence level. Degradation estimates represent maximum effects, as they may not occur throughout the entire buffer. The residual cumulative effect of vegetation degradation is expected to be of low magnitude and **not significant (minor)**.

17.9.8.4 Overall Cumulative Effect on Other Terrestrial Ecosystems

Considering potential for cumulative loss and degradation effects on other terrestrial ecosystems, the overall cumulative effect, summarized in Table 17.9-15, is expected to be **not significant (minor).**

17.10 Summary of Assessment of Potential Environmental Effects on Terrestrial Ecosystems

Table 17.10-1 summarizes the assessment of potential effects for each of the seven Terrestrial Ecosystems VCs. For each VC, Table 17.10-1 identifies the potential effects and associated key mitigation measures, the Project phase during which the effects could first occur, and the final significance determinations for the Project-related and cumulative effects assessments.

17.11 Terrestrial Ecosystems Conclusions

Seven terrestrial ecosystem VCs were scoped into the effects assessment: potential pine mushroom habitat, avalanche track ecosystems, BC CDC blue- and red-listed ecosystems, riparian and floodplain ecosystems, alpine and parkland ecosystems, old forest ecosystems, and other terrestrial ecosystems. The VCs, identified based of their cultural or ecological importance, represent ecosystems or habitats that represent preservation or conservation priorities.

Despite application of mitigation measures, residual effects of vegetation loss are possible for each of the VCs due to vegetation clearing during the construction and operation phases. Whereas vegetation loss estimates were calculated for the proposed footprint, degradation estimates were calculated within a buffer surrounding the footprint, within which Project activities could adversely affect adjacent terrestrial ecosystems.

Table 17.10-1. Summary of Assessment of Potential Environmental Effects: Terrestrial Ecosystems

Valued Component	Phase of Project	Potential Effect	Key Mitigation Measures	Significance Analysis of Project Residual Effects	Significance Analysis of Residual Cumulative Effects
Potential Pine Mushroom Habitat	Construction	Vegetation Loss	Adherence to the general management considerations within the Vegetation Clearing Management Plan (Chapter 26.20.1). Minimize clearing to the dimensions required; Preferentially retain mature and old trees, where option exists to clear younger stands.	Not Significant (Minor)	Not Significant (Minor)
		Vegetation Degradation	Re-vegetate or seed as soon as possible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Monitor re-vegetated areas to assess success of re-vegetation and minimize related degradation; Develop effective management and monitoring plans for windthrow and invasive plant species; Ensure clearing activities are coordinated with the Fugitive Dust Emissions Management Plan (Ch. 26.11.2), the Erosion Control Plan (Ch. 26.13.2), the Fish and Aquatic Habitat Management Plan (Ch. 26.19), and the Wildlife Management Plan (Ch. 26.22)	Not Significant (Minor)	Not Significant (Minor)
Avalanche Track Ecosystems	Construction	Vegetation Loss	Pre-construction review of mapped avalanche polygons to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required	Not Significant (Moderate)	Not Significant (Minor)
		Vegetation Degradation	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Not Significant (Minor)	Not Significant (Minor)
Listed Ecosystems	Construction	Vegetation Loss	Pre-construction review of mapped and known listed ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required; Adopt low disturbance methods to clear vegetation, where clearing cannot be avoided; Preferentially retain mature and old trees (> 80 yrs), where the option exists to remove younger stands; Where the listed ecosystem is a riparian ecosystem, ensure work practices proceed in accordance with the legislated reserve and/or management zone widths	Not Significant (Minor)	Not Significant (Minor)
		Vegetation Degradation	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS Windthrow Management Manual (Zielke et al. 2010); Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Not Significant (Minor)	Not Significant (Minor)
Riparian and Floodplain Ecosystems	Construction	Vegetation Loss	Pre-construction review of mapped riparian and floodplain ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Adhere to the legislated riparian reserve and/or management zone setbacks under FRPA; Minimize clearing to the dimensions required	Not Significant (Minor)	Not Significant (Minor)
		Vegetation Degradation	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS Windthrow Management Manual (Zielke et al. 2010); Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; develop an operational plan to effectively manage for invasive plant species	Not Significant (Minor)	Not Significant (Minor)
Alpine and Parkland Ecosystems	Construction	Vegetation Loss	Pre-construction review of mapped alpine and parkland ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required; Use of low disturbance clearing methods, where feasible	Not Significant (Minor)	Not Significant (Minor)
		Vegetation Degradation	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Not Significant (Minor)	Not Significant (Minor)
Old Forest Ecosystems	Construction	Vegetation Loss	Pre-construction review of mapped old forest ecosystems to assess options to minimize effects; Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1); Minimize clearing to the dimensions required	Not Significant (Moderate)	Not Significant (Minor)

