11. Cumulative Effects Assessment

11.1 Methodology

11.1.1 Introduction

11.1.1.1 Cumulative Effects and Regulatory Requirements

The objective of the cumulative effects assessment (CEA) is to identify whether the residual effects of the Morrison Copper/Gold Project (the Project) will interact with the residual effects of other past, present, or probable future projects or activities, and to assess the significance of the combined effects of any such interactions.

The concept of cumulative effects recognizes that while the effects of an individual action may be relatively small, the effects of two or more actions may combine to produce cumulative effects that could be considered significant. The Canadian Environmental Assessment Agency (CEA Agency) defines cumulative environmental effects as "changes to the environment that are caused by an action in combination with other past, present and future human actions" (1999b). Under this definition, "actions" include anthropogenic projects and activities. Projects are typically some form of commercial or industrial development that is planned, constructed, and operated, and is typically identified by a specific name. Activities may either be part of a project or may arise over time because of continual human presence in an area. A mine development, a resource access road, or both together are examples of a project. The unmanaged effects of public traffic, hiking, and hunting along that road are examples of activities (CEA Agency 1999b).

11.1.2 Methodology Overview

The methodology is divided into 11 steps that can be grouped into two key stages: scoping (steps 1 through 7), and analysis of effects (steps 8 through 11).

Scoping:

1. identify the valued ecosystem components (VECs) and valued socio-economic components (VSECs);
2. identify the residual effects from the Project;
3. identify spatial boundaries;
4. identify temporal boundaries;
5. identify other past and present human actions/projects for consideration in the assessment;
6. establish the future scenario of each human action/project under consideration;
7. describe how Project residual effects may interact with residual effects of other human actions/projects.

Analysis of effects:

1. describe the combined effects of human actions/projects on each VEC/VSEC;
2. evaluate the significance of residual cumulative effects from the Project;
3. establish confidence limits of the assessment;
4. identify mitigation measures not previously considered, but which may be required to prevent a VEC/VSEC from surpassing a threshold due to cumulative effects.

11.1.2.1 Valued Ecosystem and Socio-economic Components

The VECs and VSECs included in the CEA are taken from the results of the Environmental and Social Effects Assessment for the Project (Table 11.1-1).

Table 11.1-1
VECs/VSECs included in the Cumulative Effects Assessment

Component	VEC/VSEC
Climate, Meteorology	weather, climate change
Air Quality	air quality
Surface Water	surface water quantity and quality
Groundwater	groundwater quantity and quality
Aquatic Resources	aquatic resources
Fish and Fish Habitat	fish habitat, rainbow trout, pacific salmon, lake trout, dolly varden
Navigable Waters	navigable waters
Wetlands	wetland extent and function
Terrestrial Ecosystems and Vegetation	terrestrial ecosystems, culturally significant plants
Soils	soil quality
Terrain Hazards	terrain, natural drainages, mine worker safety
Wildlife and Wildlife Habitat	grizzly bear, moose, mule deer, American marten, fisher, western toad, waterfowl, forest birds, raptors
Archaeology and Heritage	archaeological and heritage sites protected by the Heritage Conservation Act (HCA)
Socio-economic	employment and income, education, skills and training, population and demographics, business opportunities and economic development, cultural identity and sustainability, community well-being, services and infrastructure
Visual Resources and Aesthetics	visual quality
Noise	noise
Human Health	human health
Land Use	access, quality of experience, quantity of resources, cultural values, management objectives

11.1.2.2 Residual Effects

For cumulative effects to occur the Project must have a residual adverse or beneficial effect on a VEC/VSEC and that VEC/VSEC must also be affected by one or more other actions/projects. All residual adverse or beneficial social and environmental effects of low, medium, or high significance are brought forward and considered. All potential effects assessed to be insignificant are also brought forward if there is reason to believe they may be significant in the context of other past, present, or future human activities/projects in the area.

11.1.2.3 Spatial Boundary

The spatial boundary constrains which other human projects and activities will be considered in the CEA. Socio-economic effects and environmental effects are constrained by different boundaries. Environmental effects are generally bounded hydrologic and topographic boundaries while socio-economic effects are constrained by land use and the flow of people in conjunction with development. Thus, each VEC/VSEC (or group of related VECs/VSECs) will be assessed within a spatial boundary. The boundary reflects the distance beyond which effects become negligible for that particular VEC/VSEC.

11.1.2.4 Temporal Boundary

The temporal boundary for this assessment is from the period before construction to 10 years after the end of the operational life of the Project.

11.1.2.5 Human Actions/Projects Considered

Human actions (projects and activities) to be considered in the CEA include past (closed), existing, and reasonably foreseeable future activities that are likely to have an effect on the VECs/VSECs. Reasonably foreseeable future industrial activities are those that have entered, are close to entering, or have completed regulatory review, but are not yet operational.

Projects and activities in the area that may combine with residual effects from the Project and lead to a cumulative effect include:

- forestry
- mining
- mineral exploration
- roads
- transmission lines
- recreation and tourism
- fishing, hunting, and trapping
- urban and rural communities

Past and Present Human Actions/Projects

Several past and present human activities/projects have been identified for the CEA for the Project (Figure 11.1-1).

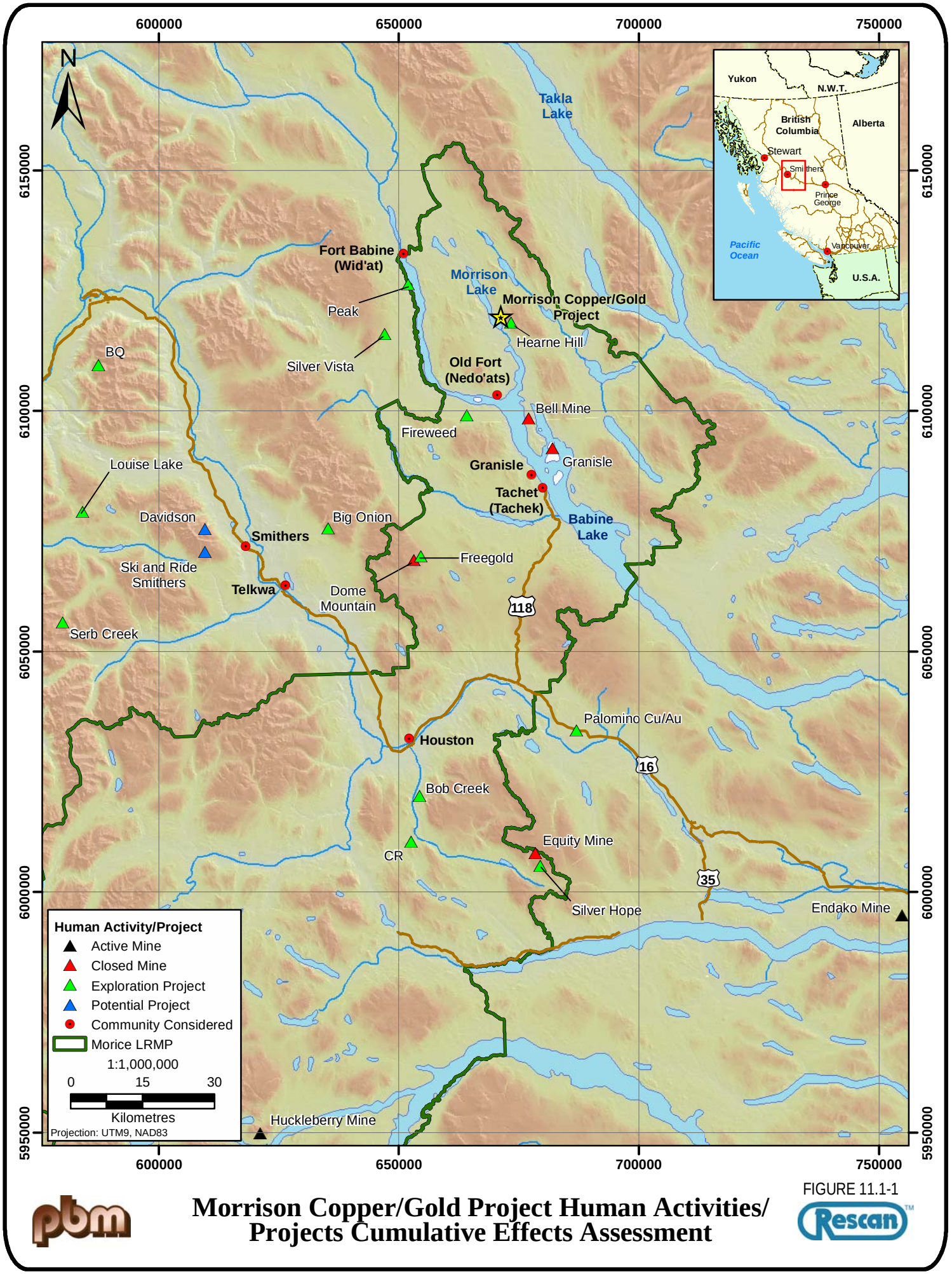

FIGURE 11.1-1

Morrison Copper/Gold Project Human Activities/ Projects Cumulative Effects Assessment

Forestry

The Project is in the Morice timber supply area (TSA), between the Bulkley TSA and the Lakes TSA. The current allowable annual cut (AAC) for the Morice TSA is 2,165,000 m^3, effective February 1, 2008. This value represents an increase of 25% since 2002, despite the fact that the volume harvested has been significantly below allowable levels for the past several years (BC MOFR 2008). The AAC was increased to maximize value from dying and dead trees affected by the mountain pine beetle (MPB) infestation. The AAC for non-pine species is equal to 550,000 m^3/year. The AAC will undergo a review within five years. It can be assumed that high volumes of "gray" (dead/dying trees) will continue until a time when the infestation is over (projected at 2018) and/or until the merchantable dead pine trees are available (projected at 2018 to 2024; BC MOFR 2008). Cutblock data from the provincial government indicate that there are 141,691 ha of forest cutblocks, which includes 82,777 ha of active cutblocks (cutblocks approved for harvesting), 4,302 ha of pending cutblocks (approval not yet granted for harvesting), and 54,512 ha of recently (within the last 3 years) retired cutblocks (all activities with respect to the harvesting authority have been completed for the cutblock).

The current AAC for the Bulkley TSA is 882,000 m^3, effective November 2001, and it is to be reviewed in 2011. Between 2001 and 2006, the AAC was undercut by 3.6 million cubic metres (68% of the AAC; BC MOFR 2007). The AAC for the Lakes TSA is 3,162,000 m^3, although there has been significant undercut in this TSA as well (BC MOFR 2008). MPB infestation is less of an issue in these TSAs relative to the Morice TSA because pine trees make up a smaller proportion of the harvestable landbase. Thus, companies have been allowed to transfer much of their harvesting operations to the affected areas (i.e., to the Morice TSA).

Mining

Several mines have been developed near the Project within the last several decades (Table 11.1-2, Figure 11.1-1).

Bell Mine

The Bell Mine is on the Newman Peninsula at the north end of Babine Lake, approximately 20 km south of the Project site. This mine produced copper, gold, and silver from 1972 to 1992 when it was closed because of depleted ore reserves (BC MEMPR 2008a). This mine site is along the shores of Babine Lake, which contains important fisheries; therefore the environment surrounding this site is sensitive to any release of water of unacceptable quality. Drainage chemistry at Bell Mine was assessed and it was predicted (Morin and Hutt 1997, 1999) that drainages from most WRDs, dams, and tailings impoundments were expected to turn from near neutral pH to acidic pH within several decades, accompanied by increased concentrations of several metals. In 1999, geochemical studies determined current conditions are close to the original predictions (Morin and Hutt 2001).

Table 11.1-2
Past and Present Mines near the Morrison Copper/Gold Project

Project	Location	Coordinates	Current or last owner	Project Type	Operational Period
Bell Mine	22 km south of the Project on the Newman Peninsula of Babine Lake	55º0′10″N 126º13′55″W	Noranda Inc	copper/gold	1960s–1992
Dome Mountain Mine	60 km southwest of the Project	54º44′42″N 126º37′18″W	Eagle Peak Resources Inc.	gold, silver, zinc, lead	1992–1993
Equity Mine	35 km southeast of Houston	54º11′22″N 126º15′48″W	Placer Dome Ltd.	silver, copper, gold, antimony, arsenic	1980–1994
Granisle Mine	29 km south of the Project on McDonald Island (now considered part of Sterrett Island) in Babine Lake	54º56′40″N 126º9′26″W	Noranda Inc	copper/gold	1960s–1992
Huckleberry Mine	86 km southwest of Houston	53º40′52″N 127º10′41″W	Huckleberry Mines Ltd.	Copper/moly bdenum	1997–present (operation expected until 2010)

Dome Mountain Mine

Dome Mountain Mine is an inactive, underground gold mine approximately 60 km southwest of the Project. The site is accessible from Smithers by a 64 km, all-weather gravel road that leaves Highway 16 about 4 km south of Smithers. Dome Mountain Mine operated from 1991 to 1993, with gold (Au), silver (Ag), zinc (Zn), and lead (Pb) as the main commodities. During this period, 43,909 Mt with an average grade of 0.39 oz/Mt Au were reportedly mined and shipped to an off-site mill (Scot Willson Roscoe Postle Inc 2008). There have been some reclamation activities on-site since the mine stopped production in 1993. There is currently no surface infrastructure on-site. The property is currently owned by Eagle Peak Resources Inc. Eagle Peak is pursuing necessary steps both from the perspective of continued exploration and production development to bring the Dome Mountain project back into production (Eagle Peak Resources Inc. 2006).

Equity Silver Mine

The Equity Silver Mine, 35 km southeast of Houston, was BC's largest producing silver mine. The mine began operations in 1980 and ceased milling in January, 1994, after 13 years of open pit and underground production. Equity Mine held a permit to release treated mine water into the Bulkley River via Foxy Creek (BC MOE 1986a, 1986b). The mine site has been reclaimed and revegetated but still produces a significant volume of acid rock drainage (ARD) that requires collection and treatment. This situation is expected to continue indefinitely. In 2006, approximately 1,306,700 m^3 of treated ARD, site runoff, and excess tailings pond water was discharged from the pit to the environment (Goldcorp Inc 2006). The treated water contains elevated levels of nitrogenous compounds that contribute to nutrient loadings (Chris Schell Consulting 2003). Comprehensive environmental effects monitoring studies are carried out

every four years to monitor the health of the aquatic ecosystem downstream from the mine site (Goldcorp Inc 2006).

Granisle Mine

Granisle Mine is on MacDonald Island in Babine Lake approximately 29 km south of the Project. Gold, silver, copper, and molybdenum were mined at this site from 1966 to when mining was suspended in 1982 (BC MEMPR 2008b).

Huckleberry Mine

The Huckleberry open pit copper/molybdenum mine is just south of the Bulkley River watershed, 86 km south of Houston. The mine began operations in September, 1997, and is projected to close in 2010 if no further deposits are developed. The mine site is accessible by a 123 km gravel forest services road and a private access road. Copper concentrate produced at the mine is hauled by road to the Port of Stewart via Highway 16 and molybdenum concentrate is trucked to and sold in Vancouver. Following a large exploration program at Huckleberry that identified additional resources, the mine operators have applied to mine an extension of the main zone ore body that would extend the current mine life beyond 2010 (Imperial Metals 2009).

Mineral Exploration

There has been an extensive history of mining exploration and development in the CEA area since the early 20th century. Several past and ongoing exploration projects occur approximately within 125 km of the Project property (Table 11.1-3, Figure 11.1-1).

Table 11.1-3
Mineral Exploration near the Morrison Copper/Gold Project

Project	Location	Coordinates	Current or last owner	Project Type	Operational Period
Big Onion	16 km east of Smithers	54°48'5"N 126°53'46"W	Eagle Peak Resources Ltd.	Cu, Au, Mo	1970s to present
Bob Creek	12 km south of Houston	54°18'15"N 126°37'41"W	Canadian Gold Hunter Corporation	Ag, Au, Zn	preliminary drilling in 2003
BQ	25 km northwest of Smithers	n/a	Endurance Gold Corp	Au	drilling in 2008
CR	17 km south of Houston	n/a	Manson Creek Resources	Cu, Au, Mo, Ag	exploration in 2005/2006; drilling in 2007; ongoing
Fireweed	54 km northeast of Smithers	55°00'43"N 126°26'02"W	Jantar Resources	Ag, Pb, Zn	abandoned in 2008
Freegold	35 km east of Smithers; adjoins the Dome Mountain Mine Property	55°45'43"N 126°36'24"W	Eagle Peak Resources Ltd.	Au	1932 to 1951; 1980s; additional exploration expected
Hearne Hill	Adjacent to the Morrison Property above Babine Lake	55° 10'54"N 126°16'36"W	Pacific Booker Minerals Inc. last known owner	Cu	1993 to 1997
Louise Lake	37 km west of Smithers	54°51'08"N 127°28'41"W	North American Gem Inc.	Cu, Au, Mo	1970 to 1992

(continued)

Table 11.1-3
Mineral Exploration near the Morrison Copper/Gold Project (completed)

Project	Location	Coordinates	Current or last owner	Project Type	Operational Period
Peak	65 km northeast of Smithers	n/a	Grizzly Diamonds Ltd.	Au, Ag	drilling completed 2008
Palomino	25 km east of Houston	54°25'N 126°7'W	Manson Creek Resources Ltd	Cu, Au	abandoned after 2006 drilling
Serb Creek	40 km SW of Smithers	54°38'46"N 127°45'40"W	Candorado Operating Company Ltd	Mo	status unknown
SilverVista	57 km northeast of Smithers	55°10'30"N 126°40'51"W	Eagle Peak Resources Ltd.	Ag, Cu, Zn	exploration underway
Silver Hope	Immediately south of closed Equity Mine, south of Houston	54°10'N 12°615'W	Finlay Minerals Ltd.	Ag, Cu, Au	drilling in 2008

Roads

The road between Highway 118 turnoff and north to the Bell Mine is paved and was constructed for the Bell and Granisle mines. Highway 118 is also paved and is used by the surrounding communities. Highway 16 is the major highway that passes through the CEA study area. This highway is a main transportation route through northern BC, connecting Alberta and northeastern BC with Prince Rupert and the Pacific ports. The highway receives a significant and regular volume of local and regional traffic as well as traffic associated with tourism and industry.

Electric Power Transmission Lines

The existing regional British Columbia Transmission Corporation (BCTC) transmission network and the proposed transmission line for the Project are presented in Figure 11.1-2.

Recreation and Tourism

Recreation and tourism-related activities are very prominent within the CEA study area. Local mountains, lakes, and rivers provide residents and visitors a wide range of front country (parks, recreation areas) and backcountry opportunities. Principal activities include hiking, hunting, fishing, camping, kayaking, canoeing, rafting, horseback riding, all-terrain vehicle riding, snowmobiling, cross-country and downhill skiing, climbing, mountaineering, and wildlife viewing. Eco-tourism and the outdoor recreation industry is a growing industry in the CEA study area. Tourism is an important source of revenue and employment throughout BC, and the BC Tourism Action Plan aims to double revenue from tourism by 2015 (BC MTCA 2007).

Fishing, Hunting and Trapping

The CEA will consider all fishing, hunting, and trapping activities known within the assessment boundary.

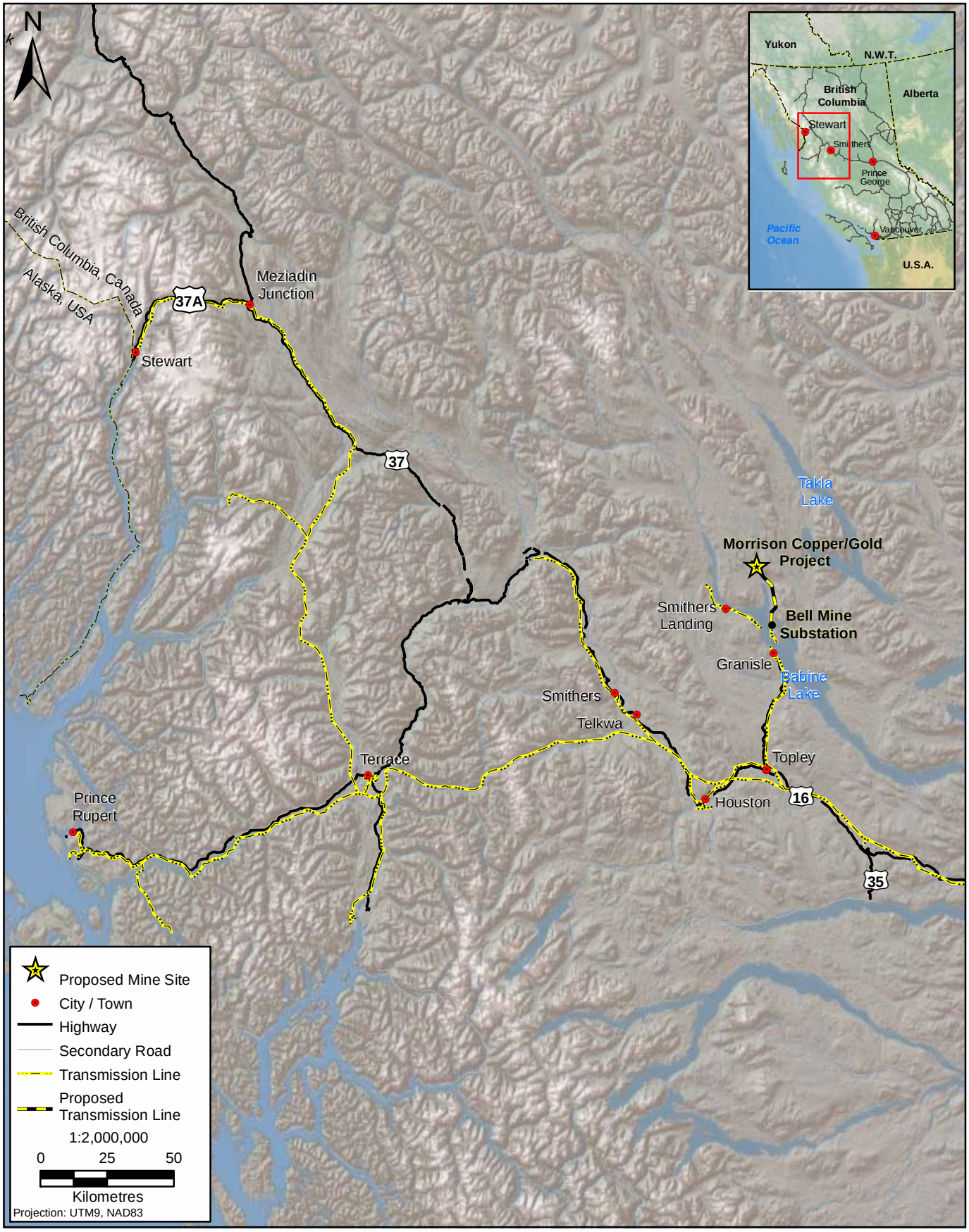

FIGURE 11.1-2

Morrison Copper/Gold Project
Regional BCTC Transmission Network

Urban and Rural Communities

Granisle

The village of Granisle, north of Houston on the western shores of Babine Lake, was built to support the Granisle and Bell mines when they came into operation in the 1960s. During the 1970s and 1980s, Granisle was a bustling mining town with a population of 2,200. By the early 1990s, both mines had closed and today the population of Granisle and area is approximately 450. Local residents make a livelihood mainly from tourism, logging, and government services (BC MAL and BC ILMB 2007). Residents of Granisle mostly have expressed enthusiasm for the potential economic stimulus that the mine will bring to the community, which was formerly dependent on the past operating Bell and Granisle Mines

A sewage treatment plant (STP) in Granisle, owned and operated by Babine lodge owners, discharges treated effluent to the Babine Lake. The authorized effluent discharge to the lake is under a valid permit subject to the conditions of the *Waste Management Act* (BC MOE n.d.).

Tachet

Tachet is on the Fulton River where it enters Babine Lake. Tachet has approximately 130 permanent residents, a satellite band office, and a water treatment plant. Local amenities include a community hall, child care facility, large sports field, Trappers Gas station, and a well-stocked convenience store with Aboriginal crafts available (Lake Babine Nation 2009).

Fort Babine

Fort Babine is a small Aboriginal community at the northern tip of Babine Lake approximately 30 km northeast of the Project. It is accessible by an all-weather gravel logging road. There are approximately 60 year-round residents (Lake Babine Nation 2009).

Old Fort

Old Fort, at the northern end of Lake Babine and approximately 20 km south of the Project, is used seasonally with no permanent residents reported.

Smithers, Houston, and Telkwa

Smithers (population 5,257), Houston (population 2,999), and Telkwa (population 1,359) are the largest community bases identified within the CEA (BC Stats 2008).

Reasonably Foreseeable Future Activities/Projects

Reasonably foreseeable future activities and projects that, depending on the VEC/VSEC, may need to be considered for their interaction with the Project include the proposed Davidson mine, the re-establishment of the Dome Mountain project (Section 11.1.5.1), and the Hudson Bay Mountain Resort expansion. The future scenario is established using information gathered about existing and future human actions. A realistic "worst case" scenario is developed such that the maximum potential cumulative effects are considered. The future scenario does not have a specific date attached to it, as the exact timelines for future human actions are difficult to predict. For each of the human actions identified in the previous stage, a future condition is assumed based on existing knowledge (Table 11.1-4).

Table 11.1-4
Future Scenarios

Activity/Project	Future Scenario
Forestry	Harvesting will continue to increase until the end of the pine beetle epidemic then will likely decrease until new trees are available to cut, at which time levels will stabilize.
Davidson Mine	The Davidson Mine will open; it is assumed that it will be operational until the end of its projected life span.
Dome Mountain Mine	It is assumed that Dome Mountain Mine will eventually be operational.
Roads	Local traffic volumes likely to increase because of increased numbers of workers and visitors to the area.
Recreation and tourism	Tourism numbers may increase in the Smithers area with the planned expansion of the Ski and Ride Smithers project.
Fishing, hunting, and trapping	The contribution of First Nations to fishing, hunting and trapping will probably stay constant, but the contribution of others may increase because of an increased work force in the area.
Urban and rural communities (Granisle, Tachet, Old Fort, Fort Babine, Houston, Telkwa, Smithers)	The population currently working at Huckleberry mine may relocate to live closer to the Davidson and Morrison Copper/Gold Projects, both of which will require a daily commute (i.e., instead of site-based camps).

Davidson Mine

The Davidson project is about 9 km north of Smithers, on the eastern flank of Hudson Bay Mountain. Blue Pearl, which currently owns and operates the project, is proposing to develop the Davidson deposit as an underground molybdenum mine and to transport the ore to the existing Endako mine for processing. The Project is currently under the EA review process.

Dome Mountain Mine

Dome Mountain Mine is an inactive, underground gold mine 38 km southeast of Smithers. The property is currently owned by Eagle Peak Resources Inc. Eagle Peak is pursuing the necessary steps both from the perspective of continued exploration and production development to bring the Dome Mountain project back into production (Eagle Peak Resources Inc. 2006).

Hudson Bay Mountain Resort

The owners of Hudson Bay Mountain Resort have submitted a master plan to expand their capacity to provide winter and all-season activities. The master plan is divided into three phases and the total ski area plan considers the ski hill development over a 20-year period. Implementation beyond Phase 1 is in part dependent on improvements to transportation and access, including the expansion of the Smithers Regional Airport, to accommodate greater numbers of visitors from outside of the region. The has been approved in May, 2008, by the Resort Development Branch of the BC MTCA (2008).

11.1.2.6 Interaction with Human Actions/Projects

To produce a cumulative effect, the residual effects of the Project must act in combination with the residual effects of one or more other past, present, or reasonably foreseeable human projects

or activities. Thus, a key step in the CEA is to establish linkages between the Project's residual effects and the residual effects of the other human actions/projects.

Interactions may be considered in the following perspectives, if applicable:

- Physical-chemical Transport: a physical or chemical constituent (e.g., air emissions, waste, water effluent, sediment) is transported from the Project where it then interacts with the same constituents from another (past, present, or future) project or activity.
- Nibbling Loss: a relatively small effect from the Project, which itself may be insignificant, but in combination with other past, present, or future activities/projects, becomes significant (e.g., fragmentation of wildlife habitat).
- Spatial and Temporal Crowding/Overlap: cumulative effects can occur when too much activity is happening within too small an area. A threshold may be exceeded and the environment may not be able to recover to pre-disturbance conditions. Spatial crowding is an overlap of the effects from multiple projects/activities. Temporal crowding may occur if effects from multiple activities overlap or occur before the VEC/VSEC has time to recover.
- Spin-off Potential: each new action can induce further actions to occur. The effects of these "spin-off" actions (e.g., increased vehicle access into a previously inaccessible area) may add to the cumulative effects already occurring.

11.1.2.7 Predicted Residual Cumulative Effects

The likely condition of each VEC/VSEC is to be evaluated, taking into account the combined effects of the identified human actions/projects. Each effect is described with reference to the direction, scope, duration, frequency, and magnitude (defined in Table 11.1-5). Wherever possible, quantitative data and regional baseline information are used to evaluate the cumulative effect. When this information is not available qualitative descriptions and professional judgment are used.

Where applicable and possible, a threshold level at which the condition of a VEC/VSEC is deemed unacceptable is determined (in practice, thresholds may be difficult or impossible to ascertain). Thresholds are specific to each VEC/VSEC and can be goals, targets, standards, guidelines, carrying capacities, or limits of acceptable change.

