PROSPERITY
A Gold-Copper Project of Taseko Mines Limited

Taseko Prosperity Gold-Copper Project

Appendix 5-4-E

Taseko Mines Limited

Taseko Prosperity Gold-Copper Project

VOLUME 5: BIOTIC ENVIRONMENT

SECTION 4: SOILS AND TERRAIN

BASELINE REPORT

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Abbreviations

%	percent
<	less than
>	greater than
µ	micro
$\mu g/m^3$	micrograms per cubic meter
ALCA	*Agriculture Land Commission Act*
ALR	Agricultural Land Reserve
BC	British Columbia
BCEAA	British Columbia *Environmental Assessment Act*
BCM	bank cubic meter
BEC	Biogeoclimatic Ecosystem Classification
CCLUP	Cariboo-Chilcotin Land Use Plan
CDC	Conservation Data Centre
CEAA	Canadian *Environmental Assessment Act*
CLI	Canada Land Inventory
DEM	digital elevation model
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
EAA	*Environmental Assessment Act*
EAO	Environmental Assessment Office
EC	electrical conductivity
EEM	environmental effects monitoring
EMP	environmental management program
EMS	environmental management system
ESSF	Engelmann spruce–subalpine fir zone
IDF	interior Douglas-fir zone
JW–AXYS	Jacques Whitford–AXYS
KIR	Key Indicator Resource
LSA	Local Study Area
m asl	metres above sea level
MEMPR	Ministry of Energy, Mines and Petroleum Resources
MOE	Ministry of Environment
MOFR	Ministry of Forests and Range
MS	montane spruce zone
NRCan	Natural Resources Canada
PRS	Project Report Specifications
PSAI	Pacific Soil Analysis Inc.
QA/QC	quality assurance/quality control
RIC	Resources Inventory Committee
RISC	Resources Information Standards Committee
ROM	run-of-mine
ROW	right-of-way
RSA	Regional Study Area
SBPS	sub-boreal pine-spruce zone
SBS	sub-boreal spruce zone
SIL	Survey Intensity Level
SMU	soil map unit

TEM	Terrain Ecosystem Mapping
TOR	Terms of Reference
VEC	Valued Ecosystem Component

4 Soils and Terrain

4.1 Introduction

This section provides a baseline assessment of soils and terrain resources necessary for carrying out an Environmental Assessment (EA) of the potential effects of the proposed Prosperity Gold-Copper Project (the project, or the proposed mine) on these resources. This baseline contains an overview of previous soils and terrain reports completed for the project prior to 2000, and the results of updated studies carried out by JW–AXYS in 2006 in order to meet current EA standards. The process of scoping the environmental components to be assessed and the baseline methodology used are also addressed.

The objective of the soils assessment is to provide baseline soils information for the area encompassed by the proposed mine development in order to assess potential project-related disturbances to these resources and for reclamation planning purposes. The objective of the terrain component is to describe the baseline surficial geology and terrain integrity, or terrain stability, conditions that may be affected by the project; this information will be used to guide mine activities that could result in mass movements.

4.2 Scoping

Scoping is the process of determining which potential effects are to be assessed and the spatial and temporal boundaries within which these effects are to be assessed.

Specifically, scoping includes:

- identification of the key issues and explanation of their relevance to the project
- selection of Valued Ecosystem Components[1] (VECs) and Key Indicator Resources[2] (KIRs)
- identification of the measurable parameters that will be used to assess project-specific effects and cumulative effects on each VEC and KIR
- selection of the spatial (geographical) and temporal boundaries of the assessment

Scoping of key issues for this project was discussed during an EA methodology workshop on September 25, 2006 and during subsequent meetings and discussions throughout 2006. Issues scoping also involved identifying and integrating regulations, standards and practices for the mining industry (e.g., BC *Mines Act*, Canadian *Environmental Assessment Act*, Canadian *Environmental Protection Act*).

The assessment has been prepared in accordance with the direction provided in the BC Environmental Assessment Office publication, *Mine Proponent's Guide: How to Prepare Terms of Reference and an Application for an Environmental Assessment Certificate* (EAO 2006) and the Prosperity Gold-Copper Project: Project Report Specifications (PRS) (Prosperity Project Committee 1998). Project descriptions used in this document were provided through ongoing consultations with Taseko Mines Limited (Taseko) and a general project overview is provided in the *Prosperity Gold–Copper Project: Project*

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[1] VECs are defined as broad components of the biophysical environment that if altered by the project, would be of concern to regulators, First Nations, resource managers, scientists and/or the public.

[2] KIRs are species, species groups, resource and/or ecosystem functions that are used as representative components of a broader VEC.

Overview (AXYS 2006). The assessment scope and methods build on the Soils/Geology/Terrain Baseline Scope of Work: Prosperity Project 2006, Gap Analysis, Workplan and Cost Estimate (JW–AXYS 2006), and input from regulatory agencies.

Temporal boundaries used for the soils and terrain assessment are defined in Section 4.2.4 and spatial boundaries are defined in Section 4.2.5. Other soils and terrain-related issues not covered in this section are: effects on surface-water and ground-water hydrology, including flooding hazards, which are addressed in Volume 4, Section 3; detailed geology provided in Volume 3, Section 5, and; the mine plan including geotechnical work, mine design, tailings impoundment and storage, seismic assessment, and sediment control provided in Volume 3, Section 6.

4.2.1 Key Issues

Key issues of concern related to the project were identified through:

- input from the EAO, other regulatory agencies, and First Nations during the development of the PRS
- ongoing discussions and input from regulators
- precedence in other EAs
- professional judgement of the assessment team

Through the issues identification process, soils and terrain resources were identified as the key VECs to be addressed in this section. Key issues arising for soils and terrain resources associated with the project include:

- changes in soil physical, chemical and biological properties arising from alterations in soil moisture regime, erosion, soil admixing, contamination, compaction and rutting associated primarily with site clearing and grubbing, soil stripping and project construction and closure activities
- changes in slope stability including increased incidence of mass wasting events (such as debris flows, slumps, earth flows, and other forms of slope instability) associated primarily with site clearing and contouring, road construction and upgrading, trenching, blasting, and other project construction and closure activities

Where it was determined that interactions between project activities and VECs might occur, a determination was made as to whether the residual environmental effects would be significant following mitigation efforts. For this purpose, an issues identification matrix was developed as part of the scoping exercise in order to identify potential effects related to construction, operations, closure and post-closure. Interactions between activities and soil and terrain resources were ranked on a scale of “0” through “2”, where:

- 0 = no interaction between the project activity and soil resources
- 1 = potential, but non-significant (with or without mitigation) interaction; not considered in the EA
- 2 = potential for a significant environmental effect; to be considered in the EA

Potential project effects to soils and terrain resources are greatest during construction activities for the minesite, transmission line corridor and access road; hence, subsequent activities will not add greatly to the additional loss or alteration of soil and terrain resources. Accidental events, malfunctions, unplanned events and cumulative effects related to other activities such as logging that are unrelated to the proposed mine will be addressed in the EA document.

Table 4-1 Interaction of the Project with Soils and Terrain Resources

Project Activities/Physical Works	Project Description Reference for Activity	
Construction and Commissioning	Soils Resources	Terrain Resources
Access road construction and upgrades	1	1
Camp construction	2	1
Fisheries compensation	1	1
Site clearing (clearing and grubbing)	2	1
Soils handling and stockpiling	2	1
Construction: plant site and other facilities	2	1
Lake dewatering	0	0
Starter dam construction	1	1
Sourcing water supplies	0	0
Water diversion(s)	1	1
Site waste management	1	0
Clearing of transmission line right-of-way (ROW)	1	1
Installation of transmission line	1	1
Vehicular traffic	1	0
Trans-shipment facility (Williams Lake)	0	0
Operations		
Pre-production	1	0
Production	0	0
Crushing and conveyance	0	0
Ore processing and dewatering	0	0
Tailings storage (assume loss of permanent soil area)	1	1
Waste rock stockpiles	1	1
Potable and non-potable water use	0	0
Site drainage and seepage management,	1	1
Wastewater treatment and discharge	1	1
Water release contingencies	1	1
Solid waste management	1	0
Maintenance and repairs	0	0
Concentrate transport and handling	0	0
Vehicle traffic	0	0
Closure		
Processing and reclamation of low grade stockpiled material	1	0
Reclamation of waste rock stockpiles	1	0
Tailings impoundment reclamation	1	0
Pit lake filling	0	0
Plant and associated facility removal	0	0
Road decommissioning	0	1
Transmission line decommissioning	0	0
Post-closure		
Tailings impoundment monitoring	0	0
Pit Lake monitoring	0	0
Reclamation monitoring	1	0
Interaction of Other Projects and Activities on VECs	Addressed in EA document	
Accidents, Malfunctions and Unplanned Events	Addressed in EA document	

NOTES: 0 = No interaction
1 = Interaction occurs; however, based on past experience and professional judgment the interaction would not result in a significant environmental effect; even without mitigation; or interaction would not be significant due to application of codified practices. Details on justification for this rating are provided in the issues scoping section for the VEC or KIR
2 = Interaction may result in a significant environmental effect; potential effects are considered further in EA

4.2.1.1 Potential Environmental Effects to Soil Resources

Potential environmental effects include admixing, compaction, contamination, erosion, rutting, and soil moisture. These terms are defined by the BC Ministry of Forests (2001) and Powter (2002) as follows:

Admixing: The reduction of soil quality as a result of the mixing or dilution of topsoil with subsoil, spoil or waste. It can lead to adverse changes in soil texture, structure, organic matter content or friability.

Compaction: The packing together of soil particles by external forces. Soil particles are packed closer together while aggregates are crushed and porosity decreases. In this case the concern is for compaction resulting from the use of heavy equipment.

Contamination: The condition or state of soil caused by a substance release or escape which results in damage or impairment to the environment, human health, safety or property.

Erosion: The wearing away of the land surface (soil) by natural or anthropogenic means. These include running water, wind, ice, other geological agents, and animal or human activities.

Rutting: Creating ruts in the soil as a result of using heavy equipment. In British Columbia ruts are defined as impressions or ruts at least 30 cm wide and 2 m long caused by heavy equipment traffic. Two different depth criteria (5 and 15 cm) apply, depending on the compaction hazard of the site being assessed.

Soil Moisture: Percentage of soil volume occupied by water. Soil moisture changes resulting from mining activities can have an effect on vegetation communities and soil or land capability.

These five potential effects on soil resources may vary depending on the project component and have therefore been assessed separately for the minesite, transmission corridor, access road and rail loadout facilities.

Minesite

Camp construction, site clearing and grubbing, soils handling and stockpiling, and the construction of the plant site and other facilities are activities carried out during the construction phase which have the potential to result in significant effects on soils resources; hence these activities are all ranked “2” in Table 4-1 and are the focus of the EA for soils resources. It is assumed that site clearing and grubbing will involve soil stripping to remove and store all active soil layers for future site reclamation.

Construction phase project activities ranked as “1” such as fisheries compensation, starter dam construction, water diversion and site waste management can be mitigated using established methods and practices or are, for the purposes of the soil VEC, eclipsed by the effects of the four activities ranked as “2” above (e.g., site clearing and grubbing). Fisheries compensation will be addressed further in the EA if scenarios change substantially.

Operations phase activities ranked as “1” include pre-production, waste rock stockpiles, site drainage and seepage management, wastewater treatment and discharge, water release contingencies and solid waste management. These activities can all be addressed through standard mitigations combined with ongoing monitoring of vectors which could affect soil resources.

Closure phase activities ranked as “1’ include processing and reclamation of low grade stockpiled materials, reclamation of waste rock stockpiles, and tailings impoundment reclamation. Any adverse effects associated with these activities can be addressed through standard mitigations and best management practices.

Table 4-2 identifies construction activities within the minesite that are most likely to result in significant effects on soil resources, and the specific effects associated with each activity. No Agricultural Land Reserve (ALR) lands are located within the minesite area, therefore only reclamation suitability is considered.

Table 4-2 Potential Environmental Effects to Soil Reclamation Suitability Associated with the Minesite

Project Activities and Physical Works	Potential Environmental Effects				
	Compaction and Rutting	Soil Contamination	Admixing	Soil Loss (Erosion)	Soil Moisture Changes
Construction and Commissioning					
Camp construction	✓	✓	✓	✓	
Site clearing (clearing and grubbing)	✓	✓	✓	✓	
Soils handling and stockpiling	✓	✓	✓	✓	
Construction: plant site and other facilities	✓	✓	✓	✓	

Transmission Corridor

Construction of the transmission line will involve transportation of poles and cable, and placement of poles. No new access roads are proposed and poles will be transported into sensitive areas such as wetlands by helicopter. This considered, activities associated with the clearing of the ROW and construction of the transmission line should not have a significant environmental effect on soils resources and have been ranked “1”. Non-ALR lands were not assessed due to the limited effect that transmission line construction is expected to have on non-agricultural soil resources – most notably because no new roads are proposed to access the transmission line.

Access Road

Activities associated with access road construction and upgrades could potentially affect soil resources, primarily during the construction phase. However, the 3.4 km of proposed new access road referred to as the minesite access road is contained within the minesite footprint; hence, it is assumed that the area occupied by the minesite access road will be restored and revegetated as part of the mine reclamation activities. This interaction has therefore been rated as “1” in Table 4-1.

Road upgrading activities planned for the access road are restricted primarily to two small areas that are largely located within the exiting road ROW. Therefore, these effects are not anticipated to have serious consequences for soils resources. Assuming the application of standard mitigation procedures and best management practices for road construction, including pre-construction assessments, these activities have been rated as "1" in Table 4-1. Non-ALR lands are not assessed due to the limited extent of the disturbance, because current road construction practices minimize impacts to soil resources, and because the road is likely to remain in service beyond the life of the mine.

Rail Loadout Facility

The ore concentrate from the Prosperity mine will be transported by truck to a rail loadout located near McLeese Lake BC. This rail load out is an existing facility built and operated to service the Gibraltar Mine. The additional concentrate from Prosperity will be accommodated using the existing infrastructure and no incremental disturbance is planned at this site. The potential for dust from Prosperity concentrate to cause elevated trace metal levels in soil resources along the access road route and rail loadout area is assumed to be mitigated by best management practices, including covering of ore concentrate loads. Therefore, the activities associated with the rail load out will not affect soils resources and will not be considered further within the soils section of the assessment.

4.2.1.2 Potential Environmental Effects to Terrain Resources

Potential environmental effects to terrain resources are limited to mass wasting events, or slope instability, which may be affected as outlined below for each of the four project activities.

Minesite

Mass wasting may be accelerated by forest removal and subsequent minesite construction activities, including trenching of surficial sediments and blasting of bedrock. Changes to both forest cover, surficial and bedrock geology, and natural hydrology generally result in changes in the natural equilibrium of a slope that may result in slope instability.

The majority of the minesite LSA is flat to gently sloping terrain where terrain stability is not considered a significant issue. Minesite activities that may occur on steep and potentially unstable slopes will be limited and subject to best management practices and mitigation measures designed by qualified professionals. Other stability issues related specifically to mine design, tailing impoundment and storage, and seismic assessments and geotechnical work are addressed in detail in the mineplan provided in Volume 3, Section 6. Therefore for this assessment, no significant effects on terrain integrity are anticipated that can not be mitigated by engineering and geotechnical practices, hence minesite activities have been ranked as "0" or "1" as listed in Table 4-1.

Transmission Corridor

Mass wasting may be accelerated by forest removal during the clearing of the transmission line corridor and subsequent related construction activities. Changes to both forest cover, surficial geology and natural slope drainage following these activities could result in slope instability.

Construction of the transmission line will involve transportation of poles and cable, and placement of poles. Most noteworthy regarding the assessment of the potential effects on terrain integrity, no new access roads are proposed and poles will be transported into sensitive areas such as wetlands by helicopter. This considered, activities associated with the clearing of the ROW and construction of the transmission line should not have a significant environmental effect on terrain resources following standard mitigation measures and best management practices and have both been ranked as “1” in Table 4-1.

Access Road

Mass wasting may be affected by forest removal and subsequent road construction activities, including road widening and blasting of bedrock. Changes to both forest cover, surficial and bedrock geology, and natural slope drainage generally caused by these activities could result in slope instability.

The 3.4 km of proposed new access road is located on benign terrain contained within the minesite footprint and should not result in a significant effect on terrain resources. Construction activities for the remainder of the access road are limited to road upgrades along existing roads where: the majority of terrain is characterised by low gradient slopes with no terrain stability concerns, and; stability issues have already been identified and addressed. Hence, it is assumed that the effects associated with access road construction and upgrades will be adequately addressed with the application of standard mitigation procedures and best management practices, including pre-construction terrain stability assessments where necessary, and these activities have been rated as “1” in Table 4-1.

Rail Loadout Facility

Activities associated with the rail loadout facility should not contribute to mass wasting and are not considered further in the terrain section of this assessment.

4.2.2 Selection of Key Indicator Resources

KIRs are defined as being important resources that have intrinsic biophysical and/or social value. They are sensitive to activities related to the project and are used as representative components of a broader VEC.

To assist in identifying the potential effects of the project, the following key biophysical components were designated as KIRs that are representative of the soils VEC (KIR 1 and KIR 2) and the terrain VEC (KIR 3) during scoping:

- agricultural capability in ALR areas
- reclamation suitability in non-ALR areas
- terrain integrity

Agricultural Capability

Project-related activities have the potential to affect soil resources on ALR lands. There are ALR lands within the access road and transmission line corridors but not within the minesite area.

Agricultural capability was chosen as a KIR because of its importance in the determination of land suitability for agricultural production. Agricultural capability is defined as the suitability of land for sustained production of cultivated crops based on soil and climate characteristics. In British Columbia seven classes have been developed to rate agricultural land capability. Class 1 lands have the highest and Class 7 lands the lowest capability to support agricultural land use activities.

The potential project-related effects during the construction, operation and decommissioning phases include: compaction and rutting, soil contamination, admixing, soil loss (erosion) and soil moisture changes. The primary activities having the potential to result in soil degradation within the ALR are soil handling and storage during road and transmission line construction and decommissioning, and vehicular use of the access road and transmission line access and maintenance roads. Potential reductions in capability are generally greatest during construction and decommissioning and diminish during operations and maintenance activities. Effects to soils are highly localized and their magnitude differs with the type of activity.

Agricultural capability ratings assess soil physical and chemical factors such as texture, salinity, fertility, stoniness, and rooting restrictions in addition to site characteristics such as slope class and drainage pattern (Canada Land Inventory 1969). Soil capability in agricultural areas is assessed by evaluating surface soil degradation potential and loss. Measurable parameters include: land capability classification, soil erosion risk, and soil compaction and puddling hazard.

In this report the Canada Land Inventory (CLI) soil capability classification for agriculture rating system was applied to measure agricultural capability. This rating system has been applied to agricultural lands throughout Canada to assess the suitability of land to sustain agricultural crops.

Reclamation Suitability

Project-related activities also have the potential to affect soil resources on non-ALR lands. Non-ALR lands comprise the majority of area along the access road and the transmission line, and within the minesite.

Reclamation suitability was chosen as a KIR because it can be used to assess the ability of land to sustain non-agricultural uses such as forest and wildlife production. Reclamation suitability can be defined as the ability of a disturbed site to support the process of returning it to its former or other productive uses. Soils rated “good” or “fair” are generally suitable for reclamation with a minimal amount of management or inputs. Soils rated as poor can be used for reclamation, but only under intensive management.

The potential project-related effects during the construction, operation and decommissioning phases include: compaction and rutting, soil contamination, admixing, soil loss (erosion) and soil moisture changes. The primary activities having the potential to lead to soil degradation of non-ALR lands include: soil handling and storage, site clearing and contouring, road construction and subsequent vehicular traffic, and the development of other mine infrastructure such as buildings. Potential reductions in suitability are generally greatest during the construction and decommissioning phases and diminish during operations and maintenance activities. Project effects on soils are generally highly localized and their magnitude differs with the type of activity.

