BC EAO EAC Application – Tenas Project

Section 4.0 Environmental Effects Assessment
Chapter 2 Terrain and Soils Valued Component

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Tenas Project

Section 4.0 Environmental Effects Assessment
Chapter 2 Terrain and Soils Valued Component

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Abbreviations and Acronyms

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
AAFC	Agriculture and Agri-Food Canada
AIR	Application Information Requirements
AQMP	Air Quality Management Plan (S13.0-C2)
ALR	Agricultural Land Reserve
BC	British Columbia
BC EAO	British Columbia Environmental Assessment Office
BC MECCS	British Columbia Ministry of Environment and Climate Change Strategy
BC MEMLI	British Columbia Ministry of Energy, Mines, and Low Carbon Innovation
BC MFLNRORD	British Columbia Ministry of Forests, Lands, and Natural Resource Operations and Rural Development
BC MOE	British Columbia Ministry of Environment
BC MOF	British Columbia Ministry of Forests
BC MOFR	British Columbia Ministry of Forests and Range
BC MOTI	British Columbia Ministry of Transportation and Infrastructure
BC OGC	British Columbia Oil and Gas Commission
BMP	best management practice
C	Chapter
CanSIS	Canada Soil Information System
CCME	Canadian Council of Ministers of the Environment
CEA	cumulative effects assessment
CEMP	Construction Environmental Management Plan (S13.0-C4)
CEPA	*Canadian Environmental Protection Act*, 1999, SC, c33 (Government of Canada [GovCan] 1999)
CLI	Canadian Land Inventory
CNR	Canadian National Rail
Code	Health, Safety and Reclamation Code for Mines in British Columbia (British Columbia Ministry of Energy, Mines, and Low Carbon Innovation [BC MEMLI] 2021)
CPP	Coal Processing Plant
DTSM	detailed terrain stability mapping
EA	environmental assessment
EAA	*Environmental Assessment Act*, SBC 2002, c 43 (Government of British Columbia [GovBC] 2002)
EAC	Environmental Assessment Certificate
EMP	Explosives Management Plan (S13.0-C6)

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
FMSCP	Fuel Management and Spill Control Plan (S13.0-C7)
GIS	Geographic Information System
GovBC	Government of British Columbia
GovCan	Government of Canada
Lidar	light detection and ranging
LRMP	Land and Resource Management Plan
LSA	Local Study Area
MERP	Mine Emergency Response Plan (S13.0-C9)
MIC	Mine Infrastructure Complex
MSWG	Mapping System Working Group
MTCP	Minesite Traffic Control Plan (S13.0-C10)
MWMP	Minesite Water Management Plan (S13.0-C11)
n	number
PAG	potentially acid generating
POC/COC	Parameters of Concern/Contaminants of Concern
POPC/COPC	Parameters of Potential Concern/Contaminants of Potential Concern
Project	Tenas Project
QA/QC	Quality Assurance and Quality Control
RCP	Reclamation and Closure Plan (S13.0-C15)
RDBN	Regional District of Bulkley-Nechako
RIC	Resources Inventory Committee
RISC	Resource Information Standards Committee
ROM	run-of-mine
ROW	right of way
RSA	Regional Study Area
S	Section
SC (only in tables)	subcomponent
SEPSCP	Surface Erosion Prevention and Sediment Control Plan (S13.0-C17)
SMU	soil map units
SRMP	Sustainable Resource Management Plan
TAC	Tenas Access Corridor
TCL	Telkwa Coal Limited
TK	Traditional Knowledge
TSA	Timber Supply Area
TSC	Terrain Stability Classes
TSM	Terrain Stability Mapping

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
UTM	Universal Transverse Mercator
VC	Valued Component
VMP	Vegetation Management Plan (S13.0-C18)
WMP	Wildlife Management Plan (S13.0-C21)

Units of Measure

Abbreviation or Acronym	Long Form of Abbreviation or Acronym
%	percent
<	less than
>	greater than
ha	hectare
kV	kilovolt
m	metre
V	volt

EXECUTIVE SUMMARY

This chapter addresses the potential effects of the Tenas Project (Project) on the Terrain and Soils Valued Component (VC). Terrain and Soils were selected as a VC based on the likelihood of interaction with the Project, their contributing role on landscape form, function, and future land capability and (by extension) their interactions with biodiversity, ecosystem function and capacity to support wildlife habitat. Terrain and Soils then contributes to environmental, socio-economic, and cultural values of Indigenous groups, regulators, the public and other stakeholders. Subcomponents and associated indicators under the Terrain and Soils VC refer to:

- Terrain Stability: change in stability and morphology; and
- Soil Quality: change in physical and chemical properties of soil in context of land use capability.

Changes to terrain are defined by the net alteration to landscape stability and morphology from baseline conditions. Changes to soil quality are defined by changes in both soil quantity and soil chemicals and physical characteristics to the extent that they change current land capability. Potential effects on the Terrain and Soils subcomponents include:

- Terrain Stability: change to terrain from vegetation and rock removal; and
- Soil Quality: loss of soils and changes to soil quality due to change in chemical and physical properties.

The Project will be developed to design-specifications so that a safe and stable landscape exists during all Project phases. Project activities will be planned and sequenced to account for terrain stability, soil erosion and soil conservation to the extent practical. Mitigation measures will be designed and implemented to monitor and maintain Terrain Stability and Soil Quality during all Project phases. The mitigation being proposed is based on industry best management practices (BMPs), procedures, and proven/accepted mitigation used on other similar projects.

After mitigation, Project residual effects for both Terrain Stability and Soil Quality should mostly be within the limits of the natural range of variability or, otherwise, at the limits of the natural range of variability. Upon further characterisation and determination of Likelihood and Significance, the residual effects for the Terrain and Soils VC are expected to be **Not Significant**. The Level of Confidence for this prediction is High.

Project-related residual effects were assessed in terms of their cumulative effect within the Regional Study Area (RSA) based on available information and understanding of other reasonably foreseeable projects and activities. The assessment of Project-related effects and cumulative effects was conducted according to the methods set out in **Section (S) 3.0 Assessment Methodology** of the **Environmental Assessment Certificate (EAC) Application**. Upon review of all projects and activities within the RSA (past, present, and reasonably foreseeable future), and after determining that no additional mitigation measures are expected to be necessary, it was predicted that there is no potential for Project residual effects to interact cumulatively within the RSA for the Terrain Stability subcomponent, and that cumulative effects in the RSA are expected to occur but are characterised as **Not Significant** for the Soil Quality subcomponent. Therefore, cumulative effects on the Terrain and Soils VC are **Not Significant**.

1. Introduction

This chapter presents the identification and assessment of the potential for residual effects of the Tenas Project (Project) and the cumulative effects on the Terrain and Soils Valued Component (VC) in a thorough, rigorous, and concise manner. For this Environmental Assessment Certificate (EAC) Application, the Terrain and Soils VC is represented by two (2) subcomponents: Terrain Stability and Soil Quality.

This assessment is comprised of the following steps:

- **Regulatory Context:** A description of the applicable legislation, policies, standards, and guidelines pertaining to the protection of the Terrain and Soils VC;
- **Scope of the Assessment:** A description of the assessment scope including issues scoping, rationale for the selection of the Terrain and Soils VC, subcomponents and indicators, and definition of the assessment boundaries;
- **Existing Conditions:** A description of the baseline studies undertaken for the Project, other relevant information, and descriptions of the Terrain and Soils VC within the defined spatial boundaries;
- **Assessment of Project-related Effects:** A description of the potential interactions between the Project and the Terrain and Soils VC, potential effects, proposed mitigation measures, an evaluation of potential residual effects that remain following implementation of the proposed mitigation measures, and an assessment of the significance of these potential residual effects;
- **Cumulative Effects Assessment (CEA):** A description of the residual effects of the Project in combination with the residual effects of past, present, and reasonably foreseeable future projects and activities, (if/where necessary) the development of additional mitigation measures to eliminate, reduce, or control cumulative effects and an assessment of the cumulative effects on the Terrain and Soils VC and their significance; and
- **Follow-up Strategy:** A presentation of monitoring programs to verify assessment predictions and evaluate mitigation effectiveness, and a discussion of adaptive management program(s) to be implemented to address any unexpected Project effects on the Terrain and Soils VC.

2. Regulatory Context

This environmental assessment (EA) has considered applicable federal and provincial legislation, regulations, strategies, guidelines, plans, and best management practices (BMPs) relevant to the Terrain and Soils VC, and includes information provided by Indigenous groups. Applicable recommendations in provincial land use plans and designations were also considered.

The Tenas Project Application Information Requirements (AIR) for the Project, approved by the British Columbia Environmental Assessment Office (BC EAO) in 2022, outlines the requirements of the EA for the Terrain and Soils VC to meet the provincial EA requirements under the *Environmental Assessment Act,* SBC 2002, c 43 (Government of British Columbia [GovBC] 2002) (*EAA*). The EA for the Terrain and Soils VC follows these guidelines and legislated requirements and is consistent with the requirements of the Project AIR. Legislation specific to the Terrain and Soils VC and descriptions of the data requirements to assess the environmental effects are presented in the following subsections.

2.1 Federal Legislation and Regulations

Federal legislation, regulations, and policy applicable to the Project and relevant to the Terrain and Soils VC are described in **Table 2.1-1.**

Table 2.1-1: Summary of Federal Legislation, Regulations and Policy Applicable to the Terrain and Soils Valued Component (VC)

Name	Year	Description
Canadian Environmental Protection Act, 1999, SC, c33 (Government of Canada [GovCan] 1999) *(CEPA)*	1999	The *CEPA* focuses on protecting environmental and human health by preventing, controlling, and managing pollutants, wastes, and other toxic substances and contributing to sustainable development.
Canadian Soil Quality Guidelines (Canadian Council of Ministers of the Environment [CCME] 2007)	2007	The Canadian Soil Quality Guidelines integrate national environmental quality guidelines for all environmental media including soil for agricultural, residential/parkland, commercial and industrial land uses.
Fisheries Act, 1985, c F-14 (GovCan 1985)	1985; amended 2019	The Act prohibits harmful alteration, disruption, and destruction of fish habitat, supports restoration of fish habitat and riparian areas, and regulates commercial fisheries and other industry and development, promoting a biodiversity- and ecosystem-based approach.