Table 11.1-5
Definitions for Residual Cumulative Effects Attributes

Attribute	Options	Definition
Direction	Positive	Beneficial effect on VEC/VSEC
	Neutral	No change to VEC/VSEC
	Negative	Adverse effect on VEC/VSEC
Scope	Sub-regional	Effect extends to the area within a few kilometres of the Project footprint
	Regional	Effect extends throughout CEA area
Duration	Short-term	Effects last <1 year before recovery; or, for species, for less than one generation
	Medium-term	Effects last between 1 and 10 years; or, for species, for less than one generation
	Long-term	Effects last for >10 years; or, for species, for more than one generation

(continued)

Table 11.1-5
Definitions for Residual Cumulative Effects Attributes (completed)

Attribute	Options	Definition
Frequency	Once	Occurs once only
	Continuous	Occurs on a regular basis at regular intervals
	Sporadic	Occurs rarely and at irregular intervals
Magnitude	Low	Minimal or no additional impairment or improvement of VECs/VSECs function or process (e.g., for wildlife, a species' reproductive capacity, survival, or habitat suitability) because of interactions with these projects/activities
	Moderate	Impairment or improvement in VECs/VSECs function or process exceeding baseline conditions but not the threshold value
	High	Impairment or improvement in VECs/VSECs function or process (e.g., for wildlife, serious change to species productivity or habitat suitability) exceeding threshold values.

11.1.2.8 Assessment of Significance

The significance of each predicted residual cumulative effect is evaluated to reflect the expected change in condition of the VEC/VSEC being assessed, using the residual effects descriptors as a basis (Section 11.1.8). If the magnitude of an effect exceeds a threshold for a VEC/VSEC, and the effect is not temporary, then the effect is usually significant. If on the other hand, the combined effects of all actions within a region do not exceed a certain limit or threshold, the cumulative effects of an action are considered insignificant.

Definitions of the significance of cumulative effects are presented in Table 11.1-6. Figure 11.1-3 depicts these same levels of significance visually by tracing the possible changes in the condition of a VEC/VSEC over time, beginning with its condition at the start of the Project (taking into account all past and existing projects within the study area) and ending with its condition post-closure (assuming mitigation is successful).

11.1.2.9 Confidence Limits

There will often be some uncertainty associated with the information and methods presented in an assessment, frequently termed the *confidence limits* (CEA Agency 1994). This may especially occur when considering cumulative effects because the assessment process requires that predictions be made about whether future developments will take place and about the effects of those developments.

For each potential cumulative effect, the limitations and uncertainties associated with the data and their analyses are documented, including the reliability or variability of results or conclusions. Where possible, a quantitative description of the uncertainty and error should be made. Where data or models are not available, the evaluation of confidence limits can be carried out using best professional judgment and expertise. The descriptors for confidence limits are defined in Table 11.1-7.

11.1.2.10 Additional Mitigation

Mitigation, monitoring, and management procedures that are technically and economically feasible are identified to reduce the cumulative effects. The need for management and monitoring on a scale beyond the scope identified for the Project is suggested, where appropriate.

Table 11.1-6
Significance Definitions for Residual Cumulative Effects

Level of Significance	Definition	
	Adverse Effects	**Beneficial Effects**
Negligible	Cumulative effects may result in a slight decline in condition of the VEC/VSEC for a short period, but the VEC/VSEC should return to baseline conditions within the operational lifetime of the Project; no threshold is reached	Cumulative effects may result in a slight improvement in the condition of the VEC/VSEC for a short period, but the VEC/VSEC is likely to return to baseline conditions within the operational lifetime of the Project
Low	Cumulative effects may result in a slight decline in condition of the VEC/VSEC during the life of the Project, but the VEC/VSEC should return to baseline conditions after Project closure. No threshold is reached	Cumulative effects may result in slight improvement in condition of the VEC/ VSEC during the life of the project, but the VEC/VSEC is likely to return to baseline conditions after closure of the Project
Moderate	Cumulative effects could result in a decline in condition of the VEC/VSEC to lower-than-baseline but stable levels after Project closure and into the foreseeable future; no threshold is reached, but the condition of the VEC/VSEC is closer to a threshold than previously or Cumulative effects result in a decline of the VEC/VSEC, exceeding the threshold, but the condition improves over time and returns to below the threshold	Cumulative effects could result in an substantial improvement in condition of the VEC/VSEC to greater-than-baseline levels during the life of the Project
High	Cumulative effects could threaten the sustainability of the VEC/VSEC; the threshold is exceeded, no recovery expected	Cumulative effects could result in an very substantial improvement in condition of the VEC/VSEC to greater-than-baseline levels after Project closure and into the foreseeable future

Table 11.1-7
Confidence Limits Definitions

Descriptor	Definition
High	There is a good understanding of the cause-effect relationship and all necessary data are available; thus, there is a high degree of certainty that the conclusions of the assessment are accurate
Intermediate	The cause-effect relationships are not fully understood **or** data are incomplete; thus, there is an intermediate degree of certainty that the conclusions of the assessment are accurate
Low	The cause-effect relationships are poorly understood and data are incomplete; thus, there is a low degree of certainty that the conclusions of the assessment are accurate

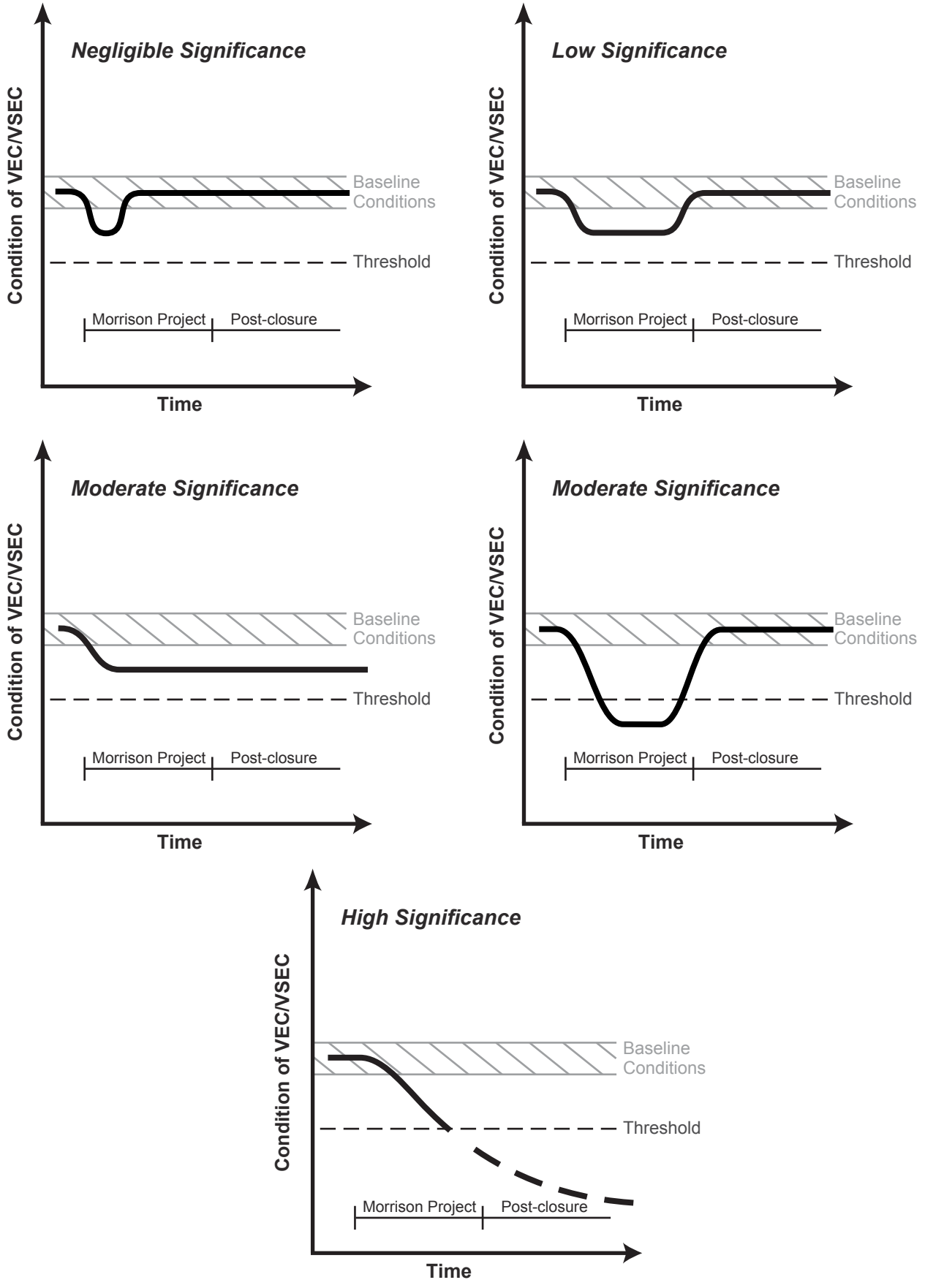

FIGURE 11.1-3

Morrison Copper/Gold Project: Cumulative Effects Assessment Significance Criteria

11.2 Climate and Meteorology

11.2.1 Valued Environmental Components

Climate describes the predominant weather patterns in an area and was selected as a VEC for the Project because it is a fundamental aspect of the natural environment. Changes to the climate will affect many other ecosystem components.

Accumulating greenhouse gases (GHGs) in the atmosphere have affected global climate patterns. GHGs include water vapour, CO_2, CH_4, N_2O, and O_3. Rising GHG levels from increased industrial activity and fewer large carbon sinks increase the heat retained within the Earth's atmosphere, causing global climate changes.

The most significant consequences from climate change will likely relate to air temperature and precipitation (Section 8.2.1). These changes could result in potential effects to hydrological regimes, vegetation, and wildlife on a global scale. This section addresses the potential for additional human activities within a defined area to compound potential residual effects identified in Section 8.2 associated with climate change from Project activities.

11.2.2 Residual Effects of Project

Climate effects from the incremental increase in atmospheric GHGs from any single source can not be quantified (CEA Agency 2003). Therefore, the significance of effects on the climate as a result of the Project were assessed by comparing projected Project emissions to national, provincial, and industry sector standards. GHG emission intensity can be stated in terms of emissions per unit of ore produced (kt CO2-eq/MT) or per unit energy consumed (kt CO2-eq/terajoules). The Project's projected emission intensity per unit energy consumed is slightly less than half of the Canadian metal mining sector average and the projected emission intensity for the Project per unit produced is only 22% of the Canadian metal mining sector average. Because of the incremental contribution of GHG to total atmospheric levels and the resiliency of the climate, the Project's residual adverse climate effects were classified as having a minor level of significance, and were therefore carried forward to the cumulative assessment (Section 8.2.6).

11.2.3 Spatial Boundary

The study area for the CEA refers to the maximum area over which the potential for cumulative effects is assessed. The CEA spatial boundary reflects the same spatial boundary as that described in Section 8.2 (climate effects are considered to have a trans-boundary geographic extent). This assessment accounts for effects to GHG levels on a cumulative scale and must consider all contributing actions. Therefore, it is not appropriate to discuss the implications of the emissions within a defined spatial boundary because it is the total global atmospheric GHGs that contribute to global climate change.

11.2.4 Temporal Boundary

Temporal boundaries included the Project's proposed construction (2 years), operational (21 years) and closure and decommissioning (1 to 3 years) lifetime. For the purposes of the CEA, the temporal boundary will be further extended to include a 10-year post-closure phase.

However, because of the resiliency of the atmosphere the maximum temporal effects of the Project on GHG emissions and climate change are anticipated to occur within the Project's lifetime. In addition, although GHG emissions will be emitted during the mine's construction and closure phases, because of their short-term timeframe their nature and extent are expected to be negligible and are not assessed quantitatively.

11.2.5 Human Actions Considered

Human actions (projects and activities) considered in the CEA include past (closed), existing, and reasonably foreseeable future activities that are likely to have an effect on climate change within a global context.

Within the CEA boundary described in Section 11.1, there are a number of human activities and projects that may interact with the Project's effects on GHG emissions and climate change including:

- Huckleberry Mine, 86 km southwest of Houston (expected closure 2010);
- Forestry (Morice TSA);
- Roads: Highway 118 and Highway 16;
- Existing and proposed regional transmission line network; and
- Urban and rural communities: Granisle, Tachet, Smithers, Old Fort, and Fort Babine.

The global nature of climate change effects requires considering human activities on a larger scale than those described in Section 11.1. Therefore, in addition to the above-documented human activities, this CEA section considers the contributions of industrial and other GHG contributors within British Columbia (BC).

GHG contributors in BC have been broadly categorized by the Ministry for Environment (2006) into the following main groups:

- Transportation (36%)
- Fossil fuel production (21%)
- Residential and commercial (12%)
- Other industry (14%)
- Net deforestation (6%)
- Agriculture, waste, and electricity (11%)

Transportation accounts for the largest share of provincial GHG emissions, followed by the oil and gas industry. These sectors are also among BC's fastest growing emission sources, along with electricity supply, agriculture, and landfill waste (BC MOE 2006).

However, compared to many other North American jurisdictions, the electricity industry remains a small contributor to BC's total GHG emissions because of the province's reliance on hydroelectric power generation (BC MOE 2006).

11.2.6 Interactions with Other Developments and Activities

The primary GHGs from human sources are CO_2, CH_4, and N_2O. The Project will emit all three as a consequence of energy consumption in the form of fuel (diesel and propane) and electricity. Consuming diesel and propane will result in direct GHG emissions by Project components. Hydro-electrical energy use by Project components will generate indirect GHG emissions.

Similarly, each of the projects described in Section 11.2.5 will contribute to global GHG emissions and have an effect on climate change by consuming fuel and electricity. Therefore, the GHG emissions from the Project will interact on a cumulative basis with emissions produced by widespread human activities to potentially contribute to climate change on a global scale.

The incremental increase in global GHG emissions from a single facility can not be used to estimate a resulting change in the global or local climate (CEA Agency 2003). As these interactions occur on such a large scale, it is important to understand the extent of GHG emission contributions from the Project in comparison to a provincial or trans-boundary spatial extent.

The estimated annual fuel and energy use and resulting GHG emissions from the Project during Year 1 of production are described in Table 11.2-1. Year 1 of production is considered the worst case scenario as it involves the highest energy demand during the Project lifecycle. Year 1 has the highest total for the tonnage of ore and waste rock that is handled. For a further detailed breakdown of GHG emissions resulting from specific Project components, refer to Section 8.2.3.

Table 11.2-1
Estimated Annual Energy Use and GHG Emissions from the Project – Year 1 of Production

	Energy Use		Emissions			
Source	**Quantity**	**Energy (terajoules)**	**Direct (kt CO_2-eq)**	**Indirect (kt CO_2-eq)**	**Total (kt CO_2-eq)**	**Total Intensity (total kt CO_2-eq/ total terajoules)**
Diesel	7.985 million L	308.9	22.5	-	22.5	0.073
Propane	2.535 million L	64.6	3.9	-	3.9	0.060
Electricity	224.0 GWh	806.3	-	3.8	3.8	0.005
Total	**-**	**1,180**	**26.4**	**3.8**	**30.2**	**0.026***

Note: *Total intensity of GHG emissions is equal to total emissions divided by energy (30.2/1180 = 0.026). Propane emissions were assumed to be from stationary sources and diesel emissions from mobile sources. Propane consumption, energy, and intensity were calculated using section 12, Tier C Method from the Climate Registry's *General Reporting Protocol* (2008). Diesel consumption, energy, and intensity were calculated using section 13, Tier B Method from the Climate Registry's *General Reporting Protocol* (2008). Indirect emissions, energy, and intensity from electricity were calculated using section 14, Tier B Method from the Climate Registry's *General Reporting Protocol* (2008).

The projected emission intensity for the Project per unit energy consumed is slightly less than half of the Canadian metal mining sector average and the projected intensity for the Project per unit produced is only 22% of the Canadian metal mining sector average (CIEEDAC 2008). The

projected GHG emissions for the Project equate to approximately 0.004% and 0.05% of the Canadian and British Columbian estimated total GHG emissions. Data provided by the BC MOE on provincial sector GHG emissions show the Project to contribute only 0.003 % of the "other industry category" (includes mining activities) and 0.0075% of the total contributions from forestry activities within the province (BC MOE 2006).

The Project is within the Morice TSA. The current AAC limit of 2,165,000 m^3 is expected to increase in the coming years to maximize value from dying and dead trees affected by the MPB infestation. The projected increases in forestry production in the future may lead to increased contributions of GHGs to the global airshed through increased harvesting and slash burning. An additional interaction associated with neighboring deforestation activities is the removal of local carbon sinks. As a result, forestry activities have the potential to emit CO_2 emissions instead of removing CO_2 from the atmosphere (Environment Canada 2006).

The interactions described above put the Project's GHG emissions into context. The data presented demonstrate that the annual GHG emissions associated with the Project constitute a minor portion of national, provincial, and industry sector inventories.

11.2.7 Predicted Residual Cumulative Effects

Increases in gross GHG contributions to the atmosphere as a result of the Project have the potential to lead to changes in global climatic conditions, and have therefore been classified as a residual cumulative effect. With projected annual emissions of 30.2 kt CO_2-eq at an intensity of 0.026 kt CO_2-eq per terajoule of energy consumed, the magnitude of the residual cumulative effects is low (Table 11.2-2). The GHG emissions associated with the Project were demonstrated to be negligible in comparison to national, provincial, and sector GHG emission norms described in Section 11.2.6.

Table 11.2-2
Residual Cumulative Effects Summary Table

Effect	Direction	Scope	Duration	Frequency	Magnitude
Increased GHG emissions concentrations potentially altering climatic conditions	Negative	Provincial/ trans-boundary	Long-term	Continuous	Low

Emissions from the Project will contribute to the global GHG inventory; therefore, the climate effects have a trans-boundary spatial extent.

GHGs will be emitted throughout the life of the mine and will cease once Project operations stop. The airshed is expected to experience rapid recovery following discontinuation of an emissions source. Thus, the climate effects will have a long-term duration and continuous frequency.

11.2.8 Assessment of Significance

Project development will result in GHG emissions. The Project's GHG emissions on a cumulative basis (i.e., considering the past, present, and future projects) are very minor when

considered on a global scale. The direct effects to climate change from the cumulative GHG emissions will not be measurable, but it will be possible to estimate the Project's GHG emissions based on the annual consumption of diesel, propane, and hydroelectric energy.

CO_2, the dominant GHG that will be emitted by the Project and by the cumulative human actions identified, is consumed by carbon sinks, such as forests and large waterbodies. Hence, a portion of the GHG emissions produced will naturally be consumed or sequestered resulting in a short-term reversibility of the climate effects. Because of the natural ability of the environment to consume GHG emissions and the global nature of the inventory to which the Project emissions will contribute, the resilience of the regional airshed is high.

In summary, because of the low magnitude, the incremental contribution of the Project's GHGs to global atmospheric levels, and the resiliency of the regional airshed to GHG emissions, the Project's residual adverse cumulative climate effects are assessed to have a low significance level.

11.2.9 Confidence Limits

The release of CO_2, CH_4, and N_2O during fossil fuel consumption is scientifically certain. However, uncertainty does exist in the projection of annual energy consumption and the resulting amount of GHG emissions. A worst case scenario for the Project was assessed, allowing for generation of conservative estimates.

There is an additional level of uncertainty associated with considering cumulative effects. The assessment process requires that predictions be made about whether future developments will take place, the nature and extent of GHG emissions and about the effects of the developments. As a result, the confidence level of this air quality cumulative assessment has been classified as intermediate.

11.2.10 Additional Mitigation

No additional mitigation is required beyond that outlined in the air emissions and fugitive dust management plan (Section 13.2) and the annual GHG accounting that will be required if the proposed BC mandatory reporting of GHG emissions regulation is approved in 2009.

11.3 Air Quality

11.3.1 Valued Environmental and Socio-economic Components

Air quality was selected as a VEC because of its importance to employee and residents' health, wildlife, vegetation, and water quality. Air quality also has aesthetic qualities in terms of visibility and odour. Air quality issues can extend to regional and global scales to include potential acidic depositions (acid rain) and climate effects (global warming).

There will be emissions during the construction, operation, decommissioning, and closure phases of the Project. Fuel-consuming Project components will affect air quality through emissions, which may increase ambient concentrations of SO_2, NO_2, CO, and particulate matter (PM_{10} and $PM_{2.5}$). Mine-related traffic along paved and unpaved roads and mine blasting may produce fugitive dust, which also increases ambient PM concentrations. Project emissions will consist

primarily of diesel emissions from mobile equipment and trucks (hauling ore and waste rock), emissions from ventilation systems, and fugitive dust from drilling, blasting, crushing, waste rock placement, and traffic along unpaved roads.

11.3.2 Residual Effects of Project

The Project's residual effects on air quality were limited to ambient concentrations of fine PM (PM_{10} and $PM_{2.5}$). Modelling predictions showed that PM emissions resulted in ambient air quality that exceeded the Canada Wide Standards and British Columbia Ambient Air Quality Objectives outside the Project fence line. For all other criteria, the ambient concentrations were predicted to fall below the relevant standards and objectives.

The major sources of particulate emissions are the open pit mine, crushing, waste rock placement, and trucks travelling along unpaved haul roads and the access road. With the appropriate mitigations, as discussed in Section 13.2, the significance of the Project's residual effects was assessed as low.

11.3.3 Spatial Boundary

The study area for the CEA refers to the maximum area over which the potential for cumulative effects is assessed. The purpose of the study area is to set a boundary for the identification of other human actions that may interact with the Project. A local and regional study area was previously identified in Section 8.3 as a means of determining the extent of effects to air quality as a result of the Project in isolation. For the CEA, the regional study area will reflect the boundary of the Morice TSA to encompass all past, present, and future forestry activities that may interact with the Project. This boundary will also encompass the Granisle, Fort Babine, and Old Fort communities and the two historical mining operations within 30 km of the Project site: Bell Mine and Granisle Mine.

11.3.4 Temporal Boundary

The Project's temporal boundaries were previously identified in the effects assessment (Section 8.3). Temporal boundaries included the Project's proposed lifetime of 21 years (construction, operation, decommissioning, and closure). For the purposes of the CEA, the temporal boundary will include a 10-year post-closure phase. However, because of the generally rapid recovery of ambient air quality following the closure of an emissions source, the maximum temporal effects of the Project on ambient air quality are anticipated to occur within the Project's lifetime.

11.3.5 Human Actions Considered

Human actions (projects and activities) considered in the CEA include past (closed), existing, and reasonably foreseeable future activities that are likely to have an effect on the air quality in the regional airshed. A review of the region surrounding the Project site was completed to determine any past, present, or future human actions that may interact with the Project and potentially have combined effects on ambient air quality (Section 11.1). The following projects and activities that may contribute to ambient air quality residual effects include:

- forestry

- mining
- mineral exploration
- roads
- transmission lines
- recreation and tourism
- fishing and tourism
- fishing, hunting, and trapping
- urban and rural communities

Within the air quality CEA boundary, there are four additional human activities and projects that may interact with the Project effects on ambient air quality:

- Bell Mine—closed 1992
- Granisle Mine—closed 1982
- forestry
- local communities: Granisle, Fort Babine, Old Fort

A number of other past, present, or future human activities were identified in Section 11.1 that did not warrant inclusion in the CEA for ambient air quality. Air emissions from human activities more than 40 km from the Project site are not likely to interact with emissions associated with the Project, primarily because of the high degree of mixing and dilution available in the atmosphere.

11.3.6 Interactions with Other Developments and Activities

Mining activities, forestry, and active communities will all contribute to the generation of PM and other criteria air contaminants to the Project's airshed. The interactions and effects associated with each human activity are described below.

Mining

A number of past mining activities were located near the Project. The Bell and Granisle mining operations, when in full production, produced air emissions including SO_2, NO_2, CO, and PM_{10} and $PM_{2.5}$. The Bell mine closed in 1992 and the Granisle mine closed in 1982. Following the discontinuation of an emissions source the surrounding airshed is expected to recover rapidly. Therefore, there are no links between residual impacts from the Project and the Bell and Granisle mines (Table 11.3-1). Cumulative effects associated with the Bell and Granisle mines are not considered further in this assessment.

Community Interaction: Granisle, Old Fort, Fort Babine

There are close to 10,000 people living within the larger CEA area. However, this population is spread over several small rural communities, of which only three are near enough to potentially interact with emissions from the Project. Granisle, Old Fort, and Fort Babine have a total of

approximately 510 permanent residents. For further information on the socio-economic status of these communities refer to Section 7.19.

CALPUFF dispersion modelling demonstrated that the ambient air quality effects associated with the Project (for all contaminants modelled) did not extend as far as the Granisle, Old Fort, and Fort Babine communities. Human activities associated with each of these communities that will contribute air emissions to the regional airshed include:

- vehicle operation producing diesel emissions and particulate matter; and
- residential wood burning contributing particulate matter.

Emissions associated with these actions could potentially interact with the emissions produced from mining activities at the Project site, creating a cumulative effect.

Forestry

The Project is within the Morice TSA. The current AAC limit of 2,165,000 m^3 is expected to increase in the coming years to maximize value from dying and dead trees affected by the MPB infestation. Projected increases in forestry production may lead to increased PM contributions to the ambient air through increased harvesting and slash burning (Table 11.3-1). Increased harvesting and equipment operation may result in an increase in diesel emissions to the ambient air.

Table 11.3-1
Summary of Links between the Project and Future Human Actions for Air Quality

Human Action	Potential Effect on Air Quality
Past Projects	
Bell Mine	No Link
Granisle Mine	No Link
Existing and Future Projects	
Local Communities: Granisle, Fort Babine, Old Fort	Increased traffic from residential activities, tourism, and recreation may increase diesel-related emissions and fugitive dust
Forestry	Timber harvest in the region increases PM and other criteria air contaminants through truck traffic and slash burning

11.3.7 Predicted Residual Cumulative Effects

Human actions that may lead to cumulative air quality effects within the assessment boundary include potentially increased clearing rates in the nearby forestry reserve and activities associated with local communities. The potential emission interactions between these projects and the Project are described above.

Interacting effects from future projects in the area are generally limited to fugitive dust creation. Fugitive dust typically settles quickly near the source under gravitational forces. Therefore,

cumulative ambient air quality effects are not expected to occur between areas of fugitive dust generation at the mine and fugitive dust associated with forestry or community activities. In the event that the PM generated does not settle rapidly, adaptive management strategies can be effectively implemented through methods such as additional road watering to rapidly reduce fugitive dust emissions.

Although regular activities in nearby communities will contribute to air emissions, the extent of such emissions is insignificant on a regional scale. Table 11.3-2 draws comparisons between the emissions sources found at a typical regional community and those of greater magnitude at the Project site. Based on the small-scale nature of emissions contributions from nearby communities, cumulative ambient air quality effects are expected to be negligible.

The potential effects associated with increased PM as a result of cumulative human actions is considered regional and extends throughout the entire spatial boundary. The duration and frequency of the potential cumulative ambient air quality effects are long term and continuous. Although potential cumulative effects are expected to occur throughout the Project life, the recovery of the ambient air quality is rapid following discontinuation of an emissions source. Therefore, the magnitude of cumulative effects to ambient air quality is assessed as low (Table 11.3-3).

Table 11.3-2
Air Emissions Sources at Local Communities Relative to the Project Site

Activity	Community	Project
Vehicle movement	• On-road	• Off-road[1]
Vehicle fuel consumption	• Relatively minor	• Substantial[2]
Vehicle type	• Light weight	• Heavy weight (industrial scale)
Traffic volumes	• Low	• High
Vehicle/equipment utilization	• Low	• High

[1] US EPA considers vehicles that drive on unpaved roads and industrial sites off-road vehicles when calculating emission factors
[2] Morrison vehicle fuel consumption is estimated to be 7.99×10^6 litres for Year 1 of operations (see details in Section 8.2)

Table 11.3-3
Residual Cumulative Effects Summary Table

Effect/VEC	Direction	Scope	Duration	Frequency	Magnitude
Increased ambient concentrations of PM	Negative	Regional	Long-term	Continuous	Low

11.3.8 Assessment of Significance

All residual cumulative effects are assessed to have a negligible significance. Future projects in the area are not expected to emit large quantities of PM. Any potential changes to air quality as a

result of the interactions described above are not expected to produce ambient PM concentrations that exceed Canada Wide Standards and British Columbia Ambient Air Quality Objectives. The probability of cumulative effects occurring is considered low because most of the new PM sources are associated with fugitive dust generation, which generally settles to the ground quickly and can be effectively mitigated through methods such as road watering.

11.3.9 Confidence Limits

Air emissions estimates were generated using a commonly accepted and reputable model (CALPUFF). Worst case scenarios for the Project were assessed, creating conservative estimates. Although there is the potential for variability in relationships identified in the model, the conservative approach suggests that real-time air emissions data will not likely be significantly greater than the model estimates.

However, there is an additional level of uncertainty associated with considering cumulative effects. The assessment process requires predictions regarding future developments and their effects. As a result, the confidence level of this ambient air quality CEA is intermediate.

11.3.10 Additional Mitigation

No additional mitigation is required beyond that outlined in the air emissions and fugitive dust management plan (Section 13.2).

11.4 Surface Water and Sediment Quality

11.4.1 Valued Environmental and Socio-Economic Components

Surface water and sediment quality are identified as VECs for the CEA because activities at the Project may combine with the residual effects of other activities in the watershed to increase the risk of their degradation. These VECs could be affected by several activities at the Project site, as well as by forestry, transportation, and other mines in the region.

11.4.2 Residual Effects of Project

All residual effects on surface water and sediment quality, even if they were considered to be of negligible significance, have been carried forward to the CEA. Negligible effects were carried forward because of the concern that when combined with effects outside the Project, they could significantly reduce water or sediment quality within the CEA boundaries.

Five primary effects of the Project on surface water quality were assessed:

1. Surface runoff and siltation.
2. Airborne contaminant loading.
3. Nitrogen residues from blasting.
4. Metal Leaching and Acid Rock Drainage (ML/ARD).
5. Discharges and/or spills of contaminants.