Characteristics which affect the suitability of materials for reclamation purposes include: soil texture, coarse fragment content; soil structure, soil available water storage capacity, soil nutrient holding capacity, soil organic matter content, soil salt and sodium content, and soil reaction (pH).

The reclamation suitability rating system originally developed by Alberta Agriculture, Food and Rural Development in the *Soil Quality Criteria Relative to Disturbance and Reclamation* document (AAFRD 1987) was applied. This rating system has been applied in Alberta and in British Columbia to assess changes in reclamation suitability.

Terrain Integrity

Project-related activities may also affect terrain integrity (slope stability) potentially resulting in mass wasting events. Mass wasting events are most likely to be triggered during the construction phase; however, project-related effects could persist for long periods contributing to mass wasting events during all project phases and many years after the related project activities have ceased.

Mass wasting is a natural process; however, it may be accelerated by forest removal and subsequent road and other construction activities, including trenching of surficial sediments and blasting of bedrock. Changes to both forest cover, surficial and bedrock geology, and natural hydrology generally result in changes in the natural equilibrium of a slope that can result in mass wasting events and may have a considerable effect on terrain integrity. While the effects are generally local in nature, it is difficult to properly ascertain their frequency, duration and magnitude without more detailed geotechnical studies.

In this report terrain integrity is qualitatively assessed primarily through the study of geomorphic processes, slope gradient, surficial material type, drainage, and other terrain conditions. Effects are typically localized and their magnitude will differ with the type of activity, nature of materials, and other site specific factors. For example, the construction of access roads or the removal of forest cover on steep slopes will likely have a greater impact on terrain integrity than the development of temporary campsites on level terrain.

4.2.3 Project Components Assessed

For this section, the activities associated with this project have been broken down into four components:

- minesite
- transmission corridor
- access road
- rail loadout facility

It is important to note that the rail loadout facility is located completely within the footprint of the existing Gibraltar Mine loadout, and under the current proposal it is assumed that mitigations will include covered trucks and a covered loading facility (i.e., no or limited potential for spillage of concentrate of dusting of vegetation and soil). This considered, the rail loadout component will not be assessed further. In addition, because planned project developments associated with the ore concentrate haul route are limited to relatively minor upgrades involving little additional clearing or disturbance, only baseline mapping and an overview level baseline summary has been conducted for this component. A total of 2.5 km of new access road construction is required to link the exiting forest access road to the minesite and this portion of the road was assessed as part of the minesite disturbance. A summary of key issues and effects pathways for each project component is provided in Table 5.2-3 at the end of this section.

Each of the three remaining project components has the potential to directly or indirectly interact with KIRs. Relevant key issues, pathways for effects on soils and terrain KIRs, and the project parameters to be used in the assessment of the potential effects of these three project components on soils and terrain KIRs are addressed below and in Tables 4-6 and 4-7, respectively.

4.2.3.1 Soil Resources

Table 4-3 Project Components Assessed and Rationale for Selection: Soils Resources (Agricultural Capability and Reclamation Potential) Effects Assessment

Project Component	Project Parameters Used for the Assessment	Key Issues	KIRs Potentially Affected	Pathways for Effects
Minesite	An area defined to encompass all minesite facilities in the minesite area throughout the life of the project. This area is ~ 4400 ha in size	• compaction and rutting • soil contamination • admixing • soil erosion • soil moisture change	• reclamation suitability	• mining and removal of soils from site clearing and grubbing • clearing of vegetation • changes in drainage patterns • lake dewatering • reclamation of waste rock stockpiles
Transmission Corridor	A linear corridor 500 m wide centered on the proposed transmission line route (250 m buffer on either side of existing alignment) is used as a local study area to facilitate assessment. This area is ~ 3500 ha in size	• compaction and rutting • soil contamination • admixing • soil erosion	• agricultural capability	• road construction • clearing of ROW • excavation of towers
Access Road	A linear corridor 400 m wide centered on the existing roads and proposed extension (200 m buffer on either side of existing road alignment) is used as a local study area to facilitate assessment. This area is ~ 6260 ha in size	• compaction and rutting • soil contamination • admixing • soil erosion	• agricultural capability	• road construction • clearing of ROW

4.2.3.2 Terrain Resources

Table 4-4 Project Components Assessed and Rationale for Selection: Terrain Integrity Effects Assessment

Project Component	Project Parameters Used for the Assessment	Key Issues	KIR(s) Potentially Affected	Pathways for Effects
Minesite	An area defined to encompass all minesite facilities in the minesite area throughout the life of the project plus a 500 m buffer to allow for unforeseen changes in the project footprint. This area is ~ 5900 ha in size (~3500 ha without buffer)	mass wasting	terrain integrity	• clearing of vegetation • removal and piling of surficial materials • changes in slope angles • lowering of compaction levels of materials • changes in drainage patterns
Transmission Corridor	A linear corridor 3 km wide centered on the proposed transmission line route (1500 m buffer on either side of existing alignment) is used as a local study area to facilitate assessment. This area is ~ 38,000 ha in size	mass wasting	terrain integrity	• clearing of ROW • changes in slope angles and drainage patterns due to road construction • excavation of towers
Access Road	A linear corridor 2 km wide centered on the existing roads and proposed extension (1000 m buffer on either side of existing road alignment) is used as a local study area to facilitate assessment. This area is ~17,500 ha in size	mass wasting	terrain integrity	• road construction and associated changes in slope angles • clearing of ROW • changes in drainage patterns

4.2.4 Temporal Boundaries

The temporal boundaries for the assessment are based on the timing and duration of project effects in relation to each VEC. Temporal boundaries for the project are divided into the following categories:

- construction and commissioning
- operations
- closure (decommissioning and reclamation)
- post-closure

4.2.4.1 Baseline

Baseline conditions reflect the biophysical characteristics of the proposed minesite local study area (LSA), the proposed transmission line corridor, and the access road as of the summer of 2006, including all existing disturbances and projects.

4.2.4.2 Construction and Commissioning

The construction and commissioning phase includes access upgrades, construction of minesite facilities (waste rock foundations, water management, tailing pond starter dam construction crusher station, ancillary facilities, etc.) and pre-production pit development. The effects to soils and terrain resources are primarily concentrated in the construction phase, hence the EA will focus on this phase of the project.

4.2.4.3 Operations

The operations phase includes open pit mining, crushing, waste rock stockpiling, truck loading and hauling, mill processing, ore concentrate haul, and tailing disposal. Environmental effects to soils and terrain resources are primarily concentrated in the construction phase, hence the operations phase will not be a major component of the soils and terrain EA.

4.2.4.4 Closure (Decommissioning and Reclamation)

The closure phase includes decommissioning facilities, recontouring waste dumps, topsoil replacement and revegetation, establishing long-term water management and drainage and reclamation monitoring.

4.2.4.5 Post-Closure

The post-closure scenario represents conditions forecast approximately 20 years into the future following closure (i.e., completion of decommissioning and reclamation) of the mine. This scenario assumes implementation of all mitigation recommendations and all components of the Reclamation Plan.

4.2.5 Spatial Boundaries

LSAs have been defined for the minesite, access road and transmission corridor below. None of these three project components assessed required a defined regional study area (RSA) because soil and terrain resources generally stay in situ, potential project-related effects will be site-specific, and the LSAs as defined above will account for any reroutes or deviations in the proposed project activities and their related disturbances.

4.2.5.1 Local Study Area

LSAs have been defined for each of the three activity components assessed in the EA are outlined below and are presented in Figure 4-1.

Figure 4-1 Local Study Areas for Soils and Terrain KIRs

Minesite Local Study Area

The minesite LSA has been defined as those areas related to resource extraction and tailings storage that would involve activity that may impact soil and terrain resources. This includes the mine pit, minesite related roads (excluding the access road), tailings areas, processing facilities and related infrastructure. It can also be described as the disturbance footprint. The proposed footprint encompasses approximately 4419 ha.

Transmission Corridor Local Study Area

The transmission corridor extends approximately 125 km from the existing BC Hydro transmission line (approximately 15 km east of the Fraser River) to the proposed minesite near Fish Lake. The LSA is defined as a 250m buffer on either side of the transmission line and encompasses some 6264 ha of land.

Access Road (Eastern Fork Option) Local Study Area

The access road LSA extends from the Bella Coola Highway (Hwy 20) at Hanceville to the proposed minesite. When the new portion of road is complete, the access road will be 105.4 km in length. This includes 84 km of the Taseko Lake Road and 19 km of the 4500 Road. New road construction is limited to the southern end of 4500 Road, which will be extended 3.4 km, allowing access into the minesite. The LSA is defined by a 200 m buffer on either side of the access road center line and covers a total area of approximately 3495 ha.

4.2.6 Administrative and Technical Boundaries

4.2.6.1 Administrative Boundaries

Administrative boundaries include all environmental regulations pertaining to terrain and soils: the BC *Mines Act*, the *Health, Safety and Reclamation Code for Mines in BC (Part 10)*, and to a lesser extent, the *Agricultural Land Commission Act, 2002.*

The BC *Mines Act* and the *Health, Safety and Reclamation Code* provide requirements pertaining to approval of mine plans and reclamation programs. These requirements are directly associated with the provincial EA process, and include requirements for terrain mapping, soil handling, and erosion control and sediment retention.

The *Agricultural Land Commission Act* (ALCA) replaced the *Land Reserve Commission Act*, the *Agricultural Land Reserve Act*, and the *Soil Conservation Act* in 2002. This Act sets the legislated framework for the establishment and administration of the agricultural land preservation program in BC, and provides regulations around the preservation of arable land, including soil conservation. Sections of the ALCA that are relevant to the project include S.20 and S.58(j).

The project is located within the boundaries of the Cariboo-Chilcotin Land Use Plan (CCLUP) area, and is therefore subject to any regulations/bylaws under this plan. The CCLUP is an integrated planning tool pertaining primarily to biophysical resources and tourism/recreation. Additional information on the CCLUP is provided in (Vegetation Resources (Volume 5, Section 5).

Other administrative boundaries include the Cariboo Regional District, the Chilcotin, Williams Lake, and 100 Mile House Forest Districts, and the Ministry of Environment

Cariboo Region. The mandates of these agencies are considered in the EA; however, the terrain and soils requirements are limited.

4.2.6.2 Technical Boundaries

Terrain Classification System for British Columbia (Howes and Kenk 1997), Guidelines and Standards to Terrain Mapping in British Columbia (Resources Inventory Committee 1996) and Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998).

Information sources used in the assessment included the terrestrial ecosystem map (TEM) developed for the project, existing hazard mapping, surficial geology maps, and soil and terrain manuscript maps published by the BC Ministry of Environment.

4.2.7 Influence of Consultation on the Assessment

To the extent possible, information and/or concerns raised through consultation with regulators, stakeholders, community members and First Nations have been incorporated into the scope of the baseline data collection. Further details are provided in the following sections.

4.2.7.1 Project Report Specifications

A consultative process was completed during the initiation phase of the project to define the scope of the assessment. The proponent and regulators worked collaboratively to develop the PRS outlining the full scope of disciplines to be considered and the key elements to be addressed by each of these disciplines. The PRS were followed in completing the terrain and soils component of this environmental assessment.

4.2.7.2 Additional Consultations with Regulatory Authorities

Additional consultations were carried out with Diane Howe, Regional Manager Exploration and Mining, Southwest Region (Victoria)[3], to discuss key components to be included in the terrain baseline and EA (Howe 2006 and 2007, pers. comm.).

4.3 Baseline Conditions

4.3.1 Summary of Previous Work and Gap Analysis

A number of relevant studies have been completed in the past decade within or immediately adjacent to the proposed Minesite, including work by Brommeland and Wober (1997), Talisman Land Resource Consultants Inc. (Talisman 1997, 1998, 1999) and Madrone Consultants Ltd. (Madrone 1997); each of these is discussed in more detail below.

Several exploration studies were conducted in the vicinity of the project area. One of the latest involved a diamond drilling program (Brommeland and Wober 1997) that addressed geological, engineering and mine design parameters. The report provides some valuable information on the surficial geology of the minesite area.

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[3] Diane Howe is the individual responsible for carrying out the government review for all terrain components of the Taseko EA

The Talisman study (1997) consists of a preliminary overburden assessment and suitability for reclamation assessment for the open pit area. The study includes a surficial deposit sampling program and laboratory analysis of background trace metal concentrations. General soil parameters, including texture, percent coarse fragments, pH, etc., are used to characterize the different types of surficial deposits. Overall results have been used to evaluate the suitability of surficial deposits for use in soil reconstruction. This data is incorporated in this report (field data are listed in Appendix A).

A terrain assessment was carried out by Talisman along the transmission corridor and documented in an unpublished draft report in 1998. The assessment describes and maps at 1:50,000 scale important landform features within the 3-km wide transmission corridor, as well as terrain hazards and constraints that could potentially affect transmission line construction and maintenance. This report was prepared based on published maps and written reports—most notably 1:100,000 CLI maps—as well as data from the 1997 field program and air photo assessment. Although the terrain assessment covers the entire transmission corridor, only areas of potential hazards or constraints related to terrain were identified on the 1:50,000 scale map produced with this report.

A detailed soil survey was also undertaken by Talisman (1999). The soil survey includes maps and descriptions of soil map units, salvage suitability, slope analyses and sample site locations.

A TEM was developed by Madrone (1997) for the minesite area. This study used 1993 1:15,000 scale colour photography; final map products were issued at 1:20,000. Mapping was completed directly from hardcopy air photos. The TEM program sampled over 410 sites or 33% of the 1252 polygons mapped, meeting the standards outlined by the Province for Survey Intensity Level (SIL) 3 work. These data are also incorporated into this report (Appendix A).

The Talisman reports (1997, 1998, 1999) for the Prosperity Gold-Copper Mine EA were reviewed and compared with requirements for soils, surficial geology and terrain data described in the PRS. These specifications were issued under the harmonized British Columbia *Environmental Assessment Act* (BCEAA) and Canadian *Environmental Assessment Act* (CEAA) in 1998. This historic information was also reviewed in light of current requirements and practice for proposed projects (e.g., Kemess North Mine) and existing regulations (e.g., BC *Mines Act* Permit Application requirements) pertaining to mining operations in British Columbia. The aim of this review was to anticipate current regulatory requirements that must be met for the EA and to facilitate the gathering of information necessary for an eventual permit application.

The Kemess North Mine, Panel Review process, and documentation were reviewed for further guidance on matters related to the collection and interpretation of baseline data.

Overview level results of the review of historic data and reports are as follows:

- methods, site selection, sampling frequency and reporting followed the PRS
- methods and reporting were in accordance with standards in effect at the time
- additional studies were recommended for 2006 to better define baseline conditions, address new data collection standards and to meet current regulatory requirements for both the EA and regulatory requirements under MAPA

Additional studies were recommended for 2006 to better define baseline conditions, address new data collection standards and to meet current regulatory requirements for both the EA and regulatory requirements under MAPA.

Other considerations include:

1. a requirement for baseline mapping of the Access Road corridor to support effects assessment for all terrestrial disciplines
2. requirements for more detailed mapping (larger map compilation scale and higher survey intensity level) to meet MAPA requirements in the minesite area
3. reclamation requirements to map soil depth by horizon within the minesite area to support soil salvage and reclamation efforts

4.3.2 Approach and Methods for 2006 Assessment

Data accumulated between 1995 and 1998 by Talisman, along with data collected for the TEM program by Madrone (1997) during 1993 and 1995, was used in conjunction with data collected during the summer of 2006, in order to meet current regulations applicable to mine permitting and EA. Every effort was made to preserve as much of the previous data as possible, and the 2006 data collection methods were matched to the previous studies to ensure that data was compatible. The data sources were combined into a single database and were used to develop the updated soil map and associated map products. A similar approach to development of the Talisman soil map units was employed, however the increased level of detail available following the 2006 field season led to modifications of the map units developed for the 2006 report. In addition, the 2006 terrain mapping upon which the soil map was developed was remapped at a finer scale (within most of the minesite LSA). Details of the process are listed below.

4.3.2.1 Review of Literature and Existing Data

A review of existing literature applicable to the project area provided valuable information on the physiography, surficial geology, vegetation, and soil conditions in the project area. This included the previously discussed reports by Talisman and Madrone, along with the soil report published for the area (Valentine et al. 1987). The literature and data reviewed and used for the terrain baseline assessment is identified in Sections 4.3.1 and 4.3.3, and listed under references in Section 4.4.

4.3.2.2 TEM Mapping Program

TEM mapping of the area was carried out in the office using the PurVIEW^{TM} softcopy mapping system to delineate polygons used for both the soils and terrain assessments; the use of this technology has been accepted by both the BC Ministry of Forests and Range and the BC Ministry of Environment. Mapping was followed by a field inventory program where soils and terrain data was collected for the baseline study. Results were compiled and are described below, as well as the methods used. The TEM mapping area is delineated in Figure 4-1.

4.3.2.3 Soils Field Program

Soils

Data was incorporated from three primary sources for the soils component of this report:

- 2006: JW–AXYS field program
- 1995-1998: Talisman field program
- 1993-1995: TEM field program (Madrone)

A brief summary of Talisman data collection methodology is included because of the significant contribution of Talisman data to the overall program and to the similarities in methodology to those used in 2006. Thirty-three inspection sites from the TEM program conducted between 1993 and 1995 were utilized. These sites were part of a soil sampling program which included chemical analysis and detailed soil descriptions.

Jacques Whitford–AXYS Soil Survey Program (2006)

The following methods were used to determine the baseline conditions for soil in the LSA:

- the existing soil report (Valentine et al. 1987) and the soil survey completed by Talisman in 1999 for the minesite were reviewed for baseline soils conditions
- a soil survey was completed for the minesite LSA to increase the overall sampling intensity and to fill in spatial gaps identified in the original survey. Soil inspection sites were designed to meet SIL 2 requirements. Survey points were also established along the proposed access road and transmission corridor
- chemical analyses of the typical soil subgroups in the LSA were completed to confirm soil classification and reclamation suitability

Field Survey

The field survey was carried out in the summer and early fall of 2006. There were a total of 223 soil inspections completed at representative sites in and around the minesite LSA, and along the access road and transmission line corridors. Soil field plots for each field program are listed in Table 4-5 and presented in Figures 4-2, 4-3, and 4-4.

A SIL 2 soil survey was carried out on the minesite LSA.

All soil inspections were conducted using a shovel and Dutch auger to a depth of 1.2 m. For each inspection, the following site conditions were recorded:

- GPS coordinates
- surface expression
- slope
- slope position
- aspect
- gradient
- slope length

- drainage
- surface stoniness
- parent materials

Table 4-5 Summary of Soil Field Plots

Survey Area/Survey Period	**Plots**	**Hectares/Plot**
Minesite LSA		
JW–AXYS (2006)	136	32.4
Talisman (1995-1998)	223	19.8
TEM (1993-1995)	30	146.9
Total 38	**9**	**11.3**
Transmission Line		
JW–AXYS (2006)	**18**[4] **n/a**	
Access Road		
JW–AXYS (2006)	**78**[5] **n/a**	

Figure 4-2 Soils and Terrain Field Plot Locations of the Minesite LSA

Figure 4-3 Soils and Terrain Field Plot Locations of the Transmission Line Corridor LSA

Figure 4-4 Soils and Terrain Field Plot Locations of the Access Road LSA

For each soil pit, soil horizons were described using the Canadian System of Soil Classification criteria established by the Soil Classification Working Group (1998) and according to national standards established by the Expert Committee on Soil Survey (1983; 1987). The following information was collected for each horizon:

- depth
- texture
- Munsell color
- structure
- consistency

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[4] 18 plots were established along the original transmission line LSA. Of these seven occur within the current LSA; however, the remaining 11 plots are still relevant in the characterization of soils for the area.

[5] 78 plots were established along the original access road LSA. Of these 57 lie within the current LSA; however, the remaining 21 plots are still relevant in the characterization of soils for the area.