2.2 Provincial Legislation and Regulations

The British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC MFLNRORD) is responsible for the stewardship of provincial Crown land and ensures the sustainable management of natural resources (including forest, wildlife, water, and other land-based resources) within the region containing the Project. The study areas for the Terrain and Soils VC (defined in **3.2.4**) are located within the Regional District of Bulkley-Nechako (RDBN). Provincial legislation, regulations, and policy applicable to the Project and relevant to the Terrain and Soils VC are described in **Table 2.2-1.**

Table 2.2-1: Summary of Provincial Legislation, Regulations, and Policy Applicable to the Terrain and Soils Valued Component (VC)

Name	Year	Description
Agricultural Land Commission Act, SBC 2002, c 36. (Government of British Columbia [GovBC] 2002a)	2002	The Act sets the legislative framework for the establishment and administration of the agricultural land preservation program. The associated Agricultural Land Reserve Use Regulation, BC Reg 30/2019 (GovBC 2019) permitted land uses within the Agricultural Land Reserve (ALR), and the Regulation sets out the required application procedures for alternative (i.e., non-farm) land uses.
Environmental Assessment Act, SBC 2002, c 43. (GovBC 2002b) (*EAA*)	2002	The *EAA* provides a mechanism for the Province of British Columbia (BC) to review all major projects proposed in the province to assess for any potentially adverse environmental, economic, social, heritage, or health effects (GovBC 2002). This Project requires an assessment of potential adverse environmental effects under the Reviewable Projects Regulations, BC Reg 370/02 (GovBC 2002b), of the Act as the Project exceeds the production capacity of 250,000 tonnes per year.
Environmental Management Act, SBC 2003, c 53. (GovBC 2003)	2003	The Act regulates pollution, hazardous waste, contaminated site remediation, and the discharge of municipal and industrial waste to the environment while ensuring the protection of human health and the environment. The Contaminated Sites Regulations, B.C. Reg. BC Reg 375/96 (GovBC 1996a) of the Act provide quantitative standards to define site contamination and to evaluate reclamation success.
Forest and Range Practices Act, SBC 2002, c 69. (GovBC 2002c)	2002	The Act outlines standards and requirements for how forest and range practices and natural resource activities should be conducted on Crown land in BC in a manner that safeguards protection of natural resources, including vegetation (GovBC 2002c). The Act also regulates terrain stability, erosion prevention and soil disturbance.
Land Act, RSBC 1996, c 245. (GovBC 1996a)	1996	Crown land is partly managed under the authority of the Act, which is the primary legislation the Province of BC uses to convey land to the public for community, business, or industrial use. Sustainable management of Crown land and natural resources is guided in part by the Act and associated Land Use Objectives Regulation, BC Reg 357/2005 (GovBC

Name	Year	Description
		2005), in addition to land use plans, which work to protect species at risk and their habitats within certain geographical regions.
Mines Act, RSBC 1996, c 293. (GovBC 1996b)	1996	The Act and accompanying Health, Safety and Reclamation Code for Mines in British Columbia (British Columbia Ministry of Energy, Mines, and Low Carbon Innovation [BC MEMLI] 2021) (Code) include provisions for the protection of land and watercourses by minimizing the environmental risks associated with mining activities, as well as reclamation requirements for disturbed areas.
Water Sustainability Act, SBC 2014, c 15. (GovBC 2014b)	2014	The Act is the primary legislation to manage the licensing, diversion, and use of water resources, and establishes protections for water quantity, quality, and aquatic ecosystems.
Weed Control Act, RSBC 1996, c 487. (GovBC 1996c)	1996	The Act establishes the duty to control designated noxious weeds growing on any occupied land in BC.
Weed Control Regulation, BC Reg 66/85. (GovBC 2011)	2011	The Act specifies provincial and regional noxious weeds and provides instruction on controlling their introduction and spread.

2.3 Strategies, Guidelines, Plans and Best Management Practices (BMPs)

Strategies, guidelines, plans, and BMPs applicable to the Terrain and Soils VC are listed in **Table 2.3-1.** These documents were considered when identifying the potential effects of the Project, developing appropriate mitigation measures, and characterising residual and cumulative effects.

Table 2.3-1: Summary of Strategies, Guidelines, Plans and Best Management Practices (BMPs) Applicable to the Terrain and Soils Valued Component (VC)

Name	Year	Description
Aggregate Operators Best Management Practices Handbook for BC (British Columbia Ministry of Mines [BC MEM] 2002)	2002	The purpose of the handbook is to provide information, guidance and best management practice (BMP) options to sand and gravel pits and rock quarry operators for many aspects of planning, operating, and reclaiming aggregate operations in British Columbia (BC). Incorporating the aggregate BMP can provide effective erosion and sediment control, minimize exposed soil areas, and re-establish vegetation.
British Columbia Conservation Framework: Conservation Priorities for Species and Ecosystems (British Columbia Ministry of Environment [BC MOE] 2009)	2009	A science-based framework designed to prioritize species and ecosystems for conservation, select effective conservation actions, and coordinate management actions. Results can be used to advise conservation programs for a variety of stakeholders and organizations.
Canadian Biodiversity Strategy (Government of Canada [GovCan] 1995)	1995	The three (3) objectives of the strategy are the conservation of biodiversity, the sustainable use of biological resources, and the fair and equitable sharing of the benefits that result from the use of genetic resources.

Name	Year	Description
Guidelines and Standards for Terrain Mapping in British Columbia (Resources Inventory Committee [RIC] 1991)	1996	This document outlines established standards for ecosystem unit characterisation, symbology, sampling, mapping procedures, interpretation, and legends.
Handbook for Mineral and Coal Exploration in British Columbia (British Columbia Ministry of Energy, Mines, and Petroleum Resources [BC MEMPR] & BC MOE 2008)	2008	This handbook summarizes industry recommended BMPs pertaining to reclamation including project planning, siting of features, soil salvage and handling, and installation/maintenance of mitigation measures.
Health, Safety and Reclamation Code for Mines in British Columbia (British Columbia Ministry of Energy, Mines, and Low Carbon Innovation [BC MEMLI] 2021) (Code)	2021	The Code outlines requirements for mining operations to minimize associated risks to human and environmental health and safety. Topics under Section 9 and 10 specify criteria pertaining to end-land use, re-vegetation, watercourse/water crossings, and environmental monitoring.
Policy for Mitigating Impacts on Environmental Values (Government of British Columbia [GovBC] 2014a)	2014	This policy provides guidance to decisions concerning environmental mitigation measures. It incorporates environmental, social, and economic values, encourages use of the best available data and data sharing, and provides a recommended mitigation hierarchy and recommended mitigation process and plan.
Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998)	1998	This document outlines established standards for ecosystem unit characterisation, symbology, sampling, mapping procedures, interpretation, and legends.

2.4 Land Use Plans

The Project Area is located within lands managed under the Bulkley Land and Resource Management Plan (LRMP) that directs the management of 760,000 hectares (ha) of Crown land in northwestern BC (GovBC 1999). The eastern extent of the Project Area is situated within the Bulkley Valley Landscape Unit wherein land use planning objectives are further guided by the Bulkley Valley Sustainable Resource Management Plan (SRMP) (GovBC 1998). The western extent is situated within the Telkwa Landscape Unit wherein land use planning objectives are guided by the Telkwa Land Use Plan (GovBC 1999). Together, these plans specify objectives and strategies for forest resource management within this landscape with emphasis on biodiversity conservation and sustainable development. These land management objectives were considered in the development of mitigation measures as described in **5.3 Mitigation Measures.**

3. Scope of the Assessment

The assessment of the Terrain and Soils VC, including the assessment of Project-related effects and cumulative effects, was conducted according to the methods set out in **S3.0 Assessment Methodology** of this **EAC Applicatio**n. The assessment boundaries specific to the Terrain and Soils VC are provided in **3.2.4 Assessment Boundaries** and the characterisation criteria specific to the Terrain and Soils VC are provided at the start of **5.4 Residual Effects and Significance of Residual Effects**.

This subsection outlines the scope of the assessment, including the rationale for the inclusion of Terrain and Soils as a VC along with its subcomponents, the selection of indicators, and the definition of spatial and temporal boundaries. The assessment is informed by the **Terrain and Soil Baseline Report (Appendix 4.2-A)**, as well as input from Indigenous groups, the public and government agencies through working groups and comment solicitation, which identified the importance of Terrain and Soils. This assessment is organized into two (2) subcomponents: Terrain Stability and Soil Quality (**3.2.2 Subcomponents**).

3.1 Issues Scoping

Telkwa Coal Limited (TCL) has undertaken an engagement and consultation process to support the scoping of issues for the Project (refer to **Part C-S11.0 Wet'suwet'en Rights and Interests Assessment** and **Part D-S12.0 Public Consultation** of this **EAC Application** for details on the consultation program). The consultation and engagement process has included technical working groups established with Indigenous groups and government departments, community meetings, one-on-one and small group meetings, regarding key themes of interest and discussion of candidate VCs to represent the themes of interest.

3.2 Rationale for Selection of Terrain and Soils Valued Component (VC)

The Terrain and Soils VC and associated subcomponents were selected during the pre-Application phase of the Project following the VC selection process set out in **3. Scope of the Assessment** and using the methodology provided in the Guideline for Selection of Valued Components and Assessment of Potential Effects (BC EAO 2013). The goal was to focus on relevant issues, concerns, and components of the natural and human environment that may be affected by the Project.

Baseline study findings; conservation status; review of applicable government legislation, policies, and plans; effects assessments for other relevant projects; professional judgement of the Project team; and inputs from Working Group members, government agencies, Indigenous groups, the public, and other interested parties during consultation were considered and used to inform the selection of VCs and subcomponents.

3.2.1 Valued Component (VC)

Terrain and Soils were selected as an VC based on the likelihood of interaction with the Project, particularly their contributing role on landscape form, function and future land capability, and (by extension) their interactions with biodiversity, ecosystem function and capacity to support wildlife habitat. As such, the Terrain and Soils VC then contributes to environmental, socio-economic, and cultural values of Indigenous groups, regulators, the public and other stakeholders. The Terrain and Soils VC supports (i.e., are inputs to) and/or are dependent on the assessment of several VCs:

- **Dependent on:**
  - **Groundwater VC (S4.0-Chapter [C] 4)** – Groundwater interacts with terrain and soils via hydrologic connectivity to shape groundwater flow and water cycling within landscape form and function;
  - **Surface Water VC (S4.0-C3)** – Surface water interacts with terrain and soils via hydrologic connectivity to shape surface drainage patterns within landscape form and function; management of surface water is a key components of reclamation design;
- **Supporting:**
  - **Vegetation VC (S4.0-C7)** – Vegetation interacts with terrain and soils to shape ecosystem form and function and biodiversity; terrain, soil and vegetation are, together, key components of reclamation design and reinstatement of equivalent land capability;
  - **Aquatic Resources VC (S4.0-C5)** – Terrain and soils contribute to landscape form and function that support aquatic resources depending on hydrological conductivity;
  - **Atmospheric VC (S4.0-C1)** – Terrain and soils contribute to landscape form and function that affect air quality via dust deposition;
  - **Avian Species VC (S4.0-C9)** – Terrain and soils contribute to landscape form and function that support avian species and habitat;
  - **Fish and Fish Habitat VC (S4.0-C6)** – Terrain and soils contribute to landscape form and function that support for fish and fish habitat;
  - **Human Health VC (S8.0-C1)** – Terrain and soils contribute to landscape form and function that define landscape aesthetic and land capability and, thereby, affect human health;
  - **Land and Resource Use VC (S4.0-C4)** – Terrain and soils contribute to landscape form and function that define landscape aesthetic and land capability and, thereby, affect land and resource use;
  - **Visual Resources VC (S6.0-C2)** – Terrain and soil contribute to landscape form and function that define landscape aesthetic and land capability and, thereby, affect visual resources; and
  - **Wildlife VC (S4.0-C8)** – Terrain and soil contribute to landscape form and function that support wildlife species and habitat.