Of these five effects, three were assessed for sediment quality: surface runoff and siltation, ML/ARD, and discharges and/or spills of contaminants. These effects were assessed for the Project and discussed in detail in Sections 8.4 and 8.8.

11.4.3 Spatial Boundary

The spatial boundary for this CEA includes the Babine Watershed from the confluence of the Skeena and Babine rivers to the headwaters of Babine Lake (Figure 11.1-1). The primary concern regarding cumulative effects to surface water quality is the influence of the historical Granisle and Bell mines together with the proposed Project on the surface water quality of Babine Lake and the Babine River.

11.4.4 Temporal Boundary

The temporal boundary for cumulative effects to surface water includes the mine's construction, operations, and decommissioning phases and its associated infrastructure and will extend for many years following Project closure.

11.4.5 Human Actions Considered

Introduction

Several human actions were considered to have a potential cumulative effect on surface water and/or sediment quality in the Project area. These actions include:

- past, present, and future mining activities;
- mineral exploration;
- forestry;
- roads and other modes of transportation (i.e., barge);
- community sewage/runoff.

The potential effects to the VECs from these activities are described in the following sections.

11.4.5.1 Mining

Mining activities could affect surface water and sediment quality through spills, discharging contaminated effluent, blasting residues, and sedimentation from developed areas. There are several existing mines within the Project's CEA boundary, including Granisle, Bell, and Dome Mountain. None of these mines are currently operating.

Granisle Mine

The Granisle Mine is on McDonald Island in Babine Lake and operated from 1966 to 1982 (Torunski 2009b). The current owner is Xstrata plc. Potential issues that could contribute to cumulative effects include the seepage of poor quality water from the mine into the surrounding environment. The Granisle Mine does not have a permit to discharge effluent to Babine Lake, but seepage does occur through containment berms and through groundwater at the mine site (Torunski 2009b).

Bell Mine

The Bell Mine is on the Newman Peninsula of Babine Lake, north of the Granisle Mine. It operated in a similar time frame from 1972 to 1992 and was owned by the same company as the Granisle Mine. The current owner is Xstrata plc. The Bell Mine has a permit to discharge effluent into Babine Lake, which include criteria for the protection of aquatic life (Torunski 2009a).

Dome Mountain Mine

The Dome Mountain Mine is a small, inactive, underground gold mine that is near a tributary of the Fulton River, which flows into Babine Lake. It operated from 1991 to 1993; however, exploration has occurred on the site since the early 1900s. During its operational period, approximately 43,909 Mt with an average grade of 0.39 oz/Mt of gold were reportedly mined and shipped to an off-site mill (Scot Willson Roscoe Postle Inc 2008). The property is owned by Eagle Peak Resources, which is currently pursuing plans to reactivate the mine (Eagle Peak Resources Inc. 2006). No water quality data are currently available from the mine site.

Mineral Exploration

Several exploration sites are within the CEA boundary for water quality. These exploration properties include the Fireweed, Freegold, Hearne Hill, Peak, and Silver Vista projects. The Fireweed Project was abandoned in 2008. The Freegold Property last experienced exploration activities in the 1980s, but additional exploration is anticipated. The Hearne Hill property was last explored in 1997. Drilling was completed in 2008 at the Peak Property. Exploration is still underway at the Silver Vista Project. Mineral exploration can have similar effects to mining, but on a smaller scale because of the smaller disturbances generally associated with exploration activities and the lack of mineral processing and waste rock or tailing storage activities.

11.4.5.2 Forestry and Logging

The Project is within the Morice TSA. Forestry and logging can affect surface water and sediment quality through introducing sediment and nutrients to waterbodies (Chamberlin, Harr, and Everest 1991). In general, roads associated with logging operations are a significant source of sediment to streams through surface erosion, sediment transport, and destabilizing slopes leading to mass wasting (Furniss, Roelofs, and Yee 1991). Maintaining the riparian zone around streams is important in maintaining water and sediment quality because these areas act as natural filters for sediment-laden runoff water.

Concentrations of inorganic nutrients may increase in streams as a result of logging because trees normally take up these nutrients. Chemicals such as pesticides, herbicides, and fire retardants may also be introduced to waterbodies around logging operations. These chemicals have toxic effects on aquatic life, as well as increased nutrient levels, potentially resulting in stimulated primary production and decreased dissolved oxygen (Norris, Lorz, and Gregory 1991).

11.4.5.3 Urban and Rural Communities

Four small communities are in the Morrison CEA boundary for water quality. Granisle is the largest community, located on Babine Lake. Granisle has a population of approximately 450 people; however, the population was as high as 2,200 when the Granisle and Bell mines

were operating. An STP in Granisle discharges treated effluent to Babine Lake. The Village of Granisle lodge is permitted to discharge a maximum of 27 m^3/d of effluent throughout the year (BC MOE n.d.). The permitted discharge characteristics are 60 mg/L of total suspended solids (TSS) and a 5-day biochemical oxygen demand of 45 mg/L.

Tachet is a small community with 130 permanent residents at the outlet of the Fulton River. A water treatment plant is in this community (Lake Babine Nation 2009).

Fort Babine is a small Aboriginal community at the north end of Babine Lake. There are approximately 60 full-time residents (Lake Babine Nation 2009).

Old Fort is a seasonally used community at the north end of Babine Lake. No permanent residents are reported (Lake Babine Nation 2009).

11.4.5.4 Transportation

Several transportation forms in the cumulative effects area may affect surface water and sediment quality. Forest roads are discussed in a previous section (11.1.5.2). Municipal roads and highways may also contribute to cumulative effects. Many municipal roads in Granisle and the other communities on Babine Lake are unpaved, which may increase suspended solids to local waterbodies through surface erosion and airborne dust.

Sand or salts used on municipal roads and highways in winter will also affect water quality if they reach streams or lakes during spring runoff. These chemicals increase chloride concentrations in streams and lakes, which can lead to changes in density gradients in lakes and potentially stimulate algal growth (Ramakrishna and Viraraghavan 2005).

Motorized transportation introduces the risk of fuel spills and other contaminants. A barge provides service from Granisle to the east side of Babine Lake for logging trucks and other vehicles. Recreational boats are a commonly used on the lake. Fuel spills may occur during fuelling of these vessels; however, no significant incidents have been reported (BC MOE 2007).

11.4.6 Interactions with Other Developments and Activities

Table 11.4-1 presents a summary of the possible interactions between the Project and other human activities in the CEA boundary.

Surface Runoff and Siltation

The Project could degrade water and sediment quality through introducing sediment during construction and operation activities. The residual significance to which this effect could degrade sediment quality was assessed as negligible. In the case of water quality it was considered to be moderate during construction and negligible during operations. Similar effects from forestry and transportation activities could have an added effect on water quality in the local area, especially along roads that will also be used for mine access. Siltation from all sources is expected to be limited to streams and waterbodies near the mine and access roads. Sediment that enters these waterbodies will increase TSS and turbidity in the short term, but is not expected to have lasting consequences to water or sediment quality in the larger cumulative

effects study area. In addition, several mitigation techniques are generally employed along roads and at logging sites that reduce erosion and the transport of sediment to streams.

Table 11.4-1
Summary of Links between the Morrison Copper/Gold Project and Other Human Activities/Projects

	Surface Runoff and Siltation Contaminant Loading	Airborne Contaminant Loading	Nitrogen Residues from Blasting	ML/ARD	Discharge and Spill Contaminant Loading
Existing or Closed Activities and Projects					
Roads	X				X
Other transportation (i.e., barge, train)	X				X
Forestry	X	X			
Bell Mine	X			X	X
Granisle Mine				X	X
Dome Mountain Mine				X	X
Mineral exploration	X		X	X	X
Urban and Rural Communities					
Granisle	X				X
Tachet	X				X
Old Fort	X				X
Fort Babine	X				X

Airborne Contaminant Loading

Airborne contaminants from the Project that could affect water quality include dust and nitrogen residues from blasting, road traffic and disturbed soils, and contaminants from vehicle and generator emissions. The residual significance of this effect on surface water quality was assessed as negligible. Other airborne contaminants in the greater cumulative effects boundaries include herbicide and pesticide residues from forestry, dust from road traffic, road maintenance, and emissions from vehicles. These could have an additive effect on water quality when combined with Project contaminants. Dust residues would have a similar effect on water quality as surface erosion, contributing to the TSS load in streams and waterbodies. However, dust transport would not contribute as much sediment to streams as surface erosion.

Little information is available on the loading of herbicides and pesticides in surface water in the Morrison cumulative effects area. Herbicides and pesticides are used to manage second growth forests but their use is generally discouraged in favour of manual brushing techniques. Best management practices (BMPs) for the use of herbicides and pesticides are in place under the *Forest and Range Practices Act* (2002a), and their effect on surface water quality is assumed to be negligible.

Nitrogen Residues from Blasting

Nitrogen residues from blasting may be carried through the air and through surface runoff to waterbodies in the Project area, increasing the potential for eutrophication in local waterbodies. The residual significance of this effect was predicted to be minor at the mine site, and negligible for all other Project components. Although concentrations of inorganic nutrients such as nitrogen in surface waters may be increased by logging, mobilizing nutrients following logging is usually tempered through soil adsorption and their uptake by microorganisms (Chamberlin, Harr, and Everest 1991). Nitrogen residues may also enter streams and waterbodies from other blasting activities in the CEA boundary. Such blasting may occur at mineral exploration sites, and along new roads and small rock quarries used for road construction material.

Metal Leaching and Acid Rock Drainage

The effects of ML/ARD to water and sediment quality were assessed as having a minor significance at the mine site. Babine Lake is considered to have the highest risk for cumulative Project effects from ML/ARD because of the decommissioned Bell and Granisle mines and the potential re-starting of the Dome Mountain Mine. If measurable ML/ARD effects occur from the Project they will most likely be seen in Morrison Lake water quality and potentially the lake sediments adjacent to the pit area. Morrison Lake empties into Morrison Creek, which flows into Babine Lake at the northern end of Morrison Arm. The area where water quality is most likely to be affected by the Bell and Granisle mines is Hagan Arm, which is south of Morrison Arm on the east side of Babine Lake. The Dome Mountain Mine is on a tributary of the Fulton River, which empties into Babine Lake near Tachet.

Since it has been estimated for the Project that a considerable proportion of the generated waste rock is potentially acid generating (PAG), the drainage from the waste rock dump (WRD) near the Morrison mine site could degrade water quality by ML/ARD. Most of the ML/ARD generated by the WRD will be collected and diverted into the pit. However, it has been estimated that at closure approximately 10% of the generated ML/ARD from this source will travel with groundwater flow to Morrison Lake and not be captured by the pit (Section 11.6).

Extensive water quality monitoring in Babine Lake has occurred in the area surrounding the existing mines. Background total copper concentrations in Babine Lake are higher than the recommended BC guidelines for protection of aquatic life (Geocon 1992). Over two decades of post-closure monitoring at the Bell Mine, periodic increases in conductivity, sulphates, calcium, total and dissolved copper, and zinc were noted at sample locations on the west side of Newman Peninsula close to the mine. However, the general physical and chemical characteristics of the water in Hagan Arm were comparable to those in the main arm of Babine Lake. Concentrations of dissolved and total copper in Hagan Arm were slightly higher than the main lake body, but remained largely unchanged relative to conditions reported in 1974 and 1984 (Geocon, Rescan, and Morwijk 1992). Copper levels observed in Babine Lake do not appear to have significantly changed over the 18 years following mine closure (Geocon 1992). Copper concentrations in Newman Bay decreased since previous monitoring in 1983 and 1984.

Of particular concern to the BC Ministry of Environment (BC MOE) is the potential for reduced water quality in Babine Lake as the Granisle and Bell mines begin to generate acid (Torunski

2009c). Between 2004 and 2008, all lake sampling sites and discharge sites at the Bell Mine reported pH values within the permit limits (Torunski 2009a). Around the Granisle Mine, pH values in Babine Lake were within the allowable range between 2004 and 2008. The seepage site that empties into Babine Lake from the Granisle Mine had a pH that ranged from 3.76 to 5.83. It is expected that once this water meets Babine Lake, the increase in pH would cause the copper to precipitate out and potentially affect local sediment quality (Torunski 2009b).

Most dumps and tailings sites at the Bell Mine were predicted to start generating acid between 2000 and 2030 (Geocon, Rescan, and Morwijk 1992). Sulphide depletion is predicted to occur between 2040 and 2100 for most sites. The addition of acidic leachate from the Project may contribute to a cumulative effect with the acid generated by the existing mines to decrease water quality in Babine Lake. The physico-chemical and limnological processes that establish the Babine Lake water quality baseline are complex. The contribution of the mine sites to the Babine Lake water quality as a whole is not well documented. As a result, the BC MOE has suggested that a long-term water quality monitoring station be established near the outlet of Babine Lake to monitor potential changes in downstream water quality (Tamblyn 2009a). The BC MOE has confirmed that water quality data for Babine Lake are extremely limited (Tamblyn 2009b) and establishing this long-term monitoring station would be very beneficial. This monitoring site is currently beyond the scope of responsibility of the proponent.

The Dome Mountain Mine also operated for a short time in the early 1990s and the feasibility of re-opening the mine is currently being investigated. ML/ARD issues may exist at the current mine site; however, there are no reports available on the current water quality near the mine. If the mine is reactivated, ML/ARD may become a concern.

Discharge and Spill Contaminant Loading

Introducing contaminants to surface water and sediment quality may occur through sewage discharge, effluent discharge (tailings storage facility (TSF) and pit) from the pit area, and accidental spills. The residual significance of effects to water quality at the mine site (including seepage from the TSF, draining Ore Pond and Booker Lake, and discharged treated sewage) was predicted to be minor during all phases. The residual significance of effects to sediment quality was assessed as being negligible.

Mine-related discharges could have an additive effect on water quality because the existing mines release similar metals into the water that are predicted to be released by the proposed Project.

The Granisle Mine has no permitted discharge(Torunski 2009b) but seepage does occur through containment berms and through groundwater at the mine site (Torunski 2009b). The flow of contaminated water from the tailings and containment ponds to groundwater and Babine Lake has been estimated as 300,000 to 400,000 m^3/year (K. A. Morin and N. M. Hutt 2003). There is one site on the Granisle mine site that discharges contaminated surface water directly into Babine Lake. This drainage is ephemeral and was flowing on only 5 of 13 site visits between 2004 and 2008 (Torunski 2009b). The total discharge rate of this drainage was estimated in April 2003 as approximately 1.4 L/s; however, later measurements ranged from 0.28 to 4.0 m^3/day.

A simplified approach for calculating the loading of copper into Babine Lake from the Granisle Mine has estimated that between 10 and 23 kg of copper reach Babine Lake yearly through groundwater, and an additional 1.2 kg/year reaches Babine Lake through surface water (K. A. Morin and N. M. Hutt 2003) for a maximum estimated loading of 24.2 kg/year.

The *Waste Management Act* Permit for the Granisle Mine requires analysis of water samples for dissolved copper concentrations. The highest recorded reading was 0.6 mg/L in 2004. Sample results from the seepage site that enters Babine Lake indicate that concentrations of dissolved copper decreased between 2005 and 2008 (Torunski 2009b), with 0.13 mg/L of dissolved copper being the greatest measured (May 19 2008).

While the Granisle Mine does not directly discharge any effluent, the Bell Mine has three permitted discharge sites. The permitted mean annual flow rate limits from each of these sites are 96,000 m^3/yr, 36,000 m^3/yr, and 55,200 m^3/yr (Torunski 2009a). The actual mean annual flows at these sites were 65,795 $m^{3/}$yr, 24,168 m^3/yr, and 58,883 m^3/yr between 2004 and 2008 (Torunski 2009a). Approximately 55% of these flows occur during the month of April.

At each of the Bell Mine discharges, dissolved copper, dissolved iron, and dissolved zinc are measured for compliance with permit guidelines (Table 11.4-2). The permitted dissolved copper concentration is 0.15 mg/L for all discharge sites and the "probable concentration" (i.e., computed as the average concentration between January 2004 and December 2007) at each of the sites ranged from 0.02 to 0.04 mg/L between 2004 and 2008 (Torunski 2009a). This corresponds to a contribution of approximately 0.8 kg/yr of copper from the three discharge sites together. Permitted iron concentrations range from 1.0 to 2.0 mg/L at each of the discharge sites, and the probable concentration ranged from 0.01 to 0.83 mg/L. The estimated total load of iron into Babine Lake was 8.8 kg/yr between 2004 and 2008. Zinc concentrations are permitted to be 0.2 mg/L at each site, but likely did not exceed 0.01 mg/L between 2004 and 2008. The estimated load of zinc into Babine Lake resulting from this discharge was 0.27 kg/yr during that period.

Any future residual discharge from the proposed Dome Mountain mine may further reduce water quality in Babine Lake and its outlet. The extent of any potential consequences to water or sediment quality from this mine are currently unknown because the mine plan has not been finalized.

Several small towns and camps discharge treated sewage into Babine Lake. Babine Lodge at Granisle has a permit to discharge treated sewage into Babine Lake. The permit allows for 27 m^3/day of treated sewage with a maximum TSS concentration of 60 mg/L to be discharged into the lake. If this level is achieved each day, the maximum loading of suspended solids from the lodge into the lake would be approximately 591 kg/year. No other data are available on permitted sewage discharge levels into Babine Lake or other Project area waterbodies, suggesting that other communities within the Project boundaries may have septic systems rather than sewage treatment.

Table 11.4-2
Summary of Water Quality from Test Sites around Bell and Granisle Mines

Mine	Source	Sample Site	Annual Flow Rate Limit (m^3/year)	Mean Annual Flow (m^3)	Max monthly flow (April) (m^3)	Probable Conc. (mg/L)			Mean Annual Loading (kg)			Max monthly loading (April) (kg)			Permit Limit (mg/L)			BC Water Quality Guidelines (mg/L)			MMER Guidelines		
						Cu	Fe	Zn	Cu	Fe	Zn	Cu	Fe	Zn	Cu	Fe	Zn	Cu	Fe	Zn	Cu	Fe	Zn
Bell	Bell Mine 2004-2008 Data Review	3-1D (Discharge)	96,000	65,795	36,187	0.04	0.04	0.01	0.4	0.4	0.1	0.22	0.22	0.055	0.15	2	0.2	0.006[§]	N/A	0.0075[‡]	0.3	N/A	0.5
		4-1 (Discharge)	36,000	24,168	13,292	0.02	0.01	0.007	0.2	0.1	0.07	0.11	0.055	0.039	0.15	1	0.2	0.006[§]	N/A	0.0075[‡]	0.3	N/A	0.5
		8D (Discharge)	55,200	58,883	32,386	0.02	0.83	0.01	0.2	8.3	0.1	0.11	4.57	0.055	0.15	2	0.2	0.006[§]	N/A	0.0075[‡]	0.3	N/A	0.5
Granisle (no permitted discharge sites)	Phase 4 Closure Plan	groundwater	N/A	300,000 to 430,0000*	N/A				18.6	-	-	-	-	-	-	-	-	0.5 [†]	-	-	-	-	-
		GNDE Creek (not permitted)	N/A			0.13 to 0.6	0.3 to 0.54	< 0.2	1.2	-	-	-	-	-	-	-	-	0.5 [†]	-	-	-	-	-

*** estimated transferral to groundwater and Babine Lake**

[†] **WQG for drinking water, not aquatic life**

[§] **based on water hardness less than 50 mg/L $CaCO_3$**

[‡] **based on water hardness less than 90 mg/L $CaCO_3$**

Treated sewage from the Project could have an additive effect on nutrient levels in surface water when combined with sewage from other sources. During construction sewage will be treated and effluent discharged to a location at least 100 m away from existing water bodies (about 360 personnel during the construction phase), while during operations sewage will be treated and mixed with tailings in the TSF.

The potential effects of spills along any access road or from boats, barges, generators, or vehicles are unlikely to affect surface water or sediment quality in the long term. Several BMPs will be in place to prevent and treat spills if they occur. The Project will have safeguards in place to prevent spills from affecting water quality (Spill Contingency and Emergency Response Plan, Section 13.18).

11.4.7 Predicted Residual Cumulative Effects

Table 11.4-3 presents a summary of the residual cumulative effects for the Project including the scope, duration, frequency, and magnitude. A definition of these attributes of residual cumulative effects can be found in Section 11.1 (Cumulative Effects Methodology).

Table 11.4-3
Residual Cumulative Effects Summary Table

Effect	Direction	Scope	Duration	Frequency	Magnitude
Surface Runoff and Siltation Contaminant Loading	Negative	Sub-regional	Short-term	Sporadic	Moderate
Airborne Contaminant Loading	Negative	Sub-regional	Short-term	Sporadic	Low
Nitrogen Residues from Blasting	Negative	Sub-regional	Short-term	Sporadic	Low
ML/ARD	Negative	Regional	Long-term	Continuous	Low
Discharge and Spill Contaminant Loading	Negative	Regional	Long-term	Continuous	Low

Surface Runoff and Siltation

Surface runoff and siltation from the Project and other activities in the cumulative effects area will likely affect waterbodies with most of the increased siltation occurring in streams near roads and disturbed areas. Lakes are less likely to be affected as any runoff that reaches the lake will likely settle quickly and not have a substantial effect on water quality. In addition, by employing mitigation techniques the volume of this material should not significantly affect sediment quality. Siltation effects are generally short term, unless ongoing disturbance or lack of maintenance results in chronic erosion and sediment transport to streams. If increased siltation becomes chronic in local waterbodies, additional mitigation will be undertaken to reduce erosion and the transport of sediment-laden water to streams and lakes. Siltation will most likely occur during construction when most soil disturbance occurs, as well as during rain storms and snowmelt events. Water quality may be temporarily degraded at these times but proper

mitigation techniques will result in recovery within the life of the Project, resulting in a moderate magnitude for this effect.

Airborne Contaminant Loading

The effects of airborne contaminants from activities (i.e., logging) within the cumulative effects boundary on surface water quality are predicted to be of low magnitude. Airborne contaminants typically reach waterbodies in low concentrations, and are unlikely to have a measurable effect on surface water quality. Sporadic deposition may occur from the increased use of roads in the Project area, which will lead to increased mobilization and transport of dust. Any change in surface water quality is predicted to be limited to the period that dust is mobilized (i.e., a short duration).

Nitrogen Residues from Blasting

Apart from the Project, there are few activities within the CEA boundary that would contribute additional nitrogen residues to surface water. Nutrients released from soils following logging may contribute to the effects of nitrogen residues from the Project; however, the effects of these nutrient pulses on water quality are only predicted to last for a short period following logging and are unlikely to contribute to decreased water quality in the greater Project area. Nutrients from all sources are more likely to be taken up by microorganisms or undergo adsorption to soil particles, resulting in a low magnitude of this effect.

Metal Leaching/Acid Rock Drainage

Any potential residual cumulative effect on surface water and sediment quality from ML/ARD is most likely to occur in Babine Lake. Two existing mines and one proposed mine currently drain into Babine Lake, and while no significant reductions in water quality have been detected in Babine Lake to date, it is predicted that acidification may occur in future years because of increasing acid production at the Bell and Granisle mine sites. Sulphide depletion at the Bell and Granisle mines is predicted to occur within the next 100 years (Geocon 1992). During this period of time ML/ARD may also result from the Morrison Mine and proposed Dome Mountain Mine, and potentially other future developed mines. The degree to which this might be the case for Dome Mountain is unknown.

It has been estimated that a considerable proportion of the generated waste rock from the Morrison mine will be PAG. To address seepage from the low grade ore stockpile, a number of management strategies will be investigated to minimize potential for seepage to groundwater and eventually to Morrison Lake. Potential management strategies include further investigation of the till suitability and quantity for use as a foundation barrier to seepage infiltration; if necessary, compacting the till during construction to decrease permeability and minimize infiltration, or installing a synthetic liner if compaction is not adequate or unfeasible; and installing a groundwater monitoring well network between the low grade ore stockpile and Morrison Lake. These approaches would allow seepage through the pile to be collected as surface runoff only, and managed along with the rest of surface runoff and pit dewatering water. The groundwater monitoring well network would identify whether residual seepage to groundwater is occurring and if further management is necessary to ensure that seepage does not reach Morrison Lake. Using these mitigation techniques would result in a low potential effect magnitude.

Discharge and Spill Contaminant Loading

Discharge and spills from mines and communities in the cumulative effects area pose a potential risk to surface water quality in the long term. Other than minor discharges from communities, only the Bell Mine directly discharges effluent into Babine Lake (although there is likely some form of discharge from the Granisle Mine). The available monitoring studies have indicated that Babine Lake water quality in areas near the mine have not degraded significantly over the past 20 years. A development schedule that would lead to a discharge from Dome Mountain is unknown. The effluent discharge schedule from the Morrison Mine currently predicts that the Project will begin discharging treated effluent approximately 24 years after pit operations cease, and continue indefinitely. Although continuous once it begins, the magnitude of this effect will likely be low in Babine Lake and downstream surface waters provided the discharge complies with permitted conditions.

11.4.8 Assessment of Significance

The level of significance for cumulative effects arising from surface runoff and siltation, airborne contaminants, and nitrogen blasting is negligible (Table 11.4-4). Several mitigation techniques will likely act to reduce or eliminate the potential for significant cumulative effects from these activities.

Table 11.4-4
Significance of Residual Cumulative Effects

Effect	Direction	Level of Significance	Confidence
Surface Runoff and Siltation Contaminant Loading	Negative	Negligible	High
Airborne Contaminant Loading	Negative	Negligible	High
Nitrogen Residues from Blasting	Negative	Negligible	High
ML/ARD	Negative	Moderate	Low
Discharge and Spill Contaminant Loading	Negative	Moderate	Low

Effects from ML/ARD and contaminants discharge could be of moderate significance. This rating primarily results from the fact that both of these effects are long-term and continue beyond the life of the Project. Although Babine Lake is the largest natural lake in BC, and it is possible that no significant effects will be observed because of a high dilution level, their long-term nature may eventually result in a cumulative effect.

11.4.9 Confidence Limits

CEAs must incorporate a level of uncertainty because the assessment process requires that predictions be made about whether future developments will take place, and how those developments will affect VECs within the Project area. The confidence limits for cumulative effects are identified in Table 11.4-4.

Confidence limits for the effects of surface runoff and sedimentation, airborne contaminants, and nitrogen residues are high. There is a good understanding of the effects these activities have on surface water quality. There is also a good understanding of how effects can be prevented with various mitigation and management techniques.

Confidence limits for the effects of ML/ARD and discharge and spill contamination are low. This is primarily because the complexity of interactions in Babine Lake is poorly understood and more data on lake water quality are required. There is a high level of uncertainty regarding the acid generation at the Bell and Granisle mines and how/when this acid generation will specifically affect water quality in Babine Lake. Similarly, there is some uncertainty about the timing and the persistence of these effects from the Morrison Mine, and how those contaminants will eventually interact with contaminants from the other mines on Babine Lake.

11.4.10 Additional Mitigation

The primary mitigation concern is protecting surface water quality in Morrison and Babine Lake. The Babine River supports important salmon runs, and Babine Lake's resources are used extensively by several small communities, as well as by tourists, hunters, and fishers. Two decommissioned mines currently exist on the lake, and two more mines (Morrison and Dome Mountain) are proposed within the Babine watershed. Because of the lake's large size, it is unlikely that surface water quality will be significantly affected by these developments; however, it will be necessary to establish long-term monitoring sites to manage any effect from the Project and ensure that water quality is protected in the future.

11.5 Surface Water Quantity

11.5.1 Valued Environmental and Socio-economic Components

Water quantity is an important environmental factor affecting downstream effects to ecosystem components such as availability of, and access to, stream habitat. It is also important for water quality, because contaminant concentrations depend on water volumes. Within the Project area there is limited human use of surface water as a resource or for navigation; however, surface water quantity is considered a VEC because water is an intrinsic part of the natural environment, and streams provide habitat for important fish populations and other aquatic resources. Maintaining sufficient water quantity is important for continued ecosystem health for aquatic species, both in terms of providing access to habitat and providing sufficient dilution to maintain water quality.

11.5.2 Residual Effects of Project

The assessment of surface water quantity (Section 8.5) was carried out at two spatial scales: local and watershed. At the local scale, mine site watersheds were first considered to determine the effects within the direct footprint area of the mine development. The significance of residual effects was assessed for each of local watersheds and is summarized in Table 11.5-1.

Table 11.5-1
Summary of Residual Effects for Local Area Watersheds

Local Area Watershed	Significance of Residual Effect
MCS-4a	Major
MCS-6	Moderate
MCS-7	Major
MCS-8	Negligible
MCS-10a	Minor

The catchment areas for these local-scale watersheds range from 3.5 to 13 km^2. Beyond the influence of the mine, there would be no other activities occurring in these individual watersheds that could produce cumulative effects. Therefore, these residual effects are not carried forward into this CEA.

At the watershed scale, effects of the mine were considered for the Morrison Creek watershed. All but one (MCS-10a) of the local-scale watersheds flow into Morrison Lake and are part of the Morrison Creek watershed (490 km^2). Therefore, the effects assessment at this scale incorporates the residual effects from the local-scale watersheds, and provides a cumulative assessment of the Project effects on water quantity.