- coarse fragments content
- presence of salts
- presence of carbonates
- extent of mottling
- horizon boundaries

Each soil profile was classified to the subgroup level according to the Canadian System of Soil Classification (Soil Classification Working Group 1998). For a general soil and site description for each soil inspection site, see Appendix A.

Chemical Analysis

Chemical analyses were completed for inspection sites established during three separate programs (Table 4-6):

- 2006: Jacques Whitford–AXYS field program
- 1995 to 1997: Talisman field program
- 1993 and 1995: TEM field program (Madrone)

The chemistry and physical property data collected assisted in proper soil classification to the subgroup level and provided information necessary for calculating reclamation suitability ratings. Soil chemical and physical properties from the three field campaigns are summarized in Appendix B.

During the 2006 field program samples were collected from 15 soil inspection sites and submitted to Norwest Labs in Edmonton, Alberta for analyses. The profiles selected for analytical work were representative of the dominant mineral soils in the LSA or represented soils where analyses were required to verify soil classification. Samples of each horizon were placed in clean, labelled plastic bags and sent to the laboratory for physical and chemical analyses.

Using standard analytical procedures, topsoil horizons (i.e., A horizons) were analyzed for organic matter and all horizons were analyzed for pH, and particle size (texture). Fully sampled profile horizons were analyzed for electrical conductivity, saturation percent, cation exchange capacity and sodium adsorption ratio.

Table 4-6 Soil Sample Program for the Prosperity Project

Field Programs	Soil Sample Sites
Talisman 1995-1998	25
TEM 1993 - 1995 (Madrone)	33
Jacques Whitford–AXYS 2006	15

Talisman Soil Survey Program (1995-1998)

Soil surveys were conducted in August of 1995, September 1996, July 1997, and in late October 1998. Soil survey and classification was conducted following standard provincial and federal guidelines (Agriculture Canada Expert Committee on Soil Survey 1987; Expert Committee on Soil Survey 1983; 1987; Luttmerding et al. 1990).

The soil maps for most of the proposed development area were presented at a scale of 1:20,000. A detailed survey was conducted in the Open Pit and Plant Site areas. These were presented at a scale of 1:5000. A semi-detailed survey was conducted in the Tailings Storage Facility areas with an inspection site intensity of about 25 to 30 ha per inspection site.

In the locations for the Tailings Storage Facility, Waste Rock Dumps, and areas mapped at a reconnaissance level, soil polygons were stereoscopically delineated using 1:31,840 scale, black and white air photographs taken in 1967. Through digital photogrammetric techniques, McElhanney Engineering Ltd. transferred soil polygon boundary lines from stereo photographic pairs to controlled digital topographic bases (NAD 1983). 1:10,000 and 1:15,000 scale color air photographs from 1987 and 1993 were used to map the Open Pit and Plant Site areas. The polygons were transferred by hand to a 1:5000 topographic base map and subsequently digitized.

The site and soil characteristics recorded for each inspection location generally included the following:

- slope (%)
- site drainage
- coarse fragment content (percent volume of particles >2 mm in diameter)
- soil horizonation
- soil texture for each soil horizon
- type of parent material(s)
- comments or rating of the soil’s suitability for salvage

Soil samples representative of the major soil types mapped within the project area were analyzed by Pacific Soil Analysis Inc. (PSAI). PSAI uses standard analytical techniques that generally follow those listed in the Manual on Soil Sampling and Methods of Analysis (McKeague 1978).

Soil analyses included:

- coarse fragment content (screen #10 and weigh material >2 mm and <2 mm)
- particle size analysis
- pH
- electrical conductivity (EC)
- CEC and exchangeable cations: Mg, Ca, K, Na
- available macronutrients: P, K, Mg, Ca
- total nitrogen, carbon, and sulphur
- available sulphate: sulphur
- lime requirement

A total of 119 soil samples[6] (82 in 1996; 37 in 1997) were analyzed for pH, electrical conductivity and percent coarse fragment content. Some of the samples were analyzed for additional parameters (e.g., nutrients, cation exchange capacity, exchangeable cations and

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[6] Note that some of these samples no longer occur within the current proposed mine footprint.

particle size). Not all of these samples correspond to inspection sites occurring within the current proposed minesite footprint.

4.3.2.4 Soils Mapping Methodology

A soil map unit is a "defined and named repetitive grouping of soil bodies occurring together in an individual and characteristic pattern over the soil landscape" (Gregorich et al. 2001). A soil map unit may consist of a single soil type, but more commonly consists of a dominant soil type and inclusions of other soil types.

Soil map units were developed for the buffered minesite and for the access road. No model was developed for the transmission line corridor. The transmission line was excluded for the following reasons:

- The soil disturbance created during transmission line construction is generally confined to tower or pole locations and to roads related to construction and maintenance.
- The level of soil disturbance is typically minimal for this type of activity.
- The final transmission line route has not been determined.
- Because of the above factors, a limited number of soil inspections were undertaken on the proposed transmission corridor. The inspection points were focused on areas designated as ALR. When the extent and location of potential soil disturbances have been determined, a decision can be made whether further inspections are required.

Soil Map Symbols

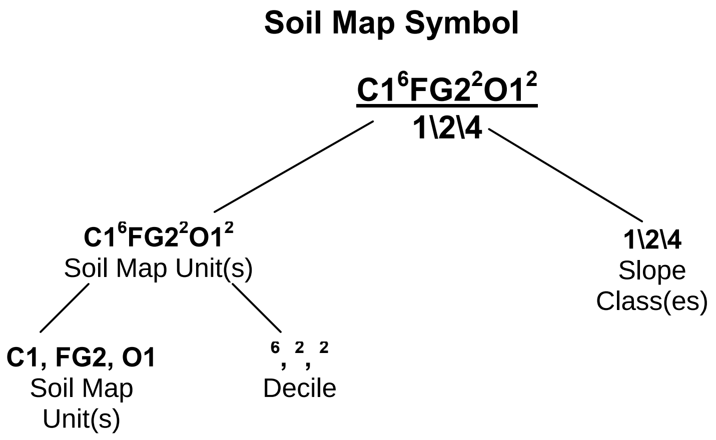
The description of a map symbol is based on the proportions of different soil types in specific landscape types. At large mapping scales, the goal of mapping is to subdivide the landscape into units consisting of one main soil type. However, this could not be consistently achieved in the minesite LSA or along the road corridor because of the variability in soil types over short distances. Therefore, where more than one soil type was present, the map symbol consisted of complexes. These complexes consisted of a dominant soil type with one or two differing soil types, which together account for the entire map symbol.

The soil map symbol has two components:

- soil map unit(s) and decile extents
- slope class(es)

Each of these components is illustrated in Figure 4-5 and described in detail below.

Figure 4-5 Map Symbol Description



The least complicated symbol would apply to a homogonous polygon with a single soil map unit (SMU) and a single associated slope (e.g,. C1^{10}/1). The first part of the SMU symbol, a one or two letter code followed by a single numeral, signifies the SMU that occupies the polygon. For example, the “C1” SMU can be described as moderately well to very rapidly drained soils found on thin deposits of colluvial parent material (the soil subgroups associated with each SMU are described in Table 4-7 and Table 4-8. The superscript number following the SMU code refers to the spatial extent, by decile, that the SMU occupies within the polygon (in the example above the “10” indicates that 100% of the polygon is SMU “C1”). Below the SMU/decile part of the symbol is another number code which signifies the dominant slope class for the polygon (in the above example the “1” signifies a slope range of 0-2%). Up to three SMU/decile combinations and up to three slope classes can potentially occur in a polygon, although this is uncommon. Slope classes are separated by backslashes (\) and indicate dominant slope class, secondary slope class and tertiary slope class. These slope classes are tied to the polygon, not the SMU/decile.

Table 4-7 Soil Map Unit Symbol Descriptions for the Minesite Area

Parent Material	Soil Map Unit	Surface Expression[1]	Drainage[2]							Soil Subgroup[3]
			VR	R	W	MW	I	P	V	
Colluvial	C1	x,v,w	x	x	x	x	-	-	-	Brunisolic Gray Luvisol/ Orthic Dystric Brunisol/Orthic Regosol (Orthic Eutric Brunisol)
	C2	a,b,j,k	x	x	x	-	-	-	-	Brunisolic Gray Luvisol/Orthic Dystric Brunisol (Orthic Eutric Brunisol/Orthic Humo-Ferric Podzol)
Residuum	D1	all	x	x	x	-	-	-	-	Orthic Eutric Brunisol/Orthic Dystric Brunisol/Orthic Regosol
Fluvial	F1	f,t,v	-	x	x	x	-	-	-	Orthic Dystric Brunisol/Brunisolic Gray Luvisol (Orthic Eutric Brunisol)
	F2	j,p,v	-	-	-	-	x	x	-	Orthic Humic Gleysol/Rego Humic Gleysol (Gleyed Cumulic Humic Regosol)
Glaciofluvial	FG1	a,k,r	-	x	x	x	-	-	-	Orthic Dystric Brunisol/Orthic Gray Luvisol (Orthic Eutric Brunisol)
	FG2	b,j,m,p,t,u	-	x	x	x	-	-	-	Orthic Dystric Brunisol/Brunisolic Gray Luvisol (Orthic Eutric Brunisol)
	FG3	b,j,p,u	-	-	-	-	x	x	-	Orthic Humic Gleysol/Rego Humic Gleysol
Lacustrine	L1	p	-	-	x	x	x	x	-	Rego Humic Gleysol/Orthic Humic Gleysol (Orthic Gray Luvisol)
Morainal	M1	v,w,x	-	x	x	x	-	-	-	Orthic Dystric Brunisol/Orthic Eutric Brunisol (Brunisolic Gray Luvisol)
	M2	k,r	-	x	x	x	-	-	-	Brunisolic Gray Luvisol/Orthic Eutric Brunisol/Orthic Gray Luvisol (Orthic Dystric Brunisol)
	M3	a,b,j,m,p,u	-	x	x	x	-	-	-	Orthic Eutric Brunisol/Brunisolic Gray Luvisol/Orthic Gray Luvisol (Orthic Dystric Brunisol)
	M4	b,j,p,t,u	-	-	-	-	x	x	-	Rego Humic Gleysol/Orthic Humic Gleysol/Orthic Gleysol
Organic	O1	b,j,p	-	-	-	-	-	-	x	Typic Mesisol/Typic Humisol (Terric Mesisol/Terric Humisol)
	O2	v (b,p with poor drainage)	-	-	-	-	-	x	x	Terric Mesisol/Terric Humisol
	O3	x	-	-	-	-	-	x	x	Rego Humic Gleysol/Rego Gleysol/Orthic Humic Gleysol (peaty phase)
Bedrock	R1	all	-	-	-	-	-	-	-	Non-soil
Water	WA	not applicable	-	-	-	-	-	-	-	Water
Anthropogenic	DL	all	-	-	-	-	-	-	-	Disturbed Land

NOTES:

[1] Surface expression codes are shown in Table 4-9

[2] Drainage codes are shown in Table 4-10

[3] Subgroups are listed in order of likelihood; those surrounded by parenthesis may occur but are typically minor components of the soil map unit

Table 4-8 Soil Map Unit Symbol Descriptions for the Access Road

Parent Material	Soil Map Unit	Surface Expression[1]	Drainage[2] Soil							Subgroup(s)[3]
			VR	R	W	MW	I	P	V	
Colluvial	C1	v	x	x	x	x	-	-	-	Brunisolic Gray Luvisol/Orthic Eutric Brunisol (Orthic Gray Luvisol)
	C2	a,b,j,k	-	x	x	x	-	-	-	Orthic Gray Luvisol/Brunisolic Gray Luvisol (Orthic Eutric Brunisol)
Fluvial	F1	f,j,p,t,v	-	x	x	x	-	-	-	Brunisolic Gray Luvisol/Rego Dark Brown Chernozem (Orthic Gray Luvisol/Orthic Eutric Brunisol)
	F2	f,j,p,v	-	-	-	-	x	x	-	Orthic Humic Gleysol/Rego Humic Gleysol (Gleyed Cumulic Humic Regosol)
Glaciofluvial	FG1	a,h,k,r,s	-	x	x	x	-	-	-	Orthic Eutric Brunisol (Orthic Gray Luvisol)
	FG2	b,f,j,m,p,t,u	-	x	x	x	-	-	-	Orthic Gray Luvisol/Orthic Eutric Brunisol (Eluviated Eutric Brunisol)
	FG3	j,p,u	-	-	-	-	x	x	-	Orthic Humic Gleysol/Rego Humic Gleysol
	FG4	v	-	x	x	-	-	-	-	Orthic Eutric Brunisol/Brunisolic Gray Luvisol (Orthic Gray Luvisol)
Lacustrine	L1	p,v	-	-	-	x	x	x	-	Orthic Gray Luvisol/Orthic Dark Brown Chernozem (Rego Humic Gleysol/Orthic Humic Gleysol)
Morainal	M1	v,w	-	x	x	x	x	-	-	Orthic Eutric Brunisol (Brunisolic Gray Luvisol/Orthic Gray Luvisol)
	M2	h,k,r	-	x	x	x	-	-	-	Orthic Gray Luvisol/Orthic Eutric Brunisol (Brunisolic Gray Luvisol)
	M3	a,b,j,m,p,u	-	x	x	x	-	-	-	Orthic Gray Luvisol (Orthic Eutric Brunisol/Brunisolic Gray Luvisol/Eluviated Dark Brown Chernozem)
	M4	b,j,p,u	-	-	-	-	x	x	-	Rego Humic Gleysol/Orthic Humic Gleysol/Rego Gleysol
Organic	O1	b,p	-	-	-	-	-	-	x	Typic Mesisol/Typic Humisol (Terric Mesisol/Terric Humisol)
	O2	v,w (b with poor drain)	-	-	-	-	-	x	x	Terric Mesisol/Terric Humisol
	O3	x	-	-	-	-	-	x	x	Rego Humic Gleysol/Rego Gleysol/Orthic Humic Gleysol (peaty phase)
Bedrock	R1	all	-	-	-	-	-	-	-	Non-soil
Water	WA	not applicable	-	-	-	-	-	-	-	Water
Anthropogenic	DL	all	-	-	-	-	-	-	-	Disturbed Land

NOTES: Surface expression codes are shown in Table 4-9
Drainage codes are shown in Table 4-10
Subgroups are listed in order of likelihood; those surrounded by parenthesis may occur but are generally minor components of the soil map unit

The SMUs were developed using the inspection points established during three separate field campaigns:

- the TEM program in 1993 and 1995
- the soil survey conducted by Talisman between 1995 and 1998
- the soil survey conducted by Jacques Whitford–AXYS during the summer and early fall of 2006

The SMUs and map symbols developed for this project were based on previous work completed by Talisman (1999). Additional field work and terrain mapping was undertaken by Jacques Whitford–AXYS in 2006. The SMUs were modified and expanded to account for additional terrain map units created when the terrain mapping for the minesite was updated to a scale of 1:10,000 rather than the original 1:20,000 scale. It also reflects an increase in soil survey density.

Decision Matrix

A model decision matrix was developed in an iterative process whereby logical groupings of soil parent materials, surficial expressions and drainages were matched to the soil subgroups common in the area. The starting point for this process was the 1999 Talisman soil survey SMUs. These were then compared to the output of the 2006 terrain mapping exercise and adjustments were made to incorporate the more refined terrain and soils data. The updated SMUs reflect an increased level of resolution supported by an increased number of plots, a better distribution of sample points and a finer terrain mapping scale within the minesite footprint and LSA. Talisman SMUs were retained in some cases and modified in other cases. New SMUs were developed for parent material/surface expression/drainage conditions not documented during the initial Talisman survey.

The application of the model decision matrix was through spatial analysis with the ESRI ARC software platform. In the spatial and database environment of the ARC platform, specific combinations of terrain attributes were identified for each polygon and, based on the model decision matrix table, soil map units were identified and assigned a soil map unit symbol (Table 4-7 and Table 4-8). Descriptions of codes used in the tables are included in Tables 4-12 and 4-13.

The resulting output table created additional columns containing the predicted soil map units for each decile of the terrain classification. Each polygon was populated with at least one SMU to a maximum of three, depending on the complexity of the terrain attributes assigned during classification. On successful completion of the beta test, the outputs of the model were assessed and reviewed. Model adjustments were then made.

Soil map unit symbols were assigned to each delineated polygon in the minesite area and access road corridor to create the final baseline soil map products. A colour coded soil map with appended legend was developed using GIS software.

Table 4-9 Surface Expression Codes Used in Table 4-7 and Table 4-8

Code Des	cription[7]
a	moderate slope
b	blanket (>1 m deep)
c	cone(s)
d	depression(s)
f	fan(s)
h	hummock(s)
j	gentle slope
k	moderately steep
m	rolling
p	plain
r	ridge(s)
s	steep slope
t	terrace(s)
u	undulating
v	veneer
w	mantle of variable thickness
x	thin veneer (>10 cm <1 m deep)

Table 4-10 Drainage Classes Used in Table 4-7 and Table 4-8

Symbol	Drainage Class	Description[8]
x	Very Rapid	Water is removed from the soil very rapidly in relation to supply
r	Rapid	Water is removed from the soil rapidly in relation to supply
w	Well	Water is removed from the soil readily but not rapidly
m	Moderately Well	Water is removed from the soil somewhat slowly in relation to supply
i	Imperfect	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season
p	Poor	Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen
v	Very Poor	Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen

4.3.2.5 Determining Soil Reclamation Suitability

Soil reclamation suitability was designated as the KIR for areas located outside of the ALR. Mining related activities have the ability to create a significant residual environmental effect on soil resources on non-ALR land. Any significant shift from higher to lower reclamation suitability classes would indicate that mining activities were negatively impacting soil resources. Maintaining classes as closely as possible to pre-

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[7] As defined in Howes and Kenk (1997)

[8]. As defined by Expert Committee on Soil Survey (1983) and in Soil Classification Working Group (1998)

mining structures is the primary goal of soils conservation and reclamation plans and activities. Some minor degradation is generally expected, but the overall class structure should not shift as a result of mining activities.

Reclamation suitability ratings for the undisturbed mineral soil of the root zone (mineral soil above the C horizon) on the minesite LSA were determined using the methods outlined in Soil Quality Criteria Relative to Disturbance and Reclamation (AAFRD 1987) and the physical and chemical data gathered for the soil map units (Appendix E). The criteria used were those developed for the Eastern Slopes Region (Table 4-11). It was felt that the eastern slopes criteria most closely matched conditions in the minesite area. No modifications to the criteria were deemed to be necessary.

Table 4-11 Criteria for Evaluating the Suitability of Root Zone Material in the Eastern Slopes Region

Rating/Property	Good (G)	Fair (F)	Poor (P)	Unsuitable (U)
Reaction (pH)[1]	5–6.5	4–5; 6.5–7.5	3.5–4; 7.5–9	<3.5 and >9
Salinity (EC)[2] (dS/m)	<2	2–4	4–8	>8
Sodicity (SAR)[2]	<4	4–8	8–12	>12[3]
Saturation (%)[2]	30–60	20–30; 60–80	15–20; 80–100	<15 and >100
Coarse Fragments[4] (% Vol)	<30[5]; <15[6]	30–50[5]; 15–30[6]	50–70[5]; 30–50[6]	>70[5]; >50[6]
Texture	L, SiCL, SCL, SL, FSL,	CL, SiL, VFSL, SC, SiC	LS, S, Si, C, HC	Consolidated bedrock
Moist Consistency	very friable, friable	Loose, firm	very firm	extremely firm
$CaC0_3$ (%)	<2	2–20	20–70	>70

Notes:

[1] pH values presented are most appropriate for trees, primarily conifers. Where reclamation objective is for other end land uses, such as erosion control, and where other plant species may be more important, refer to Table 6 in *Soil Quality Criteria Relative to Disturbance and Reclamation* (AARD 1987).
[2] Limits may vary depending on plant species to be used.
[3] Materials characterized by an SAR of 12 to 20 may be rated poor if texture is sandy loam or coarser and saturation % is less than 100.
[4] 0.2 to 25 cm diameter fragments in the soil material.
[5] Matrix texture (modal) finer than sandy loam.
[6] Matrix texture (modal) sandy loam and coarser.