3.2.2 Subcomponents

During the VC scoping exercise two (2) subcomponents were selected to focus the Terrain and Soils VC assessment of key themes of interest identified through consultation, and reviews of other information. The subcomponents of the Terrain and Soils VC are Terrain Stability and Soil Quality (**Table 3.2-1**), which reflect relevant parameters related to their role in the maintenance of the ecosystem and biodiversity and land use capability.

Terrain Stability and Soil Quality are fundamental and interrelated components of landscape form and function that shape a given landscape's capacity to support predictable ecological assembly and land use. Terrain Stability and Soil Quality have been delineated as distinct subcomponents due to their respective spatio-temporal contexts and associated indicators of measurable change.

Table 3.2-1: Summary of Rationale for Selection of Terrain and Soils Valued Components (VC) and Subcomponents and Their Linkages

Subcomponent	Rationale for Inclusion	Source of Information	VC Linkages	
Terrain Stability	▪ Potential for Project interaction; ▪ Provincial management concern; ▪ Sensitive to disturbance; ▪ Habitat for wildlife; and ▪ Historically addressed for previous projects with similar conditions.	▪ Land and resource management plans; and ▪ Issues Scoping	**Dependent on:** ▪ Groundwater; and ▪ Surface Water	**Supporting:** ▪ Aquatic Resources; ▪ Avian Species; ▪ Fish and Fish Habitat; ▪ Land and Resource Use; ▪ Vegetation ▪ Visual Resources; and ▪ Wildlife.
Soil Quality	▪ Potential for Project interaction; ▪ Provincial management concern; ▪ Sensitive to disturbance; ▪ Historically addressed for previous projects with similar conditions; and ▪ Contributes to biodiversity, nutrient cycling, and productivity.	▪ Land and resource management plans; ▪ Issues scoping; and ▪ *Agricultural Land Commission Act*, SBC 2002, c 36. (Government of British Columbia [GovBC] 2002a)	**Dependent on:** ▪ Groundwater; and ▪ Surface Water	**Supporting:** ▪ Aquatic Resources; ▪ Atmospheric Environment; ▪ Avian Species; ▪ Fish and Fish Habitat; ▪ Human Heath; ▪ Land and Resource Use; ▪ Vegetation; ▪ Visual Resources; and ▪ Wildlife.

Notes: *Project=Tenas Project; VC=Valued Component*

3.2.3 Indicators

Indicators are quantitative and qualitative parameters used to describe existing VC or VC subcomponent conditions and trends, and to evaluate potential Project effects on the VC and cumulative effects. VC indicators used in the assessment of the Terrain and Soils VC are change in stability and morphology and change in physical and chemical properties of soil in context of land use capability. Rationale for the selection of these indicators isprovided in **Table 3.2-2.**

Table 3.2-2: Indicators for Terrain and Soils Valued Component (VC) and Subcomponents

Indicator	Rationale for Selection
Terrain Stability	
Change in stability and morphology	Project activities have the potential to alter the stability and morphology of the terrain on the landscape.
Soil Quality	
Change in physical and chemical properties of soil in context of land use capability	The Project has the potential to alter the soil quality on the landscape.

Notes: *Project=Tenas Project*

3.2.4 Assessment Boundaries

The spatial and temporal boundaries encompass the area within, and times during which, the Project is expected to interact with the Terrain and Soils VC. The administrative and technical boundaries represent any constraints that may be placed on the EA due to political, social, and economic realities (i.e., administrative boundaries), or limitations in predicting or measuring changes (i.e., technical boundaries).

This subsection identifies the spatial, temporal, and technical boundaries for the analysis of potential effects on the Terrain and Soils VC.

3.2.4.1 Spatial Boundaries

The spatial boundaries for the Terrain and Soils VC are described in **Table 3.2-3**, and presented in **Figure 3.2-1**. As detailed in **S3.0-C2 Assessment Methodology, Assessment of Boundaries** of this **EAC Application**, the Project Area refers to the maximum area within which the Project will be constructed and operated, including the Minesite and access routes. The Project Area is a conservative spatial estimate of the area of direct disturbance effects on the Terrain and Soils VC within this assessment.

The Terrain and Soils Local Study Area (LSA) covers 3,667.64 ha and encompasses the Project Area plus:

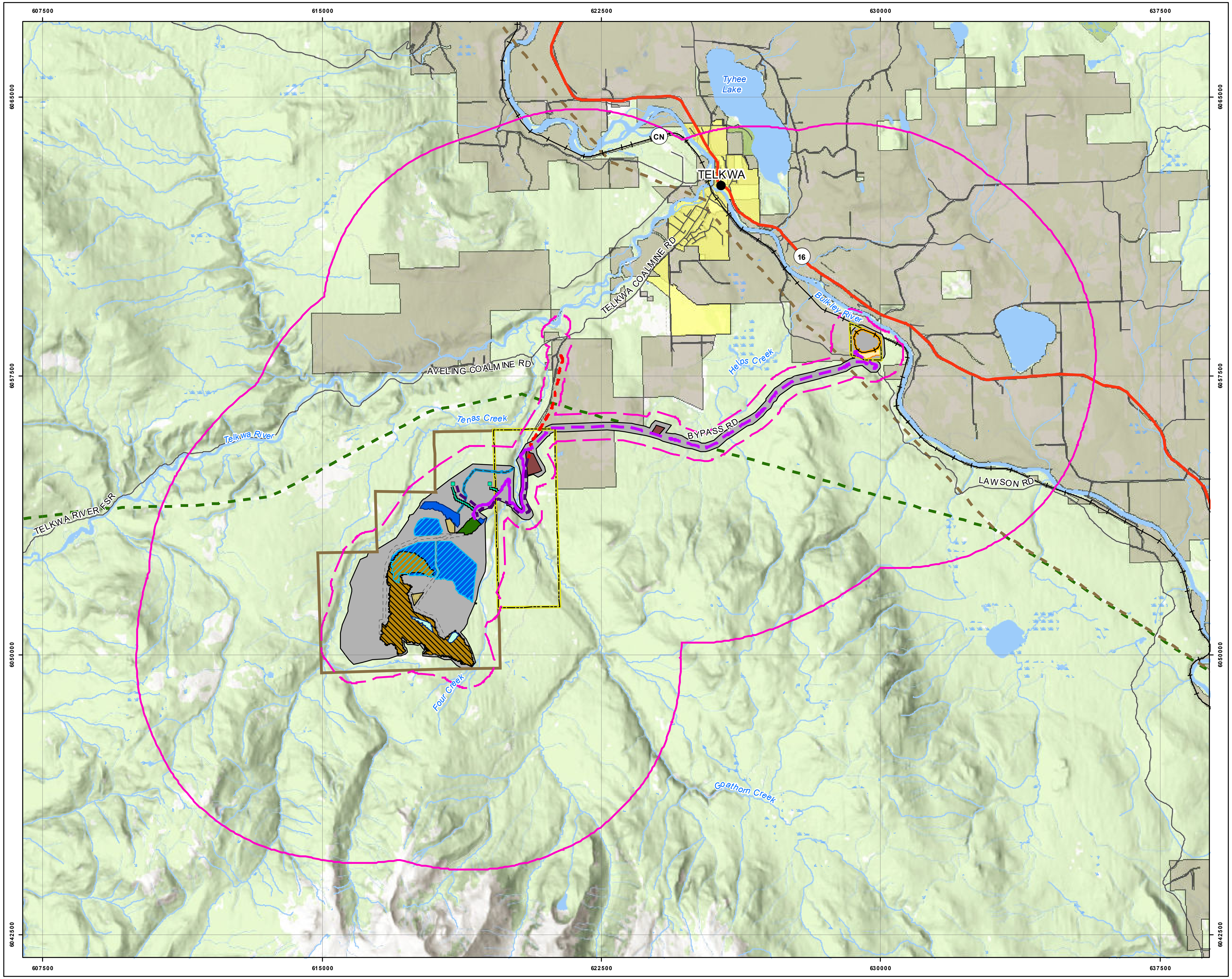
1. a 250 metre (m) buffer for all linear infrastructure (Tenas Access Corridor [TAC], powerline, etc.); and
2. a 500 m buffer for all other infrastructure (Minesite, Minesite Infrastructure, and Rail Infrastructure).

These buffer zones were delineated to capture direct effects more effectively, and most of the indirect effects likely to occur on the Terrain and Soils VC and subcomponents. Considerations used to establish the spatial boundaries of the Terrain and Soils LSA include bioterrain polygons, terrain stability ratings, geohazard ratings and delineated soil management units.

The Terrain and Soils RSA covers 35,726 ha and encompasses the Project Area plus a minimum 5 km buffer. This buffer zone was delineated to capture all indirect effects of the Project and provide context of the type, distribution, and extent of Terrain Stability and Soil Quality in relation to land capability. The Terrain and Soils RSA also corresponds with the CEA Area within which Project-related residual effects may interact with other land uses and activities (i.e., past, present, and reasonably foreseeable future).

Table 3.2-3: Spatial Boundary Definitions for Terrain and Soils Valued Component (VC)

Spatial Boundary	Description of Study Area
Project Area	Maximum disturbance area within which the Tenas Project (Project) will be constructed and operated
Local Study Area (LSA)	Encompasses the Project Area plus: ▪ a 250 metre (m) buffer for all linear infrastructure (e.g., Tenas Access Corridor [TAC], powerline, etc.); and ▪ a 500 m buffer for all other infrastructure (e.g., Rail Infrastructure and Minesite).
Regional Study Area (RSA)	Encompasses the Project Area plus a minimum 5 kilometre (km) buffer



Tenas Project

Spatial assessment boundaries for the Terrain and Soils Valued Component

Legend

- City/Town
- Rail Line
- Highway
- Road
- Watercourse
- Wetland
- Waterbody
- Park or Protected Area
- Municipal Area
- General Private Property
- 138 kV Transmission Line
- 500 kV Transmission Line

Project Features

- Existing 25 kV Power Line
- 25 kV Power Line
- Haul Road
- Rail Loop
- Discharge Path
- Tenas Access Corridor
- Backfill Area
- Control and Plant Sedimentation Pond
- Explosive Infrastructure
- Management Pond
- Mine Infrastructure Complex
- Open Pit
- Pit Lake
- Quarry
- Rail Infrastructure
- Topsoil Stockpile
- Tenas Coal Licenses
- Telkwa Coal Limited Private Property
- Project Area
- Terrain and Soils Local Study Area
- Terrain and Soils Regional Study Area

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Map

N

1:100,000

0 1 2 3 4 5

Kilometres

NAD 1983 UTM Zone 9N

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3.2.4.2 Temporal Boundaries

As described in **S3.0-C1-3.2** of the **EAC Application**, the temporal boundaries for the assessment of Project-related effects on the Terrain and Soils VC encompass the time periods during which the Project is expected to interact with the Terrain and Soils VC. These include Construction, Operation, Decommissioning and Reclamation, and Post-closure phases (**Table 3.2-4**).