Potential residual effects to the Morrison Creek watershed include:

- adding water to the system from dewatering Booker Lake and Ore Pond during the construction phase. Dewatering will be scheduled to take place during the late summer and fall low-flow period. From a water quantity perspective, this was considered a negligible effect and is not carried forward into the CEA.
- altered inflow to and outflow from Morrison Lake from:
  - losing watershed area to the TSF and lower mine site (15.5 km^2 (3%) at maximum TSF extent);
  - withdrawing water from Morrison Lake for potable water supply;
  - losing water because of groundwater pumping for pit dewatering during operation (40 to 55 m^3/hr);
  - gaining water caused by releasing the TSF and pit water at closure (3.0 Mm^3/yr)

During operation, the net effect of these flow alterations would be to decrease outflow from Morrison Lake, which would be most pronounced during the low-flow periods. At closure, flow would increase during the freshet/summer period, but decrease through the fall/winter. However, the magnitude of these changes is generally around 2% to 3%. The significance of residual effects to Morrison Creek was assessed as negligible**.**

11.5.3 Spatial Boundary

The spatial boundaries for the CEA of surface water quantity will be the Morrison Creek watershed (490 km^2). Other projects and human activity occurring within this watershed could combine with Project effects to compound environmental effects. Morrison Creek flows directly into Babine Lake. The Morrison Creek watershed represents 7.5% of the 6,480 km^2 Babine Lake watershed. The expected magnitude of changes to the Morrison Creek flow regime are not expected to have measureable effects within Babine Lake, or downstream into Babine River. Therefore, reviewing water use for the Babine Lake watershed is beyond the scope of this assessment.

11.5.4 Temporal Boundary

The temporal boundary will start at pre-construction and extend to 50 years following closure.

11.5.5 Human Actions Considered

In general, there is limited human activity within the Morrison Creek watershed. Based on the human actions identified in Section 11.1, two were identified for consideration.

Historical logging has taken place within the Morrison Creek watershed, with approximately 2,000 ha of retired cutblocks. Currently there are approximately 680 ha of active cutblocks, which represents approximately 1.5% of the watershed area, though this may increase in the near future due to MPB related logging. The majority of logging activity has occurred on the western side of Morrison Lake, with some additional activity on the southeastern side, near the Project area. Based on satellite imagery, the northern and eastern sides of the lake appear to be untouched.

Hearn Hill is another mineral exploration property within the Morrison Creek watershed. Some early exploration work was completed on the property in the early 1990s; however, there is no current activity at this site, and no reasonable expectation that activity will increase in the near future.

11.5.6 Interactions with Other Developments and Activities

Forestry activity can affect surface water quantity and flow timing in several ways. Removing vegetation reduces infiltration into soils as well as evapotranspiration, leading to more rapid runoff response. However, such effects are temporary, as natural hydrologic conditions are restored with re-growth.

11.5.7 Predicted Residual Cumulative Effects

Given the relatively low level of forestry activity within the watershed, the magnitude of hydrological change related to forestry is expected to be negligible, and no cumulative effects are expected.

11.6 Groundwater

11.6.1 Valued Environmental and Socio-Economic Components

Groundwater is an inherent component of the water cycle and is therefore linked with the environmental conditions and ecosystems within the study boundaries. Although consumptive use of groundwater as a resource in the Project area does not occur, groundwater contributes to base stream flow and influences stream and lake water quality on which aquatic resources depend. Groundwater is protected under both the *Canada Water Act* (1985) and British Columbia's *Water Act* (1996).

11.6.2 Residual Effects of Project

Residual effects for groundwater quality and quantity identified in Sections 8.6 and 8.7 are summarized in Table 11.6-1

Table 11.6-1
Summary of Residual Effects for Groundwater Quantity and Quality

Residual Effect	Level of Significance
Groundwater Quantity	
Decrease in water table elevation, change in flow paths, and decrease in aquifer storage around the open pit area during operations, and into post-closure (though to a lesser degree than operations).	Major (Operations); Negligible (Closure and post-closure)
Increase in water table levels, change in flow paths, and increased aquifer storage around the tailings storage facility (effect increases through time, and is maintained into post-closure).	Negligible
Minor local changes in groundwater table elevation, flow paths, and aquifer storage caused by collecting and diverting surface water.	Negligible (Construction and operations) Moderate (Post-closure)
Groundwater Quality	
Seepage from the tailings storage facility introducing increased levels of chloride, ammonia, nitrate, nitrite, molybdenum, and potassium to groundwater (effect increases through time, and is maintained into post-closure).	Moderate
Residual seepage from low grade ore stockpile enters groundwater during operation (source is removed at closure).	Minor

11.6.3 Spatial Boundary

The spatial boundaries for the groundwater CEA will be the Morrison Creek watershed. The residual effects of other projects and human activity occurring within this watershed could potentially combine with Project effects to compound environmental effects.

11.6.4 Temporal Boundary

The temporal boundary will start at pre-construction and extend to 50 years following closure.

11.6.5 Human Actions Considered

In general, there is limited human activity within the Morrison Creek watershed. Based on the human actions identified in Section 11.1, only one was identified for consideration.

Hearne Hill is another mineral exploration property within the Morrison Creek watershed. Some early exploration work was completed on the property in the early 1990s; however, there is no current activity at this site, and no reasonable expectation that activity will increase in the near future.

11.6.6 Interactions with Other Developments and Activities

There are no current plans for additional industrial development in or near the groundwater assessment area. Mineral exploration has taken place at the Morrison and Hearne Hill properties, and further exploration may be conducted in the future. However, exploration activity is not anticipated to affect groundwater. Commercial forestry is not anticipated in the Project area during the mine life and moderate post-closure timeframe.

11.6.7 Predicted Residual Cumulative Effects

There are no anticipated linkages between the Project's residual effects and other human actions with regard to groundwater. Therefore, there is no potential for cumulative effects.

11.7 Aquatic Resources

11.7.1 Valued Environmental and Socio-Economic Components

Aquatic resources (which include periphyton, phytoplankton, benthic invertebrate and zooplankton communities) have been identified as a valued environmental component (VEC) for the CEA because activities at the Project may combine with other development activities in the watershed to increase the risk for these aquatic resources in downstream waterbodies.

These organisms are fundamental components for aquatic ecosystem function, processing available nutrients and providing the biomass to support higher trophic levels (i.e., fish, birds, etc.). Aquatic communities are closely linked to the physical features of their habitat. For this reason, monitoring aquatic resources is useful for detecting changes to the quality of sediment, water, and aquatic habitat in general. Because of their sensitivity to changes in the environment, aquatic resources are useful early indicators of potential shifts or disturbances to ecosystems. In particular, monitoring the changes to macro-invertebrate communities is often used to indicate a disturbance to the aquatic environment (Fore, Karr, and Wisseman 1996).

Aquatic resource communities may be affected by several activities at the Project site, as well as by forestry, transportation, and other mines in the region.

11.7.2 Residual Effects of Project

All residual effects to aquatic resources, even if they were considered of negligible significance, were carried forward to the CEA. Negligible effects were carried forward because of concern

that even they, when combined with effects from other sources, could significantly degrade aquatic resources within the CEA boundaries.

Six Project effects on aquatic resources were considered: (1) surface runoff and siltation, (2) airborne contaminant loading, (3) nitrogen residues from blasting, (4) ML/ARD, (5) discharges and/or spills of contaminants, and (6) habitat loss. These effects are assessed and discussed in detail in Section 8.9.

11.7.3 Spatial Boundary

The spatial boundary for this CEA includes the Babine Watershed from the confluence of the Skeena and Babine rivers to the headwaters of Babine Lake (Figure 11.1-1).

11.7.4 Temporal Boundary

The temporal boundary for cumulative effects includes the construction, operations, and decommissioning of the mine and its associated infrastructure, and will extend into the Project post-closure phase.

11.7.5 Human Actions Considered

Similar to those discussed for surface water quality (Section 11.4), several human actions were considered to have a potential cumulative effect on aquatic resources in the Project area. These actions include:

- past, present, and future mining activities
- mineral exploration
- forestry
- roads
- community sewage/runoff

These potential effects on aquatic resources are described in the following sections.

11.7.5.1 Mining

Mining activities could affect aquatic resources through spills, discharge of contaminated effluent, blasting residues, and sedimentation from developed areas. There are several existing mines within the cumulative effects boundary of the Project, including Granisle, Bell, and Dome Mountain. None of these mines are currently operating. In some cases, historic water quality data are available because monitoring surface water quality was part of the closure plan. However, there are no historic data regarding aquatic resources near these mines.

Granisle Mine

The Granisle Mine is on MacDonald Island in Babine Lake and operated from 1966 to 1982 (Torunski 2009b). The current owner is Xstrata plc. Potential issues that could contribute to the Project's cumulative effects include the seepage of poor water quality from the mine into the surrounding environment. The Granisle Mine does not have a permit to discharge effluent to

Babine Lake, but seepage does occur through containment berms and through groundwater at the mine site (Torunski 2009b).

Bell Mine

The Bell Mine is on the Newman Peninsula of Babine Lake, north of the Granisle Mine. It operated (from 1972 to 1992) and was owned by the same company as the Granisle Mine. The current owner is Xstrata plc. The Bell Mine has a permit to discharge effluent into Babine Lake, which include criteria for the protection of aquatic life (Torunski 2009a).

Dome Mountain Mine

The Dome Mountain Mine is a small, inactive, underground gold mine that is near a tributary of the Fulton River, which flows into Babine Lake. It operated from 1991 to 1993, but exploration has occurred on the site since the early 1900s. During its operational period, approximately 43,909 Mt with an average grade of 0.39 oz/Mt of gold were reportedly mined and shipped to an off-site mill (Scot Willson Roscoe Postle Inc 2008). The property is owned by Eagle Peak Resources, which is currently pursuing plans to reactivate the mine (Eagle Peak Resources Inc. 2006). No water quality data are currently available from the mine site.

Mineral Exploration

As detailed in Section 11.4, several exploration sites (five in total) are within the cumulative effects spatial boundary. If any of these projects progress into the development stage, they could affect the downstream aquatic resources and they will likely be required to produce their own CEA.

11.7.5.2 Forestry and Logging

The Project is within the Morice TSA. Forestry and logging can introduce sediment and nutrients to waterbodies (Chamberlin, Harr, and Everest 1991). Roads associated with logging operations are a significant source of sediment to streams through surface erosion, sediment transport, and slope destabilization (Furniss, Roelofs, and Yee 1991).

Increased concentrations of inorganic nutrients and chemicals such as pesticides, herbicides, and fire retardants may be introduced to streams around logging operations. These chemicals have toxic effects on aquatic life and increased nutrient levels may stimulate primary production and decrease dissolved oxygen concentrations in the aquatic habitat (Norris, Lorz, and Gregory 1991).

11.7.5.3 Urban and Rural Communities

Four small communities are in the Morrison cumulative effects boundary. These include Tachet (130 permanent residents), Fort Babine (60 permanent residents), Old Fort (used seasonally), and Granisle. Granisle is the largest community on Babine Lake with a population of approximately 450 people; however, the population was as high as 2,200 when the Granisle and Bell mines were operating. An STP in Granisle discharges treated effluent to Babine Lake. The permitted discharge is to a maximum of 27 m^3/d of effluent throughout the year (BC MOE n.d.). The permitted discharge characteristics are 60 mg/L of TSS and a 5-day biochemical oxygen demand of 45 mg/L.

11.7.5.4 Transportation

Several forms of transportation in the cumulative effects area may affect aquatic resources. Forest roads are discussed above (11.7.5.2). However, many municipal roads in Granisle and the other communities on Babine Lake are unpaved, which may increase suspended solids to local waterbodies through surface erosion and airborne dust.

Sand and salts used on municipal roads and highways in winter will also affect aquatic resources if they reach streams or lakes during spring runoff. These chemicals increase chloride concentrations in streams and lakes, which can lead to changes in density gradients in lakes and stimulate algal growth (Ramakrishna and Viraraghavan 2005).

Motorized transportation introduces the risk of fuel and other contaminant spills. A barge provides service from Granisle to the east side of Babine Lake for logging trucks and other vehicles, and several recreational boats are present on the lake. Fuel spills may occur during fuelling of these vessels; however, no significant incidents have been reported.

11.7.6 Interactions with Other Developments and Activities

Table 11.7-1 presents a summary of the possible interactions between the Project and other human activities in the CEA boundary.

Table 11.7-1
Summary of Links between the Morrison Copper/Gold Project and Other Human Activities/Projects

	Surface Runoff and Siltation Contaminant Loading	Airborne Contaminant Loading	Nitrogen Residues from Blasting	ML/ARD	Discharge and Spill Contaminant Loading	Habitat Loss
Existing or Closed Activities and Projects						
Roads	X				X	
Other transportation (i.e. barge, train)	X				X	
Forestry	X	X				
Bell Mine				X	X	
Granisle Mine				X	X	
Dome Mountain Mine				X	X	
Mineral exploration	X			X	X	X
Urban and Rural Communities						
Granisle	X				X	
Tachet	X				X	
Old Fort	X				X	
Fort Babine	X				X	

Surface Runoff and Siltation

The Project could degrade aquatic resources by introducing sediment during construction and operations. The potential extent of this effect was considered to be moderate during construction and negligible during operations. Similar effects from forestry and transportation could have a cumulative effect in the local area, especially along roads that will also be used for mine access. Siltation from all sources is expected to be limited to streams and waterbodies near the mine and access roads. In addition, several mitigation techniques (silt traps, etc.) are generally employed along roads and at logging sites to reduce erosion and sediment transport to streams.

Airborne Contaminant Loading

Airborne contaminants from the Project that could affect water quality include dust and nitrogen residues from blasting, road traffic, and disturbed soils, and contaminants from vehicle and generator emissions. The residual significance of this effect on aquatic resources is expected to be negligible.

Other airborne contaminants in the greater cumulative effects boundaries include herbicide and pesticide residues from forestry, dust from road traffic, and emissions from vehicles. These could have a cumulative effect on aquatic resources when combined with contaminants from the Project. BMPs for using herbicides and pesticides are in place under the *Forest and Range Practices Act* (2002a), and their effect on aquatic resources is assumed to be negligible. Although they are unlikely to act in concert with any other airborne contaminants, they may increase toxicity in waterbodies that receive mine effluent.

Nitrogen Residues from Blasting

Nitrogen residues from blasting may be carried through the air and through surface runoff to waterbodies in the Project area, increasing the potential for eutrophication in local waterbodies. The residual significance of this effect was predicted to be negligible during all Project phases. Nitrogen residues may also enter streams and waterbodies from other blasting activities in the cumulative effects boundary. Such blasting may occur along new roads and the dam centreline or plant site construction.

Metal Leaching and Acid Rock Drainage

The effects of ML/ARD to aquatic resources were assessed as having a minor significance at the mine site. Babine Lake is considered to have the highest risk for cumulative effects of ML/ARD from the Project because of the presence of the decommissioned Bell and Granisle mines and the potential re-starting of the Dome Mountain Mine. If measurable ML/ARD effects occur from the Project they will most likely be seen in Morrison Lake. Morrison Lake empties into Morrison Creek, which flows into Babine Lake at the northern end of Morrison Arm. The area of Babine Lake most likely affected by the Bell and Granisle mines is Hagan Arm, which is south of Morrison Arm on the east side of Babine Lake. The Dome Mountain Mine is on a tributary of the Fulton River, which empties into Babine Lake near Tachet.

Because it has been estimated that a considerable proportion of the generated waste rock is PAG, the drainage from the WRD near the Morrison mine site could be degraded by ML/ARD. Most of the ML/ARD generated by the WRD will be collected and diverted into the pit. However, it

has been estimated that at closure approximately 10% of the generated ML/ARD from this source will travel with groundwater flow to Morrison Lake and not be captured by the pit (Section 11.6).

Of particular concern to the BC MOE is the potential for reduced water quality in Babine Lake as the Granisle and Bell mines begin to generate acid (Torunski 2009b). Between 2004 and 2008, all lake sampling sites and discharge sites at the Bell Mine reported pH values within the permit limits (Torunski 2009a). Around the Granisle Mine, pH values in Babine Lake were within the allowable range between 2004 and 2008. The seepage site that empties into Babine Lake from the Granisle Mine had a pH that ranged from 3.76 to 5.83. It is expected that once this water meets Babine Lake, the increase in pH would cause the copper to precipitate out and potentially affect local sediment quality (Torunski 2009b).

Most dumps and tailings sites at the Bell Mine were predicted to start generating acid between 2000 and 2030 (Geocon, Rescan, and Morwijk 1992). Sulphide depletion is predicted to occur between 2040 and 2100 for most sites. The addition of acidic leachate from the Project may contribute to a cumulative effect with the acid being generated by the existing mines to decrease water quality in Babine Lake. The physico-chemical and limnological processes that establish the Babine Lake water quality baseline are complex. The contribution of the mine sites to the Babine Lake water quality as a whole is not well documented. As a result, the BC MOE has suggested that a long-term water quality monitoring station be established near the outlet of Babine Lake to monitor potential changes in downstream water quality (Tamblyn 2009). The BC MOE has confirmed that water quality data for Babine Lake are extremely limited (Tamblyn 2009b) and establishing this long-term monitoring station would be very beneficial. This monitoring site is currently beyond the scope of responsibility of the proponent.

The Dome Mountain Mine also operated for a short time in the early 1990s and the feasibility of re-opening the mine is currently being investigated. ML/ARD issues may exist at the current mine site; however, there are no reports available on the current water quality near the mine. If the mine is reactivated, the potential for ML/ARD will be assessed.

Discharge and Spill Contaminant Loading

The introduction of contaminants to surface water and sediment quality may occur through sewage discharge, effluent discharge (TSF and pit) from pit area, and accidental spills. The residual significance of effects to aquatic resources at the mine site (including seepage from the TSF, draining Ore Pond and Booker Lake, and discharging treated sewage) was predicted to be minor during all phases.

Other activities within the cumulative effects boundary that could affect surface water quality through discharged or spilled contaminants include the existing Bell Mine, Granisle Mine, Dome Mountain Mine, forestry activities, transportation, mineral exploration, and urban and rural communities.

Mine-related discharges could have a cumulative effect on water quality because the existing mines release similar metals into the water that are predicted to be released by the proposed Project. The Granisle Mine has no permitted discharge (Torunski 2009b) but some contaminated

water likely seeps from the mine through groundwater and uncontrolled surface drainage. The flow of contaminated water from the tailings and containment ponds to groundwater and Babine Lake has been estimated as 300,000 to 400,000 m^3/year (K.A. Morin and N.M. Hutt 2003). There is one site on the Granisle mine site that discharges contaminated surface water directly into Babine Lake. This drainage is ephemeral and was flowing on only 5 of 13 site visits between 2004 and 2008 (Torunski 2009b). While the Granisle Mine does not discharge any effluent, the Bell Mine has three permitted discharge sites. At each of the Bell Mine discharges, dissolved copper, dissolved iron, and dissolved zinc are measured for compliance with permit guidelines.

Any future discharge from the proposed Dome Mountain mine may further reduce water quality in Babine Lake. The extent of any potential consequences to aquatic resources from this mine are currently unknown because the mine plan has not been finalized.

Several small towns and camps discharge treated sewage into Babine Lake. Granisle has a permit to discharge treated sewage into Babine Lake. The permit allows for 27 m^3/day of treated sewage with a maximum TSS concentration of 60 mg/L to be discharged into the lake. No other data are available on permitted sewage discharge levels into Babine Lake or other Project area waterbodies, suggesting that other communities within the Project boundaries may have septic systems rather than sewage treatment.

Treated sewage from the Project may have an additive effect on nutrient levels in surface water when combined with sewage from other sources. However, the only discharge of treated sewage effluent will occur during the construction phase (250 to 400 persons) when an STP will be in place at the mine site.

The potential effects of spills along any access road or from barges, power generators, or vehicles are unlikely to affect surface water or sediment quality in the long term. Several BMPs will be in place to prevent and to treat spills if they occur. The Project will have safeguards in place to prevent spills from affecting water quality (spill contingency and emergency response plan, Section 13.18).

11.7.7 Predicted Residual Cumulative Effects

Table 11.7-2 presents a summary of the residual cumulative effects for the Project including the scope, duration, frequency, and magnitude. A definition of these attributes of residual cumulative effects can be found in Section 11.1 (cumulative effects methodology).

Surface Runoff and Siltation

Surface runoff and siltation from the Project and other activities in the cumulative effects area may increase siltation in streams near roads and disturbed areas. Lakes are less likely to be affected as any runoff that reaches the lake will likely settle quickly and not have a substantial effect on water quality. Siltation effects are generally short-term, unless ongoing disturbance or lack of maintenance results in chronic erosion and sediment transport to streams. If increased siltation becomes chronic, additional mitigation will be undertaken to reduce erosion and the transport of sediment-laden water to streams and lakes. Siltation will most likely occur during

construction when most soil disturbance occurs, as well as during rain storms and snowmelt events. The potential risks to aquatic resources include mortality or reduced growth through respiratory inhibition via smothering. A general reduction in water clarity and light penetration in the water column could result in reducing the productivity of primary producers. Aquatic resources may be temporarily degraded but proper mitigation techniques will result in recovery within the Project life, resulting in a moderate magnitude for this effect.

Table 11.7-2
Residual Cumulative Effects Summary Table

Effect	Direction	Scope	Duration	Frequency	Magnitude
Surface Runoff and Siltation Contaminant Loading	Negative	Sub-regional	Short-term	Sporadic	Moderate
Airborne Contaminant Loading	Negative	Sub-regional	Short-term	Sporadic	Low
Nitrogen Residues from Blasting	Negative	Sub-regional	Short-term	Sporadic	Low
ML/ARD	Negative	Regional	Long-term	Continuous	Low
Discharge and Spill Contaminant Loading	Negative	Regional	Long- term	Sporadic	Low
Habitat Loss	Negative	Regional	Long- term	Once	Moderate

Airborne Contaminant Loading

The effects of airborne contaminants from activities (i.e., logging) within the cumulative effects boundary on surface water quality are predicted to be of low magnitude. Airborne contaminants typically reach waterbodies in low concentrations, and are unlikely to have a measurable effect on aquatic communities. Sporadic deposition may occur from increased road use in the Project area, which will lead to increased dust mobilization and transport. Any effect is predicted to be limited to the period that dust is mobilized (i.e., a short duration).

Nitrogen Residues from Blasting

Apart from the Project, there are few activities within the cumulative effects boundary that would contribute additional nitrogen residues to surface water. Nutrients released from soils following logging may contribute to the effects of nitrogen residues from the Project; however, the effects of these nutrient pulses are only predicted to last for a short period following logging and be localized. Nutrients from all sources are more likely to be taken up by terrestrial microorganisms or undergo adsorption to soil particles resulting in a low magnitude of this effect.

Metal Leaching/Acid Rock Drainage

Any potential residual cumulative effect to aquatic resources from ML/ARD is most likely to occur in Babine Lake. Two existing mines currently drain into Babine Lake, and while no significant reductions in water quality have been detected in Babine Lake to date, future

acidification may occur because of increasing ARD at the Bell and Granisle mine sites. ML/ARD may also result from the Morrison mine and proposed Dome Mountain mine.

It has been estimated that a considerable proportion of the generated waste rock from the Morrison mine will be PAG (Appendix 15). The seepage and runoff will be collected during operations and will drain to the open pit. For seepage from the low grade ore stockpile, a number of management strategies will be investigated to minimize potential for seepage to groundwater and eventually to Morrison Lake. Potential management strategies include further investigation of the till suitability and quantity for use as a foundation barrier to seepage infiltration; if necessary, till compaction during construction to decrease permeability and minimize infiltration, or installation of a synthetic liner if compaction is not adequate or unfeasible, and installing a groundwater monitoring well network between the low grade ore stockpile and Morrison Lake. These approaches would allow seepage through the pile to be collected as surface runoff only, and managed along with the rest of surface runoff and pit dewatering water. The groundwater monitoring well network would identify whether residual seepage to groundwater is occurring and if further management is necessary to ensure that seepage does not reach Morrison Lake. Using these mitigation techniques cause the magnitude of this potential effect to be low.

Discharge and Spill Contaminant Loading

Discharge and spills from mines and communities in the cumulative effects area pose a potential risk to surface water quality in the long term. Other than minor discharges from communities, only the Bell Mine directly discharges effluent into Babine Lake, seepage from the Granisle Mine also enters Babine Lake. The available monitoring studies have indicated that Babine Lake water quality in areas near the mine have not degraded significantly over the past 20 years. A development schedule that would lead to a discharge from Dome Mountain is unknown. The effluent discharge schedule from the Morrison Mine currently predicts that the Project will begin discharging treated effluent approximately 24 years after pit operations cease. Although continuous once it begins, the magnitude of this effect will likely be low in Babine Lake and downstream surface waters.

Habitat loss

In addition to the aquatic habitat loss that is known will occur at the Morrison Mine, the potential exists within the cumulative effects area for some habitat loss with the development of the Dome Mountain Mine.

11.7.8 Assessment of Significance

The level of significance for cumulative effects arising from surface runoff and siltation, airborne contaminants and nitrogen blasting is negligible. Several mitigation techniques will likely reduce or eliminate the potential for significant effects on aquatic resources from these activities. The level of significance for cumulative effects arising from habitat loss is also considered negligible, based on the current information regarding proposed development in the cumulative effects area.

Effects from ML/ARD and various discharges could be of moderate significance. This rating primarily results from the fact that both of these effects are long term and continue beyond the

life of the Project. Although Babine Lake is the largest natural lake in BC, and it is possible that no significant effects will be observed because of the high level of dilution, their long-term nature may eventually result in a cumulative effect.

11.7.9 Confidence Limits

CEAs must incorporate a level of uncertainty because the assessment process requires that predictions be made about whether future developments will take place, and how those developments will affect VECs within the Project area. The confidence limits for cumulative effects are identified in Table 11.7-3.

Table 11.7-3
Significance of Residual Cumulative Effects

Effect/VEC/VSEC	Direction	Level of Significance	Confidence
Surface Runoff and Siltation Contaminant Loading	Negative	Negligible	High
Airborne Contaminant Loading	Negative	Negligible	High
Nitrogen Residues from Blasting	Negative	Negligible	High
ML/ARD	Negative	Moderate	Low
Discharge and Spill Contaminant Loading	Negative	Moderate	Low
Habitat Loss	Negative	Negligible	Low

Confidence limits for the effects of surface runoff and sedimentation, airborne contaminants, and nitrogen residues are high. There is a good understanding of the effects these activities have on surface water quality. There is also a good understanding of how effects can be prevented with various mitigation and management techniques.

Confidence limits for the effects of ML/ARD and discharge and spill contamination are low. This is primarily because the complexity of interactions in Babine Lake is poorly understood and more data on lake water quality are required. There is a high level of uncertainty regarding acid generation at the Bell and Granisle mines and how/when this acid generation will specifically affect water quality in Babine Lake. Similarly, there is some uncertainty about the timing and the persistence of these effects from the Morrison Mine, and how those contaminants will eventually interact with contaminants from the other mines on Babine Lake.

Confidence limits for the effects of habitat loss are also low. This is primarily a result of not having enough information regarding future development in the cumulative effects area.

11.7.10 Additional Mitigation

The Babine River supports important salmon runs, and the resources of Babine Lake are used extensively by several small communities, as well as by tourists, hunters, and fishers. Two decommissioned mines currently exist on the lake, and two more mines (Morrison and Dome Mountain) are proposed within the Babine watershed. Because of the large size of the lake, it is unlikely that the lake will be significantly affected by these developments; however, it will be

necessary to establish long-term monitoring sites to manage any effect from the Project and ensure that these resources are protected in the future.

11.8 Fish and Fish Habitat Cumulative Effects

11.8.1 Valued Environmental Components

The effects assessment for fish and fish habitat (Section 8.10) assessed the potential effects of the Project on the following VECs:

- lake trout (*Salvelinus namaycush*)
- Dolly Varden (*Salvelinus malma*)
- rainbow trout (*Oncorhynchus mykiss*)
- anadromous Pacific salmon species
- "other" fish species
- fish habitat

The potential combined effects of human actions on the considered VECs were identified through a scoping assessment and the significance of the Project was assessed through an analysis of effects.

11.8.2 Residual Effects of Project

The predicted potential impacts of mine components on each VEC were identified and assessed in the effects assessment section (Section 8.10). Project components include the mine site, access road, and transmission line. All three Project components could affect fish during different Project phases if not properly mitigated. Results of the effects assessment analysis are presented for the four Project phases: construction, operations, decommissioning and closure, and post-closure (Tables 8.10-4 to 8.10-9). Project components that may affect an identified VEC are discussed in relation to lethal effects, sublethal effects, and habitat loss. The degree of likelihood of the Project component effects is not estimated.

Based upon the effects assessment analysis, residual adverse environmental effects of minor, moderate, or major significance were identified for each VEC. The fish and fish habitat residual adverse effects are presented in Table 11.8-1. All residual adverse effects were determined to be negligible for lake trout and "other" fish species VECs. However, even negligible Project effects were considered in the CEA because residual effects may grow in significance when combined with other human actions in the study area.