The potential suitability ratings range from unsuitable for use as a reclamation material to good suitability (Table 4-12). These ratings provide a guide for developing soil handling recommendations. Suitability ratings for organic sites are not accounted for as the ratings have been designed strictly for mineral soils. Organics are coded as “O” and volumes are calculated for use as a soil amendment. These ratings apply to both the minesite and the access road.

Table 4-12 Reclamation Suitability Ratings

Rating	Soil Map Unit	Description
Good	No soils with a Good rating were identified in the LSA.	None to slight limitations that can affect plant growth
Fair	F1, F2, M1, M4	Moderate to severe limitations; can be overcome by proper planning and good management
Fair to Poor	L1, M3	Contains soils with fair and poor ratings
Poor	M2	Severe soil limitations that make use questionable; careful planning and very good management are required
Unsuitable	C1, C2, D1, FG1, FG2, FG3, FG4, R1, WA, DL	Chemical or physical soil properties are so severe that the reclamation is not possible or economically feasible
Not Rated	O1, O2, O3	Organic soils and disturbed land are not rated in this system

4.3.2.6 Determining Soil Salvage Depths and Volumes

Soil salvage depths for each soil map unit encountered in the minesite LSA were calculated by summarizing field data for each SMU and determining average salvageable depths for each grouping. The soil polygons with assigned map units were checked against the plot data. All polygons containing plot data were correlated with the site data and an average depth assigned based on soil map unit. The estimated salvage depths combine topsoil and subsoil due to the general lack of an “A” horizon (topsoil). Organic matter (LFH and thin O horizons) was also incorporated to determine a total salvage depth. This approach will be more effective at the operational level as all salvage will include any material above the parent material or C horizon.

Table 4-13 summarizes the estimated salvage depths applicable to the soil map units found within the minesite LSA. Bedrock (R1), water bodies (WA) and disturbed lands (DL) are categorized as non-soils and have a corresponding salvage depth of zero. The residual map unit (D1), the steeper, drier glaciofluvial unit (FG1), the lacustrine unit (L1), the thin morainal unit (M1), and the thin organic veneer (O1) have been assigned a salvage depth of 30 cm. The colluvial soil map units (C1, C2) along with wet or thin glaciofluvial units (FG3, FG4) have salvage depths of 35 cm. The drier fluvial map unit (F1) along with the steeper, drier morainal unit (M2) have a salvage depth of 40 cm, while the relatively gently sloped, drier glaciofluvial and morainal map units (FG2, M3) were assigned a salvage depth of 45 cm. It was determined that the appropriate salvage depth for the poorly drained morainal unit (M4) was 50 cm, and for the remaining fluvial map unit (F2) 80 cm. The two deeper organic soil map units (O1, O2) had relatively deep salvage depths of 160 and 115 cm respectively.

Table 4-13 Soil Map Units and the Corresponding Salvage Depths

Soil Map Unit(s)	Salvage Depth (cm)
R1, WA, DL	0
D1, FG1, L1, M1, O3	30
C1, C2, FG3, FG4	35
F1, M2	40
FG2, M3	45
M4	50
F2	80
O2	115
O1	160

4.3.2.7 Determining Agricultural Land Capability

The ALR is a provincial land use zone in which agriculture is recognized as the priority use. No ALR land is present within the minesite LSA; however ALR lands are present in the access road LSA and the transmission line LSA. For the access road LSA, 1:250,000 Canada Land Inventory mapping was overlain on the project soil map to generate an agricultural capability rating for each soils polygon within the ALR. Agricultural capability maps were then created for the ALR portions of the access road LSA. A majority of the soils in this region were rated as Class 4, 5 or 6. Appendix C summarizes the codes used in the Canada Land Inventory agricultural capability rating system.

4.3.2.8 Soils Quality Control

This section will primarily discuss quality control for work performed by Jacques Whitford–AXYS. Soils work performed prior to 2006 was completed by Talisman (1999) and Madrone (1997) and is summarized in these reports. Jacques Whitford–AXYS completed some QA/QC was on data collected by Talisman and Madrone when original data sheets were available, including detailed horizon descriptions.

The quality control component of the 2006 field program included a field correlation exercise and a plot card review process.

The field correlation was completed at the beginning of the 2006 field program, after a review of the Talisman (1999) and Valentine et al. (1987) soil reports. The soils lead worked with a senior soil scientist for the first two days of the minesite field program and periodically during the rest of the field program. This was done to ensure that both soil scientists working on the project shared an understanding of the purpose of the program and used standardized data collection methods. It also ensured a common understanding of parent materials, horizon sequences and soil subgroups common in the area.

Field plot cards were reviewed on a nightly basis by the soils lead to ensure that data was consistently collected and recorded. In addition, a portion of the plot cards were reviewed by a senior soil scientist following the field program.

Quality control during data entry was accomplished in two ways. The first was the use of a junior soil scientist for data entry. Through an understanding of soils terminology and concepts, the data enterer could spot any errors that may have occurred on the original plot cards. The database was then reviewed by the soils lead to spot any remaining errors and to identify inconsistencies.

A comprehensive senior review process was also carried out at the final stages of the baseline to ensure overall quality control of the final product.

4.3.2.9 Analyzing Model Accuracy and Final Adjustments

Model effectiveness was assessed by using background literature, previous mapping of the area by Talisman (1999) and Valentine et al. (1987), and by comparisons to ground inspection data. On-site field plot data from Talisman, Madrone and from the 2006 field season were used to verify model accuracy. Any discrepancies between model results and the field data were noted. Discrepancies with the model were adjusted to best reflect field data.

Soil map unit assignments using the model decision matrix were checked against field data collected at a SIL 2 density (~ 1 inspection per 11 ha for the minesite LSA).

4.3.2.10 Terrain Field Program

Terrain field data were collected as part of the overall Terrestrial Ecosystem Mapping (TEM) and soils field programs conducted between June to August 2006, and again in October 2006 for terrain mapping of the transmission line corridor. The field programs recorded information on surficial sediment types (e.g., till, organics, etc.), surface expression, slope, drainage and geologic modifying processes including mass movements. The minesite and transmission line areas were accessed mainly by helicopter, while the existing road was used to study the access road area.

The terrain field data was used both to verify preliminary terrain linework and to provide classification data for individual terrain units. At each detailed ground site, the following attribute data were recorded on a standard data sheet:

- slope gradient (percent)
- topographic position
- parent material (surficial sediment type)
- surface expression
- texture of surface material
- texture of parent material
- percentage of coarse fragments
- coarse fragment description
- drainage
- geomorphic modifying processes, including rapid and slow mass movements

Visual site inspections were also carried out while in the field, primarily during helicopter flights over the study area. However, terrain field data collection was limited to that information which could be collected with confidence. Heavily forested areas were not considered suitable for visual inspection.

Terrain field plots are identified for the minesite, transmission line corridor, and access road LSA in Figures 4-2, 4-3 and 4-4 respectively. Table 4-14 summarizes field sites by local study area.

Table 4-14 Terrain Field Sites by Local Study Area

Local Study Area	Talisman/Madrone Field Programs		Summer-Fall 2006 Field Program		Total Sites	Hectares per Plot
	Detailed Ground Sites	Visual Sites	Detailed Ground Sites	Visual Sites		
Minesite (4419 ha)	253	unknown	136	0	389	11.4
Access Road (3495 ha)	0	0	78	0	78[9]	44.8
Transmission Line Corridor (6264 ha)	26	unknown	36	22	58[10]	108

4.3.2.11 Terrain Mapping Methodology

To develop a better understanding of the terrain within the project area, in-house earth scientists undertook detailed terrain mapping of the minesite and access road as part of the JW–AXYS TEM mapping program. Terrain mapping was not carried out for the transmission corridor because it was determined during the scoping process that existing mapping by Valentine et al. (1987) and Talisman (1998) was sufficient for the EA.

Mapping of the Minesite was completed at 1:10,000 to 1:7500 using a combination of 1997 1:15,000 color and 1:20,000 2005 colour aerial photographs. The intent of this mapping was to use the existing mapping completed by Madrone (1997) and subdivide the polygons to better reflect the terrain conditions within the minesite area. Revisions were completed by subdividing, redrawing and reclassifying individual map units where necessary.

Terrain maps identifying terrain hazard and constraints (flooding, gullying, etc.) were produced at 1:50,000 scale by Talisman in 1998 for the transmission line corridor and buffer area. Polygons with terrain hazards were field checked either by helicopter or on-site inspections to confirm terrain and hazard assessments. Terrain information for the transmission corridor was supplemented from soils maps produced by Valentine et al. (1987) at 1:100,000 scale.

No previous mapping was available for the access road, hence new mapping was completed for this area along the original LSA - a one kilometre wide corridor centred on the road. Mapping was done at a scale of 1:20,000 using 1999 black and white 1:35,000 scale air photos. Rather than using the traditional approach to airphoto interpretation (i.e., using hardcopy air photos and a stereoscope), our terrain scientists use the PurVIEW^{TM} softcopy mapping system to complete mapping.

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[9] 78 field plots were established along the original access road LSA (which used a 1 km buffer on either side of the access road). Of these, 57 lie within the current LSA; however, the remaining 21 plots are still relevant in the characterization of terrain conditions of the area.

[10] 58 plots were established along the original transmission line LSA and alignment (which used a 1.5 km buffer on either side of the transmission line). Of these 33 occur within the current LSA; however, the remaining 25 plots are still relevant in the characterization of the terrain conditions of the area.

The JW–AXYS TEM mapping process involved scanning of the hardcopy airphotos at 10 µ using a high-resolution scanner and merging these digital files with BC TRIM Digital Elevation Model (DEM) data to create digitally rectified files that can be viewed in three dimensions on a computer monitor. Using PurVIEW^{TM} mapping systems, the mapper is able to “zoom down” to scales as large as 1:1000 from the original hard copy aerial photographs. This provides tremendous advantage to the mapper in his/her ability to better delineate subtle features of the landscape and to properly classify terrain units.

A team of surficial geologists began delineating relatively homogenous terrain by zooming down in the digital imagery to an approximate scale of 1:10,000 to 1:7500. Minimum polygon (map unit) size was 1 cm^2, an area equivalent to 1.5 ha at 1:7500 scale. Individual polygons were delineated based on five key physical parameters:

- surficial material
- surface expression
- slope
- drainage
- geomorphic modifying process

Where applicable, the following terrain mapping standards were followed: Howes and Kenk (1997), Resources Inventory Committee (1996) and British Columbia Ministry of Environment and British Columbia Ministry of Forests (1998).

Below is a listing of the key variables or attributes identified within the delineation and classification process.

Slope

Table 4-15 lists the slope classes and ranges used in the mapping process.

Table 4-153 Slope Classes and Ranges

Slope Class	Slope Range[1] (%)	Description
1	0–5	Plain (planar), very gently undulating
2	6–26	Gentle slope, undulating
3	27–49	Moderate slope, inclined
4	50–70	Moderately steep slope, inclined
5	70+	Steep slope, inclined

NOTE: [1] Defined in Howes and Kenk (1997)

Surficial Materials

Surficial materials are defined as non-lithified, unconsolidated sediments. They form from weathering of bedrock, deposition of sediments by ice and water, biological accumulation and human and volcanic activity. Surficial deposits are classified according to their mode of formation, transport and deposition. They can also be described by the status of their mode of formation - either active (A) or inactive (I) (Howes and Kenk 1997). Table 4-16 lists the surficial material types mapped within the three LSAs.

Table 4-16 Surficial Material Types

Class	Surficial Material Type[1]
A	Anthropogenic (altered by human activity)
C	Colluvium
D	Weathered bedrock (in situ)
E	Eolian
F	Fluvial
FG	Glaciofluvial
L	Lacustrine
M	Moraine (till)
N	Water
O	Organic
R	Bedrock

NOTE: [1] Defined in Howes and Kenk (1997)

Surface Expression

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial deposit at the land surface. The three-dimensional shape of the deposit is called a "landform". Surface expression symbols also describe how unconsolidated surficial materials relate to the underlying deposits or bedrock (Howes and Kenk 1997). Table 4-9 lists the surface expression classes used in the terrain and soils mapping programs.

Drainage

Drainage refers to how well or poorly drained a particular surficial deposit or bedrock unit is. Areas with ponding or permanently high water tables are considered very poorly drained, whereas areas that hold no moisture at all, such as steep bedrock faces, are considered very rapidly drained. Table 4-10 lists the drainage classes used for terrain and soils mapping programs.

Geomorphic Modifying Processes

Geomorphological (geomorphic) processes are natural mechanisms of weathering, erosion and deposition that result in the modification of surficial sediments and landforms at the earth's surface (Howes and Kenk 1997). These processes can be further described by their status of activity—either active (A) or inactive (I). Table 4-17 lists the geomorphic modifying process classes used in the mapping process.

Table 4-17 Geomorphic Modifying Process Classes

Class	Geomorphic Modifying Process[1]
A	Snow avalanche
E	Channelled by meltwater
F	Slow mass movement
H	Kettled
I	Irregularly sinuous channel
L	Surface seepage
M	Meandering channel
R	Rapid mass movement
U	Inundation
V	Gullying

NOTE: [1] Defined in Howes and Kenk (1997)

4.3.2.12 Determining Terrain Integrity

Land clearing and contouring, road construction, trenching and blasting and other project-related activities that could result in terrain instability are typically localized and site-specific. These activities require on-site terrain stability assessments in areas considered most prone to project-related instability. Such detailed terrain stability assessments are typically done at the permitting stage prior to construction/development once the precise location of the proposed activity is known. Currently, exact locations for proposed project infrastructure, such as access road alignments for the haul road and transmission line corridors, have not been established and therefore, detailed terrain stability assessments are not yet warranted. However, guidance can be provided by identifying terrain within each LSA where the likelihood of project-related terrain instability is highest.

Past baseline studies have included terrain stability mapping to provide guidance for mine development activities. For example, terrain stability mapping was carried out at 1:20,000 scale for the Kemess North project (Klohn Crippen 2005) and at 1:60,000 scale for the Red Chris project (AMEC 2004). However, due to the large combined LSAs for this project, and the relative benign nature of the majority of the terrain within these areas, a more focused approach was considered more appropriate.

Evidence of existing mass wasting in terrain polygons indicates areas most likely to experience further terrain instability, both natural and development-related. According to the Mapping and Assessing Terrain Stability Guidebook (Anonymous 1999), such unstable terrain is classified as “U” (unstable) or “Class V” at reconnaissance (1:20,000-50,000 scale) or detailed (1:5000–20,000 scale) mapping scales, respectively (Anonymous 1999). For this assessment, maps of the minesite and access road LSAs showing all terrain polygons containing rapid or slow mass movement processes have been produced to identify areas of high hazard. These maps were produced during the TEM bioterrain mapping program at a scale of 1:10,000 to 1:7500 for the minesite and 1:20,000 for the access road corridor. In the transmission line corridor LSA, terrain hazard maps produced by Talisman (1998) at 1:50,000 scale were used to identify areas where terrain stability hazards were observed. Terrain constraints to transmission line construction such as flooding and gullying were also identified in the Talisman mapping.

In polygons where terrain instability is not evident and no terrain stability mapping exists, an assessment of the likelihood of significant project-related residual environmental effects becomes more subjective and less reliable without more detailed study and/or on-site assessment. Although the majority of the terrain within the LSAs would be classified as having a very low to low likelihood of project activities triggering terrain instability, there may still be areas where the likelihood is high. Where no terrain stability mapping or on-site assessments exist it has been standard practice within the forest industry in BC to identify slopes greater than 60% in gradient as being potentially prone to instability related to development such as road construction and timber removal. Should development be proposed in such areas, a terrain stability assessment would then be carried out prior to commencement of the development activity. At this stage of the project such an approach is considered appropriate for the purpose of this baseline assessment.

Slope gradient maps generated using digital elevation models were produced for the LSAs in order to identify potentially unstable areas where slope gradient exceeds 60%. Terrain maps can also provide further guidance when used to identify surficial materials such as glaciolacustrine sediments which may be prone to mass wasting on slopes less than 60%.

4.3.2.13 Terrain Quality Control

Quality control and quality assessments were completed for preliminary mapping, field inventory programs, final mapping and classification, and through senior review of the entire baseline report.

Preliminary mapping was reviewed early in the process by one of JW–AXYS's senior terrain scientists. This individual reviewed the mapping to ensure that it adhered to the mapping standards for the Project and properly portrayed the landscape in a meaningful manner. Linework that was not acceptable was modified and subsequently reviewed.

A review of all plot data was completed on a nightly basis to ensure that all required fields were properly filled out and that the classification of materials and soils types made sense.

Final mapping and classification were reviewed to ensure compliance with Provincial mapping standards. Formal classifications were reviewed and compared to previously completed mapping by Madrone (1997) to assess their level of congruence. Interpretations related to slope, drainage and percentile of polygon were deemed acceptable if they were either identical or within one class of the reviewer's interpretation. For parent materials and geomorphic modifying processes, a more subjective evaluation was made. If there was a measurable difference in the properties of the materials (e.g., moraine versus organic), then the classification was deemed not acceptable.

A minimum of 80% of all terrain classifications, including both the new and the Madrone work were reviewed at various stages of the classification process. As the terrain mapping was used as a basis for the soil mapping program, the soil mappers also reviewed the terrain classifications. If any discrepancies were noted, the classifications were reviewed and changes were made where necessary.

A comprehensive senior review of the entire baseline was also carried out to ensure the overall quality of the final product.

4.3.3 Overview of Baseline Conditions

4.3.3.1 Physical Setting

Physiography

The Taseko Prosperity Gold-Copper Project is situated in the Fraser Plateau Section of the Interior Plateau; this flat to gently rolling plateau forms a major part of the Interior physiographic system (Demarchi 1995; Holland 1976). The geologic (dominantly level or gently dipping lava flows) and physiographic history (e.g., extensive Pleistocene glaciation) is similar across the Interior Physiographic System, which extends from the Coast Mountains in the west to the Rocky Mountains in the east.

The extensive Interior Plateau is of low to moderate relief underlain by Tertiary age basaltic flows within the southern Interior Physiographic System. The southern Interior Plateau is drained by the Fraser River. Holland (1976) characterized the area as being the "remnants of the very widespread late Tertiary erosion surface which was uplifted and dissected". Subsequently, extensive Miocene and early Pliocene basalt lava flows resulted in the development of plains of low relief throughout this area.

The topography is characterized by an undulating to rolling plateau dissected by a few valleys and associated rivers. Stream erosion was rejuvenated following the uplift of the plains created in early Pliocene time. The general surface of the Fraser Plateau was raised to 1525 m above sea level (asl) and resulted in deep incisions in the main valleys (e.g., Fraser River) and much less so at the valley heads which were created in pre-Pleistocene times. Very little dissection or incision of the uplands had occurred on the western Fraser Plateau by the end of the Tertiary period. The main river system is the Taseko River; its main tributary is Fish Creek. .

The transmission line corridor for the proposed Taseko Mine extends across the Fraser Plateau section of the Interior Plateau which is a major component of the Interior Physiographic System, and crosses the Fraser River Valley between Meason Creek to the northeast and Word Creek to the southwest. Slopes are generally low in plateau areas, and steeper on valley walls.

Elevations within the Minesite range from 1222 to 1830 m asl, with a mean elevation of 1538 m asl. The Access Road spans 607 to 1644 m asl, averaging 1226 m asl. The transmission line corridor averages 1276 m asl and has a range of 341 to 1979 m.

Bedrock Geology

This section provides a general overview of the bedrock geology of the study area. A detailed description is provided in Volume 3, Section 5.

