5.17 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

5.17.1 Scope of the Effects Assessment

The environment in which the project is located may have minor (inconvenience) to more profound (cause the mine to cease operations for some period) effects on the project. This section examines four factors which have the greatest potential to affect the project:

- forest fires
- geohazards (i.e., avalanches, slides, flooding)
- seismic activity
- global climate change

5.17.2 Forest Fires

The BC Ministry of Forests and Range (MOFR) forecasts that the forest fire risk may increase if warmer, dryer summers occur. However, mountain pine beetle infestations of lodgepole pine will result in an increased hazard because of the abundance of dry fuel unless standing dead trees are harvested before they fall. The current mountain pine beetle epidemic in British Columbia is caused, in part, by warmer winters (Climate Change Impact and Adaptation Directorate (CCIAD) 2004 cited in Ministry of Forests and Range 2006). These recent warmer winters and reduced mortality of the beetle plus a large amount of susceptible pine have resulted in a large area of BC being affected (Carroll et al. 2004 cited in Ministry of Forests and Range 2006).

Table 5.17-1 provides a record of forest fires in the Mackenzie Forest District since 1980.

Table 5.17-1: Forest Fire Record 1980-2006 for Mackenzie Forest District

Year	No.	Area (ha)	Year	No.	Area (ha)
1980	17	129	1993	75	456
1981	111	21,433	1994	26	94
1982	32	4559	1995	7	12,767
1983	16	8387	1996	7	15.1
1984	43	870	1997	2	0.5
1985	46	2500	1998	51	4120
1986	25	238	1999	30	5615
1987	21	678	2000	12	88
1988	10	109	2001	4	0.25
1989	19	129	2002	6	2157
1990	57	5559	2003	14	442
1991	46	5523	2004	33	1165

Table 5.17-1: Forest Fire Record 1980-2006 for Mackenzie Forest District (continued)

Year	No.	Area (ha)	Year	No.	Area (ha)
1992	50	686	2005	8	1.4
			2006	46	13,337
Total	814	91,058			
Median	25.5	778			
Minimum	2	0.25			
Maximum	111	21,433			

Source: British Columbia Forest Service, Mackenzie BC.

The area affected by fires varies widely with no apparent pattern over the 26 years.

A relatively simple protective measure against forest fires for the project is to ensure an adequate treeless buffer zone on the project periphery. The greatest damage would occur if a fire reached the plant site and associated buildings. The large TSF on the east and north sides and the open pit on the west side provide a significant buffer zone in those three directions.

Terrane will have vehicles and people on site who could help fight a forest fire if required. As well, a water reservoir and distribution system for fire fighting purposes would be located at the mine site. In an extreme case, the pumps on the TSF reclaim barge could also be used for water to fight fires on the mine property itself where any water would flow back into the TSF. Terrane staff will be particularly attentive during lightning storms and will report to the Ministry of Forest and Range any fires caused by a lightning strike. Terrane will also abide by Forest Protection Fire Hazard ratings and closures, particularly doing construction.

5.17.3 Geohazards

5.17.3.1 Background

The Mt. Milligan project site is situated on the Nechako Plateau, a region of flat to gently rolling terrain. Local relief is provided by a northwest trending ridge which rises about 300 to 500 m above the local plateau elevation of 1,000 m. The area was extensively glaciated during the last glacial period. A large north trending belt of glacial and glaciofluvial deposits about 100 km long and 10 to 20 km wide covers the area of interest with glacial deposits exceeding 100 m in thickness. Thinner till veneers and colluvium deposits frequently mantle the steeper slopes of hills. Isolated deposits of fine grained glaciolacustrine sand, silt and clay are found within topographic depressions. Drainages are typically dendritic with meandering stream courses that connect potholes lakes, ponds and swamps.