Table 3.2-4: Temporal Boundaries for the Tenas Project

Phase	Year	Duration (years)	Description of Activities
Construction	-0.5 to 0	1.5	Site clearing, soil salvage, open pit development, building construction, service and haul road development, Rail Infrastructure construction, bridge construction and development of onsite utilities and services. Development of mine rock, and overburden storage piles, stockpiling of reclamation material such as soil, overburden and other materials suitable for reclamation. Development of water management systems and management ponds for storage of potentially acid generating (PAG) materials.
Operation	1 to 21	21	Development of the open pit through drilling, blasting, loading, and hauling functions. Development of mine rock, and overburden storage piles, stockpiling of reclamation material such as soil, overburden, and other materials suitable for reclamation. Development of water management systems and management ponds for PAG storage. Conducting coal processing, stockpiling of raw coal prior to processing, and stockpiling of processed coal prior to shipping. Progressive reclamation will be accomplished during operation including, where available, reclamation activities such as sloping, topsoil placement and revegetation.
Decommissioning and Reclamation	22 to 25	4	Tear-down of infrastructure onsite plus reclamation activities, including sloping of storage piles, backfill materials, and placement of reclamation materials including growth media, overburden and non-PAG rock for management pond covers and revegetating surfaces that are planned to be reclaimed.
Post-closure	26 to 50	10	Active: This involves the filling of the open pit with water, monitoring of vegetation growth and water quality for both groundwater and surface water and wildlife. Control and sedimentation ponds may still be needed for settling of total suspended solid levels. The management ponds are left as dry land reclamation except for portions that will be left as open water.
		15	Passive: This stage is when the control and sedimentation ponds are no longer required for settling of total suspended solid (TSS) levels and the management ponds are left as dry land reclamation except for portions that will be left as open water. Telkwa Coal Limited (TCL) is now simply monitoring the site.

3.2.4.3 Administrative Boundaries

Administrative boundaries refer to legally documented and attributed jurisdictional boundaries. These boundaries define the rights, responsibilities, and interests on the land. The Terrain and Soil LSA and RSA are situated within the Wet'suwet'en Traditional Territory. The LSA and RSA are also situated within the RDBN, the Bulkley Timber Supply Area (TSA), and the Skeena Stikine Natural Resource District of the Skeena Natural Resource Region. Forest resources therein are managed by the BC MFLNRORD. The Terrain and Soils VC Study Areas are also located within the boundaries of the Bulkley LRMP (the eastern extent is situated within the Bulkley Valley Landscape Unit, whereas the western extent is situated within the Telkwa Landscape Unit)**.**

The northeastern portion of the Terrain and Soils VC Study Areas is located within the BC Agricultural Land Reserve (ALR): a provincial designation in which agriculture is recognized as the priority land use and farming is encouraged. Non-agricultural (i.e., non-farm) land uses therein are regulated by the Agricultural Land Commission (ALC) under the *Agricultural Land Commission Act,* SBC 2002, c 36 (GovBC 2002a). Project features in the ALR (51.35 ha, representing approximately 5 percent [%] of the total Project Area) comprise part of the TAC, the Rail Infrastructure (tying-in to the existing Canadian National Rail (CNR) main line), and a gravel quarry. Permitting for this portion of the Project has been addressed in a separate application to the ALC.

3.2.4.4 Technical Boundaries

Technical boundaries refer to the limitations of the assessment imposed by the availability of data and the measurability of an effect. Knowledge of Terrain Stability and Soil Quality within the Terrain and Soils VC is based on targeted field surveys and baseline inventories, available historic and spatial inventories, and the professional judgement of the EA team.

As summarized in **4. Existing Conditions**, the terrain and soil field surveys and associated mapping products provide a robust baseline inventory of resources covering the Project Area and the LSA. However, it should be noted that the investigative boundaries of terrain stability (3,413 ha) and soil mapping (3,314 ha) are slightly different. Baseline studies were planned and completed at a preliminary stage of the Project's design. Baseline data capture covers nearly the entire Project Area, however there are some discrete undefined portions in each respective study area. Where applicable, undefined portions of the Project Area, LSA, and RSA have been identified in the descriptions in **4. Existing Conditions.** Given the spatio-temporal context for the Project and its interaction with the Terrain and Soils VC, these technical limitations were deemed inconsequential and would not influence the assessment.

4. EXISTING CONDITIONS

The information in this subsection establishes the context for the assessment of effects on the Terrain and Soils VC, including regulatory context, Traditional Knowledge (TK), and baseline studies undertaken for the Project.

4.1 Background Information and Studies

4.1.1 Traditional Knowledge (TK)

The Terrain and Soil LSA and RSA are situated within the Wet'suwet'en Traditional Territory. TK is addressed in **S11.0 Wet'suwet'en Rights and Interests Assessment** of the **EAC Application**.

4.1.2 Scientific and Other Information

The assessment considered various sources of scientific and other information relevant to the Project, including available studies, historic surveys, and databases to describe existing conditions and environmental context. A summary of the desktop and field studies related to the characterisation of terrain is presented in **Table 4.1-1**. A summary of the desktop and field studies related to the characterisation of soils is presented in (**Table 4.1-2**). These sources were also considered by the baseline studies (see **4.1.3**).

Table 4.1-1: Summary of Desktop and Field Studies Related to Terrain

Study Name	Study Purpose, Duration and Spatial Boundaries
Soil Survey and Land Capability Evaluation of the Telkwa Coal Project. (Pedology Consultants 1983)	The report provides detailed descriptions of the surficial materials and surficial geology. The mapping was carried out at a 1:5,000 scale in a core area centred on Goathorn Creek and at 1:20,000 scale for an area north and east of Goathorn Creek. A polygon map was not available.
Borehole logs (Piteau Engineering Ltd. 1997)	The borehole logs provide information on surficial material quaternary stratigraphy and depth to bedrock in the open pit area.
Manalta Baseline Report. Appendix 4.1.1: Terrestrial Ecosystem Mapping (1:20,000) (Oikos Ecological Services 1999)	This report was used for reference. Mapping of bioterrain polygons at 1:20,000 scale of the proposed Manalta Project encompasses the Project Area. The polygon attributes include surficial material and surface expression.
Terrain Stability Mapping funded by Forest Renewal BC (FRBC); 1:20,000. (Madrone Consultants Ltd. 1999)	Detailed terrain stability mapping (DTSM) was completed at 1:20,000 scale available for operable forest on crown land in the lower Telkwa watershed (Minesite and portions of the Bypass Road). The DTSM does not cover private land such as land owned by Telkwa Coal Limited (TCL).
Levson et al. (1998)	This document includes a description and discussion of quaternary ice-flow direction and till mineralogy in the Babine Mountains – Bulkley Valley area, including the Telkwa watershed.
Stumpf (2001); Stumpf et al. (2004)	These documents contain descriptions of quaternary stratigraphy in the Babine Lake – Bulkley River Region, including stratigraphic description in the lower Telkwa watershed.

Table 4.1-2: Summary of Desktop and Field Studies Related to Soils

Study Name	Study Purpose, Duration and Spatial Boundaries
Soils of the Telkwa Coal Project Area for Crowsnest Resources Ltd. 1:5,000 and 1:20,000 (Pedology Consultants 1984)	This is a 1:5,000 scale mapping of a previously proposed development area centred on Goathorn Creek, and 1:20,000 scale mapping of an area north and west of Goathorn Creek. The mapping does not cover the open pit or Rail Infrastructure area. 52 soil units were described, based on soil class, morphology, landform, and materials. Field plot locations are unavailable. The detailed soil descriptions help to confirm soil map units (SMUs), but the map polygons were large and generalized, and did not cover the same study area (paper copy only, not in a Geographic Information System [GIS]).
Manalta Baseline Report. Appendix 4.1.1: Terrestrial Ecosystem Mapping (1:20,000) (Oikos Ecological Services Ltd. 1999)	Mapping in this report was completed at 1:20,000 scale and encompassed most of the Tenas Project Area. Nine (9) soil map units were described, along with suitability ratings. Active and inactive floodplain units were not differentiated. Rich lower (seepage slope) fluvial fans and colluvial cones were not differentiated. A digital ecological plot file includes detailed soil descriptions, but plot locations are only referenceable to the map polygon, not a specific Universal Transverse Mercator (UTM) location. A soil map layer was not found. The range of land capability for agriculture was described for each SMU.
Canada Land Inventory, Soil Capability for Agriculture, Map sheet 93L NW Telkwa (Agriculture and Agri-Food Canada [AAFC]1974)	1:125,000 scale agriculture capability mapping was available for reference. The mapping is 50 years old, carried out at a time when Agriculture Canada had a research station based in Smithers.

4.1.3 Baseline Studies

Project-specific baseline studies represent the most recent and complete inventories used for identifying potential Project effects, developing appropriate mitigation measures, and characterising the residual effects and, finally, the potential for cumulative effects. Project-specific terrain and soil baseline investigations were conducted by Ardea Biological Consulting (Smithers, BC) from 2017 to 2019 under the oversight and coordination of Laurence Turney, R.P.Bio. Assessment of terrain morphology and stability (including characterisation of geohazards) was led by Irene Weiland, P.Geo, Eng.L. (Weiland Terrain Sciences, Smithers, BC), and assessment of soil resources (including characterisation of agricultural capability units) was led by Irene Ronalds, R.P.Bio, (Irene Ronalds Ecological Consulting Ltd., Smithers, BC). Quality Assurance and Quality Control (QA/QC) assessments were carried out by qualified independent professionals Claudia Houwers, R.P.Bio. (Houwers Ecological Consulting) and Dave Yole, P.Ag. (D. Yole Consulting).

Methodological details (including total number of field assessment plots and survey intensity levels), survey parameters and assumptions, and comprehensive data summaries/findings are presented in the Project-specific **Terrain and Soil Baseline Report (Appendix 4.2-A)**. Study topics addressed in the baseline report are listed in **Table 4.1-3**, and these topics account for terrain and soil resources within the boundaries of the RSA and are supported by detailed mapping products for the LSA that encompass all components of the Project Area. As mentioned in **3.2.4.4 Technical Boundaries**, the investigative boundaries of terrain stability (3,413 ha) and soil mapping (3,314 ha) are marginally different. Baseline data capture covers nearly the entire Project Area, however there are some discrete undefined portions in each respective study area. Where applicable, undefined portions of the Project Area, LSA, and RSA have been identified in the descriptions of **3.2.4 Assessment Boundaries.** Initial interpretations of existing conditions began in early 2017 using spatial and attribute data, including detailed contours generated from bare-earth light detection and ranging (Lidar) digital elevation data, acquired from TCL's in-house data collection and from the Data BC spatial inventory. Field data collection for initial reconnaissance began in 2017, followed by more extensive field sampling in 2018, with 2019 studies guided by preliminary terrain polygons. Field surveys for assessment of terrain and soils were executed by multidisciplinary field teams, comprised of specialists in the characterisation of terrain, soil and ecosystems. The summary of these field studies provides a robust and detailed inventory of existing conditions pertaining to the Terrain and Soils subcomponents, including terrain stability ranking classes and characterization of soil erosion potential (Terrain Stability subcomponent) as well as soil mapping units (SMUs), land capability units and soil salvage potential (Soil Quality subcomponent). Additional information pertaining to the geomorphic history and physiography is presented in the baseline study **(Appendix 4.2-A)**.