The three LSAs fall within the westernmost portion of the Intermontane Belt, about 50 km northeast of the Coast Plutonic Complex boundary. Most of the area is underlain by Late Palaeozoic to Cretaceous lithotectonic assemblages intruded by Mid-Cretaceous to Early Tertiary plutons (Brommeland et al. 1998).

The Yalakom Fault lies southwest of the LSAs. Northeast of the fault, the majority of exposed rocks are composed of feldspathic sandstones, conglomerates and shales. Andesitic volcaniclastic and volcanic rocks that are thought to correlate with andesites, tuffaceous sandstones, argillites and siltstones are exposed near the mouth of Fish Creek. Fossils from shale deposits between the volcanic rocks at Fish Creek suggest an Early

Cretaceous (Hauterivian) age. Flat to gently dipping Miocene plateau basalts and non-marine sedimentary rocks are associated with the Chilcotin Group (Brommeland et al. 1998).

The geological details of the Taseko Prosperity Gold-Copper deposit are also discussed by Brommeland et al. (1998) and the interpretation is based on 379 diamond drill holes and 68 percussion holes. The Prosperity deposit is mainly within Cretaceous andesitic volcaniclastic and volcanic rocks, although rocks of the Late Cretaceous Fish Lake Intrusive Complex can be found in the western portion of the deposit (Brommeland et al. 1998).

Surficial Geology

Physiography, landforms and surficial deposits of the area are associated with the Late Wisconsinan glaciation which occurred between approximately 10,000 and 25,000 years before present. During this glacial period, ice from the Chilcotin and Pacific ranges moved north and northeastward in a radial pattern over the Fraser Plateau (Talisman 1997).

During Pleistocene glaciation the upper surface of the ice sheet was in excess of 2450 m. The main effect of this period was the deposition of drift over the plateau surfaces and resultant rolling, drumlinized till plain configuration, with the same general configuration of the underlying basalt flows. During the subsequent warmer period of ice wasting, approximately 10,000 years before present, meltwater channels were occupied by large streams, resulting in numerous glacioflucial landforms. Many of these former channels are drainage ways occupied by much smaller modern streams. Many lakes and organic filled depressions were formed as a result of the ice movement and subsequent melting and development of enclosed depressions.

Preliminary baseline reports by Talisman (1997, 1999), Brommeland and Wober (1997) and Brommeland et al. (1998) discuss the surficial sediments in the area. Compact glacial till is the most common glacial deposit within the project area. In general, these till are described as a heterogeneous mix of subrounded to subangular boulders, cobbles, and pebbles in a sandy to sandy loam matrix. However, the texture varies depending on the bedrock the material is derived from and the distance it has been transported. Results from drilling assessment reports (Brommeland and Wober 1997, Brommeland et al. 1998) identified a till with a gray clay-rich matrix with up to 60% clasts of various lithologies, including some that are not typical of the area. The depth of glacial till ranges from less than one meter on steep valley side-slopes (e.g., along the west and north sides of the Open Pit) to more than five meters in the valley bottoms (Talisman 1999).

Extensive glaciolacustrine deposits were identified in cores drilled in the southern part of the future open pit (Talisman 1997, Brommeland et al. 1998). The deposits consist primarily of horizontal, varved clay and silt beds up to 30 cm thick, which often contain interbeds of coarse sand and gravel. At the base of some of the beds there is a layer of black organic debris which commonly contains leaf fossils and woody debris (Brommeland et al. 1998). Extensive glaciolacustrine deposits are also found within the transmission line corridor LSA, most prominently on the terraced and gullied east slopes of the Fraser River.

Glaciofluvial deposits commonly occur as sinuous ridges (eskers) or irregular mounds (kames) and are generally formed of abundant round to subrounded pebble- to cobble-sized coarse fragments set in a sand or silty sand matrix. Eskers and kames are most prominently found in valley bottoms and tend to be coarse-textured, with well rounded to subrounded gravel to cobble sized clasts (Talisman 1997). Extensive glaciofluvial terraces are located along the Fraser River above modern fluvial deposits.

Recent fluvial deposits are also present throughout the area, primarily along valley bottoms and floodplains. Fluvial deposits range from silts to gravels and are typically finer in texture than glaciofluvial sediments (Talisman 1997) with sandy pebble/cobble gravel being the most common. A cap of finer sediments (overbank deposits) is common in the upper 10–50 cm.

Overburden and soil reports from Talisman (1997, 1999) describe colluvial materials located on the mid and upper slopes of steep areas. The deposits range from coarse, angular, stony talus derived from basalt with little or no fines, to medium-grained, moderately coarse-textured deposits that may have been reworked by water.

Organic accumulations are present in many areas of the minesite, particularly in areas to the east and south. The organic accumulations have developed in poorly drained depressions in the southern and eastern portions of the pit area and vary in thickness from 15 to 300 cm (Talisman 1997). Fibre contents generally reflect moderately well to well decomposed materials and are dominated by Mesisols and Humisols.

The area has been subjected to volcanic activity: thin to very thick (0.5–48 m) basalt flows are found next to and within the surficial deposits (Brommeland et al. 1998, Talisman 1997, 1999).

Terrain maps showing the surficial materials of the minesite, transmission line corridor and access road LSAs are provided in Figures 4-6, 4-7 and 4-8 a-c, respectively.

Figure 4-6 Surficial Materials of the Minesite LSA

Figure 4-7 Surficial Materials of the Transmission Corridor LSA

Figure 4-8a Surficial Materials of the Access Road LSA (Southern Section)

Figure 4-8b Surficial Materials of the Access Road LSA (Central Section)

Figure 4-8c Surficial Materials of the Access Road LSA (Northern Section)

Elevation and Slope

The elevation of the open pit and plant site ranges from about 1457 m asl at Fish Lake to 1570 m asl at the maximum elevation of the crest along the west side of the open pit.

The transmission line corridor generally falls between 1050 and 1250 m asl but adjacent to the Fraser River elevations decline quickly to less than 500 m asl. Near the minesite the route gains elevation relatively quickly to a maximum of just over 1600 m asl where the transmission line enters the minesite.

The access road begins at just over 1600 m asl where the road leaves the minesite area. It quickly loses elevation to between 1350 and 1400 m asl approximately 15 km from the minesite. Thirty kilometers from the minesite boundary the elevation drops to about 1250 m asl. The next 25 km see a further elevation decrease of only about 100 to 1150 m asl. As the road nears the Chilcotin River valley the elevations decrease quickly. The last point sampled north along the road corridor measured 722 m asl. This point was still above the valley floor.

Slopes ranging between 5 and 15% dominate all three project areas. There are extensive areas within the minesite with slopes between 0 and 2% (level to near level) and slopes between 2 and 5% (very gentle) are common throughout the region. Slopes greater than 15% are relatively rare in any of the areas (minesite, access road or transmission line corridor). Slopes between 15 and 50% are generally associated with hummocky morainal deposits.

Biogeoclimatic Zones

The Ecoregion Classification System was adopted in 1985 to identify the great diversity of ecosystems within British Columbia. The minesite is located in the Central Interior Ecoprovince, the Fraser River Plateau Ecoregion and the Chilcotin Plateau Ecosection of British Columbia (Demarchi 1995).

British Columbia’s Biogeoclimatic Ecosystem Classification (BEC) delineates ecological zones by vegetation, soils, and climate. It classifies ecosystems within the ecological zones, based on the potential of the site at climax or mature successional stages (British Columbia Ministry of Forests 2003). The minesite occupies parts of three biogeoclimatic subzones. General descriptions of these three subzones are described below. A detailed description of the study area by both BEC zone and variant/subzone (see Figure 5.2-1) is provided in the Vegetation and Wetlands baseline report (Volume 5, Section 5).

The Sub-Boreal Pine - Spruce Zone (SBPS)

This is a montane zone that occupies the rainshadow of the Coast Mountains. The SBPS occurs in the gently rolling landscape of the Fraser Plateau and the southern-most portions of the Nechako Plateau. The SBPS generally occurs at elevations above the Interior Douglas-fir zone (IDF) and below the Montane Spruce zone (MS). Areas of the open pit and tailings storage facility occur within this subzone.

The Climate of the SBPS is continental and can be characterized by cold, dry winters and cool, dry summers. These conditions are largely a result of the Coast Mountains rainshadow and relatively high elevations. Mean annual precipitation ranges from 335 to 580 mm.

Upland coniferous forests dominate the SBPS landscape. Lodgepole pine is the most common tree species. Forest productivity is limited by the harsh climate. Other tree species include white spruce and trembling aspen. Undergrowth vegetation is generally dominated by dwarf shrubs, grasses, lichens, and mosses.

Soil development in the SBPS is generally weak. Common soil subgroups include Brunisols and Luvisols. On well to moderately well drained morainal deposits, Brunisolic Gray Luvisols and Orthic Dystric Brunisols are common. On imperfectly or poorly drained sites, gleyed subgroups of Brunisolic and Luvisolic orders and Gleysols dominate. Non-forested wetlands are abundant on poorly drained areas of the plateau surface (Meidinger and Pojar 1991).

Montane Spruce Zone (MS)

The Montane Spruce zone extends from the northern limits of the Fraser Plateau to the U.S. border, on the lee side of the Coast Mountains (and in other areas). The MS zone is found at higher elevations than the IDF or SBPS zones over most of their ranges. The MS zone dominates the area north of the minesite.

The MS has a cool, continental climate characterized by cold winters and moderately short, warm summers. The climate of the zone is between that of the Englemann Spruce–Subalpine Fir (ESSF) and the IDF (or SBPS) zones. Mean annual precipitation ranges from 380 to 900 mm. The growing season is sufficiently warm and dry that moisture deficits can occur in the drier subzones.

The MS zone is characterized as a transitional zone between the ESSF and the IDF/SBPS zones. Tree species include hybrid white spruce and subalpine fir. Trembling aspen is a common seral species. Common understory species include *Vaccinium membranaceum* (black huckleberry), *Lonicera utahensis* (Utah honeysuckle), *Vaccinium scoparium* (grouseberry), and *Calamagrostis rubescens* (pinegrass). Douglas-fir is a seral species in zonal ecosystems, and a climax species on warm, south-facing slopes in the driest ecosystems.

On moderately well to well drained, loamy to clayey morainal deposits, soils are generally Orthic Gray Luvisols and Eutric Brunisols. Humo-Ferric Podzols and Dystric Brunisols develop on coarser-textured or wetter parts of the zone. Wetlands are uncommon in the mountainous topography typical of the MS; however wetlands do occur where terrain is subdued (Meidinger and Pojar 1991).

Interior Douglas Fir Zone (IDF)

The IDF occupies the rolling terrain and valleys of the southern Interior Plateau and fingers into the lee side of the Coast Mountains. Typically, the IDF occurs at elevations below the MS zone. In the northern portions of the zone it is surrounded by the SBPS and SBS zones. The continental IDF climate is characterized by warm, dry summers, a fairly long growing season, and cool winters. This subzone has the warmest and driest climate in the project area and is restricted to the Taseko River valley. The main climatic influence is the rainshadow created in the lee of the Coast Mountains. Mean annual precipitation ranges from 300 to 750 mm.

The IDF zone is dominated by open to closed, mature Douglas-fir forests. Pure Douglas-fir climax stands are common. Ponderosa pine is a common climax species on drier sites, and in moister subzones it occurs on dry, south-facing slopes. At higher elevations in the transition zone to the MS zone hybrid white spruce is common. Lodgepole pine is widespread at higher elevations where it is a common successional species, while trembling aspen is distributed throughout the zone. There are large grassland communities in parts of the IDF. Grasslands in this area are dominated by *Stipa richardsonii* (spreading needlegrass) and *Festuca saximontana* (Rocky Mountain fescue) (Meidinger and Pojar 1991).

Typically soils on morainal deposits in the zone are Orthic or Dark Gray Luvisols, and Eutric or Dystric Brunisols. Soils displaying moderately deep organic enriched topsoils, Melanic Brunisols, are generally limited to the steep, relatively warm, south or west facing slopes (Talisman 1997). Non-forested wetlands are also common in the IDF. These range from marshes in shallow depressions, to fens, to saline meadows. Bogs are uncommon in the IDF.

Common Soil Associations

A broad reconnaissance level soil survey conducted by Valentine et al. (1987) for the region indicates that the minesite LSA potentially intersects 11 soil associations, the transmission line LSA potentially intersects 14 associations and the access road LSA potentially intersects 17 associations (see Table 4-18, Table 4-19 and Table 4-20).

The minesite occurs in an area mapped predominantly as moderately weathered, well to moderately-well drained, Orthic Gray Luvisols. These soils developed in gravelly sandy to gravelly coarse-fine loamy-textured, non-calcareous, morainal deposits, which commonly occur in hummocky (16 to 30% slopes) or inclined (10 to 15% slopes) topography. Poorly drained, sedge dominated wetlands occur in depressions.

The access road is mapped predominantly as well drained Orthic Gray Luvisols on till. Slopes are generally gentler than those on the minesite. At the northern extent of the access road glaciofluvial and fluvial parent materials dominate along the Chilcotin River. These are mapped predominantly as Gleysols and Brunisols, but some Chernozems were mapped for the area as well.

The transmission line LSA was mapped as predominantly Orthic Gray Luvisols on gravelly, coarse to medium textured till. Some Orthic Gray Luvisols have developed on glaciofluvial materials. Chernozems were mapped towards the eastern extent of the corridor on similat morainal material. The remaining associations constituted a minor component of the landscape.

Table 4-18 Common Soil Associations for the Minesite LSA

Soil Parent Material	**Soil Association**	**Dominant Soil[11]**	**Comments**
Bedrock	RO – Rock Land	Non-soil	Bedrock outcrops
Colluvium	WN - Willan Lake	Orthic Gray Luvisol	Morainal and colluvial deposits over bedrock; variable slopes
Fluvial	NW - New Meadow	Rego Humic Gleysol	Loamy fluvial soils (peaty phase); level to very gently sloping
	PU - Purjue	Orthic Regosol	Sandy-skeletal floodplains and fans; level to moderately sloping
Glaciofluvial	HS – Hawks	Eluviated Eutric Brunisol	Sandy-skeletal material in narrow river valleys; very gently to gently sloping
	SH – Shemwell	Orthic Gray Luvisol	Loamy-skeletal water washed moraine; variable slopes
Morainal	GC – Granite Creek	Orthic Dystric Brunisol	Sandy-skeletal moraine in mountain valleys and lower slopes; variable slopes
	KL – Kloakut	Orthic Gray Luvisol	Loamy-skeletal moraine between 1500 and 1800 m; variable slopes, hummocky

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[11] Note that several of the soils classified as Orthic Gray Luvisols in this report would be classified as Brunisolic Gray Luvisols under the present classification system (Kloakut, Shemwell and Willan Lake associations).

Table 4-18 Common Soil Associations for the Minesite LSA (cont'd)

Soil Parent Material	Soil Association	Dominant Soil[12]	Comments
	TT- Tete Hill	Eluviated Dystric Brunisol	Loamy-skeletal moraine between 1600 and 2000 m; variable slopes
	YT – Yohetta	Orthic Eutric Brunisol	Gravelly morainal material on south facing slopes; moderately to steeply sloping
Organic	CL - Chaunigan Lake	Terric Mesisol	Shallow organic meadows (0.4 to 1 m); level to gently sloping
	RL - Rail	Terric Mesisol	Moderately decomposed organics; level to nearly level

Table 4-19 Common Soil Associations for the Transmission Corridor LSA

Soil Parent Material	Soil Association	Dominant Soil[13]	Comments
Colluvium	CM – Chasm	Eluviated Eutric Brunisol	Gravelly-loamy colluvium on upper slopes of river valleys; moderately to steeply sloping
Fluvial	NW - New Meadow	Rego Humic Gleysol	Loamy fluvial soils (peaty phase); level to very gently sloping
	PU - Purjue	Orthic Regosol	Sandy-skeletal floodplains and fans; level to moderately sloping
	TK – Taseko	Rego Dark Brown	Sandy fluvial material on terraces floodplains; very gently sloping
Glaciofluvial	HS – Hawks	Eluviated Eutric Brunisol	Sandy-skeletal material in narrow river valleys; very gently to gently sloping
	SH – Shemwell	Orthic Gray Luvisol	Loamy-skeletal water washed moraine; variable slopes
Mixed (fluvial/ glaciofluvial/morainal)	DC3 – Dog Creek	Orthic Dark Brown	Sandy-skeletal mixed material; strongly to steeply sloping; terraced and often gullied
Morainal	CE – Cone Hill	Gleyed Gray Luvisol	Gravelly coarse-loamy till blankets; very gently to gently sloping
	CY1 – Chimney	Orthic Dark Brown	Loamy-skeletal till on undulating plateaus; variable slopes
	KL – Kloakut	Orthic Gray Luvisol	Loamy-skeletal moraine between 1500 and 1800 m; variable slopes, hummocky
	TE2 – Tyee	Orthic Gray Luvisol	Gravelly, loamy till; variable slopes
	WC – Whiskey Creek	Orthic Eutric Brunisol	Gravelly, coarse morainal material on upper slope of river valleys; moderate to steep slopes
	WL1/WL2 – Williams Lake	Orthic Gray Luvisol	Gravelly loamy till blankets; gentle to moderate slopes
Organic	CL - Chaunigan Lake	Terric Mesisol	Shallow organic meadows (0.4 to 1 m); level to gently sloping

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[12] Note that several of the soils classified as Orthic Gray Luvisols in this report would be classified as Brunisolic Gray Luvisols under the present classification system (Kloakut, Shemwell and Willan Lake associations).

[13] Note that several of the soils classified as Orthic Gray Luvisols in this report would be classified as Brunisolic Gray Luvisols under the present classification system (Kloakut, Shemwell and Willan Lake associations).

Table 4-20 Common Soil Associations for the Access Road LSA

Soil Parent Material	Soil Association	Dominant Soil[14]	Comments
Colluvium	CM – Chasm	Eluviated Eutric Brunisol	Gravelly-loamy colluvial material on upper slopes of river valleys; moderately to steeply sloping
	WN - Willan Lake	Orthic Gray Luvisol	Morainal and colluvial deposits over bedrock; variable slopes
Eolian	CI - Chilcotin	Orthic Dark Brown	Eolian over glaciofluvial material on terraces; level to moderately sloping
Fluvial	EL – Elliot	Rego Humic Gleysol	Fine-loamy fluvial materials in linear depressions; level to gently sloping
	NW - New Meadow	Rego Humic Gleysol	Loamy fluvial soils (peaty phase); level to very gently sloping
	TK – Taseko	Rego Dark Brown	Sandy fluvial material on terraces floodplains; very gently sloping
Glaciofluvial	HA - Hargreaves	Orthic Eutric Brunisol	Coarse, loamy glaciofluvial material on terraces; variable slopes
	HS – Hawks	Eluviated Eutric Brunisol	Sandy-skeletal material in narrow river valleys; very gently to gently sloping
	SH – Shemwell	Orthic Gray Luvisol	Loamy-skeletal water washed moraine; variable slopes
Lacustrine	ZO – Zenzaco	Orthic Brown	Loamy lacustrine material; variable slopes
Morainal	CD – Cardiff	Orthic Gray Luvisol	Gravelly-loamy morainal material overlaying bedrock; variable slopes
	CY1 – Chimney	Orthic Dark Brown	Loamy-skeletal till on undulating plateaus; variable slopes
	DX – Drummond	Eluviated Dark Brown	Loamy-skeletal till on rolling plateau; nearly level to moderately sloping
	KL – Kloakut	Orthic Gray Luvisol	Loamy-skeletal moraine between 1500 and 1800 m; variable slopes, hummocky
	TE1 – Tyee	Orthic Gray Luvisol	Gravelly, loamy till; variable slopes
	WC – Whiskey Creek	Orthic Eutric Brunisol	Gravelly, coarse morainal material on upper slope of river valleys; moderate to steep slopes
Organic	CL - Chaunigan Lake	Terric Mesisol	Shallow organic meadows (0.4 to 1 m); level to gently sloping

Soils maps produced for this baseline report for the minesite, transmission corridor and access road LSAs are provided in Figures 4-9, 4-10 and 4-11 a-c, respectively.