Geohazards are events caused by geological features and processes that present severe threats to humans, property and to natural and built environments. Earthquakes, floods, landslides, volcanoes, avalanches, and tsunamis are typical examples of such events. Landslides, earthquakes, avalanches, and floods are considered important geohazards with respect to the Mt. Milligan project. The project components that would be influenced by geohazards consist of the following areas:

- upgrade to the existing forestry access road from Fort St. James to the mine site
- development of the mine site
- construction of a power line from a sub-station near Mackenzie to the mine site

A geohazards assessment was completed in the early 1990's and indicated that the site was a relatively low hazard site with respect to landslides, earthquakes, and avalanches and that structures would need to be located at the proper elevations to avoid the flooding potential (Hallam Knight Piésold 1991).

The geohazards for the project components have been reviewed and include input from Madrone Environmental Services Ltd with respect to the forestry access road and from Geo Wise Engineering for the power line[1]. They are further described in Section 4.2, Terrain, Soils and Geology.

5.17.3.2 Upgrade to the Forestry Service Road from Fort St. James to the Site

Madrone Environmental Services (2007) completed an assessment of road alignment and concluded that "the majority of the road was located on stable ground and did not pose any terrain stability risks. The hill slopes were generally subdued with slope gradients less than 30%. In some areas the slopes were slightly steeper as where streams had incised into the thick glacial deposits forming river scarps."

Madrone (2007) noted two small areas of concern with respect to slope stability along the road alignment at specific chainage and mitigation measures were proposed. The areas in question are between KM 19 and 20.5 and between KM 28.0 and 28.6.

The first section contains large and locally unstable cutslopes on the existing road. To upgrade this road to a 10 m wide road will result in the creation of larger, and potentially more unstable, cutslopes. Madrone (2007) suggested two options to mitigate the instability. They were:

- move the centre-line up and to the left (into the hillslope) filling onto the bench portion of the existing road; end-haul excess spoil; scale back cutslopes to 80% if less than 10 m long and to 70% if more than 10 m long (scale back more to reduce maintenance requirement if desired); plant long cutslopes with pine or aspen

[1] Reports are attached in Volume 8.

- maintain the existing alignment and grade; scale back cutslope and end-haul requirements according to the recommendations in option 1; plan for one-way traffic on this section only and install appropriate safety measures (signs, turn-outs)

The second section is located east of the mine site and does not require upgrade to haul road status. The amount of widening is considerably less therefore than in the first section of the road. Widening can be done without destabilizing native slopes above. However, Madrone (2007) suggested scaling back cutslopes to 80% if less than 10 m long (slope distance) or to 70% for slopes greater than 10 m in length. Additional scaling can be considered with the trade-off between higher end-haul costs versus lower maintenance costs over the life of the road. Planting suitable species (pine and/or aspen) on the cutslopes should provide long-term stability and erosion control.

The avalanche potential along the road is classified as low.

In addition, Madrone (2007) noted that bridge crossing upgrades and stream culverts crossings require careful consideration to minimize the flooding potential. Bridges will be designed and built to pass 1:100 year return flow.

5.17.3.3 Mine Site Area

The mine site area is located on gentle subdued hill slopes. King Richard Creek and Meadows Creek have incised into the thick till plain forming river scarps or erosional slopes. Air photos and site reconnaissance suggest that these slopes have a low terrain stability risk.

The avalanche potential for the site is low because the factors that produce avalanches are not present on the site. Avalanche risk areas are typically recognized by the following:

- slopes ranging between 28 and 55 degrees
- upstream slope change greater than 10 degrees; this promotes the breaking in the continuity of the snow blanket
- vegetation type; a dense tree coverage avoids the creation of a compact and homogeneous layer

Surface water management during project development will require careful planning and consideration to minimize flooding potential. Facilities are not expected to be affected by floods in Rainbow Creek because of the almost 100 m elevation difference.