Table 4.1-3: Topics Addressed in the Terrain and Soils Baseline Report

Baseline Study Topics	Study Purpose, Duration, and Spatial Boundaries
Terrain Stability Subcomponent	
Quaternary Stratigraphy	Characterisation of parent materials and geomorphologic processes
Bioterrain Mapping	Delineation of landforms, surficial materials, and geomorphologic processes
Terrain Stability Classification and Surface	Assignment of Terrain Stability Classes and Surface Erosion Potential Ratings (based on bioterrain mapping)
Erosion Potential Ratings	Delineation of erosion potential based on surficial materials, terrain characteristics and soil properties
Soil Quality Subcomponent	
Soil Map Units (SMUs)	Delineation of soil groupings with related properties Consolidation of soil information for environmental assessment (EA), management, and mitigation
Soil Salvage Potential	Soil salvage potential developed based on evaluating soil texture, coarse fragment content and organic content within the Local Study Area (LSA)
Agricultural Capability Assessment	Classification of agricultural land capability based on biogeoclimatic parameters
Soil Metal Composition	Sampling and analysis of surface soil samples for chemical characterisation of soil properties and baseline metal content/concentration.

4.1.3.1 Terrain Mapping

Terrain mapping was completed to define terrain mapping units that delineate landforms, surficial materials, and geomorphologic processes. In this respect, bioterrain mapping presents the terrain information as a base layer for further interpretation of soil units and ecosystem units; terrain stability mapping (TSM) is a Resource Information Standards Committee (RISC) standard approach used to delineate areas of stable and/or unstable terrain including the assessment of the landslide hazard. The surface erosion potential was rated as part of TSM. Assessment of terrain stability also included the identification of any other natural hazards pertaining to the LSA and Project Area, including snow avalanche hazards and hydrogeomorphic (fluvial) hazards.

Terrain mapping follows BC provincial standards; specifically, the Guidelines and Standards for Terrain Mapping in British Columbia (Resources Inventory Committee [RIC 1996]) and the Terrain Classification System for British Columbia, v.2 (Howes and Kenk 1997). Digital data management follows the Standard for Digital Terrain Data Capture in British Columbia, Terrain Technical Standard and Database Manual, Errata 2002-1.1 (BC MOE 2007); bioterrain data management has been updated to follow the Terrestrial Ecosystem Information Digital Data Submission Standard - Draft for Field Testing, Database and GIS Data Standards, v.2.1. (BC MOE 2012). The soil drainage classes follow those outlined in the Field Manual for Describing Terrestrial Ecosystems, 2nd Edition (British Columbia Ministry of Forests and Range [BC MOFR] and BC MOE 2010). TSM, including assigning terrain stability classes and soil erosion potential ratings to each terrain polygon, follows the standards described in the Mapping and Assessing Terrain Stability Guidebook (British Columbia Ministry of Forests [BC MOF] and BC MOE 1999).

4.1.3.2 Soil Mapping

Soil mapping was completed to define SMUs and delineate groupings of soils with related properties to provide soil information efficiently for environmental assessment, environmental management and mitigation, and reclamation purposes. The units represent systematic and predictable changes of soil properties across the landscape and have a minimum number of inclusions and unidentified features (Mapping System Working Group [MSWG] 1981, RIC 1985). Accordingly, SMUs provide standard units for assigning soil salvage potential and soil erosion potential within the LSA and Project Area.

Soil mapping follows BC and Agriculture Canada standards, which include Soil Inventory Methods for British Columbia (RIC 1995), the Field Manual for Describing Terrestrial Ecosystems, 2nd Edition (BC MOFR and BC MOE 2010), The Canada Soil Information System (CanSIS): Manual for Describing Soils in the Field, 1982 Revised (Expert Committee on Soil Survey 1982), the Soil Survey Handbook Volume 1 (Coen 1987), and The Canadian System of Soil Classification, 3rd Edition (GovCan 1998). Assignment of soil salvage potential was based on criteria found in Soil Quality Criteria Relative to Disturbance and Reclamation (Revised) (Alberta Soils Advisory Committee 1987); assignment of soil erosion potential is based on standards found in the Mapping and Assessing Terrain Stability Guidebook (BC MOF 1999) and Proceedings of the BC Soil Survey Workshop on Soil Interpretations for Forestry (Vold 1982).

Given that the northeast portion of the LSA and Project Area occur within the boundaries of the ALR, an assessment and mapping of agricultural capability was completed. Agricultural capability mapping follows Land Capability Classification for Agriculture in British Columbia (Kenk and Coltic 1983; BC ALC 2017), which is consistent with Soil Capability Classification for Agriculture - Canada Land Inventory (CLI) 1972 (Agriculture and Agri-Food Canada 1974).

4.2 Description of Existing Conditions

The Project is in northwest BC near the Village of Telkwa, southwest of the confluence of the Telkwa and Bulkley rivers and situated within the Skeena River Watershed. The RSA for the Terrain and Soil VC includes the Village of Telkwa and part of Tyhee Lake, Round Lake, the lower slopes of Hunter Basin, and the lowest reaches of Pine Creek (**Figure 3.2-1**).

Predominant land use, vegetation composition and ecological assembly are addressed in **S4.0- C7 Vegetation VC**. In the context of the Terrain and Soil VC, most of the Terrain and Soil RSA and LSA are located on undeveloped forested land. In this respect, the RSA has undergone previous disturbance associated with various discrete land use activities, including road development and commercial forestry (i.e., cutblocks and access roads), agricultural land use (i.e., hay land, pasture, rangeland), and rural residential development. These land use activities mostly occur in the north and northeast portions of the RSA and LSA and coincide within the boundaries of the ALR.

Landform elements within the RSA are characterised by hummocks and ridges on surface plateaus, and floodplains and terraces along the extensive network of rivers and creeks. The LSA for the Terrain and Soils VC is characterised by subdued or rolling terrain marking a transition of the Hazelton Mountains to the Nechako Plateau. Key landscape features within the LSA include the Bulkley River, Telkwa River, Goathorn Creek, and Tenas Creek.

The most recent glacial period contributed to erosion and deposition that formed these landscape features, whereby glacial till represents the predominant soil parent material. Fluvial and colluvial processes then shaped the modern floodplains and fans of the rivers and major creeks and resulted in the formation of small toe slope deposits at the base of steep slopes. Predominant soil orders occurring within the LSA include Brunisols, Gleysols, Luvisols, Podzols, Regosols, and some Organic soils. Soil profiles are then generally comprised of a combination of shallow organic veneers and blankets followed by thin/shallow mineral soils with integrated coarse fragments and bedrock. Skeletal soils (i.e., that do not show any profile development) are prevalent in some locations.

Collectively, these defining features determine the bioterrain interpretations and characteristics of the Terrain Stability and Soil Quality subcomponents existing conditions for the Project. More in-depth accounting of components of terrain stability (i.e., characteristics of surficial materials, rankings of terrain stability, erosion potential, natural hazard assessment) and soil quality (i.e., soil mapping units, characterisation of soil chemistry and metals content, agricultural capability assessment) are provided in subsections, hereafter.

4.2.1 Terrain

The geologic setting for the Project has been comprehensively described in the **Terrain and Soil Baseline Report (Appendix 4.2-A)**. Terrain morphology within the RSA and LSA has been shaped by the last glaciation (28,000 to 10,000 years ago), when the region was completely covered by the Cordilleran Ice Sheet. The surficial materials in the LSA are predominantly glacial deposits: basal till and ablation till; localized subglacial and supraglacial ice contact gravel and sand deposits; proglacial gravel and sand deposits transported by glacial meltwater streams; and clay and silt deposited in late-glacial lakes. The geomorphologic processes shaping the LSA include deglaciation (glacial retreat), mass movement and wasting (slides, slumping, and soil creep), and a combination of erosional, fluvial, and hydrologic processes. Most of the LSA coincides with flat (0 to 5%) to moderately gently sloping (less than [<] 25%) terrain. Areas characterised by moderately steep (greater than [>] 25%) to steep (>50%) and potentially unstable slopes have also been identified within the LSA. These terrain morphology and stability attributes have been captured in the Project-specific terrain mapping product (**Appendix 4.2-A**).

4.2.1.1 Terrain Stability Ranking

Terrain Stability Classes (TSC) were characterised for the LSA and Project Area (**Figure 4.2-1**). TSC descriptors are presented in **Table 4.2-1**. The spatial extents of TSCs within the Project Area, LSA and RSA are summarized in **Table 4.2-2.**

TSC 1 and 2 are the dominant classes within Project Area that, together, account for 1753.76 ha (94.65%) of the Project Area or 47.81% relative to the LSA and 4.91% relative to the RSA. These classes comprise terrain polygons generally characterised by a combination of flat, undulating, and gently sloping upland terrain consisting of glacial till; well-drained, flat to ridged gravel deposits; upland alluvial fans and thin veneers along small streams; and thin organic deposits in depressions.

TSC 3 represents 29.92 ha (1.61%) of the Project Area. This class includes terrain polygons characterised by moderately steep terrain and variable or imperfect drainage.

TSC 4 and 5 account for 37.41 ha (2.02%) of the Project Area or 1.02% relative to the LSA and 0.10% relative to the RSA. These classes include terrain polygons along the steep valley sidewalls of Tenas Creek, Goathorn Creek, and some sections of Four Creek. TSC 5 terrain units typically have moderately steep to steep slope gradients and show evidence of active or recent slope movement. TSC 4 terrain typically holds similar slope angles to or is located adjacent to TSC 5 terrain, and commonly shows signs of historic mass movement. Landslides or soil creep are expected to occur with TSC 4 and 5 during excavation or following cut-and-fill road construction. The remaining 31.86 ha of the Project Area (1.72%) were undefined.