11.8.3 Spatial Boundary

The CEA study area refers to the maximum spatial area over which the potential for cumulative effects is assessed. The study area's purpose is to set a boundary for the identification of other human actions that could interact with Project effects. The local and regional study areas were previously identified in the effects assessment (Section 8.10.2.1). The local study area includes

Table 11.8-1
Fish and Fish Habitat Residual Adverse Effects for the Morrison Copper/Gold Project

VEC	Component	Project Phase	Description	Description of Residual Effects	Significance of Residual Effects
Dolly Varden	Access Road	Construction	Particulates and residue from trucks, construction, equipment activity, and blasting increasing total suspended solids and causing sublethal effects.	Elevated dust generation because access road not wetted during summer; Quarries wetted, but nitrogen residues from blasting not washed away quickly in summer as during spring freshet.	Minor
	Access Road	Construction, operations	Spills from equipment, hauled fuels and cargos, and waste products causing mortality or sublethal effects.	Increase in potential toxins leading to mortality, or physiological stress and behavioural changes.	Minor
Rainbow Trout	Mine Site	Construction, operations, closure and decommissioning	Sedimentation from construction activities, blasting, drainage ditches, and stream redirection causing lethal smothering or sublethal effects.	Turbid water will flow into streams and lakes with minor sedimentation possible.	Minor
	Access Road	Construction	Particulates and residue from trucks, construction, equipment activity, and blasting increasing total suspended solids and causing sublethal effects.	Elevated dust generation because access road not wetted during summer; Quarries wetted, but nitrogen residues from blasting not washed away quickly in summer as during spring freshet.	Minor
	Access Road	Construction, operations	Spills from equipment, hauled fuels and cargos, and waste products causing mortality or sublethal effects.	Increase in potential toxins leading to mortality, or physiological stress and behavioural changes.	Minor
	Mine Site	Construction, operations, closure and decommissioning	Water loss in Morrison Lake tributaries from loss of upper watersheds in tailings, waste rock, and open pit areas causing winter mortality, sublethal effects, and lost habitat	Lower water levels in streams 25500 and 44800, and altered flow in stream 53400 reducing total fish habitat and potentiating winter freezing	Moderate

(continued)

Table 11.8-1
Fish and Fish Habitat Residual Adverse Effects for the Morrison Copper/Gold Project (continued)

VEC	Component	Project Phase	Description	Description of Residual Effects	Significance of Residual Effects
Rainbow Trout	Mine Site	Operations, closure and decommissioning	Rupture of tailings dam or pipeline containing tailings, filter plant effluent, and sewage effluent.	Increase in sediments and potential toxins leading to mortality, or physiological stress and behavioural changes.	Moderate
Pacific Salmon	Mine Site	Construction, operations, closure and decommissioning	Sedimentation from construction activities, blasting, drainage ditches, and stream redirection causing lethal smothering or sublethal effects.	Turbid water will flow into streams and lakes; Minor sedimentation of shoreline spawning areas possible.	Minor
	Access Road	Construction	Particulates and residue from trucks, construction, equipment activity, and blasting increasing total suspended solids and causing sublethal effects.	Elevated dust generation because access road not wetted during summer; Quarries wetted, but nitrogen residues from blasting not washed away quickly in summer as during spring freshet.	Minor
	Access Road	Construction, operations	Spills from equipment, hauled fuels and cargos, and waste products causing mortality or sublethal effects.	Increase in potential toxins leading to mortality, or physiological stress and behavioural changes.	Minor
	Mine Site	Construction, operations, closure and decommissioning	Water loss in Morrison Lake tributaries from loss of upper watersheds in tailings, waste rock, and open pit areas causing winter mortality, sublethal effects, and lost habitat	Lower water levels in streams 25500 and 44800, and altered flow in stream 53400 reducing total fish habitat and potentiating winter freezing	Moderate
	Mine Site	Operations, closure and decommissioning	Rupture of tailings dam or pipeline containing tailings, filter plant effluent, and sewage effluent.	Increase in sediments and potential toxins leading to mortality, or physiological stress and behavioural changes.	Moderate

(continued)

Table 11.8-1
Fish and Fish Habitat Residual Adverse Effects for the Morrison Copper/Gold Project (completed)

VEC	Component	Project Phase	Description	Description of Residual Effects	Significance of Residual Effects
Fish Habitat	Mine Site	Construction	Sedimentation from construction activities, blasting, drainage ditches, and stream redirection causing increases in total suspended solids, reducing sunlight and affecting food resources or covering substrate and reducing habitat.	Habitat loss, increased total suspended solids above background, and decreased primary and secondary production.	Minor
	Access Road	Construction	Sedimentation from truck hauling, construction activities, and blasting causing increases in total suspended solids, reducing sunlight and affecting food resources or covering substrate and reducing habitat.	Habitat loss, increased total suspended solids above background, and decreased primary and secondary production.	Minor
	Access Road	Construction, operations	Spills from equipment, hauled fuels and cargos, and waste products affecting fish food resources.	Decreased primary and secondary production.	Minor
	Mine Site	Operations, closure and decommissioning	Rupture of tailings dam or pipeline containing tailings, filter plant effluent, and sewage effluent.	Potential downstream habitat loss, increased total suspended solids above background, and decreased primary and secondary production.	Moderate
	Mine Site	Construction, operations, closure and decommissioning	Direct habitat loss (water) of stream 53400 upper reach due to tailings storage facility and stream 29000 lower reach due to open pit, and partial water loss in streams 25500 and 44800.	Fish habitat loss.	Moderate

the Project licence area to the terminal end of the transmission line at Bell Mine substation, near Babine Lake. These boundaries include the receiving and reference environment watercourses of the Project licence area and the proposed transmission line right-of-way (ROW). The regional study area includes all receiving and reference environment watersheds within the Project licence area; including Morrison and Tahlo Creek watersheds, Morrison, Babine, and Tochcha Lakes, and sub-watersheds of Morrison Lake (29000, 44800, 50000, 53400, 61100). The regional study area also includes all watersheds the transmission line passes through, including those draining into Morrison Creek and Lake Babine on which the Bell Mine substation is located.

The regional study area mentioned above was selected for the CEA. This cumulative effects regional study area was selected because it includes areas where the residual effects may interact with other land use activities/actions, it sufficiently addresses cause-effect relationships between actions and VECs, it encompasses watershed boundaries to address other actions in a particular watershed, and it encompasses Lake Babine Nation traditional territory. The cumulative effects regional study area boundaries consider the abundance and distribution of VECs at a regional scale.

11.8.4 Temporal Boundary

The temporal boundaries were identified in the effects assessment (Section 8.10.2.2). Temporal boundaries include the Project's proposed lifetime of 21 years (construction, operation, and decommissioning and closure) and a 10-year post-closure phase. The cumulative effects temporal boundary will begin with the Project baseline studies and will consider historical land use actions. Because of the generally fast recovery of fish populations and relatively short fish longevity, the maximum temporal effects of the Project on fish and fish habitat are anticipated within the Project lifetime. Therefore, the cumulative effects temporal boundary will terminate 10 years after Project closure and reclamation.

11.8.5 Human Actions Considered

Human actions/activities within the cumulative effects study area were identified by applying the following criteria:

- past (closed) industrial projects that have affected baseline conditions, and/or continue to exert an influence in the study areaexisting (active) projects
- land use activities
- energy and mineral exploration projects
- reasonably foreseeable future projects

A description of other past, present, and probable future human projects and activities within the overall CEA area boundary is provided in Section 11.1. Based upon the above criteria and human actions that lie within the fisheries cumulative effects regional study area, a number of human actions were selected. The human actions included are:

- the closed Bell Mine
- the closed Granisle Mine

- ongoing forestry activities
- Lake Babine Nation fishing
- fishing by outfitters and residents

The locations of the past, current, and proposed mining/exploration projects are shown in Figure 11.1-1.

One activity that could have a cumulative effect on fisheries VECs in the Project area is mineral exploration and development. Mineral exploration has occurred within the local study area since the early 20th century, but data are not available to assess the effects of all exploration projects. Within the Morrison Lake and Babine Lake watersheds, previous mining at the Granisle Mine and Bell Mine took place until 1982 and 1992, respectively, when the mines were closed. Both mines produced copper, gold, and silver.

Bell Mine is an open pit copper mine that closed in 1992. The property is on the Newman Peninsula of Babine Lake. The mine's water management system consists of collection ponds, diversion ditches, tailings pond, and open pit and pump facilities. The water management system for the mine closure was designed to meet the British Columbia Ministry of Energy, Mines and Petroleum Resources (BC MEMPR) guidelines and regulations and still meets current government guidelines and recommendations for closed mines. The tailings pond effluent discharges into Babine Lake's Rum Bay via a submerged outfall. Water quality is monitored via a remote monitoring system. Monitoring occurs weekly when discharging into Babine Lake during the spring freshet. Water that is unacceptable for discharge is collected and diverted to the open pit. Acidic water quality conditions are occurring at the Bell Mine property as predicted in 1992, but the four pit sampling sites and three discharge sites have reported pH values within permit limits of 6.5 and 8.5 (Torunski 2009a). Total copper concentrations were below the maximum allowable guideline for the protection of aquatic life of 0.006 mg/L at 0.0043 mg/L. The 1999 levels of other metals also remained below BC Water Quality Guidelines with dissolved iron concentrations lower than 0.35 mg/L, and zinc concentrations consistently lower than 0.033 mg/L. In 2007, the average total copper concentration at one of the sites was 1.12 mg/L and the average dissolved copper concentration was 0.45mg/L. The probable cause listed at the time was spring freshet flushing. Contaminated water is held on-site in the open pit, which is capable of holding water for 40 to 50 years. A water treatment plant will need to be installed when the pit nears capacity.

Granisle Mine is an open pit copper mine that also closed in 1982. The property is on Babine Lake's Sterrett Island. Of the seven potential surface water outlets that empty into Babine Lake, in 2003 two were dry, two had some seepage near the shoreline, and three had measurable surface flows (K. A. Morin and N. M. Hutt 2003). The total flow through all outlets was approximately 1.4 L/s and the total loading of total copper into Babine Lake from the flowing and seeping surface water outlets was estimated at 1.2 kg Cu/yr. Between 2004 and 2007 this rate produced dissolved copper concentrations in Babine Lake that were below the maximum drinking water guidelines (Torunski 2009b). However, dissolved copper concentrations were very close or above to the 0.006 mg/L maximum allowable total copper concentration guideline

for the protection of aquatic life, so actual measured total copper concentrations may surpass this guideline.

The 2004 to 2007 levels of other metals also remained below BC water quality guidelines with dissolved iron concentrations lower than 0.35 mg/L (all samples less than 0.05 mg/L lab minimum detection limit), and zinc concentrations consistently lower than 0.033 mg/L (Torunski 2009b). Total sulphate for all lake sampling stations were below 100 mg/L, but at one of the creek seepage sites sulphate ranged from 315 mg/L (2007) to 906 mg/L (2004). However, at an in-lake site near this seepage in 2007, total sulphate concentrations were only 4.2 mg/L. Apart from total copper, there were no discernable differences between the reference and exposure areas in terms of aqueous metal concentrations at the Granisle Mine, and thus no evidence of water quality effects (Stantec 2002). Further, no acid rock drainage (ARD) has been detected in groundwater, which is consistent with findings in the early 1990s and in August 2002 (K. A. Morin and N. M. Hutt 2003). However, it is predicted that Granisle Mine will start generating acid within the next 10 to 20 years (Torunski, pers. comm., 2009).

There are ongoing forestry operations in the fisheries study area. The Project is within the Morice TSA. In 2008, the AAC was increased to maximize value from dying and dead trees affected by the MPB infestation. It can be assumed that there will be high volumes of "gray" (dead/dying trees) until the infestation is over (projected at 2018) and/or the merchantable dead pine trees are available (projected at 2018 to 2024). The increase in forestry operations could have a cumulative effect on fisheries VECs in the Project area.

There are a total of five registered angling guides with permits in the Region 6 Skeena Resource Management Area. Of these, three guides have permits to operate on water systems within the regional study area and immediate surrounding area. Rivers and lakes used collectively by these guides and their clients are Morrison Creek, Morrison Lake, Babine Lake, and Nakinilerak Lake. The guides stipulate to the BC MOE the time period during which they wish to use the identified water systems. These time periods range from approximately mid-June to mid-November. Days spent fishing and angling depend on the guiding operation. Continuing outfitter, resident, and Lake Babine Nation fishing could have a cumulative effect on fisheries VECs in the Project area.

11.8.6 Interaction with Other Developments and Activities

To produce a cumulative effect, the Project's residual effects must act in combination with the residual effects of one or more other human actions. Therefore, an important step in the assessment process is to establish these linkages. To identify possible interactions between the Project and other past, present, or future projects, a list of potential residual effects categories from the Project was identified. The effect categories are: lethal effects, sublethal effects, habitat loss, and habitat degradation/productivity loss. Table 11.8-2 presents a summary of links between the Project and other human activities.

Lethal effects refer to fish mortality when an action results in the immediate or near immediate death of fish. Direct mortality typically has four causes: harvesting, physical damage, smothering, and physiological toxicity. Lake Babine Nation and outfitter fishing can have a cumulative effect on increased mortality through harvesting.

Table 11.8-2
Fish and Fish Habitat Summary of Links between the Project and Other Human Activities/Projects

Project or Activities	Potential residual effect interactions			
	Lethal Effects	Sublethal Effects	Habitat Loss	Habitat Degradation/ Productivity Loss
Existing or Closed				
Bell Mine		X		X
Granisle Mine		X		X
Forestry Operations		X	X	X
Lake Babine Nation fishing	X			
Fishing by outfitters and residents	X			

X = action/activity under consideration.

Sublethal effects generally lead to deterioration in the health of individuals or a population. These effects can manifest as detrimental changes to an organism with respect to their behaviour (e.g., changes in swimming patterns, decreased feeding) or physiology (e.g., increased osmoregulatory stress, decreased swimming performance). Behavioural and physiological changes can occur because of high levels of TSS from sedimentation events during construction; noise pollution from construction and operation events; blast noise propogation; ML/ARD at exposed mine sites, stockpiles, and access roads; and spilled petroleum products, tailings dam rupture, or residues from explosives. All identified human activities/projects can have a cumulative effect on increased sublethal effects, except Lake Babine Nation, residents, and outfitter fishing.

Habitat loss refers to the removal or physical alteration of environmental aspects that are used either directly or indirectly by fish. Forestry operations can have a cumulative effect on increased habitat loss through decreased riparian organic input into streams, or increased sediment input from road access construction and maintenance.

The productive capacity of fish habitat is defined as the maximum natural capability of a habitat to produce healthy fish safe for human consumption, or to support or produce aquatic organisms upon which fish depend. Productive capacity may be negatively altered by: clearing riparian vegetation; constructing dams that alter flow regime, sediment transport, and water temperature; sedimentation from construction; contamination from spilled petroleum products from equipment, haul loads, tailings dam rupture, or blasting particulates containing toxic residues; and potential ML/ARD from road alignments, quarry sites, WRDs, and mines. All identified human activities/projects can have a cumulative effect on increased habitat degradation/productive capacity, except Lake Babine Nation and outfitter fishing.

11.8.7 Predicted Residual Cumulative Effects

The predicted residual cumulative effects of past, present, and future activities on each VEC are presented in Table 11.8-3. The results are based on the effect interaction analysis in Table 11.8-2.

Table 11.8-3
Fish and Fish Habitat Residual Cumulative Effects Summary Table, Morrison Copper/Gold Project

VEC/Effect	Direction	Scope	Duration	Frequency	Magnitude
Lake Trout					
Lethal Effects	Negative	Regional	Medium-term	Continuous	Low
Sublethal Effects	Negative	Regional	Long-term	Sporadic	Moderate
Dolly Varden					
Lethal Effects	Negative	Regional	Medium-term	Sporadic	Low
Sublethal Effects	Negative	Regional	Long-term	Sporadic	Moderate
Rainbow Trout					
Lethal Effects	Negative	Regional	Medium-term	Continuous	Low
Sublethal Effects	Negative	Regional	Long-term	Sporadic	Moderate
Pacific Salmon					
Lethal Effects	Negative	Regional	Medium-term	Continuous	Low
Sublethal Effects	Negative	Regional	Long-term	Sporadic	Moderate
Other Fish Species					
Lethal Effects	Negative	Regional	Medium-term	Sporadic	Low
Sublethal Effects	Negative	Regional	Long-term	Sporadic	Moderate
Fish Habitat					
Habitat Loss	Negative	Regional	Long-term	Sporadic	Low
Habitat Degradation/Productivity Loss	Negative	Regional	Long-term	Sporadic	Moderate

All VECs and corresponding effects were assessed at a regional scoping level. A regional level was selected because all VEC species and habitats extend throughout the CEA area. For lethal effects, all fish species VECs were assessed as medium term in duration because more than a single generation is likely to be affected. All fish species VECs for sublethal effects and fish habitat VEC effects were assessed as long term in duration because these effects can affect population sustainability for future generations. Lethal effects on lake trout, rainbow trout, and pacific salmon VECs were assessed as continuous in frequency because they are regularly harvested for consumption on an annual basis. Lethal effects on Dolly Varden and other fish species VECs were assessed as sporadic in frequency because they are not generally harvested. All fish species VECs for sublethal effects and fish habitat VEC effects were assessed as sporadic in frequency because these events are not planned and do not occur on any interval pattern. Lethal effects for all fish species VECs were assessed as low in magnitude because a population's reproductive capacity, survival, or habitat suitability is minimally impaired. All fish species VECs for sublethal effects and fish habitat VEC effects were assessed as moderate in magnitude because it could result in measureable change in a population's reproductive capacity, survival, or habitat suitability. The fish habitat loss VEC was assessed as low in magnitude because the loss within the entire study area would be relatively low and the reproductive capacity, survival, or habitat suitability of an entire fish population would be minimally impaired.

11.8.8 Assessment of Significance

The significance of each predicted residual cumulative effect (i.e., lethal effects, sublethal effects, habitat loss, habitat degradation/productivity loss) was evaluated to reflect the expected change in condition of the assessed VEC (Table 11.8-3). In assessing the significance of each cumulative effect, it is assumed that the identified mitigation measures will be implemented and effective as described. The significance of each residual cumulative effect was determined by examining possible changes in the condition of a VEC over time, beginning with its condition at the start of the Project (taking into account all past and existing projects within the study area), and ending with its condition post-closure (assuming mitigation is successful). The level of significance for each cumulative effect is presented in Table 11.8-4.

Table 11.8-4
Assessment of Significance for Fish and Fish Habitat Residual Cumulative Effects, Morrison Copper/Gold Project

VEC/Effect	Direction	Level of Significance	Confidence
Lake Trout			
Lethal Effects	Negative	Negligible	High
Sublethal Effects	Negative	Low	Intermediate
Dolly Varden			
Lethal Effects	Negative	Negligible	High
Sublethal Effects	Negative	Low	Intermediate
Rainbow Trout			
Lethal Effects	Negative	Negligible	High
Sublethal Effects	Negative	Low	Intermediate
Pacific Salmon			
Lethal Effects	Negative	Negligible	High
Sublethal Effects	Negative	Low	Intermediate
Other Fish Species			
Lethal Effects	Negative	Negligible	High
Sublethal Effects	Negative	Low	Intermediate
Fish Habitat			
Habitat Loss	Negative	Low	High
Habitat Degradation/Productivity Loss	Negative	Low	Intermediate

The level of significance for lethal effects on all fish species VECs was determined to be negligible. Implementing proper mitigation measures and fishing harvest regulations/control for existing and future activities, can minimize fish mortalities and the VECS are expected to return to baseline conditions within the operational lifetime of the Project. The level of significance for sublethal effects on all fish species VECs was determined to be low. Implementing proper mitigation measures for existing and future actions/activities, can minimize changes in fish behaviour and the VECs are expected to return to baseline conditions after Project closure. The level of significance for habitat loss and habitat degradation/productivity loss for the fish habitat VEC was determined to be low.

11.8.9 Confidence Limits

There is a level of uncertainty when considering cumulative effects because the assessment process requires predictions regarding whether future developments will take place and the effects of those developments. The confidence limits for the Project's cumulative effects are identified in Table 11.8-4.

The level of confidence for lethal effects on all fish species and fish habitat VECs was determined to be high. There is a good understanding of the cause-effect relationship of lethal effects to fish populations and habitat loss, in general and for the study area; therefore, there is a low degree of uncertainty that the conclusions of the assessment are accurate. The level of confidence for sublethal effects on all fish species and habitat degradation/productivity loss VECs was determined to be intermediate. The cause-effect relationships are not fully understood because of the number of potential anthropogenic sublethal/productivity effects and their interaction with each other (Section 11.8-6) with a particular development; therefore, there is an intermediate degree of uncertainty that the conclusions of the assessment are accurate. For example, the sublethal effects of a spill on fish and fish habitat will vary according to the type and amount of material spilled, the location of the spill, the timing of the spill, and the emergency response to the spill. These are unknown variables that make it difficult to predict the final magnitude. The same reasoning applies to ML/ARD, blasting residue, sedimentation events, riparian clearing, and tailings dam rupture. However, the sensitivity of freshwater ecosystems and the importance of the Morrison and Babine Lake to the Lake Babine Nation as a fishing area warrant a cautious assessment.

11.8.10 Additional Mitigation

Mitigation and management plans are offered as recommendations and will be refined during the permitting process. No further mitigation is required at this time.

11.9 Navigable Waters

11.9.1 Valued Environmental and Socio-economic Components

The environmental assessment for navigable waters (Section 8.11) assessed the Project's potential effects on this VEC. The potential combined effects of human actions on the considered VEC were identified through a scoping assessment and the significance of the Project was analyzed through a CEA.

11.9.2 Residual Effects of Project

The predicted potential impacts of the Project infrastructure on navigable waters were identified and assessed in Section 8.11. Project infrastructure could affect navigable waters during the Project's construction phases. Based upon the effects assessment analysis, residual adverse effects were determined to be negligible for navigable waters. However, even negligible Project effects were considered for the CEA because when combined with other human actions in the study area they may become significant.

11.9.3 Spatial Boundary

The study area for the CEA refers to the maximum spatial area over which the potential for cumulative effects is assessed. The purpose of the study area is to set a boundary for the identification of other human actions that could interact with Project effects. The regional study area (RSA) was previously identified in the effects assessment (Section 8.11.2). The RSA includes the Project area to the terminal end of the transmission line at Bell Mine substation, near Babine Lake. These boundaries include all watersheds bisected by any Project infrastructure and streams downstream of this infrastructure.

This cumulative effects RSA was selected because it includes areas where the residual effects may interact with other land use activities/actions, it sufficiently addresses cause-effect relationships between actions and the VEC, it encompasses watershed boundaries to address other actions in a particular watershed, and it encompasses part of the Lake Babine Nation traditional territory.

11.9.4 Temporal Boundary

The temporal boundaries were previously identified in Section 8.11.2. Temporal boundaries include the Project's proposed lifetime of 21 years (construction, operation, decommissioning, closure) and 10 years post-closure. The cumulative effects temporal boundary will begin with the Project baseline studies and will consider historical land use actions.

11.9.5 Human Actions Considered

Human actions/activities within the cumulative effects study area were identified by applying the following criteria:

- past (closed) industrial projects that have affected baseline conditions, and/or continue to exert an influence in the study area
- existing (active) projects
- land use activities
- energy and mineral exploration projects
- reasonably foreseeable future projects

A description of other past, present, and probable future human projects and activities within the overall CEA area boundary is provided in Section 11.1. Based upon the above criteria and human actions that lie within the navigable waters cumulative effects study area, one human activity was selected:

- ongoing forestry activities

Ongoing forestry operations in the area are considered to have an additive effect on navigable waters in the Project area. The Project is within the Morice TSA. In 2008, the AAC was increased to maximize value from dying and dead trees affected by the MPB infestation. It can be assumed that high volumes of dead or dying trees will continue to be logged until a time when

the infestation is over (projected at 2018) and/or until the merchantable dead pine trees are unavailable (projected at 2018 to 2024). The increase in forestry operations and resulting roads could have an additive effect on navigable waters in the Project area because of increased access.

11.9.6 Interactions with Other Developments and Activities

To produce a cumulative effect, the Project's residual effects must act in combination with the residual effects of one or more other human actions. Therefore, a key step in the assessment process is to establish these linkages. Navigability may interact with ongoing forestry operations.

11.9.7 Predicted Residual Cumulative Effects

There is limited human use of surface water as a navigation resource within the study area, excluding Morrison Lake and Babine Lake. There was one potentially navigable waterway (streams >3 m) that will be crossed by the proposed transmission line that may potentially affect public access to navigable water. Four potentially navigable waterways (streams >3 m) and six waterbodies within the Project infrastructure also may be navigable by the public.

Given the inaccessibility of most of the watershed east of Morrison Lake and Babine Lake, and the limited current or historical use of waterways in this area, most of the Project is not anticipated to cause adverse effects on navigable waters. Additional forestry activities will not affect this assessment. Although mine construction includes draining Booker Lake, which likely is navigable, residual effects on navigable waters are predicted to be negligible because of nominal boating access and lack of recreational use (see Section 8.11).

The predicted cumulative effects of past, present, and future activities on navigability are considered below:

- Direction: Negative. Potential adverse effect on navigability with increased roads and mine development.
- Scope: Regional. Cumulative effects extend throughout the CEA study area.
- Duration: Long term. Effects are significant for more than 10 years.
- Frequency: Sporadic. Effects occur rarely with irregular intervals.
- Magnitude: Low. Minimal impairment to navigability considering the small stream, pond, and lake sizes, and minimal access within the CEA study area.

11.9.8 Assessment of Significance

The significance of the predicted residual cumulative effect was evaluated to reflect the expected change in condition of the assessed VEC. In assessing the significance of the cumulative effect it is assumed that the identified mitigation measures will be implemented and effective. The significance of each residual cumulative effect was determined by examining possible changes in the condition of a VEC over time, beginning with its condition at the start of the Project (taking into account all past and existing projects within the study area) and ending with its condition

after closure (assuming mitigation is successful). Based on this assessment, the level of significance for cumulative effects on navigability is considered to be negligible.

11.9.9 Confidence Limits

There is a level of uncertainty when considering cumulative effects because the assessment process requires that predictions be made about whether future developments will take place and about the effects of those developments.

The confidence limits for the Projects cumulative effects on navigability are considered high.

11.9.10 Additional Mitigation

Mitigation and management plans will be refined during the EA process leading to the Project Certificate and permitting process. No further mitigation is required at this time.

11.10 Wetlands

11.10.1 Valued Environmental Components

Wetland extent and function are the two wetland VECs for the Project environmental effects assessment (Section 8.12). Wetland extent is defined as the size of individual wetlands, total wetland area, the distribution of wetlands, and the types of wetlands within the study area. Wetland function refers to the role that wetlands play with respect to hydrologic regimes, biogeochemistry, wildlife habitat, and overall ecological functioning. In general, watersheds have been proposed as an important basic unit for ecological management (Montgomery, Grant, and Sullivan 1995).

11.10.2 Residual Effects of the Project

The wetland effects assessment (Section 8.12) identified a number of mine components that have the potential to result in a residual effect on wetlands in the local assessment area. These include:

- wetland ecosystem loss, including a provincially blue-listed (at risk) wetland ecosystem, in the TSF, the pit area, and the waste dumps;
- wetland ecosystem degradation through changes in the quantity and quality of surface water and groundwater, as well as through the spread of invasive plant species;
- potential beneficial residual effect of new wetlands through pooling water in newly created depressions adjacent to roads and other facilities.

The creation of the TSF will cause 27 ha of a blue-listed bog community to be lost, which is predicted to have major significance for the wetland extent VEC. An additional 30 ha of other wetlands will be lost in the local assessment area. The residual effects on wetlands due to the degradation of wetland communities and the beneficial residual effect of wetland creation are predicted to be of negligible significance.

11.10.3 Spatial Boundary

The maximum area within which cumulative effects on wetlands are assessed is bound by the Babine River basin (10,477 km^2), a sub-watershed within the Skeena River watershed. The flow of water and connection among wetlands is generally constrained by watershed boundaries, thus it is within these boundaries where effects from multiple human activities and projects may interact to result in a cumulative effect on wetlands in the area.

11.10.4 Temporal Boundary

The assessed time period ranges from the time at which baseline studies occurred (prior to construction) to 10 years after the end of the operational life of the Project.

11.10.5 Human Actions Considered

Within the wetland CEA boundary, there are five additional human activities and projects that may interact with the Project effects on wetland extent and function:

- Bell Mine
- Granisle Mine
- forest harvesting (past, present, and future)
- existing roads and transmission line corridors
- rural and urban communities (Granisle, Tachet, Fort Babine, Old Fort)

11.10.6 Interactions with Other Developments and Activities

Roads may have been built over drained wetlands, and during the lifetime of the Bell and Granisle mines wetlands may also have been permanently lost. Project vehicles travelling to and from the site on existing logging roads will represent an increase in the use of existing (shared) portions of road. This may increase the likelihood of invasive plant species in the area.

Alterations to forest vegetation and soil from forestry and other development activities cause changes in the magnitude of stream flows, sedimentation, and groundwater recharge within a watershed because of the forest's role in intercepting rainfall and surface flow (Lin and Wei 2008). These changes in hydrology may affect water levels and plant composition within wetlands.

Transmission lines typically do not result in direct wetland loss because they are often built such that towers bridge a gap from one height-of-land to the next. Thus, effects on wetlands from transmission lines are often degradation associated with vegetation clearing and access road construction.

The Bell and Granisle mines may have negatively or positively affected wetland extent and function; however, insufficient information is available to build an accurate assessment. If wetlands were present in construction areas they would have been lost. Conversely, wetlands may also have developed in areas where soil was compacted and water subsequently pooled; wetland plants would naturally begin to occupy these areas, if growing conditions were suitable.

There also exist a number of rural/urban communities in the wetland CEA area. It is possible that specific features in these communities were developed over wetlands; that would result in a wetland loss. However, it is also possible that communities are taking responsibility for their surrounding wetlands and actively promoting or conserving them. The Granisle Circle Tour includes a series of wetlands where tourists are encouraged to stop and watch for birds (BCNorth.ca 2002).

Past and present roads, forestry activities, transmission lines, mining/exploration activities, and urban and rural communities may each result in wetland loss, degradation, or gain (Table 11.10-1).

Table 11.10-1
Summary of Links between the Project and Other Human Activities/Projects

	Expected residual effect from the Morrison Copper/Gold Project		
Existing or Closed Activities and Projects	**Wetland Loss**	**Wetland Degradation**	**Wetland Gain**
Roads	X	X	X
Forestry	X	X	
Transmission line		X	X
Bell Mine	X	X	
Granisle Mine	X	X	
Mineral exploration	X	X	X
Rural / urban communities	X	X	X

11.10.7 Predicted Residual Cumulative Effects

Three predicted residual cumulative effects were identified and are described below. Two of the residual cumulative effects are increased loss; however, they are related to different community designations. It is important to separate effects to provincially listed ecosystems (Appendix 31) from undesignated wetlands because listed ecosystems are often more susceptible to significant adverse effects (Table 11.10-2). The assessment categories and standard terms are defined in the assessment methodology.