(continued)

Table 17.10-1. Summary of Assessment of Potential Environmental Effects: Terrestrial Ecosystems (completed)

Valued Component	Phase of Project	Potential Effect	Key Mitigation Measures	Significance Analysis of Project Residual Effects	Significance Analysis of Residual Cumulative Effects
Old Forest Ecosystems (cont'd)	Construction (*cont'd*)	Vegetation Degradation	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS Windthrow Management Manual (Zielke et al. 2010); Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Not Significant (Minor)	Not Significant (Minor)
Other terrestrial Ecosystems	Construction	Vegetation Loss	Adherence to the general management considerations within the Vegetation Clearing Management Plan (Ch. 26.20.1). Minimize clearing to the dimensions required; Preferentially retain mature and old trees, where option exists to clear younger stands.	Not Significant (Minor)	Not Significant (Minor)
		Vegetation Degradation	Adopt low disturbance methods within identified sensitive areas and minimize disturbance to non-target vegetation; Assess windthrow risk and develop clearing prescriptions in accordance with the BCTS Windthrow Management Manual (Zielke et al. 2010); Re-vegetate short-term disturbances and clearings as soon as possible / feasible, in accordance with the Erosion Control Plan (Ch. 26.13.2); Ensure all vehicles and equipment restrict travel to designated roads and surfaces; Develop an operational plan to effectively manage for invasive plant species	Not Significant (Minor)	Not Significant (Minor)

The potential effects were assessed and reported within the terrestrial ecosystems LSA and within four local watersheds (upper Unuk River, Sulphurets Creek, Teigen Creek, and Treaty Creek), which constitute natural drainage basins and were considered ecologically appropriate boundaries for determining the magnitude of the potential residual effects. There is medium to high confidence that irreversible vegetation loss will result within VCs such as old forest, avalanche track, alpine/ parkland, and riparian/floodplain ecosystems. These ecosystems are typically mapped with greater reliability than listed ecosystems and potential pine mushroom habitat. Similarly, although mitigation measures will minimize potential for degradation, residual degradation is possible for each VC from development and subsequent use of proposed Project facilities.

The overall effects on the VCs are expected to be not significant, although medium- and high-magnitude effects from vegetation loss and degradation are possible within avalanche track and old forest ecosystems within the Sulphurets Creek watershed.

The assessment of cumulative effects also adopted a watershed-based study boundary, albeit using higher-order watersheds (i.e., Lower Iskut River, Upper Iskut River) than were used for the residual effects assessment within the LSA. The other projects and activities with highest potential to interact cumulatively with the KSM residual effects are those resulting in additive vegetation loss or degradation within the same local watersheds (i.e., Treaty Creek, Sulphurets Creek. etc.) as the KSM Project. The projects with proposed infrastructure immediately adjacent to, or affecting the same local watersheds, are the proposed Snowfield Project, Brucejack Mine, and Treaty Creek Hydroelectric Project. However, within the Sulphurets Creek watershed, no additional loss of avalanche track or old forest ecosystems, the VCs with potential for medium and high magnitude residual effects, is expected.

Where similar VCs are assessed within other available EA Application documents (NTL, Forrest-Kerr Hydroelectric, and McLymont Creek Hydroelectric), low to medium magnitude effects are typically estimated, with respective results of not significant. The potential losses of avalanche track and old forest ecosystems, the largest potential effects from the KSM Project, are considered medium and low magnitude within the CEA, respectively, with low magnitude cumulative losses expected from other projects and activities, relative to their availability within the CEA boundary.

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