Table 4.2-1 Terrain Stability Class (TSC) Descriptors

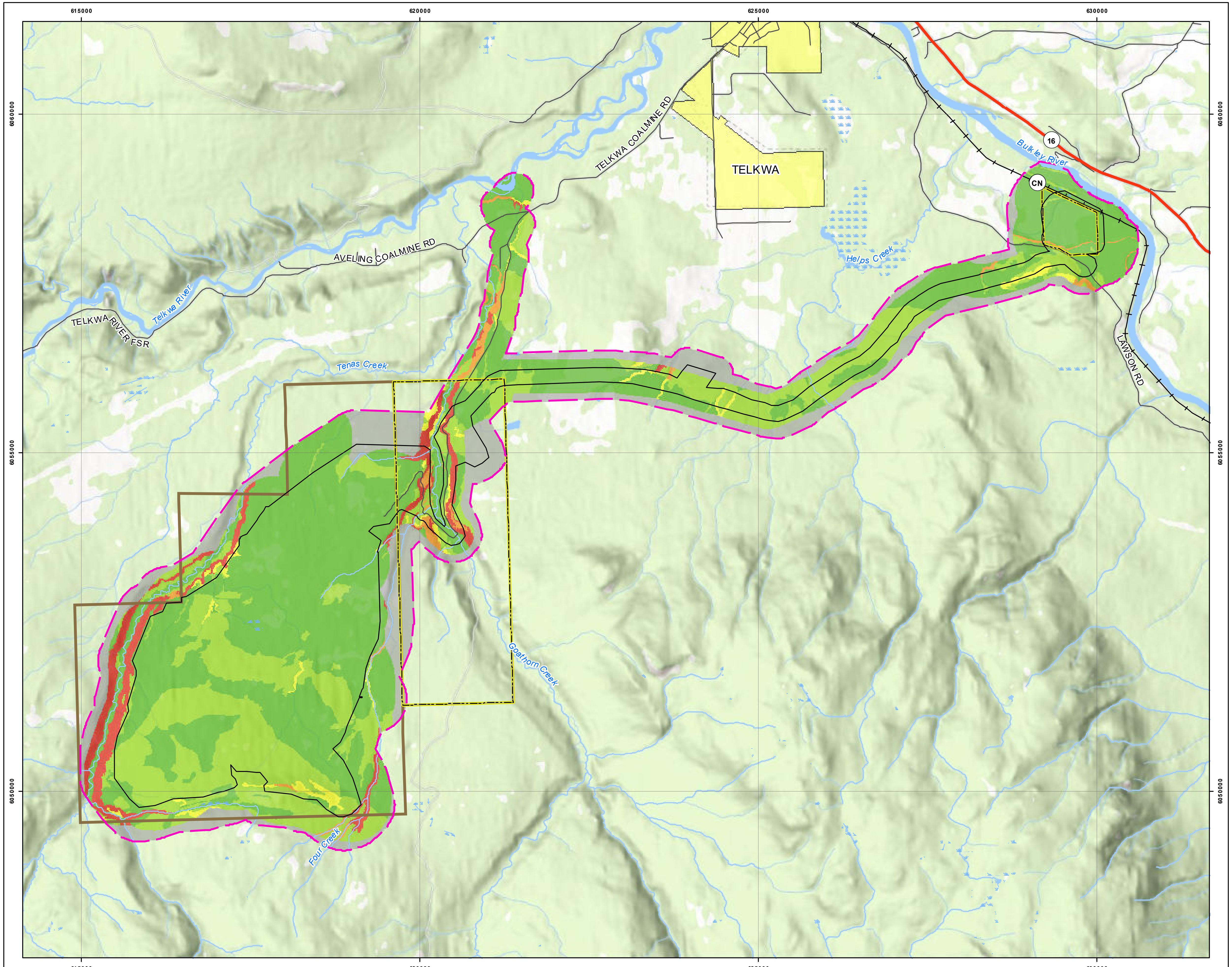
Terrain Stability Class	Terrain Stability Class (TSC) Description
Class 1	No significant problems of terrain stability are expected.
Class 2	No significant problems of instability are expected; and Low likelihood of minor inclusions of sensitive terrain.
Class 3	Minor problems of instability may occur; and Minor inclusions of sensitive terrain are possible, but no slope failures occur.
Class 4	Problems of instability are expected; marginally stable slopes and sensitive terrain exists; and Natural landslides are rare, but terrain conditions are similar to nearby unstable slopes or evidence of small-scale instability or excessive steepness exists.
Class 5	Significant problems of instability are expected; Active or recurrent landslides initiate within mostly steep terrain; and Sensitive terrain is common, such as steep-sided gullies; site with seasonally high soil pore water pressure; undercut tall stream banks.
Undefined	No data

Source: *Terrain Stability Class from British Columbia Ministry of Forests (BC MOF) and British Columbia Ministry of Environment (BC MOE) 1999*

Table 4.2-2 Area Extent of Terrain Stability Classes within Terrain and Soils Local Study Area (LSA)

Terrain Stability Class	Project Area (ha)	LSA (ha)	Project Area Relative to Study Area		
			% of Project Area	% of Total LSA	% of Total RSA
1	1154.33	1839.35	62.30	31.47	3.23
2	599.43	959.01	32.35	16.34	1.68
3	29.92	62.85	1.61	0.82	0.08
4	10.94	47.13	0.59	0.30	0.03
5	26.47	168.04	1.43	0.72	0.07
Undefined	31.86	591.26	1.72	0.87	0.09
Total	**1852.95**	**3667.64**	**100**	50.52	**5.19**

Source: *Terrain stability classes derived from Terrain Classification System for British Columbia (Howes and Kenk 1997)*
Notes: *%=percent; ha=hectare; LSA=Local Study Area; RSA=Regional Study Area*



Tenas Project

Area extent of Slope Stability Class within the Project Area and Terrain and Soils Local Study Area

Legend

- Rail Line
- Highway
- Road
- Watercourse
- Wetland
- Waterbody
- Park or Protected Area
- Municipal Area
- Telkwa Coal Limited Private Property
- Tenas Coal Licenses
- Project Area
- Terrain and Soils Local Study Area

Slope Stability Class

- I
- II
- III
- IV
- V
- No Data

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Map

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4.2.1.2 Surface Erosion Potential

Surface erosion potential ratings (i.e., in the context of the Terrain Stability subcomponent) were assigned to each terrain polygon to describe the erosion potential of surficial geologic materials exposed to overland flow or heavy rain. Soil erosion potential is further described in the context of SMUs in **4.2.2.2**.

Most of the LSA and Project Area are characterised by low to moderate surface erosion potential. These areas are characterised by low slope gradients and/or subdued landforms. Surface erosion potential then varies depending on drainage characteristics (from well- to imperfectly draining) and coarse fragment content. Areas of high or very high surface erosion potential were identified on the steep and moderately steep, fine-textured valley side walls of Goathorn Creek and Tenas Creek. Fluvial fans consisting of sand and gravels are highly susceptible to surface erosion along existing and potentially new distributary channels. Floodplain units with a silty overbank deposits were also assigned a high erosion potential rating. A few isolated areas of very low surface erosion potential were identified in the study area (e.g., typically in organic wetlands and shallow depressions).

4.2.1.3 Natural Hazard Assessment

A natural hazard assessment was completed for the LSA and Project Area to characterise the potential for geohazards associated with snow avalanches, landslides, and other hydrogeomorphic (fluvial) features.

No snow avalanche tracks were identified in the study area. However, slopes steep enough to allow an unstable snowpack to slide have been identified (e.g., on the valley walls of Goathorn Creek along access roads and transportation corridors; within the mine pit along the pit walls).

Fluvial hazards, ranging from very low to very high depending on location were identified, mapped, and characterised for the Bulkley River Floodplain and the Telkwa River Floodplain. Hydrogeomorphic hazards were then identified at Goathorn Creek and Helps Creek. The fluvial hazard within the Project Area along the Bulkley River Floodplain was mostly rated as very low or low, but also included proximal areas with moderate, high, and very high ratings (e.g., areas of low elevation and seasonally high groundwater; areas along the stream banks). The fluvial hazard along the Telkwa River Floodplain was mostly moderate or high, but also included areas with a high rating (e.g., along the stream banks).

4.2.2 Soil

The pedological setting for the Project has been comprehensively described in the **Terrain and Soil Baseline Report (Appendix 4.2-A)**. Soil resources and pedogenesis have been shaped by the parent materials, climatic and geomorphic processes, and vegetation. The LSA and Project Area are characterised by both mineral and organic soils. Predominant soil orders and great groups include Brunisols (Melanic, Eutric, Sombric, and Dystric Brunisols), Gleysols (Orthic, Humic, and Luvic Gleysols), Luvisols (Grey Luvisols), Podzols (Ferro-Humic and Humo-Ferric Podzols), Regosols (Orthic and Humic Regosols) and Organics (Mesisols and Humisols).

Soil profiles were generally comprised of a combination of shallow organic veneers and blankets followed by thin/shallow mineral soils with integrated coarse fragments and bedrock. Skeletal soils (i.e., that do not show any profile development) are prevalent in some locations. Where present, soil profiles were characterised by sandy loam, silt loam, silty clay loam, and loam textured A horizons followed by predominantly sand, sandy loam, silt loam and clay loam/loamy clay B horizons. Soil characteristics have been captured in the Project-specific soil mapping product (**Figure 4.2-2**).

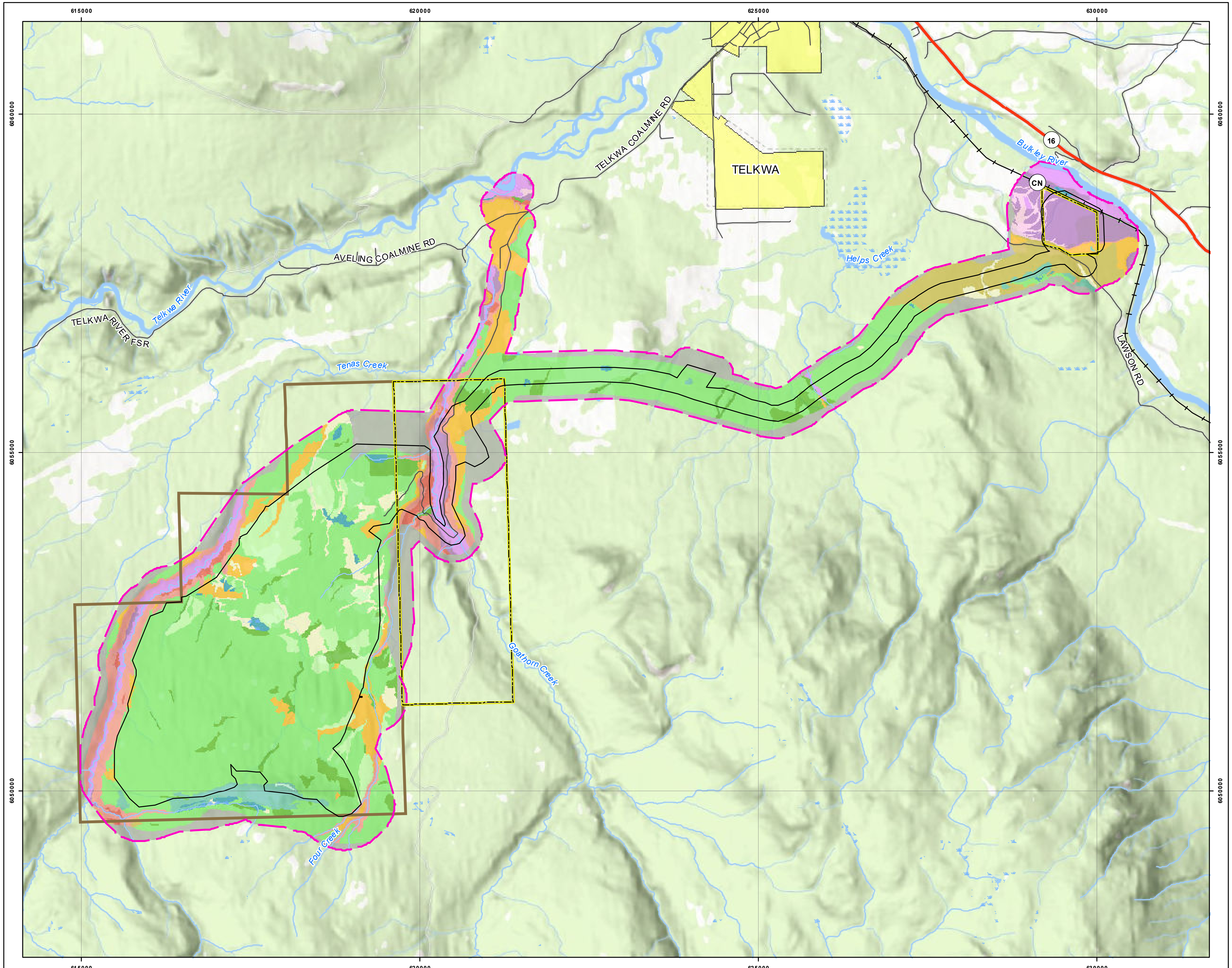
4.2.2.1 Soil Map Units (SMUs)

SMUs were characterised for the LSA and Project Area and are displayed on **Figure 4.2-2**. SMU descriptors are presented in **Table 4.2-3.** The spatial extents for SMUs within the Project Area, LSA and RSA are summarized in **Table 4.2-4.**

SMUs 1.1, 1.2, and 1.3 are predominant within the Project Area and, together, account for 1,452.74 ha (78.87%) of the Project Area, or 39.85% relative to the LSA and 4.09% to the RSA. SMU's 1.1 and 1.2 are characterised by medium textured soils derived from glacial till with poor to well drainage and coarse fragment content ranging from 10-45%, whereas SMU 1.3 is characterised by coarser textured soils with well to rapid drainage and coarse fragment content ranging from 30-60%.