Table 11.10-2
Residual Cumulative Effects Summary Table

Effect/VEC	Direction	Scope	Duration	Frequency	Magnitude
Increased wetland loss – provincially listed ecosystem	Negative	Regional	Long-term	Once	Medium
Increased wetland loss – undesignated ecosystems	Negative	Regional	Medium-term	Once	Low
Increased wetland degradation	Negative	Regional	variable	Continuous / sporadic	Low

11.10.7.1 Increased Wetland Loss (Listed and Undesignated)

Wetlands may be lost during the construction of roads and mining projects if they are in the path of the proposed infrastructure. Approximately 57 ha of wetlands are expected to be lost due to Project activities (Section 8.12), but other human activities in the area will likely cause a cumulative wetland loss greater than this amount. With time, small, seemingly inconsequential effects culminate via the "nibbling" effect (CEA Agency 1999a) into larger changes. Some of the loss will be temporary, as in areas that will be reclaimed in the long term. Given that wetland ecosystems are in general quite common within the ecosystem types found in the CEA boundary (Meidinger and Pojar 1991) the magnitude of the cumulative loss of wetlands is low. However, the residual cumulative effect is expected to be higher for the provincially blue-listed bog ecosystem because it is relatively rare/sensitive on a regional scale.

11.10.7.2 Increased Degradation

Wetland buffers of >5 ha are required during forest harvesting and around wetland complexes (BC MOF 1995; BC MOFR 2004). Thus, direct degradation to large wetlands as a result of forestry activities alone is negligible/minimal. However, changes in hydrology caused by forest harvesting may affect the structure and composition of wetlands.

The increase in road traffic on the roads leading to the Morrison property will result in increased degradation to roadside vegetation. Specifically, the amount of dust deposited onto roadside wetlands and the potential to introduce invasive plants to the area is expected to increase with higher traffic volumes.

11.10.8 Assessment of Significance

11.10.8.1 Wetland Loss

Loss of wetlands from the Project was assessed as a significant residual effect. In a regional sense, the distribution of specific types of ecosystem is not fully known; moreover, it is not known whether the same ecosystems (including the provincially blue-listed bog ecosystem) or other listed ecosystems have been lost within the wetlands CEA boundary from other human activities and projects. Regarding the blue-listed ecosystem, a threshold will likely be reached once more of these types of wetlands are lost (the exact number is unknown), at which point the wetland designation will be upgraded to the provincial red-list (extirpated, endangered, or threatened in BC). Recovery of red-listed ecosystems requires detailed planning and may or may not be achievable. The significance of wetland loss to both listed and undesignated wetlands is moderate.

11.10.8.2 Wetland Degradation

Other studies have provided inconsistent results regarding the magnitude and direction of change in hydrology caused by forest harvesting in large (>1,000 km^2) watersheds. Variations in land use, vegetation age, and spatial and temporal variations in rainfall also prevent consistent conclusions (Lin and Wei 2008). Furthermore, wetlands, ponds, and lakes help to buffer changes in surface flow through groundwater recharge. Some studies have shown that in small watersheds, a threshold of changes in hydrology occurs at values of 20 to 25% of forest cover

(Lin and Wei 2008). However, in larger watersheds this may be higher. Regardless, the total amount of land lost caused by forest harvesting, roads, urban/rural communities, and other mines in the CEA area is likely less than that. This assumes that forest harvesting within the Babine River Watershed is consistent with the amount cut within a 10-km buffer of the Project (4.4% of that area) and vegetation lost at other mines is similar in extent to that predicted to be lost because of the Project (2,110 ha). Thus, it is not likely that a threshold that will change the hydrology significantly and in turn affect wetlands will be surpassed. Further, it is likely that mitigation at each project will control invasive species to a manageable level. Overall, the significance of cumulative wetland degradation is minor.

11.10.9 Confidence Limits

Quantitative data regarding the distribution of wetlands and specifically, wetland ecosystem types, are not available on a regional scale. This lack of quantitative data limits the confidence of this CEA because of a lack of regional contextual information. However, this assessment has generally progressed by means of a general, more qualitative approach, of which the confidence is high. The overall confidence of the CEA for wetland ecosystems is moderate because of a lack of regional wetland data and quantification of CEA project/activity effects on wetlands.

11.10.10 Additional Mitigation

Given that the significance of residual cumulative effects to wetlands are predicted to be moderate for wetland loss and minor for wetland degradation no additional mitigation is necessary. Specific Project effects on the wetlands VECs will be mitigated through wetland creation in the TSF. Although this proposed mitigation does not specifically include replacing 27 ha of the blue-listed bog community, the mitigation will address the loss of wetland function and ensure that there will be a no-net-loss of wetland function as a result of the Project.

11.11 Terrain, Surficial Materials, and Overburden

11.11.1 Valued Environmental Component

Soils were selected as a VEC because they are a basic component of the terrestrial ecosystem. Soils mediate water flow and nutrient and carbon cycling within terrestrial ecosystems and they control, to some extent, the type of vegetation in a landscape. Therefore, wildlife habitat and forest resources depend, in part, on the proper functioning of soils in which they develop.

11.11.2 Residual Effects of the Project

Several Project components will have residual effects on the soils resources related to the loss of a functional soil surface and the development of less productive soils. The largest effect will be due to flooding in the TSF and the pit (where the soil surfaces will be replaced with waterbodies). These residual effects are of major significance as they are irreversible and cover a large area. Some of the disturbed areas will be reclaimed but the soils will remain less productive because the soil system has been severely disturbed. Others may occupy relatively small areas in relation to the Project area. The significance of the effects on the reclaimed and smaller areas, such as the plant site and borrow areas, were rated as minor or negligible (Table 11.11-1).

Table 11.11-1
Summary of Soil Residual Effects

Project Component	Residual Effect	Description	Area (ha)	Significance
Tailings storage facility (TSF) water area	Lost	flooded	455	Major
Pit high wall and lake	Lost	flooded and non soil	108	Major
TSF dam level and slopes	Degraded/altered	drier and steeper	69	Minor
TSF beach	Degraded/altered	non-forested	40	Minor
WRD slopes	Degraded/altered	drier and steeper	173	Minor
Plant site (water treatment plant)	Lost	covered with structure	<10	Negligible
Borrow areas	Degraded/altered	steep periphery	<70	Negligible
Linear facilities (Mine facilities area)	Lost/degraded/altered	covered with a structure	<120	Negligible
Transmission line right-of-way	Degraded/altered	partially occupied	23	Negligible
Mine site access road	Lost	covered with a structure	6	Negligible

11.11.3 Spatial Boundary

The CEA spatial boundary for the soils VEC is restricted to the Morice Land and Resource Management Plan (LRMP; Figure 11.1-1), Soils are an integral part of the identified resources (forestry and wildlife) within the LRMP. Regional management plans have been developed for these soil-based resources within the biogeoclimatic zones occurring in this LRMP.

11.11.4 Temporal Boundary

The temporal boundary will start at pre-construction and extend to 10 years following closure.

11.11.5 Human Actions Considered

As the residual effects on the soils are primarily related to the loss or reduction of the soil functioning capacity, the past, present, and future operating mines are particularly relevant to this CEA as they may result in a similar scale and type of disturbance. Projects and activities in the area that may combine with residual effects from the Project and lead to a cumulative effect include:

- Bell Mine
- Granisle Mine
- Dome Mountain Mine (past and future)
- Equity Mine
- forestry operations (past, present, and future)
- roads (present and future)

- urban and rural communities (Granisle and Tachet; present and future)

11.11.6 Interactions with Other Developments and Activities

The Bell, Granisle, Equity, and Huckleberry mines disturbed the soils. All of these mines have open pits, TSFs, and waste dumps. The pits represent a significant residual effect for each mine as these cannot be reclaimed. The Equity and Bell mines also had flooded TSF that resulted in the loss of a large area of functioning soils. The Bell, Granisle, and Equity mines are no longer operating and the disturbed areas have been revegetated, reducing the effects on the soils resource. The Huckleberry mine is still operating so that reclamation of waste dumps and other areas such as the plant site will be carried out when it closes.

The Dome Mountain mine operated in the early 1990s. It was an underground mine and the mine site has generally been reclaimed. The project may re-open, which will result in more disturbance to the soils with increased roads, waste dumps, a heap leach pad, and land lost to facilities. All of these facilities can be reclaimed, reducing the effects on the soils.

Forestry operations, past, present, and future may result in soils degradation by using heavy equipment that can cause soil compaction, which may reduce or eliminate the soils' potential to support vegetation. Such disturbance is concentrated in landing areas and along skid roads. These sites require amelioration to return to a functioning soil surface. Log bucking and hauling logs out of the forest to the landing sites may result in degradation to the soils but they may recover if the surface litter and ground cover is not severely degraded.

Roads providing access to communities, transmission lines, and forestry operations have a residual effect on soils as the road bed surfaces are no longer functioning soil surfaces. These can be ameliorated, but many of these roads are permanent. Access provided by roads frequently results in increased recreational activities, which may result in soils degradation due to more frequent trail use by a potentially wider group of users.

The Project may cause increased populations in local communities, such as Tachet. Expansion may cause a loss of functioning soil surfaces as more land is used for building residences, commercial operations, community facilities, and other infrastructure such as streets.

Possible interactions between the Project and other past, present, or future activities/projects are summarized in Table 11.11-2.

11.11.7 Predicted Residual Cumulative Effects

The predicted cumulative effects are based primarily on the loss of functioning soil surfaces of the Project. For example, functioning soils surfaces are lost because of mine facilities or potential mine facilities and their open pits, roads, and flooded TSFs. The Granisle mine did not have a flooded TSF, but the Bell and Equity mines did. If approximately 500 ha of lost soil surface is associated with the six mines and potential mines, this would represent approximately a loss of 3,000 ha of land that would not be available for wildlife habitat or for forestry operations. The CEA spatial boundary occupies 1,500,000 ha; therefore, the loss of 3,000 ha represents approximately 0.03% of the LRMP.

Table 11.11-2
Summary of Links between the Project and Other Human Activities/Projects

	Expected residual effect from the Project	
Existing or Closed Activities and Projects	**Soil Loss**	**Soil Degradation/Alteration**
Roads and transmission lines	X	X
Granisle and Tachet	X	X
Forestry operations	X	X
Bell, Granisle, Equity, and Huckleberry mines	X	X
Recreation		X
Future Activities and Projects		
Dome Mountain	X	X
Forestry operations	X	X
Tachet community expansion	X	X

Further, the soils occur predominantly in the Sub-boreal Spruce (SBS) biogeoclimatic zone, which composes approximately 880,000 ha of this LRMP. That is, there are 880,000 ha of soils that can support the vegetation types typical of the SBS biogeoclimatic zone in the Morice LRMP. Therefore, the cumulative residual effects on soils are predicted to be of low magnitude. The effects on soils are an *in situ* phenomenon and the amount of soil affected by the Project, though it may contribute to a "nibbling" loss with respect to the projects and activities considered locally, is not of a scale sufficient to reduce the functional capacity of soils in the CEA study area. The cumulative effects were rated in terms of the direction of the effect, scope, duration, frequency, and magnitude (Table 11.11-3).

Table 11.11-3
Residual Cumulative Effects Summary Table

Effect	Direction	Scope	Duration	Frequency	Magnitude
1 Soil degradation/alteration	Negative	Regional	Medium-term	Continuous	Low
2 Soil loss	Negative	Regional	Long-term	Once	Low

11.11.8 Assessment of Significance

With time, the reclaimed areas should return to a functioning soil surface. The significance is rated as negligible as there will be a slight decline in soil production for a short period and no threshold will be reached as little of the soils are degraded relative to the spatial extent of the LRMP. Loss of soils is also considered negligible as it represents a very small portion of the LRMP.

11.11.9 Confidence Limits

The confidence in the assessment of the significance of the cumulative effect is high. Successful reclamation of disturbed areas, using BMPs, is achievable. The effects on the soil loss may be substantial locally; however, the amount of functioning soils in the CEA study area will be high relative to the amount of land that will be lost in this area from various projects and activities.

11.12 Ecosystems and Vegetation

11.12.1 Valued Environmental and Socio-economic Components

Vegetated ecosystems (listed, sensitive, and undesignated) and plant species of local interest to communities (country foods) were identified as VECs for the Project.

11.12.2 Residual Effects of the Project

The Project is predicted to have significant residual effects from temporarily/permanently replacing vegetation and ecosystems with infrastructure, or from replacing a permanent shrub structural stage in the transmission line ROW (Table 11.12-1). In general, permanent losses have a higher significance than temporary losses and effects on provincially listed (i.e., rare) and sensitive ecosystems have a higher significance than effects on undesignated ecosystems and country food plant species. The degradation of natural vegetation by fugitive dust, invasive species, and windthrow is considered to have a low significance.

11.12.3 Spatial Boundary

Two different spatial boundaries exist for the ecosystems and vegetation CEA. Boundary A incorporates undesignated and sensitive vegetated ecosystems as well as country foods. This boundary parallels the regional study area used in the ecosystems and vegetation effects assessment (Section 8.15), covering 108,015 ha. This boundary was selected because the Project's residual effects on most ecosystems and vegetation will diminish to a negligible state beyond this point.

Table 11.12-1
Summary of Residual Effects from the Morrison Copper/Gold Project on Vegetation and Ecosystems

VEC	Effect	Significance
Undesignated ecosystems	Permanent Loss – replacement with infrastructure	Major
Undesignated ecosystems	Permanent Loss – replacement with shrubs in the ROW	Moderate
Undesignated ecosystems	Temporary Loss	Moderate
Listed and sensitive ecosystems	Permanent Loss – replacement with infrastructure	Major
Listed and sensitive ecosystems	Permanent Loss – replacement with shrubs in the ROW	Major
Listed and sensitive ecosystems	Temporary Loss	Major
Country food plant species	Temporary Loss	Negligible
All vegetation and ecosystems	Degradation	Low

Boundary B is for listed ecosystems. This boundary is larger than Boundary A because the abundance and distribution of rare environmental components over a broad area should be considered. Boundary B encompasses the communities of Fort Babine, Old Fort, Granisle, Tachet, Smithers, Telkwa, and Houston, and is bounded on the east by the Morice LRMP boundary (Figure 11.1-1).

The loss and degradation of vegetation and ecosystems when considered as wildlife habitat loss and degradation are assessed within a larger CEA spatial boundary in the wildlife CEA (Section 11.13).

11.12.4 Temporal Boundary

The assessed time period ranges from the point at which baseline studies occurred (prior to construction) to 10 years following the operational Project life. It will take many years beyond this before forests and other ecosystems are recovered to baseline conditions, but at that point, it should be known whether or not the ecosystems are on the right successional path.

11.12.5 Human Actions Considered

Within the ecosystems and vegetation CEA boundary, there are five past, present or future additional human activities and projects that may interact with the Project effects on ecosystems and vegetation:

- previous mining at the Bell Mine and Granisle Mine
- forest harvesting (past, present, and future)
- existing roads and transmission line corridors
- an increased human population in the area once construction begins on the Project
- urban/rural communities and agriculture

11.12.6 Interactions with Other Developments and Activities

Past mines, forestry, existing roads, transmission line corridors, recreation, and tourism will all result in either a loss or degradation of vegetation and ecosystems. The interactions and effects are described in the following paragraphs and summarized in Table 11.12-2.

11.12.6.1 Roads, Transmission Lines, and Increased Recreation

Project vehicles travelling to and from the site on existing roads will cause an increase in the use of the existing (shared) portion of road. Further, an influx of workers within the CEA boundary as proposed in the future scenario (Section 11.1) will also increase road (and off-road) traffic. Thus, there will be a spatial and temporal overlap of the effects from each activity's road use.

The Project's transmission line will meet up with the substation at the Bell Mine. Within the Project transmission ROW, forest is permanently reduced to shrubs. The proposed transmission line would constitute an *additive* effect on the vegetation structure in the study area when the existing transmission line ROW is accounted for.

Table 11.12-2
Summary of Links between the Project and Other Human Activities/Projects

Existing or Closed Activities/Projects	Expected residual effect from the Morrison Copper/Gold Project			
	Vegetation Loss permanent	Vegetation Loss temporary	Vegetation degradation	Country Food plant increase
Roads	X		X	X
Transmission line	X		X	X
Forestry		X	X	X
Bell Mine	X		X	
Granisle Mine	X		X	
Recreation and tourism			X	
Urban and rural communities	X		X	

11.12.6.2 Forestry

Forest harvesting is a temporary loss; forests will re-establish in the long term (i.e., >50 years). Undesignated (i.e., not rare or sensitive) mature mesic forests are the dominant land cover type in the area (Appendix 35). They are also the primary ecosystem type expected to experience loss during Project construction and operation (Section 8.15), and the type targeted by forestry activities. The loss of these undesignated ecosystems because of Project activities must be considered in addition to that already lost and potentially lost from forest harvesting. Because no new roads are planned beyond the mine facilities area (MFA) for the Project, and no logging will occur within the Morrison property (the property will be on mining lease, with restricted access), there is no likelihood of increased logging in the area (i.e., there is no spin-off interaction).

11.12.6.3 Urban/Rural Communities and Agriculture

There are close to 10,000 people living within the larger of the two vegetation CEA spatial boundaries. The population is spread over several small rural communities, and agriculture is one of the primary industries in areas like the Bulkley Valley. Urbanization, grazing and browsing, fire suppression, and invasive plants are all factors that cause the loss and degradation of forests and rare grassland communities in northwestern BC (Haeussler and Hetherington 1999). The loss and degradation of forest and other ecosystems from Project activities would be in addition to that already lost and degraded from other land use activities in the region.

11.12.7 Predicted Residual Cumulative Effects

This section evaluates the likely condition of each VEC, taking into account the combined effects of the human actions/projects identified above. Each effect is described with reference to direction, scope, duration, frequency, and magnitude, the definitions of which can be found in Section 11.1.

11.12.7.1 Increased Vegetation Loss (Permanent)

Project infrastructure will result in 810 ha (<1% of Boundary A) of vegetation permanently lost (Section 8.15). Vegetation loss because of the Project is local in extent but constitutes a cumulative effect when considered in the larger context of loss from other human activities in the area (Table 11.12-3).

Table 11.12-3
Residual Cumulative Effects Summary Table

Cumulative Effect/VEC	Direction	Scope	Duration	Frequency	Magnitude
Increased permanent vegetation loss – undesignated ecosystems	Negative	Regional	Long-term	Once	Low
Increased permanent vegetation loss – listed ecosystems	Negative	Regional	Long-term	Once	Moderate
Increased temporary vegetation loss	Negative	Regional	Medium-term	Once	Low
Increased vegetation degradation – undesignated ecosystems	Negative	Regional	Short-to-medium term	Continuous /sporadic	Low
Increased vegetation degradation – listed ecosystems	Negative	Regional	Short-to-medium term	Continuous /sporadic	Moderate
Increased Country Food plant species	Beneficial	Local	Short-term	Continuous	Low

The Bell and Granisle mines were roughly the same size as the Project, causing approximately 3,000 ha (<3% of Boundary A) loss in combination. Several tens or hundreds of kilometres of roads already existing within Boundary A also should be included in the total cumulative loss of vegetation. With time, small, seemingly inconsequential effects culminate via the "nibbling" effect (CEA Agency 1999b) into larger changes. This cumulative loss represents a long-term decline in the structure (spatial distribution of components) and function (interaction of components) of the ecological mosaic (Turner 1989). More details on the effects of fragmentation on plants and wildlife can be found in the vegetation and ecosystems effects assessment and the wildlife CEA (Sections 8.15 and 11.14). The cumulative loss in this case is small, and the overall function of undesignated ecosystems (e.g., non-CDC listed forests) is not impaired. Thus the magnitude of this cumulative effect is low.

A small amount (0.1 ha) of a red-listed (endangered/threatened) grassland ecosystem was predicted to occur (via the Predictive Ecosystem Map) in areas that will be cleared because of Project activities (Section 8.15). Because this would be a permanent loss, there can be no recovery to baseline conditions. There are at least 1,000 ha of this ecosystem within Boundary B, as indicated by recent data from within the Bulkley Valley (Haeussler and Hetherington 1999). Although the 0.1 ha potentially lost because of the Project is a very small proportion of

this amount, any loss of a red-listed ecosystems is serious because, by definition, that ecosystem is facing imminent extirpation or extinction. The overall distribution of such an ecosystem is threatened by any "nibbling" loss, thus the magnitude of this effect is rated moderate.

11.12.7.2 Increased Vegetation Loss (Temporary)

Forest harvesting incurs temporary forest loss. Just over 1% (392 ha) of forested areas in the regional study area are predicted to experience temporarily loss because of Project construction (Section 8.15). In comparison, 4,754 ha (4.4 %) of forests in the CEA boundary have already or will soon be harvested (for a total of 110 cutblocks, and thus a mean size of 43 ha each). The magnitude of the cumulative, temporary loss of undesignated ecosystems because of the Project is low.

Country food plant species are shrubs such as blueberry (*Vaccinium* spp.), highbush-cranberry (*Viburnum edule*), and black huckleberry (*Vaccinium membranaceum*). Although replacing vegetation with infrastructure represents a loss of these plants, many other actions (e.g., road building, transmission line extensions, trail building) provide more habitat for these plants because many of them thrive on disturbed sites with ample sunlight. Further, in many of these areas, such as along the transmission line ROW, a permanent shrub layer will be actively maintained. The extent of this potentially beneficial effect is likely small overall, but is considered a negligible residual cumulative effect.

11.12.7.3 Increased Vegetation Degradation

Increased traffic on roads leading to the Morrison property will result in increased degradation to roadside vegetation. Specifically, the amount of dust deposited onto vegetation and the potential to introduce invasive plants to the area is expected to increase with higher traffic volumes. Likewise, the potential increase in the use of all-terrain vehicles (ATVs) and snowmobiles in the area because of increased recreational use also increases the potential to introduce invasive plant species to the area, as propagules can easily become lodged in vehicle tires, tracks, and frames.

There are 807 ha of vegetation expected to experience degradation because of the Project, including 0.7 ha of the red-listed grassland ecosystem (Section 8.15). Because the Bell and Granisle mines were roughly the same size as the Project, the cumulative degradation due to mining activity within the area would be less than 3,000 ha. Further, assuming degradation of 30 m around each cutblock (this was the width of degradation assumed around roads and the transmission line ROW in the vegetation effects assessment), there is likely only a negligible amount of additional degradation in the area because of forestry activities (based on cutblocks with a mean area of 43 ha). In total, this amount of degradation is a small percentage of the total area under consideration. Degraded ecosystems are expected to recover to baseline conditions following mitigation (Section 13.9). The magnitude of the cumulative vegetation degradation is low, with the exception of the degradation to the red-listed ecosystem. This ecosystem may take longer to recover, and because of its rarity, the effect is of greater magnitude than for undesignated ecosystems.

11.12.8 Assessment of Significance

All residual cumulative effects are assessed to have a negligible significance, except for the permanent loss of undesignated and listed ecosystems which are moderately significant (Table 11.12-4). Although there will be a greater loss of undesignated ecosystems than of listed ecosystems, by definition, red-listed ecosystems are closer than undesignated ecosystems to reaching a threshold beyond which extinction or extirpation may be possible. The Project may not push this VEC past a critical threshold, but it will result in moving the VEC closer to the threshold, and it is not likely to recover without major, regional mitigation (e.g., legal protection, regulations requiring compensation). Definitions of significance can be found in Section 11.1.

Table 11.12-4
Significance of Residual Cumulative Effects

Cumulative Effect/VEC	Significance	Confidence
Increased permanent vegetation loss – undesignated ecosystems	Moderate	High
Increased permanent vegetation loss – listed ecosystems	Moderate	Low
Increased temporary vegetation loss – undesignated ecosystems	Negligible to Low	High
Increased vegetation degradation – undesignated ecosystems	Negligible	High
Increased vegetation degradation – listed ecosystems	Negligible	Low
Increased Country Food plant species	Negligible	High

11.12.9 Confidence Limits

Most of the cumulative effects assessed here have a high probability of occurring, with the exception the loss and degradation of rare ecosystems due to incomplete quantitative knowledge of the distribution of rare ecosystems within the Project footprint, and within the larger region. The confidence regarding listed ecosystems is low, as the presence of the grassland community/communities in that area is uncertain. It was mapped with only one of the mapping methodologies (predictive ecosystem mapping (PEM), not terrestrial ecosystem mapping (TEM)), and no field work was conducted that identified it in that area. Each residual cumulative effect is assigned a confidence level of Table 11.2-3; definitions of confidence can be found in Section 11.1.

11.12.10 Additional Mitigation

Mitigation strategies for vegetation and ecosystems are outlined in the ecosystems and vegetation effects assessment and management plan (Sections 8.15 and 13.9). Although it is mentioned in these plans that it may be possible to establish the listed ecosystems elsewhere, it should be emphasized that avoidance is the preferred method of mitigation. Re-creating a listed ecosystem in another location may not be possible because of the specialized environmental conditions within which it is normally found. Field surveys should be undertaken before construction to assess the true extent of the listed ecosystems. This information may then be used to guide the placement of access routes and transmission towers such that rare ecosystems are avoided as much as possible.

11.13 Wildlife and Wildlife Habitat

11.13.1 Valued Environmental Components

The environmental assessment for wildlife and wildlife habitat (Section 8.16) assessed the potential effects of the Project on the following VECs:

- grizzly bear (*Ursus arctos horribilis*)
- moose (*Alces alces*)
- mule deer (*Odocoileus hemionus*)
- American marten (*Martes americana*)
- fisher (*Martes pennanti*)
- Western toad (*Anaxyrus boreas*, formerly *Bufo boreas*)
- waterfowl
- forest birds
- raptors

The potential combined effects of human actions on the VECs under consideration were identified in a scoping assessment, and the significance of the Project on each VEC was assessed through an analysis of effects.

11.13.2 Residual Effects of Project

The predicted potential effects of mine components on each VEC were identified and assessed in the effects assessment (Section 8.16). Project components include the mine site, access road, and transmission line corridor. These components could affect wildlife during the different phases of the Project if not properly mitigated. Project components that may affect an identified VEC are discussed in relation to habitat loss or alteration, physical hazards and attractants (including mortality and disruption of movements), chemical hazards, and sensory disturbance.

Based upon the effects assessment analysis, residual adverse environmental effects of minor, moderate, or major significance were identified for each VEC (Table 11.13-1). However, even negligible Project effects were considered in the CEA because residual effects may interact with one another to make the combined effects greater than the sum of their parts. The overall effect of the Project on each VEC resulting from the combination of all of these effects was also considered (Table 11.13-2).

11.13.3 Spatial Boundary

The local and regional study areas were identified in the effects assessment (Section 8.16.2.1). The local study area (LSA) involves an area encompassing a 2-km buffer around the Project footprint. This area contains the open pit mine site, stock pile, TSF, the transport lanes between them, and the haul road to Nose Bay, as well as the transmission line corridor from the Bell mine site on Babine Lake to the mine area. The RSA is a larger area involving a 10-km buffer around the footprint.

Table 11.13-1
Wildlife and Wildlife Habitat Residual Adverse Effects for the Morrison Copper/Gold Project

VEC	Description	Description of Residual Effect	Significance of Residual Effect
Grizzly bear	Physical hazards - mortality	Mortality from collisions with Project vehicles and from human-bear interactions; increased year round accessibility (transmission line access plus winter road access) and human activity resulting in unregulated hunting of bears.	Minor
	Sensory disturbance	Disturbance to behaviour and distribution of grizzly bears in the regional study area as a result of combined anthropogenic disturbances (i.e., noise, visual, and odour).	Minor
Moose	Habitat loss or alteration	Loss or alteration of suitable winter habitat in the local study area (32%) and regional study area (5.8%).	Moderate
	Physical hazards - mortality	Mortality from collisions with Project vehicles because of attraction to roads caused by ease of movement or road salt (if used); increased year round accessibility (transmission line access plus winter road access) and human activity resulting in increased hunting of moose.	Minor
	Sensory disturbance	Individual moose will likely avoid the immediate Project area because of noise and human presence but continue to occupy the regional study area.	Minor
Mule deer	Physical hazards - mortality	Mortality from collisions with Project vehicles because of attraction to roads caused by ease of movement or road salt (if used); increased year round accessibility (transmission line access plus winter road access) and human activity resulting in increased hunting of mule deer.	Minor
American marten	Habitat loss or alteration	Suitable winter habitat lost or heavily degraded because of the Project includes 10.6% of the local study area and 1.8% of the regional study area.	Minor
	Physical hazards - disruption of movement	Developing mine roads, infrastructure, and the transmission line, along with increased traffic and human activity may create a barrier to marten movement.	Minor
Fisher	Habitat loss or alteration	The amount of suitable fisher habitat that will be temporarily or permanently lost or degraded as a result of Project development represents 1.8% (classified as lost or heavily degraded) of the total amount of suitable habitat available in the regional study area.	Minor
	Physical hazards – disruption of movement	Fisher may be reluctant to cross gaps/fragments in forest cover (mine site, transmission line corridor, and/or roads), limiting east-west movement.	Minor
Western toad	Habitat loss or alteration	Loss of identified breeding pond in the mine site.	Minor
Waterfowl	Habitat loss or alteration	Loss or degradation of waterfowl habitat within the local or regional study area.	Minor
	Sensory disturbance	Noise associated with the mine (machinery, infrastructure, traffic, blasting) may disturb waterfowl, potentially causing habitat avoidance, increased stress during breeding periods possibly decreasing reproductive success. However, some acclimation to noise anticipated.	Minor

Table 11.13-2
Summary of Overall Significance of Project Effects on each VEC

VEC	Overall Rating	VEC	Overall Rating
Grizzly Bear	Minor	Western toad	Minor
Moose	Moderate	Waterfowl	Minor
Mule Deer	Negligible	Forest birds	Negligible
American marten	Negligible	Raptors	Negligible
Fisher	Minor		

The CEA study area refers to the maximum spatial area over which the potential for cumulative effects is assessed. The study area's purpose is to set a boundary for identifying other human actions that could interact with Project effects. The wildlife CEA study area is selected based on the movement patterns and range size of wildlife VECs. Grizzly bears, the farthest ranging VEC, can use 70 to 995 km^2 (Demarchi and Johnson 2000). As a precautionary approach, the maximum range of grizzly bear was selected to define the wildlife CEA study area. This ensures the inclusion of all wildlife VECs and allows assessment of a worst-case scenario in which a VEC interacts with the maximum amount of additional human activity. The spatial boundary was calculated as the square root of 995. The CEA study area extends outside the RSA, is 32 km wide, and encompasses existing and proposed human activities in this area.