5.17.3.4 Power Line from Mackenzie to the Mine Site

Geo Wise Engineering (2006) completed a helicopter reconnaissance along the power line corridor and provided the following comments with respect to the geohazards. The proposed power line corridor passes mostly through areas of flat to gently sloping terrain of glacial outwash sands and gravels, generally moderate slopes of bedrock and crosses some bogs. Geo Wise Engineering (2006) concluded that the corridor has low risk to landslide, avalanche or flooding activities.

5.17.4 Seismicity

As noted in Volume 3, Project Description, a probabilistic seismic hazard calculation for the Mt. Milligan site indicated that for a return period of 475 years (10% probability of exceedance in 50 years), the seismic hazard is low. Nevertheless, appropriate seismic design parameters have been selected for the tailing storage facility and mine site structures based on the findings of the seismicity review and seismic risk analysis.

5.17.5 Global Climate Change

Global climate change is generally acknowledged to be occurring and to be largely influenced by greenhouse gases (GHGs). Contributions to GHGs by the project are discussed in Section 5.3, Climate and Air Quality. The focus of this section is the potential effects on the project over the mine life and post closure period of global climate change. The temporal scope of the assessment is a projected 15 year mine life plus two years of construction and about 20 years post closure for the open pit to fill and start overflowing off the site. Because of the imprecise nature of climate change models and the long projections required, scenarios discussed are of necessity broad brush.

A number of global climate change issues may affect the project and, where prudent based on risk, were taken into account in designing project facilities. They included:

- increased precipitation in the project region during summer and winter potentially leading to larger snow packs and higher runoff
- increased incidences and intensities of storms
- increased temperature extremes, both minimums and maximums
- warmer average temperatures

Environment Canada's Coupled Global Climate Model (NRCan 2007b) has the predictions below shown in Table 5.17-2, for the general area of British Columbia which includes the project area:

Table 5.17-2: Predicted Changes in Temperature and Precipitation

Change from 1961-1990 Averages by 2040 to 2060			
Annual temperature	+2 to 3 °C	Annual precipitation	0 to +10%
Winter temperature	+3 to 4 °C	Winter precipitation	0 to +10%
Summer temperature	+2 to 3 °C	Summer precipitation	-20 to -10%

There is risk in accepting current climate model predictions – the models are becoming more sophisticated, but they cannot precisely predict future climate. Current regional modeling efforts are in their infancy and their predictions should be viewed with healthy scepticism. The issue is not computer power but the level of understanding of complex climate models (MWLAP, et al. 2003).

Most of the warming in the southern and the western Canada has occurred during winter, and daily minimum temperatures have increased much more than daily maximum temperatures. The real significant changes in temperature are not in the summer highs and the winter lows, but the changes during the shoulder seasons (spring and fall). Precipitation patterns are more complex, because of geographical impactst. Higher flows occur in rivers from the onset of hydrologic spring (March through June) and then decrease through the fall (July to October). This represents a shift forward in time of the annual melting of the snow. The accumulated winter snow is expected to begin melting earlier with the result that summer lows occur sooner and last longer. This pattern was found to be ubiquitous across a band through Prince George, including the McGregor River, the Fraser River at McBride and Shelley, the Skeena River, and the Kemano River (MWLAP et al. 2003).

If precipitation were to increase by 5 to 10%, there will be a large increase in the number of landslides in northern BC (MWLAP et al. 2003). However, as discussed in this section under Geohazards, the project area is not a landslide prone area.

Warmer average temperatures in the project region could lead to earlier springs and possibly more intense freshet melting which will need to be accounted for by water management planning and structures.

Possible changes in annual and peak precipitation for Mt. Milligan because of climate change were discussed in Section 4.5, Water Resources. A factor of safety of 1.2 for operations and of 1.5 for closure will be applied to peak flows during detailed design of facilities for Mt. Milligan to account for possible climate change effects. However, the large surface area of the TSF will reduce the effect of increased peak events because small increases in pond elevation would occur associated with relatively large increases in flows.

5.17.6 References

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