SMUs 2 and 4.3 are the next predominant SMUs within the Project Area and, together, account for 146.82 ha (7.92%) of the Project Area, or 4.00% relative to the LSA and 0.41% relative to the RSA. SMUs 2 and 4.3 are both characterised by coarse textured soils with well to rapid drainage, where SMU 2 is derived from glaciofluvial material and SMU 4.3 is derived from inactive fluvial deposits.

SMU 7 is characterised by organic soils with poor drainage and represent 15.75 ha (0.84%) of the Project Area or 0.43% of the LSA and 0.04% of the RSA. SMU 6 is characterised as skeletal soils or rapid draining outcrops and represent 1.05 ha (0.06%) of the Project Area. All other SMUs (3.1, 3.2, 4.1, 4.2, 5, 8.1, 8.2) account for 199.08 ha (10.74%) of the Project Area, or 5.43% relative to the LSA and 0.56% of the RSA with detailed information described for each SMU in **Table 4.2-4**. The remaining 28.71 ha of the Project Area (1.55%) were undefined.



Tenas Project

Area extent of Soil Map Units within the Project Area and Terrain and Soils Local Study Area

Legend

- Rail Line
- Highway
- Road
- Watercourse
- Wetland
- Waterbody
- Municipal Area
- Telkwa Coal Limited Private Property
- Tenas Coal Licenses
- Project Area
- Terrain and Soils Local Study Area

Soil Map Unit

- 1.1
- 1.2
- 1.3
- 2
- 3.1
- 3.2
- 4.1
- 4.2
- 4.3
- 5
- 6
- 7
- 8.1
- 8.2
- No Data

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

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Table 4.2-3 Descriptors for Soil Map Units (SMUs)

SMU	Parent Material	General Description	Topography	Soil Texture	Average Rooting Depth (cm)	Coarse Fragment Content (% RZ)
1.1	M	Medium textured, well- to moderately-drained Orthic and Brunisolic Grey Luvisols, Eutric and Dystric Brunisols derived from tills, coarse fragment content from 10 to 40%. May have compacted Bt horizon. Limited organic enrichment.	Level to moderately steep	SiL, L, SiCL, (SL)	30	10-45
1.2	M (Fv)	Medium textured, imperfectly- to poorly-drained Humic Gleysols, Gleyed Grey Luvisols, Gleyed Melanic Brunisols, derived from tills on receiving slope positions. Organic enriched A layer is typical.	Lower receiving slope positions	SiL, SiCL, SiC, (SL, LS)	30	10-+45
1.3	M	Coarse textured, silty-sandy, well to rapidly-drained nutrient- poor Dystric Brunisols, derived from ablation tills. Cold-air ponding.	Undulating, convex	SL, LS	25	30-60
2	FG	Coarse textured, sandy, coarse-loamy to gravelly, well- to rapidly-drained Dystric Brunisols, derived from glaciofluvial parent materials.	Level to gently sloping	S, LS, (SL)	30	20-70
3.1	LG, (FG)	Fine-textured, moderately-drained Orthic and Brunisolic Gray Luvisols, derived from glaciolacustrine parent materials. Zero coarse fragments, and relatively high clay content.	Level to gently sloping	SiCL, SiL, Si	25	0
3.2	Fv [LG], LGp, Mp	Fine-textured, imperfectly- to poorly-drained Gleyed Dark Grey Luvisols, Gleyed Brunisolic Grey Luvisols, Humic Luvic Gleysols. Organic enriched A layer > 10 cm. Often signs of prolonged water saturation.	Level to gently sloping and depressions	Si, SiCL, SiL	25	0-10
4.1	F^{A}p, Fp	Coarse textured, sandy-silty, well- to moderately-drained Orthic and Cumulic Regosols on active floodplain deposits. Subsurface flooding or over-bank flooding. Organic enrichment variable.	Level to gently sloping	LS, S, SL, SiL	30	0-60
4.2	FAp, Fp	Fine-textured, silty, imperfectly- to poorly-drained Humic Regosols associated with floodplain deposits, often with organic enrichment. (Similar to SMU 3.2)	Level	SiL, SiCL, Si	25	0
4.3	Ft	Coarse-textured, sandy-silty, well- to rapidly-drained Brunisols derived from inactive fluvial deposits. (Similar to SMU 2)	Level to gently sloping	SL, LS	25	0-40

SMU	Parent Material	General Description	Topography	Soil Texture	Average Rooting Depth (cm)	Coarse Fragment Content (% RZ)
5	Mv [R or D]	Shallow, well- to rapidly-drained Dystric Brunisols over bedrock. Medium textured with high coarse fragments.	Gentle upper slopes and crests	SiL, FSL, SL	20	30-75
6	R, D	Skeletal. Rapidly drained bedrock outcrops.	Upper slopes, crests	Skeletal	< 5	Skeletal
7	O	Organic soils, poor to very poorly drained. Veneers and blankets.	Level to depression	Fibric, mesic organics	30	n/a
8.1	Cbv, FGks	Well to moderately well drained Regosols, Brunisols, Luvisols on steep to moderately steep escarpment slopes, some active failures and slumps.	Moderately steep, steep slopes	SiL, L, SiCL	30	25-80
8.2	Cfb	Humic Regosols with organic Ah horizons > 10 cm, situated in toe-slope receiving positions at base of escarpment slopes.	Gentle to moderate receiving slopes	SiL, L, SiCL	40	0-50

Notes: *>=greater than; %=percent; cm=centimetre; RZ=Root Zone; SMU=soil map unit*
Parent Material: *C=Colluvium; Cbv= colluvium thick blanket/veneer; Cfb= colluvium fan(s)/veneer; F=Fluvial; FA=Fluvial-Anthropogenic; Fap= fluvial active plain; FG=Fluvio-Glacial; Fp= fluvial plain; Ft= fluvial terrace; Fv= fluvial veneer; M=Morainal (Till); M(Fv)=Morainal fluvial veneer; Mp=morainal plain; FGks= glaciofluvial moderately steep/steep slope; Mv= morainal veneer; LG=Glacio-Lacustrine; LGp= glaciolacustrine plain; O=Organic; R=Bedrock; D=Weathered Bedrock*
Soil Texture: *L=Loam; LS=Loamy Sand; S=Sand; SL/FSL=Sandy Loam/Fine Sandy Loam; Si=Silt; SiL=Silt Loam; SiC=Silt Clay; SiCL=Silty Clay Loam*

Table 4.2-4: Area Extent of Soil Map Units (SMUs) within Terrain and Soils Local Study Area (LSA)

SMU	Project Area (ha)	LSA (ha)	Project Area Relative to Study Area		
			% of Project Area	% of Total LSA	% of RSA
1.1	1217.01	1755.15	65.68	33.18	3.41
1.2	96.43	137.58	5.20	2.63	0.27
1.3	148.10	174.65	7.99	4.04	0.41
2	77.90	252.81	4.20	2.12	0.22
3.1	58.63	144.68	3.16	1.60	0.16
3.2	67.78	92.15	3.66	1.85	0.19
4.1	11.00	150.32	0.59	0.30	0.03
4.2	2.18	20.88	0.12	0.06	0.01
4.3	68.92	131.88	3.72	1.88	0.19
5	18.35	64.79	0.99	0.50	0.05
6	1.05	1.05	0.06	0.03	0.00
7	15.75	27.39	0.85	0.43	0.04

SMU	Project Area (ha)	LSA (ha)	Project Area Relative to Study Area		
			% of Project Area	% of Total LSA	% of RSA
8.1	32.28	202.01	1.74	0.88	0.09
8.2	8.85	31.08	0.48	0.24	0.02
Undefined	28.71	481.22	1.55	0.78	0.08
Total	1858.26	3667.64	100.00	50.52	5.19

Notes: *ha=hectare;%=percent; SMU=soil map unit*

4.2.2.2 Soil Salvage Potential and Soil Erosion Potential

Soil salvage potential ratings and erosion potential ratings were characterised for the LSA and Project Area (**Figure 4.2-3** and **Figure 4.2-4**). Soil salvage descriptors are presented in **Table 4.2-5** and soil erosion potential ratings (**Table 4.2-6)** were assigned to each SMU. The spatial extents for soil salvage and erosion potential within the Project Area, LSA and RSA are summarized in **Table 4.2-7** and **Table 4.2-8**.

Soil salvage potential is variable within the LSA depending on location. Most of the LSA is characterised by good-to-fair or fair-to-poor soil salvage potential, but also some discrete areas where the landscape is unsuitable for soil salvage (e.g., due to the thin and/or skeletal soils, the predominance of organic soils, or the occurrence of steep and/or unstable terrain). Accordingly, soil erosion potential indicates a similar pattern of spatial variability. Most of the LSA is characterised by low-to-moderate and moderate-to-high soil erosion potential, but also very high erosion potential occurring in area of steep and/or unstable terrain.

A fair-to-good soil salvage potential rating is predominant within the Project Area and accounts for 1,283.61 ha (69.27%) of the Project Area or 35.00% relative to the LSA and 3.59% to the RSA. Fair-to-good soil salvage potential are associated with SMUs of 1.1, 3.2, and 4.2 that are characterised by fine textured soils with potential water table and erosion concerns. Good salvage potential is associated with SMU 1.2 that is characterised by rich lower slope soil deposits of high organic content and nutrients accounts for 113.77 ha (6.14%) or 3.10% relative to the LSA and 0.32% to the RSA. Fair, poor-to-fair, and poor salvage potential ratings are associated with SMUs 1.3, 2, 3.1, 4.3, and 5 that are characterised by predominantly coarse material with low soil nutrients and, together, account for 373.67 ha (20.17%) or 10.19% relative to the LSA and 1.05% to the RSA. Unsuitable soil salvage potential is associated with SMUs 4.1, 8.1, and 8.2 that are characterised by high coarse fragments located on steep slopes account for 53.19 ha (2.87%) or 1.45% relative to the LSA and 0.15% relative to the RSA. The remaining 28.71 ha (1.55%) of the Project Area is undefined, representing 0.78% relative to the LSA and 0.08% relative to the RSA.