Figure 4-9 Soils of the Minesite LSA

Figure 4-10 Figure 4-10 Soils of the Transmission Corridor LSA

Figure 4-11a Soils of the Access Road LSA (Southern Section)

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[14] Note that several of the soils classified as Orthic Gray Luvisols in this report would be classified as Brunisolic Gray Luvisols under the present classification system (Kloakut, Shemwell and Willan Lake associations).

Figure 4-11b Soils of the Access Road LSA (Central Section)

Figure 4-11c Soils of the Access Road LSA (Northern Section)

4.3.3.2 Soil Map Units

Minesite Local Study Area

A total of 389 inspection points were established within the minesite LSA (Figure 4-2 and Appendix A). Mineral soils are typically moderately to well drained Brunisols or Luvisols developed on morainal parent materials. There are significant areas of organic soils which have developed in depressions and along drainages. These are primarily concentrated in the southern region of the minesite LSA. A soil model matrix was developed for the minesite LSA based on plot data and information contained in the 1999 Talisman soil survey and the Valentine et al. (1987) soil report. The soil model matrix was used to populate a soil map.

A total of 14 SMUs were developed for the minesite area, excluding bedrock outcrops, waterbodies and disturbed land (Table 4-7). A soils map of the minesite LSA is provided in Figure 4-9. The types of parent material observed in the project area and the corresponding SMUs include:

- shallow to deep, very gravelly, coarse to moderately coarse-textured colluvial or mixed colluvial and morainal material (C1, C2)
- medium textured, gravelly to very gravelly residuum (D1)
- slightly gravelly to very gravelly, moderately coarse to moderately fine-textured recent fluvial material (F2)
- very gravelly, sandy glaciofluvial material (FG1, FG2, FG3)
- fine textured, non-stony lacustrine material (L1)
- shallow to deep, slightly gravelly to very gravelly, coarse to moderately fine-textured till (M1, M3, M4)
- deep to shallow organic over mineral material (O1, O2, O3)

The following section describes the SMUs developed for each parent material type in the minesite area. The descriptions include site characteristics (drainage and slope position), parent material characteristics (texture and coarse fragment content), and landforms.

Soil Map Unit Descriptions

Colluvial Soil Map Units

SMU C1

This map unit occurs on veneers of colluvium originating from local bedrock or shallow, mixed deposits of slumped morainal and colluvial materials. It contains high proportions of coarse fragments and generally has sandy loam to clay loam textures. The topography associated with this SMU is generally complex with slopes ranging from gentle to very steep (5 to >70%). They usually occur at upper and mid-slope positions. The soils of SMU C1 are generally shallow (<1 m) and rapidly to well drained. Drainage is occasionally restricted by the presence of bedrock.

The SMU C1 soils are classified as Brunisolic Gray Luvisols, Orthic Dystric Brunisols or Orthic Regosols. Orthic Eutric Brunisols occur in some instances although not generally as a major component of the landscape. Bedrock is within 1 m of the soil surface and usually less than 50 cm from the soil surface. Site 96-02B is a typical soil of this unit (see profile description Appendix D).

SMU C2

SMU C2 soils occur on colluvial and mixed morainal and colluvial deposits. They are typically between 1 and 3 m deep and contain an average of 50% coarse fragments. Textures range from silt loam to sandy loam to clay loam. Coarse fragments are often a mixture of angular, subangular and subrounded materials, suggesting that the parent material was deposited in a variety of ways. The slopes associated with SMU C2 are generally strong to very steep (20 to >70% slopes). SMU C2 soils are typically well to rapidly drained.

The most commonly found soil in the unit is a Brunisolic Gray Luvisol. SMU C2 also includes Orthic Dystric Brunisols and occasionally Orthic Eutric Brunisols or Orthic Humo-Ferric Podzols. The depth to the BC or C horizon is generally less than 75 cm. A profile description for a typical SMU C2 soil is Site BC38 (Appendix D).

Residual Soil Map Units

SMU D1

SMU D1 soils develop in situ on decomposing bedrock (residuum). Coarse fragment content is typically 45 to 90%, with 70% being average. Textures are generally sandy loam to loam. Coarse fragments are usually angular to subangular. Slopes range from near level to approximately 45% (very strong). These soils are generally well to rapidly drained.

SMU D1 soils are typically Orthic Dystric Brunisols, however, Orthic Eutric Brunisols occur where parent materials have a basic pH. Orthic Regosols predominate on less weathered sites. Depth to bedrock is generally limited to less than 30cm. A typical soil profile, BTM229, is included in Appendix D.

Fluvial Soil Map Units

SMU F2

Soils in SMU F2 developed on recent fluvial deposits and often have a shallow peaty layer at the surface. These soils are located in valley bottoms or depressions and on the floodplains and terraces of small streams. The soil texture and coarse fragment content often vary spatially and with depth, reflecting the dynamic nature of fluvial deposits. Textures generally vary between sand and sandy loam. Slopes are level to gentle (0.5 to 5%). The soils within this SMU are usually imperfectly to poorly drained.

These soils are classified as Rego and Orthic Humic Gleysols. The soils are generally mottled to the top of the mineral surface and may have a thin layer of peat at the soil surface. Gleyed Cumulic Humic Regosols also occur in this soil map unit. An example of a typical SMU F2 soil profile is included in Appendix D (plot DTM140).

Glaciofluvial Soil Map Units

SMU FG1

SMU FG1 deposits often occur as thick, irregularly shaped hummocks and sinuous, sharp-sided ridges (kame and esker topography). The parent material typically has very coarse soil textures and high, though variable (25-80%), coarse fragment content. Textures typically range from loamy sand to sandy loam near the soil surface, to sand at greater depths. Water-worked coarse fragments are rounded or subrounded and range in size from pebbles to stones. Slopes vary from gentle to extreme (5 to >50%). Soils within this unit are typically rapidly drained.

The soils in this SMU are commonly classified as Orthic Dystric Brunisols or Orthic Gray Luvisols depending on their level of development. Orthic Eutric Brunisols can occur on less weathered sites. A profile description of plot 97-70 is included in Appendix D.

SMU FG2

SMU FG2 includes undulating, rolling and terraced features, as well as gentle slopes and plains. SMU F2 soils are similar to those of SMU F1 but occur on more subtle terrain. The topography associated with this unit is often complex with very gentle to moderate slopes (2 to 15%). Coarse fragment content is generally high at 50% but varies between 30 and 70%. Textures are generally sandy loams or sands. Soils are generally well to rapidly drained.

The most common subgroups to form in this SMU are Orthic Dystric Brunisols or Brunisolic Gray Luvisols. Orthic Eutric Brunisols can also occur. A profile description of plot 105, from the Open Pit area is included in Appendix D.

SMU FG3

SMU FG3 is imperfectly to poorly drained, with gentle to moderate slopes. Sample sites indicated slightly lower coarse fragment content than the other glaciofluvial map units. Textures are typical for glaciofluvial deposits and range from sand to loamy sand. Drainage is imperfect to poor.

The most common subgroups in this SMU are Orthic and Rego Humic Gleysols. A profile description of plot DTM53 is included in Appendix D.

Lacustrine Soil Map Units

SMU L1

This SMU was encountered rarely within the Taseko minesite area and thus limited data was available. Lacustrine sites within the minesite are limited to the area around Fish Lake. This SMU can be characterized as developing on silty to clayey lacustrine material with few coarse fragments. Slopes are generally nearly level and soils are typically poor to well drained. Most of the SMU is limited to the poor drainage class.

The soils that form in areas with imperfect or poor drainage include Rego and Orthic Humic Gleysols. On better drained lacustrine sites Orthic Gray Luvisols tend to form. A profile description of a Rego Humic Gleysol (plot 97-46) is included in Appendix D.

Morainal Soil Map Units

SMU M1

SMU M1 soils have developed in shallow (generally <1 m except for where variable mantles occur), very gravelly morainal materials overlying bedrock. Textures vary from sandy loam, to sandy clay loam, to clay loam. Coarse fragment content averages 40% and ranges from gravels to stones, with occasional boulders. Slopes associated with these soils are moderate to very strong (10 to >30%). SMU M1 soils are moderately well to rapidly-drained.

These soils are generally classified as Orthic Dystric or Orthic Eutric Brunisols. Brunisolic Gray Luvisols occur on better developed sites. A complete profile description for DTM223 is included in Appendix D.

SMU M3

SMU M3 soils have developed on relatively thick deposits of morainal parent material. The topography where these soils typically occur is simple with gentle to strong slopes (6-30%). Most of the sites in this SMU fall within the lesser slope ranges. Soil textures are generally coarse, with sandy loams and sands predominating, but loams, silt loams and clay loams also occur. Typically, the average coarse fragment content is 40%, but it ranges between 10 and 80% on a site specific basis. Fragment sizes range from gravels to cobbles and stones, with the occasional boulder. SMU M3 soils are moderately well to rapidly drained.

The dominant soil subgroups found in SMU M3 are the same as in SMU M2 except that Orthic Eutric Brunisols are the most common subgroup, followed by Brunisolic Gray Luvisols and Orthic Gray Luvisols. Orthic Dystric Brunisols also occur. A profile description for an Orthic Eutric Brunisol (plot DTM225), a Brunisolic Gray Luvisol (plot TM155D), and an Orthic Gray Luvisol (plot DTM102) are presented in Appendix D.

SMU M4

SMU M4 soils have developed on morainal material in poorly and imperfectly drained areas. Often these sites are at the bases of slopes or at the margins of shallow depressions. Textures are typically loamy or sandy. Coarse fragments vary between 15 and 80% and average about 50%. Slopes range from nearly level to gentle (<1 to 10%). They commonly occur as a minor inclusion associated with SMUs M3 and M2.

This unit includes soils classified as Rego and Orthic Humic Gleysols, and Rego Gleysols. Other subgroups such as Gleyed Gray Luvisols, Gleyed Brunisolic Gray Luvisols or Orthic Gleysols may also occur, but to a limited extent. These soils tend to occur on moderate to well drained sites. Soil profile descriptions for a Rego Humic Gleysol (plot DTM231) and an Orthic Humic Gleysol (plot 109) are included in Appendix D.

Organic Soil Map Units

SMU O1

Organic soils of SMU O1 tend to be fairly deep deposits of black to very dark brown organic material. The maximum depth of organic material recorded was 355 cm (plot 97-33). Organic soils within this SMU overlie mineral material at depths greater than 100 cm from the soil surface. Sites are generally level or nearly level but some sites occurred on gentle slopes.

The dominant subgroups in this SMU include Typic Mesisols and Humisols with organic deposits in excess of 160 cm. Mesisols have a moderately well-decomposed middle tier of organic material, whereas Humisols have a well-decomposed middle tier. This SMU also includes organic deposits between 100 and 160 cm in depth (Terric Mesisols and Humisols). Profiles for a Typic Mesisol (plot 119) and a Typic Humisol (plot BC57) are presented in Appendix D.

SMU O2

Organic soils within this unit are moderately well to well decomposed, moderately deep organic soils (40 to 100 cm of organic material). These soils occur in depressions and valley bottoms throughout the project area on level to gently sloping terrain.

The soils of SMU O2 are classified as Terric Mesisols and Terric Humisols and consist of moderately to well decomposed organic matter overlying mineral soil. A soil profile description for plot 20-3 is presented in Appendix D.

SMU O3

The soils of SMU O3 are peaty phase Rego and Orthic Humic Gleysols, as well as Rego Gleysols. They are similar to the soils of SMU M4 but have developed deeper organic layers (15 to 40 cm). These subgroups usually occur in depressions, gently sloping toe positions, and lower valley slopes. They are typically underlain by slowly permeable mineral material (till or fluvial deposits). The water table is at or near the surface for most of the year.

A typical profile from a peaty Rego Gleysol (plot I18), a Rego Humic Gleysol (plot BTM187) and an Orthic Humic Gleysol (plot T95-53 are included in Appendix D.

Non-Soil Map Units

SMU R1

This SMU is reserved for bedrock outcrops. It includes exposed bedrock and thin veneers less than 10 cm (non-soil). Generally this SMU is found on steep slopes or at the top of steep ridges.

SMU WA

The WA SMU designation is for water bodies. This includes lakes and smaller water bodies that are generally filled with open water most of the year.

SMU DL

This map unit is used to designate areas that have been disturbed by human activities. Examples include road corridors and gravel pits.

Soil Map Unit Statistics

Table 4-21 summarizes the areas and proportions of each SMU for the minesite LSA. Totals are provided for each parent material type.

Most of the map units within the minesite footprint occur on either morainal or organic parent materials (77.8 and 13.4% respectively). All of the remaining parent material types add up to only 8.8% of the total area, including non-soil units such as water (WA), disturbed land (DL) and bedrock (R1). Of the morainal units, M3 occurs most often, at 54.1% of the total land area. M1 and M4 occupy 10 and 13.7% respectively. Of the organic based units, O1 and O2 dominate with 10.5 and 2.9% respectively. Colluvial based SMUs occupy 0.5% of the area, residual SMUs occupy 0.4% and lacustrine SMUs occupy less than 0.1% of the minesite LSA. Together, fluvial and glaciofluvial units account for about 3% of the total aerial extent.

Table 4-21 Soil Map Unit Areas and Proportions for the Minesite LSA

Soil Map Unit	Minesite Footprint	
	ha %	
C1	6.6	0.1
C2	16.2	0.4
Total Colluvial	22.8	0.5
D1	16.8	0.4
Total Residual	16.8	0.4
F2	22.9	0.5
Total Fluvial	22.9	0.5
FG1	4.9	0.1
FG2	102.8	2.3
FG3	10.8	0.2
Total Glaciofluvial	118.5	2.6
L1	1.4	0.0
Total Lacustrine	1.4	0.0
M1	439.1	10.0
M3	2,385.9	54.1
M4	603.8	13.7
Total Morainal	3,428.8	77.8
O1	463.6	10.5
O2	129.7	2.9
O3	0.9	0.0
Total Organic	594.2	13.4
DL	70.2	1.6
R1	6.6	0.1
WA	124.9	2.8
Total Miscellaneous	201.7	4.5
Total	4,407.1	100.0

Transmission Line LSA

A total of 18 soil inspection plots were established along the transmission line corridor (Figure 4-3). Of these, seven occur within the LSA, and 11 occur adjacent to the LSA. The intent of the reconnaissance level survey was to confirm the accuracy of the existing soil map for the route (Valentine et al. 1987) and to become familiar with the types of soils encountered along the transmission line corridor, especially for soils classified as ALR. No soil map units were developed and no SMU map was produced for the transmission line LSA. However, a soil map based on CLI data is included in this report to illustrate which broad soil types occur along the transmission line LSA (Figure 4-10). A summary of the areas of each soil order is contained in Table 4-22. The CLI polygons are very similar to those mapped by Valentine et al. (1987), but a simplified classification system was adopted. For more detailed mapping please refer to the Valentine et al. (1987) soil survey.

Few inspection points were established and no SMU map was developed because:

- transmission line construction soil disturbances are typically confined to tower/pole locations and to construction and maintenance roads
- the level of soil disturbance is typically minimal
- a final route has yet to be determined
- access road alignments are not yet known

In general, the soil inspections confirmed the findings of the Valentine et al. (1987) soil report. There were deviations, however, which can be attributed to the map scale of the soil report (1:100,000).

ALR lands closest to the minesite tended to be associated with wetlands. Wetter soils included an organic veneer on morainal material (peaty Rego Gleysol), and gleyed or humic variants of regosols. Brunisolic Gray Luvisols or Orthic Eutric Brunisols occurred on drier sites. Parent materials were either morainal or fluvial. The non-ALR soils in this section of the transmission line route appeared to be Orthic Gray Luvisols and Brunisolic Gray Luvisols similar to those found on the minesite.

West of the Fraser River the ALR lands tended to occur on, or adjacent to fluvial plains or terraces, some of which had been utilized as forage for livestock. It appeared that several of the fields had been planted to tame species. Fluvial soils included Cumulic and Orthic Humic Regosols. Soils forming on morainal parent materials included Brunisolic Gray Luvisols, Orthic Gray Luvisols, and Orthic Dark Gray Chernozems. A weakly formed Orthic Dark Gray Chernozem was sampled just west of, and above the Fraser River on a fluvial fan. Coarse fragment content was generally lower than that of the minesite or access road.

East of the Fraser River was a complex of coniferous forests, deciduous forests and grassland plains. The grasslands and deciduous forests tended to be composed of Orthic Dark Gray Chernozems on compacted till. The soils under coniferous forests were mostly Orthic Gray Luvisols; however an Orthic Eutric Brunisol was also sampled. These soils were also formed on compacted till. Coarse fragment content was generally lower than that associated with morainal materials on the minesite or the access road corridor.

Table 4-22 Soil Order Areas and Proportions for the Transmission Corridor LSA (CLI data)

Soil Order	ha	%
Unknown	12.6	0.2
Brunisol	387.5	6.2
Chernozem	411.3	6.6
Gleysol	33.9	0.5
Luvisol	5,309.9	84.8
Organic	1.3	0.0
Regosol	107.4	1.7
Totals	**6,263.9**	**100.0**

Access Road LSA

A total of 57 inspection points were established within the access road LSA along with an additional 21 points adjacent to the LSA (see Figure 4-4 and Appendix A). In general, soils along the road corridor are well drained, morainal in origin, and similar to those found at the minesite. Soils tend to be better developed along the road corridor and fewer Brunisols are present. When interpreting the soil maps it is important to remember that as the distance from the mine increases, Orthic Gray Luvisols tend to replace Brunisolic Gray Luvisols in similar landscape positions and Orthic Eutric Brunisols tend to replace Orthic Dystric Brunisols. This shift occurs rapidly as the elevations decrease moving north along the access road. In addition, at the most northerly section of the road corridor, there are fluvial and glaciofluvial parent materials associated with the Chilcotin River valley with characteristics unlike any near the minesite.

A soil model matrix was developed for the proposed access road corridor based on the access road plot data, the minesite plot data and the findings of the Valentine et al. (1987) report. The Valentine report and minesite data was used as a general guideline to fill gaps in inspection points. The soil model matrix was used in conjunction with detailed terrain mapping to populate a soil map (see Figures 4-11a, 4-11b, 4-11c). The primary difference between the minesite and access road models is in the subgroups populating the matrix, rather than in the combination of parent materials, surface expressions, and drainages which form the basis of the soil map units.

A total of 16 soil map units were developed for the access road area, excluding bedrock outcrops, water and disturbed land (Table 4-8). The types of parent material observed in the project area include:

- shallow to deep, gravelly, coarse to moderately coarse-textured colluvial or mixed colluvial and morainal material (C1, C2)
- slightly gravelly to very gravelly, finely-textured to moderately coarse recent fluvial material (F1, F2)
- gravelly to very gravelly, moderately fine to sandy glaciofluvial material (FG1, FG2, FG3, FG4)
- silty to silty clay loam lacustrine material (L1)
- shallow to deep, slightly gravelly to very gravelly, coarse to moderately fine-textured till (M1, M2, M3, M4)
- deep to shallow organic over mineral material (O1, O2, O3)

The following section describes the soil map units developed for each parent material type along the access road corridor. The descriptions include site characteristics (drainage and slope position), parent material characteristics (texture and coarse fragment content), and landforms.

Soil Map Unit Descriptions

Colluvial Soil Map Units

SMU C1

This map unit typically occurs on shallow deposits of colluvium originating from local bedrock. It also develops on shallow, mixed deposits of slumped morainal and colluvial materials. It contains high proportions of coarse fragments and generally has sandy loam to clay loam textures. Topography is generally complex and slopes range from gentle to very steep. They often occur at upper or mid-slope positions. The soils of SMU C1 are generally shallow (<1 m) and rapidly to well drained. Drainage is sometimes restricted by the presence of bedrock.