11.13.4 Temporal Boundary

The temporal boundary for the CEA will begin with the Project baseline studies and will involve all projects and activities that coincide with the Project's proposed lifetime of 21 years (construction, operation, decommissioning, closure), and 10 years beyond closure.

11.13.5 Human Actions Considered

A description of past, present, and probable future human projects and activities in the region surrounding the Project is provided in Section 11.1 (Introduction and Methodology). Human actions and activities that fall within the wildlife CEA spatial boundary and may combine with residual effects from the Project to lead to a cumulative effect are:

- forest harvesting (past, present, and future)
- previous mining at the Bell and Granisle mines
- mine exploration (Peak, SilverVista, and Fireweed exploration)
- existing roads and transmission line corridors
- hunting and trapping

Timber harvesting is ongoing in the Morice TSA. In response to the MPB infestation, the AAC was increased 25% in 2008 to maximize value from dying and dead trees affected by the infestation. Increased forestry operations in the wildlife study area will result in additional habitat alteration and may have an additive effect on a VEC. Timber harvesting generally causes

immediate habitat loss by replacing forest stands with clear-cut areas and removing security, thermal cover, and forage for wildlife. The response of wildlife populations to timber harvesting will vary according to wildlife species, type of forest stand that is cleared, pattern of harvesting, and the availability of other suitable habitat within the study area.

Previous mining and mineral exploration took place throughout the wildlife CEA study area; mineral exploration is ongoing. Historically, the Granisle and Bell mines (about 22 km from the Project) were responsible for large-scale, industrial land use within the study area. Granisle Mine operated on Copper Island from 1966 to 1982, and the Bell Mine operated on Newman Peninsula from 1970 to 1992. Both mines are currently in reclamation, which includes an extensive water quality monitoring and revegetation program. Mineral exploration data within the area are limited.

There are numerous existing forestry and mining roads within the area. A well-developed forest service road (FSR) system supports logging activities in the area. The current use level of these FSRs is low because of ongoing reforestation efforts, but it has been higher in the past. Canfor anticipates that forestry activities in and around the Project area will increase as early as two years (2011) from now (2009). This would result in a renewed influx of logging truck traffic along these FSRs, up to an estimated 10 logging trucks per day (Section 7.18 Land and Resource Use), which would have an additive effect on wildlife VECs.

The traffic levels on Highway 118 are currently low and amount to approximately 100 or more cars per day. The British Columbia Ministry of Transportation is seeking to repave Highway 118 in the near future, subject to funding and other pressures for access across the province. Increased timber harvest in reaction to the MPB epidemic is expected to cause a substantial traffic increase on Highway 118 in the next four to five years. A traffic flow rate of one truck every three minutes is predicted (Appendix 42, Land Use Baseline Report).

A variety of wildlife species are currently hunted or trapped in the Project area, including moose, mule deer, black bear, mountain goat, grizzly bear, waterfowl, and grouse. However, most local hunting activities focus on moose. There are two guide outfitting territories (Tukii Lodge and Double Eagle Guide and Outfitters) and two trapline territories that overlap with the wildlife study area. Harvest rates by recreational hunters, including both guided and resident hunters, are regulated by a permitting and licensing system that is administered by the Province of British Columbia. Members of the Lake Babine Nation do not require permits to hunt in the Morrison area, but do so under a system of clan territories. Hunting and trapping is allowed within one's clan's territory or in another clan's territory with permission from the respective clan's hereditary chief.

Provincially collected big game harvest data confirm that moose is the most commonly harvested species in the Wildlife Management Unit (WMU) 6-08, which overlaps with the wildlife study area. Levels of moose harvest have increased from 1976 to 2005, with an average of 39 moose killed annually by non-resident hunters. The highest number of kills occurred in 2000 (84 kills) and 2004 (86 kills). Black bear is the second most commonly harvested species in WMU 6-08, with an average of 21 kills a year (Appendix 42, Land Use Baseline Report).

11.13.6 Interactions with Other Developments and Activities

To produce a cumulative effect, the Project's residual effects must act in combination with the residual effects of one or more other human actions. To identify possible interactions between the Project and other past, present, or future projects, a list of potential residual effects categories from the Project was identified. The effect categories are: habitat loss or alteration, mortality, chemical hazards, and sensory disturbance. Table 11.13-3 presents a summary of links between the Project and other human activities.

Table 11.13-3
Summary of Links between the Project and Other Human Activities/Projects

Existing or Closed Activities and Projects	Expected residual effect from the Morrison Copper/Gold Project			
	Habitat Loss or Alteration	Mortality	Chemical Hazards	Sensory Disturbance
Forestry	X	X		X
Bell Mine	X		X	
Granisle Mine	X		X	
Mineral Exploration	X		X	X
Roads	X	X	X	X
Transmission Line	X	X		
Babine First Nation Hunting		X		
Outfitter and Resident Hunting		X		

X = action/activity under consideration.

Habitat loss or alteration refers to the removal or physical alteration of environmental aspects that are used either directly or indirectly by wildlife. The value of habitat can be reduced through indirect means such as habitat avoidance resulting from human presence and noise. Indirect effects on wildlife and wildlife habitat can also result from dust created by vehicle traffic, habitat fragmentation, edge effects, and invasive species establishment. Road dust can be lethal to amphibians in aquatic habitats close to the road and can also alter vegetation along the roadside, affecting wildlife habitat. Linear developments such as roads, transmission lines, and fences can dissect continuous habitat, resulting in smaller fragmented habitat patches. Habitat fragmentation reduces the total available habitat because some animals will not use isolated patches of habitat. The loss of intermediate habitat patches ("stepping stones") may also contribute to population fragmentation (Trombulak and Frissell 2000), as the movement and dispersal of some species may be prevented because of roads, human activity, or a lack of habitat. Smaller, isolated populations are more vulnerable to genetic changes caused by factors such as inbreeding (Gibeau and Heuer 1996). All identified human activities/projects, except hunting, can have a cumulative effect on the amount of wildlife habitat directly lost, degraded, or fragmented, which subsequently affects the distribution, movement, abundance, and health of wildlife populations within the wildlife study area.

Physical hazards and attractants associated with human activities may cause direct or indirect wildlife mortality. Direct wildlife mortality typically results from vehicle interactions and hunting. The development and cumulative use of forestry, mine, and highway roads within the wildlife study area increases the risk of interactions between wildlife and vehicles. Wildlife mortality from Lake Babine Nation and outfitter hunting within the area could also be affected by increased human presence and upgraded and increased access to undeveloped areas. Indirect mortality may occur when wildlife are attracted to project activities or areas that contain odours or wastes. All identified activities or projects (excluding closed mines) can have a cumulative effect on increased wildlife mortality (direct and indirect).

Chemical hazards may cause wildlife mortality if the animal is exposed to high quantities or concentrations of chemicals, including metals. Lower concentrations of toxic chemicals are more likely to lead to sublethal effects such as decreased health, productivity, or fitness levels. Metal concentrations in the environment can be elevated from ML/ARD at exposed mine sites, stockpiles, and access roads, and through unscheduled tailings discharge, or tailings dam rupture. Other environmental toxins include spilled hydrocarbons and residues from explosives. The closed mines, roads, and mineral exploration activities within the study area can have a cumulative effect on the level of metal concentrations in the surrounding environment, and their associated sublethal effect on wildlife.

Sensory disturbance refers to any disturbance (noise, visual, olfactory, or vibrations) that could negatively affect an animal, most commonly through a behavioural, endocrine (e.g., acute or chronic stress reaction), or energetic response. The responses of wildlife to sensory disturbance vary by species, distance to disturbance, and timing with sensitive periods (e.g., breeding). Some species become acclimated, some react to each disturbance but remain in the area, and others avoid areas of frequent disturbance. When animals react to disturbances, they may lose time and energy that is normally devoted to key behaviours such as feeding, breeding, or watching for predators; they may also avoid important habitats near disturbance sources (Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997), reduced reproductive success, and/or mortality of offspring and parent. Areas of human activity and human presence can have a cumulative effect on increased sensory disturbance in the wildlife study area.

11.13.7 Predicted Residual Cumulative Effects

The predicted cumulative effects of past, present, and future activities on each wildlife VEC are presented in Table 11.13-4. As outlined in Table 11.13-1, potential Project residual effects vary for each VEC. Therefore, the CEA concentrates on those effects most concerning to each individual VEC.

A regional scoping scale was selected for all wildlife VECs and associated effects because each VEC population and habitat extends throughout the CEA area. The cumulative effects of habitat loss or alteration, mortality, and/or sensory disturbance from identified projects within the CEA area are the main concerns for wildlife VECs. These effects were assessed over a long-term duration because the identified activities and projects throughout the CEA area (i.e., the source of these effects) will occur and continue for >10 years. Different effects will occur with sporadic

and continuous frequency. Wildlife mortality (from vehicle traffic or hunting) may occur rarely throughout the CEA study area, whereas sensory disturbance will continuously occur on a regular basis near project sources. Direct habitat loss or alteration could be considered both sporadic and continuous because the process of habitat loss will occur sporadically throughout the study area, but once habitat is lost, the resulting effect on wildlife is continuous until the habitat regenerates to a pre-disturbance condition.

Table 11.13-4
Predicted Wildlife and Wildlife Habitat Residual Cumulative Effects Summary, Morrison Copper/Gold Project

VEC	Effect	Direction	Scope	Duration	Frequency	Magnitude
Grizzly Bear	Habitat loss or alteration, mortality, and sensory disturbance	Negative	Regional	Long-term	Sporadic/ Continuous	Low
Moose	Habitat loss or alteration, mortality, and sensory disturbance	Negative	Regional	Long-term	Sporadic/ Continuous	Moderate
Mule Deer	Habitat loss or alteration, mortality, and sensory disturbance	Negative	Regional	Long-term	Sporadic/ Continuous	Low
American Marten	Habitat loss or alteration, mortality	Negative	Regional	Long-term	Sporadic	Low
Fisher	Habitat loss or alteration, mortality	Negative	Regional	Long-term	Sporadic	Moderate
Western Toad	Habitat loss or alteration, mortality	Negative	Regional	Long-term	Sporadic	Moderate
Waterfowl	Habitat loss or alteration, sensory disturbance	Negative	Regional	Long-term	Sporadic/ Continuous	Low
Forest Birds	Habitat loss or alteration, mortality	Negative	Regional	Long-term	Sporadic	Low
Raptors	Habitat loss or alteration, sensory disturbance	Negative	Regional	Long-term	Sporadic	Low

Overall, the magnitude of these cumulative effects is anticipated to be low for most VECs because effects could result in minimal impairment of their reproductive capacity, survival, or habitat suitability. The magnitude of the cumulative effects on moose, fisher, and western toad are considered moderate because when considering all potential Project impacts on these VECs and/or their current population status, there may be a measurable change from baseline conditions in these populations' habitat suitability or reproductive success (more details in Section 11.13.8 Assessment of Significance).

11.13.8 Assessment of Significance

The significance of each residual cumulative effect was determined by examining possible changes in the condition of a VEC over time, beginning with its condition at the start of the

Project (taking into account all past and present projects within the CEA area), and ending with its condition post-closure (assuming mitigation was successful). The level of significance of each cumulative effect is presented in Table 11.13-5.

Table 11.13-5
Assessment of Significance for Wildlife and Wildlife Habitat Residual Cumulative Effects, Morrison Copper/Gold Project

VEC	Direction	Level of Significance	Confidence
Grizzly Bear	Negative	Negligible	Low
Moose	Negative	Low	Low
Mule Deer	Negative	Negligible	Low
American Marten	Negative	Negligible	Low
Fisher	Negative	Low	Low
Western Toad	Negative	Negligible	Low
Waterfowl	Negative	Negligible	Low
Forest Birds	Negative	Negligible	Low
Raptors	Negative	Negligible	Low

Grizzly Bear

Grizzly bears are blue-listed in BC (BC CDC 2008) and considered of special concern in Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; 2002). The grizzly bear population within the Babine Grizzly Bear Population Unit (the management unit that overlaps with the CEA study area) is considered viable (Hamilton, Heard, and Austin 2004), with a population estimate of 286 individuals in 2008 (BC MOE 2008).

Within the CEA study area, the resultant changes in habitat from timber harvesting and other human activities are likely to influence the number and distribution of grizzly bears in the study area, especially given the current and likely future rate of harvesting in response to MPB infestation. The magnitude of this change is difficult to predict but is expected to be low, especially because regenerating harvested stands provide high quality foraging habitat for grizzly bear. The contribution of the Project to any such decline is anticipated to be small in comparison with the combined effects of other human actions. In addition, although there may be fluctuations in numbers and distribution of grizzly bears, the ongoing viability of the grizzly bear population is not expected to be threatened over the time considered in this assessment. Therefore, the cumulative effects of human actions in the CEA study area on grizzly bear are predicted to be of negligible significance.

Moose

Moose occur commonly throughout the forested areas of BC. The provincial population estimate for moose in 2000 was approximately 170,000 animals, over 70% of which lived in northern BC (Blood 2000), including approximately 3,000 animals within the Morice LRMP (BC MAL and

BC ILMB 2007). Moose populations in BC are generally rated as apparently secure and not susceptible to extirpation or extinction under present conditions (BC CDC 2008).

In the CEA study area, the cumulative effects on the moose population will depend on the level of timber harvesting in response to the MPB infestation, the location and pattern of harvesting, illegal hunting pressure, and whether enough suitable forage and cover habitat is maintained within moose range, particularly in critical winter range and calving habitats. Timber harvesting may temporarily benefit moose when willows and other shrubs become abundant in cutblocks, but removing too much forest cover can be detrimental. Moose need nearby cover for shelter from hot and cold weather, and to hide from predators and hunters.

Overall, considering the cumulative effects of identified projects and activities, the availability of moose habitat in the CEA study area will decrease. However, the degree to which the population demographics will be affected is difficult to predict. There may be fluctuations in moose population number and distribution among years, but the ongoing viability of the moose population is not expected to be threatened over the time considered in this assessment. With mitigation, the Project's contribution to any such decline is expected to be small in comparison with the combined effects of other human actions. Considering all current and future projects in the CEA study area, the significance of cumulative effects on moose is predicted to be low, mainly caused by increased forestry and associated roads, hunting access, and habitat degradation.

Mule Deer

In BC mule deer are yellow listed, which means that the species' welfare is not of immediate conservation concern (BC CDC 2008). Mule deer are widely distributed at low densities in the Morice LRMP area during summer, but are confined to lower elevation habitats in winter (BC MAL and BC ILMB 2007). Although the LRMP area periodically experiences snow depths that significantly impede movement and foraging opportunities for deer, low elevation habitats associated with the sub-boreal spruce dry cool (SBSdk) biogeoclimatic variant provide important mule deer winter range during winters of atypically deep snow (BC MAL and BC ILMB 2007).

Similar to moose, the cumulative effects of identified projects and activities on the mule deer population will depend on the level of timber harvesting in response to the MPB infestation, the location and pattern of harvesting, and whether areas of low elevation critical winter habitat are maintained. There may be fluctuations in mule deer population number and distribution among years; however, the ongoing viability of the mule deer population within the CEA study area is not expected to be threatened over the time considered in this assessment. With mitigation, the Project's contribution to any such decline is expected to be small in comparison with the combined effects of other human actions. Considering all current and future projects in the CEA study area and the stable status of the mule deer population in the CEA area, the significance of cumulative effects on mule deer is predicted to be negligible.

American Marten and Fisher

American marten populations in BC are generally rated as apparently secure and not susceptible to extirpation or extinction under present conditions (BC CDC 2008). This species is actively trapped throughout the province and considered an important economic furbearer in the Project

region. Fisher populations in BC are currently a conservation concern and are on the provincial blue list, meaning they are vulnerable to human activities or natural events. The size and trend of the fisher population in BC and in the Morice LRMP area is unknown (BC MAL and BC ILMB 2007), but according to Weir (2003), the population of fishers in the province may be less than 2,000 adults.

Both marten and fisher prefer mature forest stands and generally avoid areas of early stage vegetation because of a lack of overhead cover (Powell, Buskirk, and Zielinski 2003). Thus, the cumulative effects of timber harvesting, roads and human presence, and trapping on these species could result in a nibbling loss of available and suitable habitat, as well as breeding individuals. Because the American marten population is considered stable, and the Project's contribution to any such decline is expected to be small in comparison with the combined effect of other human actions, the ongoing viability of the marten population within the CEA study area is not expected to be threatened over the time considered in this assessment. Thus, the significance of cumulative effects on American marten is predicted to be negligible.

Forest harvesting has been identified as the greatest single effect on habitat quality for fishers throughout BC (Weir 2003). Considering the amount of past, current, and future forestry within the CEA area, the local fisher population may already be reaching a threshold level at which the condition of the population is unstable. Because there will be a limited amount of clearing of preferred fisher habitat for the Project, the Project's contribution to any further decline of the fisher population is likely small in comparison to the combined effects of forestry. However, considering the fisher population status, the amount of disturbance existing in the CEA study area, and limited research and uncertainty of the current viability of the local population, the significance of the cumulative effects on fisher is predicted to be low.

Western Toad

Western toad is considered secure in BC but is listed as a species of special concern under Canada's *Species at Risk Act* (2002b). Western toad population declines have been documented in southern BC and the southern Rocky Mountain states (Pyare 2005). The extent of the current western toad distribution in BC is unknown, but the central and northern parts of the province likely represent a stronghold for the species (Davis 2002).

Although toad populations may be centralized to a local area, particularly during their first year, toads migrate and are capable of moving over 5 km to breeding sites (Davis 2002). Therefore toads may cross roads and areas of forestry activity, as well as areas of Project activity. The cumulative effects of habitat loss or alteration through timber harvesting and identified project activities, and road-related mortality are difficult to predict because current toad populations and viability within the area are unknown. However, with mitigation the contribution of the Project to any such decline is expected to be small in comparison with the combined effects of other human actions. Thus, the significance of cumulative effects on western toad is predicted to be negligible.

Waterfowl, Forest Birds and Raptors

Migratory waterfowl, forest birds, and raptors undertake extensive migrations, which can extend from the northern Arctic to southern Africa. In moving among breeding, moulting, and

wintering areas, each bird population uses a network of sites or flyways to transit between these areas. Potential cumulative effects may also occur elsewhere on flyways. As a result, there are potential interactions between the Project and other developments on migratory flyways, but firm conclusions to the magnitude or significance are not possible because of the lack of information on such a large group of species at such a vast geographic scale.

Considering all current and future projects in the CEA study area, some degradation of habitat for individual birds may occur, but the habitat loss is not expected to affect the population-level carrying capacity of the overall landscape for waterfowl, forest birds, or raptors, especially if clearing is done outside of the breeding season. However, the cumulative effect of habitat loss caused by forestry and other development will result in a nibbling loss of available and suitable habitat. The ongoing viability of the waterfowl, forest bird, and raptor populations are not expected to be threatened over the time considered in this assessment. Therefore, the cumulative effects of human actions in the CEA study area on these VECs are predicted to be of negligible significance.

11.13.9 Confidence Limits

There is a level of uncertainty when considering cumulative effects because the assessment process requires predictions regarding whether future developments will take place and the effects of those developments. The probability that the combined effects of human actions will adversely affect some individuals is high. The significance of the residual effects on wildlife VEC populations in the CEA depends on a number of factors, including the numbers, sex, and age-class of individuals affected, and the influence of these variables on the demographics of the local populations. These factors are unknown and difficult to predict without quantitative data and suitable population models. Given the number of unknowns, the confidence limit of the assessment is considered low (Table 11.13-5).

11.13.10 Additional Mitigation

Management and monitoring plans for wildlife are outlined in Section 13.10 and Section 14.9. These mitigation strategies are offered as recommendations and will be refined during the permitting process through the Wildlife Working Group. No further mitigation is required at this time.

11.14 Archaeology and Heritage Resources

11.14.1 Valued Environmental and Socio-Economic Components

The archaeology and heritage resources VECs are archaeological sites that are protected by the *Heritage Conservation Act* (HCA).

Based on available information, there are approximately 90 archaeological sites in the CEA study area recorded in the Archaeology Sites Register, and likely hundreds of additional unrecorded archaeological sites exist as well. One archaeological site protected by the HCA (GhSn-7) will be affected by the Project, as currently proposed.

11.14.2 Residual Effects of Project

With the recommended mitigation measures, the adverse residual effects to GhSn-7 are anticipated to be negligible. Please note that the assessment of the Project's residual effects to archaeology and heritage resources is based on the assumptions, as outlined in Section 8.17, that the boundaries and layout of the mine components for the Project will not be substantively changed from the areas assessed. If Project changes are made, then these assumptions may become incorrect. Potentially, this could result in a change to the assessment of residual effects for archaeology and heritage resources.

11.14.3 Spatial Boundary

The spatial boundaries for the archaeology and heritage resources CEA include the proposed development areas and are illustrated in Figure 7.17-1 with an additional 5 km buffer. This study area was selected to encompass land on both sides of Babine and Morrison lakes, including both shoreline and upland areas.

11.14.4 Temporal Boundary

The temporal boundary for the archaeology and heritage resources CEA includes the lifespan of the Project, from pre-construction to 10 years following closure.

11.14.5 Human Actions Considered

The primary contributing human actions to cumulative effects on archaeological sites in the CEA study area are forestry activities and mineral exploration/mine operations. Additionally, roads built to service these industries provide vehicle access to the area, increasing the overall human presence (e.g., recreational, fishing, or trapping users) in the CEA study area. However, because of the CEA study area's remoteness, increased human presence will not likely be a significant effect.

Logging and associated forestry activities have occurred within the CEA study area since the 1970s (Drushka 1998). The Project is within the Forest Management area of Canadian Forest Products Ltd. and selected timber harvesting areas have been logged.

Two former copper/gold projects are within the CEA study area. The Bell Copper Mine operated from 1972 to 1992 and is 22 km south of the Project. The Granisle Copper Mine operated from 1966 to 1982 and is 29 km south of the Project. Additionally, since 1962 both Noranda Exploration and PBM have explored the Morrison mineral deposit.

11.14.6 Interactions with Other Developments and Activities

Human actions that are known to, or are likely to, have adverse effects to archaeological and heritage resources include the Bell and Granisle Copper mines, infrastructure developments such as road and power line construction, and forestry activity within the CEA study area. No archaeological investigations were undertaken for the footprints of the Bell and Granisle mines before their construction. Both developments encompass large areas and include areas of high archaeological potential. As such, there is a strong possibility that sites were destroyed or negatively affected without having been recorded by an archaeologist.

Approximately 25% to 50% of the CEA study area has been logged, and a number of these cutblocks underwent archaeological assessments, especially since the 1990s. Some of the approximately 90 sites recorded in the CEA study area were identified during cutblock assessments and were subject to management recommendations designed to mitigate impacts. However, cutblocks that were logged before the 1990s are less likely to have been assessed by an archaeologist and any impact to archaeological sites that may have occurred is not known.

11.14.7 Predicted Residual Cumulative Effects

Other than the Project, no large scale industrial developments are currently planned for the CEA study area; however, as any future development would likely be subject to archaeological assessment, any adverse effects to unrecorded archaeological sites would be managed at that time.

Management recommendations provided for the Project (Section 13.11) were designed to reduce adverse residual effects to a negligible level, plan for unanticipated new development areas or expansion to the existing footprint, and address the unlikely event that unrecorded archaeological sites could be uncovered during construction or mine operation. Full implementation of these recommendations will reduce cumulative effects on archaeological sites to a negligible level.

11.14.8 Assessment of Significance

Project-related adverse residual effects to archaeological sites have been assessed as negligible, and therefore any contribution to cumulative effects within the CEA study area is assessed to have negligible significance.

11.14.9 Confidence Limits

Based on the available information, a high level of confidence can be placed in the results of the CEA. As there are no anticipated adverse residual effects stemming from the Project, as currently proposed and assessed, there is a low likelihood that unidentified Project-related cumulative effects will occur to archaeological sites within the CEA study area.

11.14.10 Additional Mitigation

The recommendations for the Project (see Section 13.11) include mitigation (systematic data recovery) at site GhSn-7 that would result in recovery of information from the site before its disturbance. This recommended mitigation measure will result in negligible adverse residual effects to site GhSn-7, and therefore the Project will have a negligible contribution to cumulative effects on archaeological resources. It is unlikely that further unrecorded archaeological sites remain within the portions of the Project footprint assessed during the Archaeological Impact Assessment.

Provided the assumptions described in Section 8.17 remain correct the adverse residual effects will remain negligible.

11.15 Land and Resource Use

Federal and provincial regulations do not require a cumulative land and resource use effects assessment for the Project. However, the CEA is encouraged by the BC EAO under policy as a valuable exercise for best practice purposes, especially given the interests and concerns raised in

the consultation record (Chapter 2). The purpose of this section is to identify and assesses the potential cumulative effects of the Project and other proposed developments and human activity.

11.15.1 Valued Environmental Components

The land and resource use VECs identified through the consultation process are the socially, culturally, and economically significant issues, conditions, and considerations that support or facilitate land uses. These VECs may be affected by other project development and human activities. The VECs that will be considered as part of this CEA are:

- access
- quality of experience
- quantity of resources
- cultural value of Land
- management objectives

11.15.2 Residual Effects of the Project

Table 11.15-1 provides an overview of the residual effects discussed in Section 8.18. The effects per VEC vary depending on the land user group. Table 11.15-1 captures the direction and range of significance for each effect category. All residual effects of minor, moderate, or major significance are considered. Negligible effects are also included because they may combine with multiple other human developments and have a greater significance on a cumulative scale.

Table 11.15-1
Summary of Land Use Residual Effects

VEC	Effect	Nature	Significance
Access	Access maintenance	Beneficial	Minor
	Limitations to access	Adverse	Minor
	Prohibited access	Adverse	Minor to Major
	Increased road hazards	Adverse	Minor
Quality of Experience	Increased noise levels	Adverse	Minor to Moderate
	Increase dust and pollutants	Adverse	Minor
	Diminished drinking water quality	Adverse	Minor to Major
	Increased third party presence	Adverse	Minor to Moderate
Quantity of Resources	Decreased moose resources for hunting	Adverse	Minor to Moderate
	Increased moose resources for hunting	Beneficial	Minor to Moderate
	Permanent loss of vegetative resources	Adverse	Minor
	Temporary loss of vegetative country foods	Adverse	Negligible
	Increased availability of vegetative country foods	Beneficial	Minor
	Degraded quality of vegetative country foods	Adverse	Moderate
	Maintenance of fish resources	Beneficial	Negligible
	Decreased harvest of strategic timber blocks	Adverse	Moderate to Major

(continued)

Table 11.15-1
Summary of Land Use Residual Effects (completed)

VEC	Effect	Nature	Significance
Cultural Value of Land	Increased capacity to practice traditional activities	Beneficial	Minor
	Decreased opportunity to practice traditional activities	Adverse	Moderate
	Decreased transfer of TEK	Adverse	Minor
	Loss of knowledge of traditional land uses	Adverse	Minor
	Loss or degradation of culturally sensitive areas	Adverse	Moderate[1]
	Increased intra-clan disagreement	Adverse	Minor
	Decreased connection to the land	Adverse	Minor
Management Objectives	Conflicts with management objectives	Adverse	Minor
	Supports management objectives	Beneficial	Minor

[1] Tentative rating requiring additional information and confirmation from Lake Babine Nation.

11.15.3 Spatial Boundary

The CEA spatial boundary for land use encompasses projects and human activities in northwestern BC. More specifically, the land use CEA geographic extent is contained within part of the Morice LRMP boundaries with the southern most reaches including Houston. The spatial boundary of the CEA also includes Davidson and Dome Mountain projects, which lie outside the LRMP area.

11.15.4 Temporal Boundary

The temporal boundary starts at pre-construction and extends to 10 years after closure.

11.15.5 Human Actions Considered

Development and human activities have implications for land use considerations and conditions, causing changes in land use patterns, access, quality, and resource availability. The CEA considers activities on a regional scale that are predicted to occur eight years into the post-closure phase. The CEA focuses on projects and activities that may combine with residual effects from the Project and result in cumulative land use effects. The CEA considers the following activities: forestry, Davidson Mine, Dome Mountain Mine, roads, recreation and tourism, fishing, hunting, and trapping, as well as urban and rural communities. Table 11.1-4 (Section 11.1) provides a summary of the predicted scenarios related to each of these developments and activities.

11.15.6 Interactions with Other Developments and Activities

Land and resource use cumulative effects pertain to the Project's residual effects interacting with the residual effects of other existing or future developments and activities, because past and current developments were incorporated into the assessment of the residual effects in Section 8.18. Activities currently predicted to have a bearing on the future human environment landscape include: forestry; the Davidson Mine; the Dome Mine; roads; recreation and tourism; fishing, hunting, and trapping; and urban and rural communities. The effects of these activities are discussed by VEC.