These soils are typically classified as poorly developed Brunisolic Gray Luvisols or Orthic Eutric Brunisols. Less typical, but occurring in some landscapes, are Orthic Gray Luvisols. Bedrock is typically within 1 m, and usually less than 50 cm from the soil surface. A complete profile description for an Orthic Eutric Brunisol (TAR10) is included in Appendix D.

SMU C2

SMU C2 soils have developed on colluvial or mixed morainal and colluvial deposits. They are typically between 1 and 3 m deep and contain a high proportion of coarse fragments. Textures are generally loamy (silt loam, sandy loam or clay loam). The slopes associated with SMU C2 are generally strong to very steep. SMU C2 soils are typically well to rapidly drained.

The most commonly classified soils in the unit are Orthic Gray Luvisols. SMU C2 also includes Brunisolic Gray Luvisols and occasionally Orthic Eutric Brunisols. No soils of this SMU were sampled along the road corridor, however they were mapped by Valentine et al. (1987) within the access road corridor and similar soils were found in the minesite LSA.

Fluvial Soil Map Units

SMU F1

Soils in SMU F1 developed on moderately to rapidly drained, recent fluvial deposits. These soils are typically located above valley bottoms and streams. Slopes are quite variable and range from nearly level to very strong. Coarse fragment content is generally high.

Brunisolic Gray Luvisols and Rego Dark Brown Chernozems are the most common soil subgroups found in this soil map unit. The Chernozems are most likely to be found adjacent to the Chilcotin River at the northern extent of the access road. Orthic Gray Luvisols and Orthic Eutric Brunisols may also occur in this SMU. No SMU F1 soils were sampled along the road corridor; however they were mapped by Valentine et al. (1987) within the access road corridor.

SMU F2

Soils in SMU F2 occur on fluvial deposits and may have a shallow peaty layer at the surface. These soils are generally located in valley bottoms or depressions and on the floodplains and terraces of small streams. The soils within this SMU are usually imperfectly to poorly drained.

They are classified as Rego and Orthic Humic Gleysols. The soils are generally mottled to the top of the mineral surface. Gleyed Cumulic Humic Regosols may also occur in this soil map unit. No soils of this SMU were sampled along the road corridor, however they were mapped by Valentine et al. (1987) within the access road corridor and similar soils were found within the minesite LSA.

Glaciofluvial Soil Map Units

SMU FG1

SMU FG1 deposits often occur as thick, irregularly shaped hummocks and sinuous, sharp-sided ridges (kame and esker topography). The parent material typically has high, though variable, coarse fragment content. Slopes vary from gentle to extreme. Soils within this unit are typically rapidly drained.

The soils in this SMU are commonly classified as Orthic Eutric Brunisols or Orthic Gray Luvisols depending on their level of development. A profile description of plot BC82 (Orthic Eutric Brunisol) is included in Appendix D.

SMU FG2

SMU FG2 includes undulating, rolling and terraced features, as well as gentle slopes, fans and plains. The topography associated with this unit is often complex with very gentle to moderate slopes. Coarse fragment content is generally high but varies considerably. Drainage is well to rapid.

The most common subgroups found in this SMU are Orthic Gray Luvisols and Orthic Eutric Brunisols. Eluviated Eutric Brunisols may also occur. A profile description of plot BC63 (Orthic Gray Luvisol), is included in Appendix D.

SMU FG3

SMU FG3 is similar to SMU FG2 but is imperfectly to poorly drained, with gentle to moderate slopes.

The most common subgroups in this SMU are Orthic and Rego Humic Gleysols. No soils of this SMU were sampled along the road corridor, however imperfectly and poorly drained glaciofluvial sediments were mapped along the road corridor by Valentine et al. (1987).

SMU FG4

SMU FG4 soils include veneers and mantles of water deposited or water reworked sediments over morainal deposits. They usually have complex topography and slopes that range from very gently to strongly sloping. Soils within SMU FG4 are well to moderately-well drained.

These soils are weakly developed Orthic Eutric Brunisols and Brunisolic Gray Luvisols. Orthic Gray Luvisols are also possible in this SMU. No soils of this SMU were sampled along the road corridor; however glaciofluvial veneers were mapped along the road corridor by Valentine et al. (1987).

Lacustrine Soil Map Units

SMU L1

This SMU can be characterized as developing in silty to silty clay loam lacustrine material with few coarse fragments. Slopes are generally nearly level and drainage ranges from poor to well.

On better drained lacustrine sites Orthic Gray Luvisols or Orthic Dark Brown Chernozems tend to form. In areas with imperfect or poor drainage Rego and Orthic Humic Gleysols typically occur. A profile description of an Orthic Gray Luvisol (plot BC13) is included in Appendix D.

Morainal Soil Map Units

SMU M1

SMU M1 soils have developed in shallow (generally <1 m except for where variable mantles occur), very gravelly morainal deposits which overlay bedrock. Textures are generally loamy. Coarse fragment contents are typically high. Slopes associated with these soils are moderate to very strong (10 to >40%). Drainage is moderately well to rapid.

These soils are generally classified as Orthic Eutric Brunisols. Brunisolic Gray Luvisols or Orthic Gray Luvisols may occur. No soils of this SMU were sampled along the road corridor, however they were mapped by Valentine et al. (1987) within the access road corridor and similar soils were mapped within the minesite LSA.

SMU M2

The M2 soil map unit consists of soils that occur on hummocky, ridged and moderately steeply sloped morainal deposits. The topography of the deposits is generally complex and slopes typically range from moderate to steep (10 to 75%). Soil textures typically range from sandy loam to clay loam. The average coarse fragment content is high (50%), with site specific content ranging between 20 and 65%.

Orthic Gray Luvisols are the most common soil subgroup occurring within this map unit. Orthic Eutric Brunisols, and to a lesser extent, Brunisolic Gray Luvisols also occur. A profile description for an Orthic Gray Luvisol (plot BC61) is presented in Appendix D.

SMU M3

SMU M3 soils have developed on relatively thick deposits of morainal parent material. The topography is typically simple with level to very strong slopes (0-35%). Most of the sites fall on slopes of less than 10%. Soil textures range from sandy loam, to sandy clay loam to clay. Typically, the average coarse fragment content is 45-50%, but it ranges between 15 and 70% on a site specific basis. Fragment sizes range from gravels to cobbles and stones, with the occasional boulder. SMU M3 soils are moderately well to rapidly drained.

The dominant soil subgroups found in SMU M3 are Orthic Gray Luvisols. Orthic Eutric Brunisols, Brunisolic Gray Luvisols, and Eluviated Dark Brown Chernozems also occur. A profile description for an Orthic Gray Luvisol (plot BC21), an Orthic Eutric Brunisol (plot TAR09), and a Brunisolic Gray Luvisol (plot BC18) are presented in Appendix D.

SMU M4

SMU M4 soils have developed on poorly and imperfectly drained morainal materials. Often these sites are at the bases of slopes or at the margins of shallow depressions. Textures are variable. Coarse fragments vary between 20 and 40%. Slopes range from nearly level to gentle (<1 to 10%). They commonly occur as a minor inclusion associated with SMUs M3 and M2.

This unit includes soils classified as Rego and Orthic Humic Gleysols. Rego Gleysols and Orthic Gleysols also occur, but to a lesser extent. Soil profile descriptions for an Orthic Humic Gleysol (plot BC6B) and an Orthic Gleysol (plot TAR04) are included in Appendix D.

Organic Soil Map Units

SMU O1

Soil Map Unit O1 soils tend to occur on moderately deep deposits of black to very dark brown organic material. Organic soils within this SMU overlie mineral material at depths greater than 100 cm from the soil surface. Sites are generally level or nearly level but some sites occurred on gentle slopes. The organic map units all tend to occur towards the southern extent of the access road.

The dominant subgroups in this SMU include Typic Mesisols and Humisols with organic deposits in excess of 160cm. Organic deposits between 100 and 160cm in depth (Terric Mesisols and Humisols) are also included. The soil profile for a Typic Mesisol (BC26) is presented in Appendix D.

SMU O2

Organic soils within this unit are moderately well to well-decomposed; moderately deep organic soils (40 to 100 cm of organic material). These soils occur in depressions and valley bottoms throughout the project area on level to gently sloping terrain.

They are classified as Terric Mesisols and Terric Humisols. Soil profile descriptions for plots TAR06 (Terric Humisol) and BC71 (Terric Mesisol) are presented in Appendix D.

SMU O3

The soils of SMU O3 are peaty phase Rego and Orthic Humic Gleysols, as well as Rego Gleysols. They are similar to the soils of SMU M4 but have developed deeper organic layers (15 to 40 cm). These subgroups usually occur in depressions, gently sloping toe positions, and lower valley slopes. The water table is at or near the surface for most of the year.

A typical profile from a peaty Rego Gleysol (plot BC62) is included in Appendix D.

Non-Soil Map Units

SMU R1

This SMU is reserved for bedrock outcrops. It includes exposed bedrock and thin veneers less than 10cm (non-soil). Generally this SMU is found on steep slopes or at the top of steep ridges.

SMU WA

The WA SMU designation is for water bodies. This includes lakes and smaller water bodies that are generally filled with open water most of the year.

SMU DL

This map unit is used to designate areas that have been disturbed by human activities. Examples include road corridors and gravel pits.

Soil Map Unit Statistics

Table 4-23 summarizes the areas and proportions of each SMU for the proposed access road corridor. Totals are provided for each parent material type.

The majority of map units along the road corridor occur on morainal parent material (69.3%). Soil map unit M3 occurs most often, at 62.9% of the total land area. M1 and M4 occupy 3.6 and 2.8% respectively. Of the remaining parent materials, organic and glaciofluvial are the most significant at 3.5 and 7.1% respectively. Within the glaciofluvial category, FG2 occupies the most area at 6.4%. The organics are dominated by the O1 and O2 SMUs at 1.3 and 2% respectively. The remaining parent material categories add up to a total of 19.9%. This includes non-soil units such as water (WA), disturbed land (DL) and bedrock (R1), which total 16.1% of the total area. Colluvial based SMUs occupy 2.4% of the area, fluvial SMUs occupy 1.4% and lacustrine SMUs occupy less than 0.1% of the buffered access road.

Table 4-23 Soil Map Unit Areas and Proportions for the Access Road Corridor

Soil Map Unit	Road Corridor	
	ha %	
C1	37.9	1.1
C2	45.2	1.3
Total Colluvial	83.1	2.4
F1	18.9	0.5
F2	28.8	0.8
Total Fluvial	47.6	1.4
FG1	15.9	0.5
FG2	222.6	6.4
FG3	3.8	0.1
FG4	4.6	0.1
Total Glaciofluvial	246.9	7.1
L1	0.9	0.0
Total Lacustrine	0.9	0.0
M1	125.0	3.6
M2	9.4	0.3
M3	2,198.2	62.9
M4	96.8	2.8
Total Morainal	2,429.5	69.5
O1	46.2	1.3
O2	68.9	2.0
O3	8.8	0.3
Total Organic	123.9	3.5
DL	555.7	15.9
R1	0.7	0.0
WA	6.4	0.2
Total Miscellaneous	562.8	16.1
Total	3,494.7	100.0

4.3.3.3 Soil Reclamation Suitability in the Minesite LSA

Reclamation Suitability

Table 4-24 summarizes the areas and proportions of reclamation suitability classes for the minesite LSA. The reclamation suitability ratings by horizon and the distribution and extent of reclamation suitability classes are provided in Appendix E and illustrated in Figure 4-12. A little less than one quarter of the area within the mine footprint was rated as fair for reclamation suitability, a further 54% was rated as fair to poor and none was rated as poor. The main limiting factor for the majority of SMUs was coarse fragment content. Generally coarse fragment contents were high and they typically increased with depth. Organic soils are useful as soil amendments and were not rated using the criteria described in Section 4.3.2.5. Approximately 13.5% of the minesite area is covered by organic soil units. The remainder of the area (approximately 8%) was mapped as having unsuitable soil materials for reclamation purposes. Within this category, 53% of the area was mapped as water bodies (WA), disturbed land (DL) or bedrock outcroppings (R1). Thus only 158 hectares (or 4.4%) of mineral soil within the minesite footprint was deemed unsuitable for reclamation purposes.

Table 4-24 Reclamation Suitability Areas and Proportions for the Minesite LSA

Reclamation Suitability Class	Symbol	Soil Map Unit(s)	Minesite Footprint	
			ha %	
Good	**G**	none	0.0	0.0
Fair	**F**	F2, M1, M4	1,065.8	24.2
Fair to Poor	**F-P**	L1, M3	2,387.3	54.2
Organic	**O**	O1, O2, O3	594.2	13.5
Unsuitable	**U**	C1, C2, D1, FG1, FG2, FG3, R1, WA, DL	359.8	8.2
Total			**4,407.1 10**	**0.0**

Figure 4-12 Soil Reclamation Suitability within the Minesite LSA

Soil Salvage Depths and Volumes

Figure 4-13 displays salvage depths for the minesite LSA. Most of the salvage depths fall between 30 and 45 cm, except for organics. The most common salvage depth for mineral soils is 45 cm. Organic soils, which are used primarily as a soil amendment, have deep salvage depths in relation to the high coarse fragment content mineral soils of the region.

Table 4-25 is a summary of the volumes of the estimated salvageable material for each SMU in the minesite footprint. The majority of the volume within the mine footprint comes from morainal SMUs (~ 15 million cubic meters) or organic SMUs (8.9 million cubic meters). Approximately 0.8 million cubic meters of salvageable material is estimated for all of the remaining map units combined, and of these both the colluvial and glaciofluvial SMUs are considered unsuitable for reclamation purposes.

Figure 4-13 Soil Salvage Depth within the Minesite LSA

Table 4-25 Estimated Volumes of Salvageable Material for the Minesite LSA

	Minesite Footprint	
Topsoil Layer	**Volume (m^3)**	**Volume (%)**
C1	2.3127E+04	0.1
C2	5.6718E+04	0.2
Total Colluvial	7.9846E+04	0.3
D1	5.0316E+04	0.2
Total Residual	5.0316E+04	0.2
F2	1.8312E+05	0.7
Total Fluvial	1.8312E+05	0.7
FG1	1.4794E+04	0.1
FG2	4.6248E+05	1.9
FG3	3.7727E+04	0.2
Total Glaciofluvial	5.1501E+05	2.1
L1	4.1418E+03	0.0
Total Lacustrine	4.1418E+03	0.0
M1	1.3173E+06	5.3
M3	1.0737E+07	43.3
M4	3.0192E+06	12.2
Total Morainal	1.5073E+07	60.7
O1	7.4180E+06	29.9
O2	1.4917E+06	6.0
O3	2.6306E+03	0.0
Total Organic	8.9123E+06	35.9
Total	2.4818E+07	100.0

4.3.3.4 Agricultural Capability for ALR Lands within the Transmission Corridor and Access Road Corridor LSAs

Agricultural Capability within the Transmission Corridor LSA

No agricultural capability map or data for the transmission line corridor has been included with this report because final tower placements have not yet been determined, no new road construction is planned and the anticipated impact on soils is minimal.

Agricultural Capability within the Access Road LSA

Most of the ALR land along the access road corridor was rated as Class 5 (79.2%) or 6 (18.5%). The primary limitations to agriculture are climate, topography, moisture and stoniness. There are small proportions of class 4 soils (1.9%), and organic soils (0.2%).

Class 4 soils have severe limitations that restrict the types of crops that can be seeded and/or they may require special conservation practices. These soils tend to have low or fair productivity for most crops but may allow high productivity for specially adapted crops.

Class 5 soils have very severe limitations to growing annual crops, restricting these soils to perennial forage crops. Improvements using machinery are practical, therefore, tame or native forage species can be utilized. Improvements to soil conditions can increase forage yields and/or create a more manageable land.

Class 6 soils have very severe limitations to growing annual crops, and also have limitations related to growing perennial forage crops. Improvement practices using machinery are generally not feasible so forage productivity is typically limited.

Organic soils are not rated under this system.

Table 4-26 summarizes the areas and proportions of the CLI agricultural capability ratings for ALR lands along the access road corridor and Figures 4-14a, 4-14b, 4-14c spatially display the agricultural capability ratings.

Table 4-26 CLI Agricultural Capability Areas and Proportions for ALR Lands in the Access Road LSA

Agricultural Capability Class	Subclass Code	Subclass Description	Access Road Corridor	
			ha %	
4	C	climate	26.7	1.9
5	C	climate	158.5	11.1
	CP	climate; stoniness	885.7	62.2
	CT	climate; topography	2.0	0.1
	CW	climate; moisture	20.4	1.4
	MT	moisture; topography	16.2	1.1
	T	topography	26.5	1.9
	TM	topography; moisture	20.3	1.4
	Total		**1,129.6**	**79.2**
6	MT	moisture; topography	8.7	0.6
	T	topography	241.9	17.0
	TM	topography; moisture	8.3	0.6
	TP	topography; stoniness	4.7	0.3
	Total		**263.6**	**18.5**
O	na	na	**3.2**	**0.2**
Total			**1423.2**	**100.0**

Figure 4-14a Agricultural Capability of the Access Road LSA (Southern Section)

Figure 4-14b Agricultural Capability of the Access Road LSA (Central Section)

Figure 4-14c Agricultural Capability of the Access Road LSA (Northern Section)

4.3.3.5 Terrain and Terrain Integrity within the LSAs

Baseline investigation results are provided in this report to describe pre-development surficial geology and terrain stability conditions within the LSAs.

Surficial Geology

The following is an overview of the surficial deposits determined from the 2006 field investigations. An overview description of the LSAs is provided along with more detailed descriptions of each of the three LSAs.

The majority of the area is covered with thick deposits of till; bedrock exposures are relatively rare. Well drained morainal (glacial till) deposits are extremely abundant. The thickness of these deposits ranges from veneers (less than a meter) on steep slopes and valley walls to several meters or more in the more widespread low-lying, low-gradient areas. Several drumlinized till plains are found in the access road area. Till deposits are characterized by subrounded and subangular pebbles and cobbles in a silty sand or sandy silt matrix. Clast percentages average 30-50%, with a notable increase in coarse fragment content below 40 cm. Boulders are present as well and tend to be more angular than pebbles and cobbles.

Glaciofluvial sediments are the second most common sediment type. Large quantities of glaciofluvial sediments were deposited in meltwater channels, either in subglacial environments (e.g., ice tunnels) that ultimately produced eskers, or subaerial rivers issuing from the top and front of melting glaciers during the final stages of the last glaciation. These deposits generally consist of pebbles and cobbles and commonly form large terraces adjacent to the Taseko River. Sinuous esker ridges are found in a number of places, including the northern access road area, the Taseko River Valley, and in scattered locations within the minesite LSA. Collectively, they make up a much smaller component of the glaciofluvial deposits than the terraces. The eskers within Taseko Valley are esker complexes and are much larger in size than those found elsewhere. Large glacialfluvial terrace features capped by relic fans are prominent along the Fraser River at the transmission corridor crossing.

Glaciolacustrine deposits are rare within the LSAs, with a notable exception observed in the transmission line corridor on the east side of the Fraser River. While none were identified at the surface in the minesite or access road LSAs during the 2006 field study, Talisman (1997) identified them from drilling information as fine sand, silt and clay; these sediments were deposited in ice-dammed lakes by glacial meltwater streams.