Table 11.15-2 summarizes which of the identified residual effects predicted for the Project have potential interactions with these activities.

11.15.7 Predicted Residual Cumulative Effects

This section evaluates the Project's land use effects in conjunction with other proposed human activities and projects on each VEC. Table 11.15-3 summarizes the direction, scope, duration, frequency, and magnitude of the residual land use cumulative effects identified and discussed in this section.

11.15.7.1 Access

Increased mining and forestry activities may drive a need for additional access or increasing frequency of use on existing access. Access in areas with a long history of forestry and mineral development, if well planned and maintained and supported by multi-stakeholder access management plans, can lead to beneficial uses and effects contributing to regional and local economies while maintaining the remoteness and quality of environment people seek. Additional access to previously inaccessible or difficult to access areas may increase land user interest in and around the predicted projects. As such, this will elevate renewable and non-renewable activities and increases the potential for overcrowding, resource depletion, aesthetic deterioration, and health concerns. While some land users welcome additional access to pursue their favourite recreational, subsistence, or economic activity, others wish to maintain the status quo of a particular area (especially if it is previously undisturbed). For example there is high value placed on pristine wilderness experience by some land users. In the areas where projects are operational (e.g., a mine site), this may attract additional economic activities and at the same time become less easily used, or used differently by other land users. Increased land users using newly developed access (due to forestry and mining developments) may create greater road hazards with a mix of industrial and recreational traffic. The cumulative effect of the Project and other proposed resource development is thus determined to be mixed and moderate. The direction and scale of the cumulative effect is largely dependent on the land user group and their resilience to change. The scope of this effect is regional, its duration long term, and frequency is continuous.

11.15.7.2 Quality of Experience

The quality of the land use experience is related to noise, visual, water, and air quality. The quality issues related to the Project, in its immediate vicinity, are already moderate to major, depending on the land user group. Additional industrial development on a regional scale may further diminish quality and enjoyment of some land use activities. Increased noise levels from added traffic or industrial activities, interrupted viewscapes, diminished drinking water quality, and poor air quality may detract from land use endeavours and satisfaction, and diminish interest in engaging and pursuing them. Also, land uses with an economic interest (e.g., guide outfitters and anglers) may lose business and/or profits from a generally depreciated environmental and aesthetic quality. Lastly, quality of land use experience related to the sense of remoteness may be adversely affected by increased third party presence. With a variety of projects and human activities projected to increase over time in the CEA study area, issues of overcrowding and overlap may arise and locally increase. As such, the potential cumulative effect on quality is moderate adverse. The scope of this effect is regional, its duration long term, and frequency is continuous.

Table 11.15-2
Morrison Copper/Gold Project: Summary of Links between the Project and Human Activities

VEC/Effect	Forestry	Davidson Mine	Dome Mountain Mine	Roads	Recreation and tourism	Fishing, hunting, and trapping	Urban and rural communities
Access							
Improved access	X	X	X	X	X		
Limitations to access		X	X				
Prohibited access		X	X				
Increased road hazards	X	X	X		X		
Quality of Experience							
Increased noise levels	X	X	X	X			
Increase dust and pollutants	X	X	X	X			
Diminished drinking water quality	X	X	X	X			
Increased third party presence	X	X	X	X	X	X	X
Quantity of Resources							
Decreased moose resources for hunting	X	X	X	X		X	
Increased moose resources for hunting							
Permanent loss of vegetative resources	X	X	X	X			
Temporary loss of vegetative country foods	X	X	X	X			
Increased availability of vegetative country foods	X	X	X	X			
Degraded quality of vegetative country foods	X	X	X	X			
Maintenance of fish resources	X	X	X	X		X	
Decreased harvest of strategic timber blocks	X	X	X	X	X		
Cultural Value of Land							
Increased capacity to practice traditional activities	X	X	X				
Decreased opportunity to practice traditional activities	X	X	X				
Decreased transfer of TEK	X	X	X				
Loss of knowledge of traditional land uses	X	X	X				
Loss or degradation of culturally sensitive areas	X	X	X	X			
Increased intra-clan disagreement							
Decreased connection to the land	X	X	X				
Management Objectives							
Conflicts with management objectives	X	X	X	X	X	X	X
Supports management objectives							

Table 11.15-3
Residual Land Use Cumulative Effects Summary Table

VEC	Direction	Scope	Duration	Frequency	Magnitude
1. Access	Mixed	Regional	Long-term	Continuous	Moderate
2. Quality of Experience	Negative	Regional	Long-term	Continuous	Moderate
3. Quantity of Resources	Negative	Regional	Long-term	Continuous	Minor
4. Cultural Value of Land	Negative	Regional	Long-term	Continuous	Moderate
5. Management Objectives	Mixed	Regional	Long-term	Continuous	Minor

11.15.7.3 Quantity of Resources

The CEA study area is resource rich with ample wildlife, fish, timber, minerals, and vegetation. This drives its recreational, subsistence, cultural, and economic value. The cumulative effect on wildlife, fish, timber, and vegetation inform the level of land user interest and degree of effort to harvest or gain the resource. If these species are affected at a low level, then land user interest and effort would be maintained. However, if these resources decline, there may be fewer land users pursuing them and/or higher levels of effort and expenditure to capture them. The cumulative effects for the most desirable renewable resources (i.e., moose, sockeye salmon, huckleberries, and timber) are generally low. As such, the resulting indirect cumulative effect on land user interest in pursing these resources will most likely remain unaffected by the proposed developments and increased human activity. The scope of this effect is regional, its duration long term, and frequency is continuous.

11.15.7.4 Cultural Value

The cultural value of land is particularly sensitive to cumulative effects of multiple developments and human activity. Aboriginal perspective of land is generally holistic and balanced, based on principles of sustainability. The interconnectedness of humans, resources, and the environment is rich and intricate. While there is space and appreciation among First Nations for wage economy and resource extraction (especially metals and timber), this kind of activity and resulting economic benefits requires careful planning and consideration to ensure that it does not outweigh negative effects to the environment and subsistence activities. Too much development is considered to diminish the Aboriginal cultural value of land, including opportunity and capacity to engage in traditional activities, transfer of traditional ecological knowledge (TEK), and connection to the land. As such, the cumulative effects of the Project and other projects may have a moderate adverse effect on Aboriginal value of land. The scope of this effect is regional, its duration long term, and frequency is continuous.

11.15.7.5 Management Objectives

The Morice LRMP objectives are intended to achieve multiple outcomes at a strategic level. The assessment of the cumulative effects of the Project and further human development and their interaction with the LRMP objectives is qualitative. The LRMP both encourages economic and resource development (including logging, mining, and tourism), and also contains objectives related to maintaining and supporting environmental integrity and recreational and subsistence

values. As such, the cumulative effect of added human activity, including additional projects, may either support or create more challenges in achieving the objectives outlined in the Morice LRMP. This may have a mixed minor effect. The direction of the effect depends on the objective. The scope of this effect is regional, its duration long term, and frequency is continuous.

11.15.8 Assessment of Significance and Confidence

The confidence levels in this land use CEA are low because of numerous factors that are difficult to determine with certainty, including the intensity and duration of activities of other projects, as well as the state of the future economy and specific industries. Furthermore, proposed Project details and design are not known and, as such, specific effects are not possible to predict. Lastly, levels of human activity and their location are difficult to determine. Table 11.15-4 provides a summary of significance, nature, and confidence levels for each VEC.

Table 11.15-4
Significance of Land Use Residual Cumulative Effects

VEC	Nature	Significance	Confidence Levels
Access	Mixed	Moderate	Low
Quality of Experience	Negative	Moderate	Low
Quantity of Resources	Negative	Minor	Low
Cultural Value	Negative	Moderate	Low
Management Objectives	Mixed	Minor	Low

11.16 Socio-economic Environment

Assessing the Project's potential cumulative socio-economic and cultural effects is not a regulatory requirement under BC or federal legislation. This section exists in the interest of best practice for the Project's EA Application and reflects concerns and issues raised during First Nations and public consultation. This section endeavours to identify and assess potential cumulative effects on the social, economic, and cultural elements of the human environment resulting collectively from the Project and other human activities and projects.

As defined in Section 11.1, cumulative effects include past, present, and future human actions, but this assessment will exclusively address predicted future actions. The socio-economic residual effects assessment considered other past and present human influences, and thus a second estimation is redundant (see Section 8.19 and Appendix 45). Scheduled future human activities were factored into the Project's residual effects analysis, but were not explicitly examined alongside Project effects.

11.16.1 Valued Socio-economic Components (VSECs)

VSECs represent the key social, cultural, and economic elements of the human environment in local communities. These communities may experience cumulative effects comprising the Project's residual effects and those from other future projects and activities. VSECs include:

- Employment and income
- Education, skills, and training
- Business opportunities and economic development
- Cultural identity and sustainability
- Community well-being
- Population and demographics
- Services and infrastructure
- Land-based livelihoods

11.16.2 Residual Effects of the Project

The residual effects identified in Section 8.19 are summarized in Table 11.16-1. While these effects are anticipated to vary by community and phase, the table encapsulates the overarching predicted range of effect significance. All residual effects of minor, moderate, or major significance are considered. Negligible effects are also included because they may combine with multiple other human developments and have a greater significance on a cumulative scale.

Table 11.16-1
Summary of Socio-economic Residual Effects

VSEC	Effect	Nature	Significance
Employment and income	Increased employment	Beneficial	Moderate to Major
	Decreased employment (at closure)	Adverse	Minor to Moderate
	Increased income	Beneficial	Moderate to Major
	Decreased income (at closure)	Adverse	Minor to Moderate
	Variable access to employment and income	Adverse	Negligible to Minor
Education, skills, and training	Increased skills base	Beneficial	Minor to Major
	Decreased skills base (at closure)	Adverse	Negligible
	Increased demand for training and skill development resources	Beneficial	Minor to Moderate
	Decreased demand for training and skill development resources (at closure)	Adverse	Negligible
	Decreased incentive to continue/complete education	Adverse	Negligible
	Improved essential work and life skills	Beneficial	Moderate
Business opportunities and economic development	Increased business opportunities	Beneficial	Minor to Moderate
	Decreased business opportunities (at closure)	Adverse	Minor to Moderate
	Increased economic development	Beneficial	Major
	Decreased economic development (at closure)	Adverse	Moderate
	Increased economic dependency on mining sector	Adverse	Negligible to Minor
	Increased specialization of mining industry	Beneficial	Minor

(continued)

Table 11.16-1
Summary of Socio-economic Residual Effects (completed)

VSEC	Effect	Nature	Significance
Population and demographics	Increased population	Beneficial/ Mixed	Minor to Moderate
	Decreased population (at closure)	Adverse/ Mixed	Minor to Moderate
	Change in community demographics	Mixed	Minor to Moderate
Services and infrastructure	Increased demand on community infrastructure, programs, and services	Mixed	Minor
	Decreased demand on community infrastructure, programs, and services (at closure)	Mixed	Negligible
	Increased tax base and provision of community infrastructure and services	Beneficial	Minor
	Decreased tax base and provision of community infrastructure and services (at closure)	Adverse	Minor
	Increased property value and housing demand	Mixed	Minor to Moderate
	Decreased property value and housing demand (at closure)	Mixed	Minor
Cultural identity and sustainability	Decreased knowledge/participation in Carrier/Lake Babine cultural and/or traditional land use activities and customs	Adverse	Negligible to Minor
	Increased knowledge/participation in Carrier/Lake Babine cultural and/or traditional land use activities and customs	Beneficial	Moderate
	Increased intercultural exchange	Mixed	Minor to Moderate
	Decreased intercultural exchange (at closure)	Mixed	Negligible
Community Well-being	Increased individual self-esteem/community pride and engagement	Beneficial	Moderate to Major
	Decreased individual self-esteem/community pride and engagement (at closure)	Adverse	Minor
	Increased financial independence and access to goods and services	Beneficial	Minor to Moderate
	Increased participation in socially/health-damaging activities	Adverse	Negligible to Minor
	Increased family stress and dysfunction	Adverse	Minor
	Decreased quality of natural environment, recreation, road traffic, and safety	Adverse	Minor
	Decreased purchasing power and increased cost of living	Adverse	Negligible
Land-based livelihoods	Decrease in business profits, personal incomes, and quality of life	Adverse	Minor

11.16.3 Spatial Boundary

This CEA's spatial boundary incorporates northwestern BC and the primary and secondary socio-economic study communities within it. The primary study communities include the Lake Babine Nation communities of Fort Babine, Old Fort, Tachet, Donald's Landing, and Woyenne, as well as the non-Aboriginal communities of Granisle, Topley, Topley Landing, and Smithers Landing. Secondary study communities include Burns Lake, Houston, Telkwa, Smithers, and Stewart.

11.16.4 Temporal Boundary

The temporal boundary will start at pre-construction and extend to 10 years following closure.

11.16.5 Human Actions Considered

By their very nature, human activities have implications for communities' human environments, driving changes in resident's employment, in-/out-migration, quality of life, etc. Of interest for the CEA are those activities that are expected to occur in the future within the region, and particularly those projects and activities that may combine with residual effects from the Project and lead to cumulative social, economic, and/or cultural effects. Identified activities include:

- Forestry: Harvesting will continue to increase until the end of the pine beetle epidemic then will likely decrease until new trees are available to cut, at which time levels will stabilize. Local employment and business opportunities are expected to fluctuate with forest harvest levels.
- Davidson Mine: The Davidson Mine will open; it is assumed that it will be operational until the end of its projected 30-year life span. This project expects to directly employ approximately 200 people during construction and 125 during operations.
- Dome Mountain Mine: It is assumed that Dome Mountain Mine will eventually be operational.
- Roads: Local traffic volumes are likely to increase because of increased numbers of workers and visitors to the area. Increased traffic volumes may positively affect business and employment opportunities for roadside services.
- Recreation and tourism: Tourism numbers may increase in the Smithers area with the planned expansion of the Hudson Bay Mountain Resort. Activities related to increased tourism may in turn increase employment and business opportunities, etc.
- Fishing, hunting, and trapping: The contribution of First Nations to fishing, hunting, and trapping will probably stay constant, but the contribution of others may increase because of an increased workforce in the area.
- Urban and rural communities: The population currently working at Huckleberry mine may relocate to live closer to the Davidson and Morrison Copper/Gold projects, both of which will require a daily commute (i.e., instead of site-based camps).

11.16.6 Interactions with Other Developments and Activities

Social, economic, and cultural cumulative effects pertain to the Project's interactions with future developments and activities, because past and current developments were incorporated into the assessment of the residual effects in Section 8.19. Activities currently predicted to have a bearing on the future human environment landscape include: forestry; the Davidson Mine; the Dome Mine; roads; recreation and tourism; fishing, hunting, and trapping; and urban and rural communities. Human activity may vary by community, with the majority of effects occurring closer to the secondary study communities than the primary study communities. The effects of these activities are discussed by VSEC.

11.16.6.1 Employment and Income

Future forestry, mining, and tourism industry developments may create employment and income opportunities. While opportunities in the forestry industry are expected to be transient and fluctuate substantially over time, those created in the mining sector will be robust for a finite period of time. Increases in employment and income are also expected to arise in response to increased traffic on roads, given the greater need for roadside services. Additionally, mining-related in-migration to rural and urban communities in the region will fuel greater demand for household goods and services, and thus generate local employment and income opportunities.

Mining may cause the most significant increases in employment and income relative to other activities. The Davidson and Dome Mountain mines may create opportunities primarily in Smithers and the surrounding secondary communities; primary communities may be marginally affected, if at all. Subsequent to employment and income increases in the mining industry, reciprocal decreases are expected once operations are complete at the Davidson and Dome Mountain mines.

While the creation of employment and income is widely perceived as positive, opportunities created in forestry and the identified mining projects may provide limited scope for vulnerable groups. Work environments in these industries are often regarded as male-dominant and culturally indifferent. Therefore, these activities may inadvertently reduce the potential for equal access to employment and income opportunities for some contingents of the population (e.g., women and First Nations).

11.16.6.2 Education, Skills, and Training

The Davidson and Dome Mountain mines are the only activities identified with the potential to significantly influence education, skills, and training in the secondary communities. To a small extent in-migration in response to the Huckleberry Mine's impending closure may also contribute to a change in education, skills, and training levels. Mining developments are predicted to have a largely positive effect in this regard through in-migrating skilled workers, who are expected to be drawn to high-paying work in the mining industry. Furthermore, new projects are anticipated to provide incentive for those with a limited education to gain new skills to increase their prospects for employment. As such, demand for education resources will also increase. Once employment has been obtained, on-the-job experience is expected to further the essential work and life skills of employees in areas such as time management and accountability.

The Davidson and Dome Mountain mines may also cause adverse effects. Without the right policies in place (i.e., minimum requirement of grade 12 education), young persons may opt to pursue available work in the mining sector in preference to completing their studies. Additional adverse effects are possible at closure, including a depletion of the skills base as skilled workers move elsewhere. The incentive to complete educational courses and training will also fall, along with demand for educational resources.

11.16.6.3 Business Opportunities and Economic Development

As with employment and income, almost all identified potential future human activities are likely to increase business opportunities and economic development in the region. The majority of

business activity and economic development may be concentrated in Smithers and the other secondary communities. The Davidson and Dome Mountain mines are expected to enhance the region's reputation for mining specialization, yet may also exacerbate its economic dependency on the industry and increase its vulnerability to market downturns. Once each of these mines close, ensuing business opportunities and economic development declines are expected.

11.16.6.4 Population and Demographics

The majority of these activities will bring a greater number of people into the area. While roads and tourism may bring temporary visitors to the region, job-related migration, particularly for mining, may result in significant changes in the size and demographic composition of the local population. This population growth may concentrate in Smithers and other secondary communities with very little change in the primary communities. Population declines may result following mine closures, particularly if openings at other regional projects are limited.

11.16.6.5 Services and Infrastructure

All the identified human activities with the exception of fishing, hunting, and trapping, are expected to exert pressure on the region's services and infrastructure. Concomitantly, these activities will augment the government's tax revenue as employees pay tax on goods, services, income, and property, which will add to the government's tax base and its ability to provide community resources. In-migrating employees wishing to work at the Davidson and Dome Mountain mines may lead to escalating housing demand and prices. Once these mines are decommissioned, pressure on services and infrastructure may be alleviated if the population moves away. In such a case, the region's tax base would also decrease along with the value and demand for housing.

11.16.6.6 Cultural Identity and Sustainability

Major industry developments in forestry and mining, which are likely to employ First Nations in work environments that are predominantly of non-Aboriginal influence, could contribute to a decline in the use of the native Carrier language and participation in cultural and traditional land use activities and customs. Conversely, employment in these industries may have the reverse effect, beneficially providing income to purchase goods and services that facilitate participation in cultural and land use activities (e.g., a snow mobile).

All activities that bring new people to the region increase opportunities for cultural exchange. The closure of the Davidson and Dome Mountain mines may potentially lead to decreased cultural exchange if a population exodus eventuates.

11.16.6.7 Community Well-being

Wherever employment opportunities emerge, unemployment rates may fall and prosperity may grow, enhancing individual self-esteem and community pride. Hence this effect is potentially relevant to all of the identified future human activities, and is most prominent for large mining and forestry projects that employ significant numbers of local residents. Employees may experience greater access to goods and services, particularly those from the mining industry

receiving high wages and salaries, typical of the industry. Local businesses may increase the range of goods and services they offer in response to in-migration and high-income earners.

There are also adverse effects associated with human developments including environmental degradation, particularly as it relates to mining. As many employees of the Davidson and Dome Mountain mines will obtain relatively high levels of disposable income relative to other community members, there is a risk that they will engage in socially/health-damaging activities typically implicated with alcohol and drug use, in addition to increased family stress and dysfunction due to long shifts and periods of separation. Mining projects in particular create abrupt increases in demand for housing that can spearhead inflation and increase the cost of living. When the Davidson and Dome Mountain projects close, the ensuing large-scale employment losses are expected to result in diminished levels of individual self-esteem and community pride.

11.16.6.8 Land-based Livelihoods

The majority of the identified human activities likely to eventuate will have an adverse effect on residents dependent on land-based livelihoods. These effects will be confined within an area directly surrounding the human activity and in many cases will have limited potential for overlap, given most of these activities will be spread across the region. Any increase in tourism, fishing, hunting, and trapping may broadly benefit those with land-based livelihoods, given most of these activities also depend on the continued natural state of the environment. Forestry, mining, road and urban developments are expected to have relatively more disruptive effects on those with land-based livelihoods.

Table 11.16-2 summarizes which of the identified residual effects predicted for the Project have the potential to interact with these activities.

11.16.7 Predicted Residual Cumulative Effects

This section analyzes the socio-economic effects of the Project in conjunction with other proposed human activities and projects on each VSEC. While the various activities will likely have multiple contrasting residual effects on the VSECs felt differently in each community, they are analyzed collectively as having one broad net-cumulative effect per VSEC. For example, though some effects will counteract each other, such as an increase and decrease in employment, this assessment captures the overall cumulative change that can be expected.

This assessment considers the Project influences in combination with the identified other human activities across all the primary and secondary communities. Unless stated otherwise, the description of the residual cumulative effect represents of the maximum degree to which the effect could potentially be felt in any of the study communities, although namely in the secondary communities given this is where the most potential for cumulative effects exists. The Project's effects in the secondary communities are expected to be less substantial than those generated by the Davidson and Dome Mountain mines, and hence the majority of the cumulative effects stem from other human activities.

Table 11.16-2
Morrison Copper/Gold Project: Summary of Links between the Project and Other Human Activities/ Projects

VSEC/Effect	Forestry	Davidson Mine	Dome Mountain Mine	Roads	Recreation and tourism	Fishing, hunting, and trapping	Urban and rural communities
Employment and Income							
Increased employment	X	X	X	X	X		X
Decreased employment (at closure)		X	X				
Increased income	X	X	X	X	X		X
Decreased income (at closure)		X	X				
Reduced potential for equal access to employment and income	X	X	X				
Education, Skills, and Training							
Increased skills base		X	X				X
Decreased skills base (at closure)		X	X				
Increased demand for training and skill development resources		X	X				
Decreased demand for training and skill development resources (at closure)		X	X				
Decreased incentive to continue/complete education		X	X				
Improved essential work and life skills		X	X				
Business Opportunities and Economic Development							
Increased business opportunities	X	X	X	X	X		X
Decreased business opportunities (at closure)	X	X	X				
Increased economic development	X	X	X	X	X		X
Decreased economic development (at closure)	X	X	X				
Increased economic dependency on mining sector		X	X				
Increased specialization of mining industry		X	X				
Population and Demographics							
Increased population	X	X	X	X	X		X
Decreased population (at closure)		X	X				
Change in community demographics	X	X	X	X	X		X

(continued)

Table 11.16-2
Morrison Copper/Gold Project: Summary of Links between the Project and Other Human Activities/ Projects (completed)

VSEC/Effect	Forestry	Davidson Mine	Dome Mountain Mine	Roads	Recreation and tourism	Fishing, hunting, and trapping	Urban and rural communities
Services and Infrastructure							
Increased demand on community infrastructure, programs, and services	X	X	X	X	X		X
Decreased demand on community infrastructure, programs, and services (at closure)		X	X				
Increased tax base and provision of community infrastructure and services	X	X	X	X	X		X
Decreased tax base and provision of community infrastructure and services (at closure)		X	X				
Increased property value and housing demand		X	X				X
Decreased property value and housing demand (at closure)		X	X				
Cultural Identity and Sustainability							
Decreased knowledge/participation in Carrier/Lake Babine cultural and/or traditional land use activities and customs	X	X	X				
Increased knowledge/participation in Carrier/Lake Babine cultural and/or traditional land use activities and customs	X	X	X				
Increased intercultural exchange	X	X	X	X	X	X	X
Decreased intercultural exchange (at closure)		X	X				
Community Well-being							
Increased individual self-esteem/community pride and engagement	X	X	X	X	X		X
Decreased individual self-esteem/community pride and engagement (at closure)		X	X				
Increased financial independence and access to goods and services	X	X	X	X	X		X
Increased participation in socially/health-damaging activities		X	X				
Increased family stress and dysfunction		X	X				
Decreased quality of natural environment, recreation, road traffic, and safety	X	X	X	X	X	X	X
Decreased purchasing power and increased cost of living		X	X				
Land-based Livelihoods							
Decrease in business profits, personal incomes, and quality of life	X	X	X	X			X

The residual cumulative effects are summarized by VSEC in Table 11.16-3. Each VSEC has been ascribed a direction, scope, duration, frequency, and magnitude. For those VSECS where it is not possible to predict whether or not the effect is likely to be positive or negative overall (i.e., if the direction of the effect will vary according to personal or professional opinion), an additional "mixed" descriptor was added to those defined in Section 11.1. Residual cumulative effects may in fact be less significant in some communities than indicated in the table, given the assessment takes a conservative approach citing the maximum possible effect expected.

Table 11.16-3
Residual Socio-economic Cumulative Effects Summary Table

VSEC	Direction	Scope	Duration	Frequency	Magnitude
1. Employment and income	Positive	Regional	Medium-term	Continuous	High
2. Education, skills, and training	Positive	Regional	Long-term	Continuous	Moderate
3. Business opportunities and economic development	Positive	Regional	Medium-term	Continuous	Moderate
4. Population and demographics	Positive/ Mixed	Regional	Medium-term	Continuous	Moderate
5. Services and infrastructure	Positive/ Mixed	Regional	Medium-term	Continuous	Moderate
6. Cultural identity and sustainability	Negative/ Mixed	Regional	Medium-term	Continuous	Moderate
7. Community Well-being	Mixed	Regional	Medium-term	Continuous	Moderate
8. Land-based livelihoods	Negative	Sub-regional	Long-term	Continuous	Low

Cumulative residual effects may include increases in: employment and income; education, skills, and training; and business opportunities and economic development. The changes in these VSECs, which are expected to concentrate in Smithers and the other secondary communities, are considered largely positive with scope to affect the region with continuous frequency. The duration of the cumulative effects in these areas was predicted to be medium term. Education, skills, and training are the exception, because humans have the capacity to retain taught knowledge for long periods. Employment and income, which have significant bearing on the majority of other VSECs, may undergo a high magnitude change while changes in education, skills, and training and business opportunities and economic development are predicted to be medium magnitude.

Increases in the population and demand for services and infrastructure are also predicted to be most significant in these same communities, having either a mostly positive or mixed cumulative residual effect, depending on the adaptability of communities and the existing capacity of their infrastructure and services. Effects have the potential to occur at the regional level and have a medium duration, continuous frequency, and moderate magnitude.

Cumulative residual effects may apply to the cultural identity and sustainability of First Nation communities in the region, including the majority of the primary communities. Human activity has the potential to diminish cultural identity and sustainability, generating a mixed residual

cumulative effect with potentially negative overtones. By contrast, community well-being could not unequivocally be assessed as positive or negative, given the myriad of contrasting effects that underpin it which for example results in greater financial independence but also increased family separation and stress (see Table 11.16-2 for other effects). As such, effects on community well-being have been classified as mixed. Effects on cultural identity and sustainability as well as community well-being could be felt regionally with medium duration, continuous frequency, and moderate magnitude.

Cumulative effects on land-based livelihoods are assessed as negative, because increased human activity is predicted to disturb sensitive elements of the natural environment and therefore have a predominantly detrimental residual effect on dependent business activity. Residual cumulative effects on land-based livelihoods are likely to occur at the sub-regional level over the long term, given a change in this VSEC is a function of the natural environment near human activity. While the region as a whole will have more human activity encroaching upon areas of the natural environment that support land-based livelihoods, it is unlikely that any one community will experience cumulative effects. This is because of the highly localized nature of this effect and the tendency for human developments to be spaced apart from each other, which means the opportunity for different activities to generate overlapping effects will be limited, to the extent that cumulative effects at the sub-regional level may not actually eventuate. As such, the potential for this cumulative effect to occur was assessed as low magnitude with continuous frequency.

11.16.8 Assessment of Significance and Confidence

The overall significance of the residual cumulative effects and the confidence with which this assessment was made are summarized below in Table 11.16-4. Notably, the results of this CEA are not directly comparable to those previously established in the residual effects assessment in Section 8.19, as the scope and approach applied in this assessment is different, along with the presentation of expected effects. The nature of the effect compares closely with the direction of the effect discussed in Section 11.16.7, with an additional "mixed" descriptor added to account for situations where overall nature is highly uncertain. Similarly, the significance of the effect corresponds with the expected magnitude of the effect and also its perceived overall importance.

Table 11.16-4
Significance of Socio-economic Residual Cumulative Effects

VSEC	Nature	Significance	Confidence Levels
Employment and income	Beneficial	High	Low
Education, skills, and training	Beneficial	Moderate	Low
Business opportunities and economic development	Beneficial	Moderate	Low
Population and demographics	Beneficial/Mixed	Moderate	Low
Services and infrastructure	Beneficial/Mixed	Moderate	Low
Cultural identity and sustainability	Adverse/Mixed	Moderate	Low
Community well-being	Mixed	Moderate	Low
Land-based livelihoods	Adverse	Low	Low

Confidence levels are assessed as low because there are numerous factors that can not be determined with certainty, including the intensity and duration of activities unrelated to the Project, as well as the state of the future economy and specific industries. While economic conditions – which have significant bearing on the extent to which proposed human activity will proceed – cannot be predicted with high confidence, it is expected that conditions will gradually fluctuate between strong and low points over the period being assessed, and over the long term will spur job and population growth, particularly during economic upswings.

11.16.9 Additional Mitigation

Mitigation proposed in Chapter 13 will sufficiently address not only the Project's residual effects but also associated cumulative effects.