Colluvial deposits such as talus aprons and fans, colluvial veneers and colluviated glacial deposits are the product of weathering and gravity and transported primarily through erosion and mass wasting. These deposits are more common in areas of rugged topography, so they are relatively uncommon within the LSAs; this is particularly true of the minesite and access road LSAs. Colluvium is present on the steep slopes of major valleys and in localized areas of steeply sloping bedrock and till deposits. Coarse, angular clasts (cobbles and boulders) with little or no fine-grained matrix are the most common type of deposit; however, in areas where glacial deposits have become colluviated, both smaller clast sizes and fine-grained matrices may be present. Colluvial deposits found in gully systems and on moderately steep slopes tend to be finer-grained, and can contain clay, silt, sand and gravel depending on the composition of the parent material. Rockfall deposits consist generally of angular to very angular blocks, boulders and cobbles, with very small amounts of fine sediment.

Fluvial deposits are associated with the streams and creeks that flow through the area, most notably the Taseko River, Fish Creek, Tete Angela Creek, and the larger Chilcotin and Fraser Rivers. They are present along valley floors and at the bottom of a few gully systems. The texture of fluvial sediments is directly linked with the energy level of each stream: coarser-grained deposits are associated with faster flowing streams. Fluvial fans have developed at the confluence of some tributaries with major valleys; these can be quite large in the Taseko River valley and are subject to both flooding and debris flow activity.

Organic accumulations are shallow and occur in topographic depressions. These bogs and fens are characterized by very poor drainage.

Minesite

The Prosperity gold-copper porphyry deposit is located at the northern limit of Fish Lake. The proposed minesite footprint covers an area of 4419 ha.

North of Fish Lake, Fish Creek drains into the Taseko River and then into the Fraser River. The overall topography ranges from gently rolling to undulating.

Till is the most common surficial sediment: it accounts for approximately 78% of all deposits mapped within the minesite LSA. Till thickness ranges from less than one meter on steep to moderately steep slopes (e.g. western edge of the pit and hill crests) to several meters in flat areas and valley floors. Topography in these till-dominated areas varies from mainly level to gently undulating (0–26 % slopes) with minor areas of higher relief (e.g. 26–49%). Till matrices range from silty sand to silty clay, but silty sand and sandy silt are most common. Clasts make up 10 to 80% of the deposits, averaging approximately 40%. Most clasts are subrounded and in the pebble to cobble size range, but all clast sizes are represented and angularity ranges from angular to rounded. Boulders are generally more angular than the smaller clast sizes. Most tills are well drained, however tills near or adjacent to the numerous wetlands in the minesite LSA are moderately and imperfectly drained.

Organic accumulations (bogs and fens) are present in many parts of the minesite LSA, accounting for almost 14% of materials in this area. They have developed in topographic depressions and have very poor drainage. Bogs and fens are particularly evident in the eastern and southern parts of the minesite LSA. Thicknesses can range from less than one meter to several meters, with fine to very fine textured sediment commonly underlying these materials. Textures are equally divided among fibric, mesic and humic.

Approximately 3% of the minesite LSA is characterized by glaciofluvial deposits. These deposits are generally planar to gently undulating and are found in low-lying areas. They are poorly to moderately sorted with abundant rounded to subrounded pebble- to cobble-sized clasts set in a sand or silty sand matrix. Clast content is 20–50% and the deposits are generally well to rapidly drained.

Shallow to deep colluvial materials are limited within the minesite LSA, accounting for only 0.5% of all materials. These well to rapidly drained deposits are found most commonly on slopes exceeding 35%; they consist mainly of debris slide deposits derived from glacial sediments and rockfall deposits. The former can span all grain sizes, while the latter are most commonly composed of cobbles and boulders. Clast content is quite high, ranging from 60–80%, and clasts are dominantly angular. Small debris flows can be expected in gullies that receive rockfall or debris slide sediment and on the fluvial fans that they flow out onto.

Present day fluvial sediments are found in small streams and creeks; these recent sediments account for only 0.5% of all materials within the minesite LSA. Fluvial fans have developed at the mouth of a few minor tributaries and gullies. Drainage in these sediments is highly variable, ranging from poorly to well drained. Grain sizes range from silt to gravel with sandy pebble/cobble gravel being the most common. A cap of finer overbank sediments is common in the upper 10–50 cm.

Bedrock and weathered bedrock together make up less than 0.4% of the LSA. Weathered bedrock is most common in upland areas. Drainage varies from rapidly drained to very poorly drained depending on topography, bedrock porosity and degree of fracturing.

Modern lacustrine deposits are extremely rare (0.03%). They include beach deposits at the margins of larger lakes and lakes that have become infilled over time with very fine grained sediment. The latter may be covered by organic accumulations.

Anthropogenic materials (areas where human disturbance is the most prominent terrain feature) and water bodies make up the remainder of the LSA (1.2%).

Eolian deposits were neither identified by the field work nor by Talisman. However, southwest of the minesite, Madrone mapped eolian deposits.

Glaciolacustrine deposits were not found nor mapped within the minesite LSA. However, extensive glaciolacustrine deposits (up to 70 m thick), which can be interbedded with glaciofluvial sediments, were identified in cores drilled in the southern part of the minesite adjacent to Fish Lake (Brommeland and Wober 1997; Talisman 1997). These deposits are only found below 20 m depth and are overlain by till deposits up to 59 m thick (Talisman 1997).

Table 4-27 summarizes the surficial materials for the minesite LSA.

Table 4-27 Surficial Materials of the Minesite LSA

Parent Material	Minesite	
	Area (ha)	Portion of LSA (%)
Anthropogenic	53.2	1.21%
Colluvium	22.8	0.52%
Weathered Bedrock	16.8	0.38%
Fluvial	22.9	0.52%
Glaciofluvial	118.5	2.70%
Lacustrine	1.4	0.03%
Moraine	3,428.8	78.10%
Not Mapped[15]	124.9	2.84%
Organic	594.2	13.54%
Bedrock	6.6	0.15%
Total 4,	**390.1[16] 10**	**0.00%**
Statistics based on 1:7500 scale mapping		

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[15] Un-mapped areas include open water bodies.

[16] The mapped area of 4390.1 ha is 29.1 ha smaller than the total minesite LSA area of 4419.2 ha because 17.1 Ha was not attributed (could be grouped with "Not mapped") and 12 ha of the new LSA falls outside of the JW–AXYS TEM extent.

Transmission Line Corridor

The proposed transmission line corridor LSA extends from the existing BC Hydro transmission line (about 15 km east of the Fraser River) for a distance of approximately 125km to the proposed minesite at Fish Lake area. A buffer of 250 m parallels either side of the proposed alignment. The total area of the LSA is approximately 6264 ha.

Compact, silty-sandy till accounts for nearly 92% of the total area of surficial materials in the LSA. Clasts generally make up under 50% of the total texture, but a great range of variability exists throughout the extensive LSA. Most clasts are subrounded and in the pebble to cobble size range. Till blankets are most common over the extensive low gradient areas with veneers more characteristic of steep to moderately steep slopes which are generally rare throughout the LSA. Most tills are well drained, however tills in low-lying areas, adjacent to or underlying the numerous wetlands are moderately to very poorly drained.

Fluvial sediments are the second most abundant sediment and make up just over 3% of the LSA area. The sediments form floodplains and fans of active rivers and creeks and are most prominent along Big Creek. Drainage is dominantly well to rapid, but varies. Grain sizes range from silt to gravel with sandy pebble/cobble gravel being the most common. A cap of finer overbank sediments is common in the upper 10–50 cm of floodplain soils.

Under 1% of the total area is covered by glaciofluvial deposits. The majority of these sediments are found on the east end of the LSA and paralleling the Fraser River where terrace features were observed. On the east side of the Fraser River crossing glaciofluvial sediments are associated with glaciolacustrine deposits and are mapped as undifferentiated materials. Along the Fraser River they are generally well sorted and range from dominantly sandy cobbly in texture. Boulders were also observed in the exposed stratigraphy above the modern river bed. Other deposits are generally poorly to moderately sorted with abundant rounded to subrounded pebble- to cobble-sized clasts set in a sand or silty sand matrix. Drainage is dominantly well to rapid.

Undifferentiated materials are composed primarily of glaciolacustrine sediments interbedded with glaciofluvial deposites, with the former being the most widespread constituent. These materials cover 2% of the LSA and are found almost entirely on the east side of the Fraser River. Glaciolacustine deposits are massive and varved, with a silty to fine sand texture. These materials compose the terraced slopes along the east side of the Fraser River and are densely gullied and have a high erosion potential. A cap of Eolian material is commonly found on the flat terrace surfaces mapped as undifferentiated but these materials also make up a further 1.6% of the LSA.

Organic accumulations (bogs and fens) account for only 0.02% of the LSA. These materials have developed in low-lying areas and topographic depressions and are very poorly drained. Organic materials in the LSA are generally less than one meter deep but can be up to several meters deep. Textures are commonly mesic, with fibric and humic deposits also represented.

Colluvium is rare and found primarily on the eastern margin of the map area in associated rare bedrock outcrops and columnar basalts observed during field work. However, colluvium is also found along escarpments and steeper slopes on either side of the Fraser River. In total, colluvium accounts for just over 0.3 of the LSA

Table 4-28 summarizes the surficial materials for the transmission line corridor.

Table 4-4 Surficial Materials of the Transmission Corridor LSA

Parent Material	Transmission Corridor	
	Area (ha)	**Portion of LSA (%)**
Colluvial	21.3	0.34%
Eolian	103.5	1.65%
Fluvial	193.1	3.08%
Glaciofluvial	55.6	0.89%
Morainal	5,752.1	91.83%
Organic	1.3	0.02%
Undifferentiated Material	124.5	1.99%
Water	12.6	0.20%
Total	**6,263.9**	**100.00%**
Statistics based on Valentine et al. (1987) 1:100,000 scale soils maps		

Access Road

The proposed access road to the minesite follows an existing logging road south from Lee’s Corner to the minesite. The access road LSA is approximately 88 km long with a 200 m buffer on either side, and covers an area of 3495 ha. It includes a small area of overlap between the access road and minesite.

The access road LSA is mainly underlain by thick deposits of till; these account for approximately 70% of all materials within the LSA. The topography in these till-dominated areas is undulating, with slopes ranging from level to gently undulating (0–26%). The till is poorly to very poorly sorted, and consists of pebble, cobble and boulder gravel set in a matrix that ranges from silty clay to silty sand. Clasts are mainly pebbles and cobbles and are subrounded to angular, with subrounded fragments dominant. Boulders tend to be more angular and the coarse fraction usually makes up 10 - 35% of the upper 40 cm of the deposit, increasing to as much as 70% with depth.

The second largest area is composed of anthropogenic materials consisting primarily of the access road itself. These materials make up nearly 16% of the LSA.

Glaciofluvial sediments are much less extensive. They account for about 7% of all materials within the access road LSA. Subglacial glaciofluvial deposits in the northern part of the LSA form long, narrow, linear eskers, which in many cases are found overlying till. Subaerial glaciofluvial deposits include thick terraces along the Taseko River; the access road crosses these deposits at its northern end. The terraces are subject to riverbank erosion in many areas: retrogressive slumping on the outer banks of the river are an important terrain integrity issue. Glaciofluvial deposits consist predominantly of pebbles, cobbles and minor boulder gravel with a sand or silty sand matrix. Clasts generally make up 20-50% of the deposit and are subrounded to rounded with a minor subangular component. Glaciofluvial deposits are well to rapidly drained.

Organic accumulations (bogs and fens) are the next most common terrain type in this area; they are associated with depressional topography and are very poorly drained. They represent about 4% of materials found within the LSA and generally overlie till, recent lacustrine sediments and fluvial deposits. The thickness of organic deposits ranges from less than a meter to up to 2 meters. Bogs and fens are fibric, mesic and/or humic.

Colluvial deposits along the access road LSA are rare, but include debris slides and slumps on steep river banks and valley slopes, rockfalls from steep bedrock cliffs (e.g., basalt cliffs exposed in the northern extremity of the access road) and materials eroded from gullies. Colluvial materials account for some 2.4% of all materials within the LSA. Thickness of colluvial deposits can range from thin veneers in areas of shallow bedrock, to a few meters at the base of a slope. Clasts are angular and are generally in the cobble to boulder size range. They make up 60–80% of the deposit. Matrix, where present, consists of silty sand or sandy silt.

Modern fluvial deposits are found in small streams and creeks and at the margins of Taseko River; they account for less than 1.4% of materials within the LSA. Fluvial fans are found where small tributaries, creeks and gullies enter larger valleys. Fluvial sediments are commonly made up of pebble and cobble gravel with a sandy matrix; however, a finer-grained cap of silt, sand and/or clay is common in the upper 10–50 cm (these are likely overbank deposits). The drainage of smaller streams is mainly imperfect, but ranges from poorly to well drained; Taseko River deposits are well drained. Flooding, slumping and riverbank erosion affect fluvial deposits along Taseko River.

Recent lacustrine sediments are present around a few lakes and ponds (or drained lakes) within the access road corridor. They mainly consist of planar deposits of silty clay, which are moderately drained. They account for only 0.03% of the materials within the LSA. Bedrock exposures also make up only 0.04%.

The remainder of the LSA consists of bedrock and unmapped water bodies each of which cover approximately 0.2% or the total area.

Table 4-29 summarizes the surficial materials for the access road, including the area of overlap with the minesite.

Table 4-29 Surficial Materials of the Access Road LSA

Parent Material	Access Road	
	Area (ha)	**Portion of LSA (%)**
Anthropogenic	542.4	15.58%
Colluvium	83.1	2.39%
Fluvial	47.6	1.37%
Glaciofluvial	246.9	7.09%
Lacustrine	0.9	0.03%
Moraine	2,429.5	69.79%
Not Mapped	6.4	0.18%
Organic	123.9	3.56%
Bedrock	0.7	0.02%
Total 3,	**481.3**	**100.00%**
Statistics based on 1:7500 scale mapping		

Unstable and Potentially Unstable Terrain

The vast majority of the minesite, transmission line corridor and access road LSAs contain low gradient, stable terrain. Unstable terrain was identified using terrain mapping of rapid and slow mass movements and potentially unstable terrain was identified using DEM slope class maps to highlight all slopes over 60% in gradient. Unstable and potentially unstable areas are uncommon and are generally found on river escarpments, gullied and steep slopes.

Areas identified as unstable must undergo a detailed on-site terrain stability assessment by a qualified professional so that appropriate planning and mitigation measures can be undertaken prior to the commencement of construction activities. Potentially unstable areas with slopes greater than 60% in gradient also warrant further study by a qualified professional prior to development.

Unstable and Potentially Unstable Terrain within the Minesite LSA

The vast majority of the minesite LSA is characterized by low gradient slopes which show no evidence of instability. Approximately 17 ha, or 0.4% of the total area contains terrain that exhibits evidence of rapid mass movements (Table 4-30). Polygons containing unstable terrain are located at the southwest and northwest ends of Fish Lake (Figure 4-15) where debris slides and rockfalls have occurred on steep bedrock and colluvial slopes along western extent of the minesite LSA. Debris slides were also mapped on the north side of Little Fish Lake. No slow mass movements were observed in the LSA.

Table 4-30 Polygons Areas with Unstable Terrain

Study Area	Total Area (ha)	Polygons areas with Unstable Slopes (ha)	Portion of Total Area with Unstable Slopes (%)	Type of Mass Movement
Minesite Footprint LSA	4,419.2	17.4	0.39%	Rapid mass movements including debris slides and rockfalls
Access Road LSA (200 m buffer)	3,494.7	77.1	2.21%	Rapid mass movements including debris slides, rockfalls and slump-earthflows. One slow mass movement/slump-earthflow.
Transmission Line Corridor LSA (250 m buffer)	6,263.9	203.6	3.25%	Rapid and slow mass movements including debris slides, rockslides and slumps (as mapped by Talisman, 1998)

Figure 4-15 Slope Instability of the Minesite LSA

Slopes steeper than 60% used to identify potentially unstable slopes occupy 0.7 ha or 0.02% of the minesite LSA. These areas correspond with the unstable terrain polygons located on the eastern margins of the minesite footprint and LSA (Figure 4-18).

Outside the LSA and within the TEM mapping area, rapid mass movements including debris flows, debris slides rockfalls are concentrated along the slopes east of Taseko River, Lower Fish Creek and Big and Little Onion Lakes.

Unstable and Potentially Unstable Terrain within the Transmission Line Corridor LSA

Unstable areas within the transmission line corridor were identified by Talisman (1998) on airphotos during their reconnaissance study of the transmission line in August, 1997, and checked using a combination of ground and helicopter surveys during the Jacques Whitford–AXYS 2006 field program.

The transmission line corridor crosses terrain that is generally benign, with low slope gradients, well-drained compact tills, and no evidence of instability. Unstable terrain polygons containing evidence of rockslides, slumps, or slides comprise approximately 0.8% of the total transmission line corridor LSA making up a total area of 47.8 ha. (Table 4-30). These areas are identified in Figure 4-16 along with terrain constraints such as areas prone to flooding, gullying and surface erosion identified by Talisman (1998).

The most extensive area of hazardous terrain is found along the gullied escarpments of the Fraser River between 24 and 29 km (Figure 4-16). Mapped instability in this area includes slumping and debris slides. Gullying and surface erosion are ongoing.

Figure 4-16 Slope Instability of the Transmission Corridor LSA

On the east side of the Fraser River between 24 and 26.5 km the terrain is characterized by steep, highly gullied inter-bedded deposits of glaciofluvial and glaciolacustrian sediments prone to erosion, slumping and debris slides. On the western side of the Fraser River between 26.5 and 29 km terrace surfaces are capped with extensive fluvial fan deposits; the lower terrace escarpments are shaped by historic river erosion and ongoing gullying, and raveling. Upper slopes to the west of the Fraser River are comprised mainly of colluvial veneers and cones with bedrock outcrops; this terrain is dissected by steep, bedrock controlled gully systems where evidence of terrain instability was identified.

Rockfalls associated with columnar basalts were also observed on steep slopes along Bringham Creek and Bringham Lake. Other noteworthy areas of instability were identified just outside the LSA in confined valley bottoms and incised channels along eroded escarpments created by the undercutting of surficial materials by major creeks such as Big Creek and Bambrick Creek.

Approximately 57 ha of slopes within the transmission line corridor are steeper than 60% and considered potentially unstable (Table 4-31). This area equals just under 1% of the total LSA, with the majority of these slopes located along the Fraser River (Figure 4-19).

Unstable and Potentially Unstable Terrain within the Access Road LSA

Terrain polygons containing both slow and rapid mass movements cover 77 ha, or 2.2% of the access road LSA (Table 4-30) and are concentrated in three areas identified in Figure 4-17.

Figure 4-17 Slope Instability of the Access Road Corridor LSA

Two areas mapped with rapid mass movements classified as slumping and/or earthflows were identified in polygons on either side of the Chilcotin River crossing where the access road switchbacks up steeper slopes. Three other polygons containing slump/earthflows in the form of both rapid and slow mass movements were identified in the LSA approximately 1.5 km southwest of the Chilcotin River crossing.

Rapid mass movements were also observed at the Tete Angela Creek crossing. These debris slides were identified in polygons on slopes on both the north and south sides of the Tete Angela Creek.

A third area of instability was mapped on the west side of the proposed access road alignment approximately 10 km from the minesite LSA. Four polygons in this area were identified: two to the containing debris slides and two containing slump/earthflows.

DEM generated slope class maps were used to determine that 0.2 ha, or 0.01% of the total access road LSA contains slopes greater than 60% (Table 4-31). These areas, identified on Figure 4-20, correspond closely to the unstable polygons identified in Figure 4-17.

Table 4-31 Areas with Slopes Gradients Greater than 60%

Study Area	Total Area (Ha)	Areas with Slopes >60% (ha)	Portion of Total Area with Slopes >60%
Minesite Footprint LSA	4,419.2	0.7	0.02%
Access Road LSA (200 m buffer)	3,494.7	0.2	0.01%
Transmission Line Corridor LSA (250 m buffer)	6,263.9	57.0	0.91%

Figure 4-18 Slope Classes of the Minesite LSA

Figure 4-19 Slope Classes of the Transmission Corridor LSA

Figure 4-20 Slope Classes of the Access Road LSA

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