A low to moderate soil erosion potential rating is predominant within the Project Area and accounts for 1,381.88 ha (74.36%) of the Project Area, or 37.68% relative to the LSA and 3.87% to the RSA. Low soil erosion potential is associated with SMU's 2, 6, and 7 that are characterised by high coarse fragment content, rocky outcrops, or high organic matter content account for 94.42 ha (5.10%) or 2.57% relative to the LSA and 0.26% relative to the RSA. Moderate to high, high, and very high soil erosion potential are associated with SMUs 1.2, 3.1, 3.2, 4.1, 4.3, 4.2, 8.1, and 8.2 that are characterised by finer textured materials or located on steeper slopes account for 304.62 ha (16.44%) of the Project Area, or 8.31% relative to the LSA and 0.85% relative to the RSA. The remaining 28.71 ha of the Project Area (1.55%) were undefined.

Table 4.2-5: Soil Salvage Potential for Soil Map Units (SMU)

SMU	Average Rooting Depth (cm)	Coarse Fragment Content (% RZ)	Rating	Soil Salvage Potential / Management Comments
1.1	30	10-45	Fair to Good	Medium to fine-textured tills. May have medium coarse fragments or firm consistence.
1.2	30	10-45	Good	Rich lower slope position soil deposits. High in organic content and soil nutrients. Firm consistence. Soil saturation, fine textures, receiving slope positions all raise erosion potential.
1.3	25	30-60	Fair	Coarse sandy gravelly ablation tills. Low in soil nutrients. Low erosion potential.
2	30	20-70	Poor to Fair	Coarse sandy gravelly glaciofluvial deposits. Can have high coarse fragment content, sandy soils. Susceptible to drought. Low erosion potential.
3.1	25	0	Poor to Fair	Fine textured silty or silty clay loam soils. Can have compacted, root-restricting layer. Sticky when moist, firm when dry. Sensitive to surface erosion.
3.2	25	0-10	Fair to Good	Fine textured, poorly drained silty or silty clay loam soils with rich soil humus and Ah layers. Compact structure, possible water table and erosion concerns. Soil humus and Ah layers could be set aside for soil amendments.
4.1	30	0-60	Unsuitable	Coarse sandy gravelly active floodplain deposits susceptible to flooding and erosion. Can have high coarse fragment content. Goathorn and Tenas Creeks not applicable for salvage.
4.2	25	0	Fair to Good	Fine textured, poorly drained backchannel deposits. Compact structure, possible water table and erosion concerns. Soil humus and Ah layers could be set aside for soil amendments. Goathorn and Tenas Creeks not applicable for salvage.
4.3	25	0-40	Poor to Fair	Coarse sandy, often gravelly inactive floodplain deposits. Can have high coarse fragment content. Low in soil nutrients. Goathorn and Tenas creeks not applicable for salvage.
5	20	30-75	Poor	Thin soils over bedrock. Can have high coarse fragment content, unsuitable terrain.
6	< 5	Skeletal	Unsuitable	Bedrock outcrops and associated colluvium.
7	30	n/a	Good	Organic material with high water table. If disturbance unavoidable, possible amendment material.
8.1	30	25-80	Unsuitable	Steep unstable slopes. Unsuitable terrain, can have high coarse fragments.
8.2	40	0-50	Unsuitable	Landslide deposits at the base of steep unstable slopes.
Undefined	—	—	—	No data; not applicable

Notes: *%=percent; Ah=A horizon enriched with organic matter; cm=centimeter; RZ=Root Zone; SMU=soil map unit*

Table 4.2-6: Soil Erosion Potential Ratings for Soil Map Units (SMUs)

SMU	Rating	Soil Textures	Comments
1.1	Low to Moderate	SiL, L, SiCL, (SL)	Cohesive tills
1.2	Moderate to High	SiL, SiCL, SiC, (SL, LS)	Silty, clayey, low permeability
1.3	Low to Moderate	SL, LS	Ablation tills, sandy
2	Low	S, LS, (SL)	Sandy glaciofluvial
3.1	Moderate to High	SiCL, SiL, Si	Silty, clayey, zero coarse fragments
3.2	Moderate to High	Si, SiCL, SiL	Silty, clayey, zero coarse fragments, low permeability
4.1	Moderate to High	LS, S, SL, SiL	Sandy gravelly fluvial
4.2	High	SiL, SiCL, Si	Silty, clayey, zero coarse fragments, low permeability
4.3	Moderate to High	SL, LS	Sandy gravelly fluvial
5	Low to Moderate	SiL, FSL, SL	Can have high coarse fragments
6	Low	Skeletal	Bedrock outcrops
7	Low	Fibric, Mesic organics	Organic soil
8.1	Very High	SiL, L, SiCL	Steep slopes
8.2	Very High	SiL, L, SiCL	Landslide deposits
Undefined	—	—	No data

Notes: *SMU=soil map unit*
Soil Texture: *L = Loam; LS = Loamy Sand; S = Sand; SL/FSL = Sandy Loam/Fine Sandy Loam; Si = Silt; SiL = Silt Loam; SiC = Silt Clay; SiCL = Silty Clay Loam*

Table 4.2-7: Area Extent of Soil Salvage Potential within Terrain and Soils Local Study Area (LSA)

Soil Salvage Potential	SMU	Project Area (ha)	LSA (ha)	Project Area Relative to Study Area		
				% of Project Area	% of Total LSA	% of RSA
Good	1.2	148.10	174.65	7.99	4.04	0.41
Fair to Good	1.1, 3.2, 4.2	1283.61	1859.67	69.27	35.00	3.59
Fair	1.3	113.77	166.91	6.14	3.10	0.32
Poor to Fair	2, 3.1, 4.3	18.35	66.75	0.99	0.50	0.05
Poor	5	207.22	537.81	11.18	5.65	0.58
Unsuitable	4.1, 8.1, 8.2	53.19	380.63	2.87	1.45	0.15
Undefined	—	28.71	481.22	1.55	0.78	0.08
Total	**—**	**1,852.95**	**3,667.64**	**100.00**	**50.52**	**5.19**

Notes: *%=percent; ha=hectare; LSA= Local Study Area; Project=Tenas Project; RSA=Regional Study Area; SMU=soil map unit*

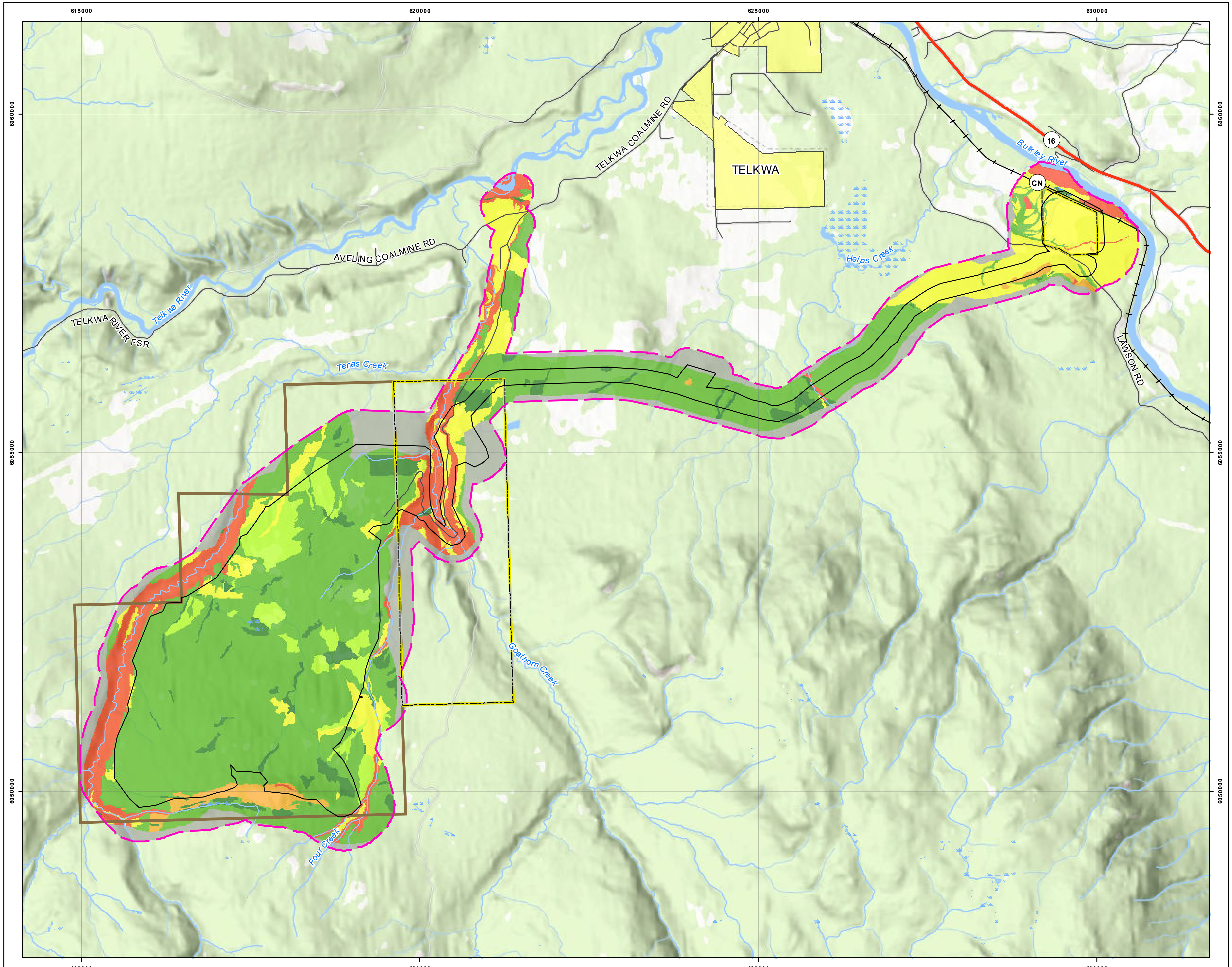
Table 4.2-8: Area Extent of Soil Erosion Potential within Terrain and Soils Local Study Area (LSA)

Soil Erosion Potential	SMU	Project Area (ha)	LSA (ha)	Project Area Relative to Study Area		
				% of Project Area	% of Total LSA	% of RSA
Low	2, 6, 7	94.42	279.97	5.10	2.57	0.26
Low to Moderate	1.1, 1.3, 5	1381.88	1994.06	74.59	37.68	3.87
Moderate to High	1.2, 3.1, 3.2, 4.1, 4.3	304.62	658.82	16.44	8.31	0.85
High	4.2	2.18	20.88	0.12	0.06	0.01
Very High	8.1, 8.2	41.14	232.68	2.22	1.12	0.12
Undefined	—	28.71	481.22	1.55	0.78	0.08
Total	**—**	**1,852.95**	**3,667.64**	**100**	**50.52**	**5.19**

Notes: *%=percent; ha=hectare; LSA: Local Study Area; Project=Tenas Project RSA=Regional Study Area; SMU=soil map unit*

Tenas Project

Area extent of Soil Salvage Potential within the Project Area and Terrain and Soils Local Study Area



Legend

- Rail Line
- Highway
- Road
- Watercourse
- Wetland
- Waterbody
- Municipal Area
- Telkwa Coal Limited Private Property
- Tenas Coal Licenses
- Project Area
- Terrain and Soils Local Study Area

Salvage Potential

- Good
- Fair to Good
- Fair
- Poor to Fair
- Poor
- Unsuitable
- No Data

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Map

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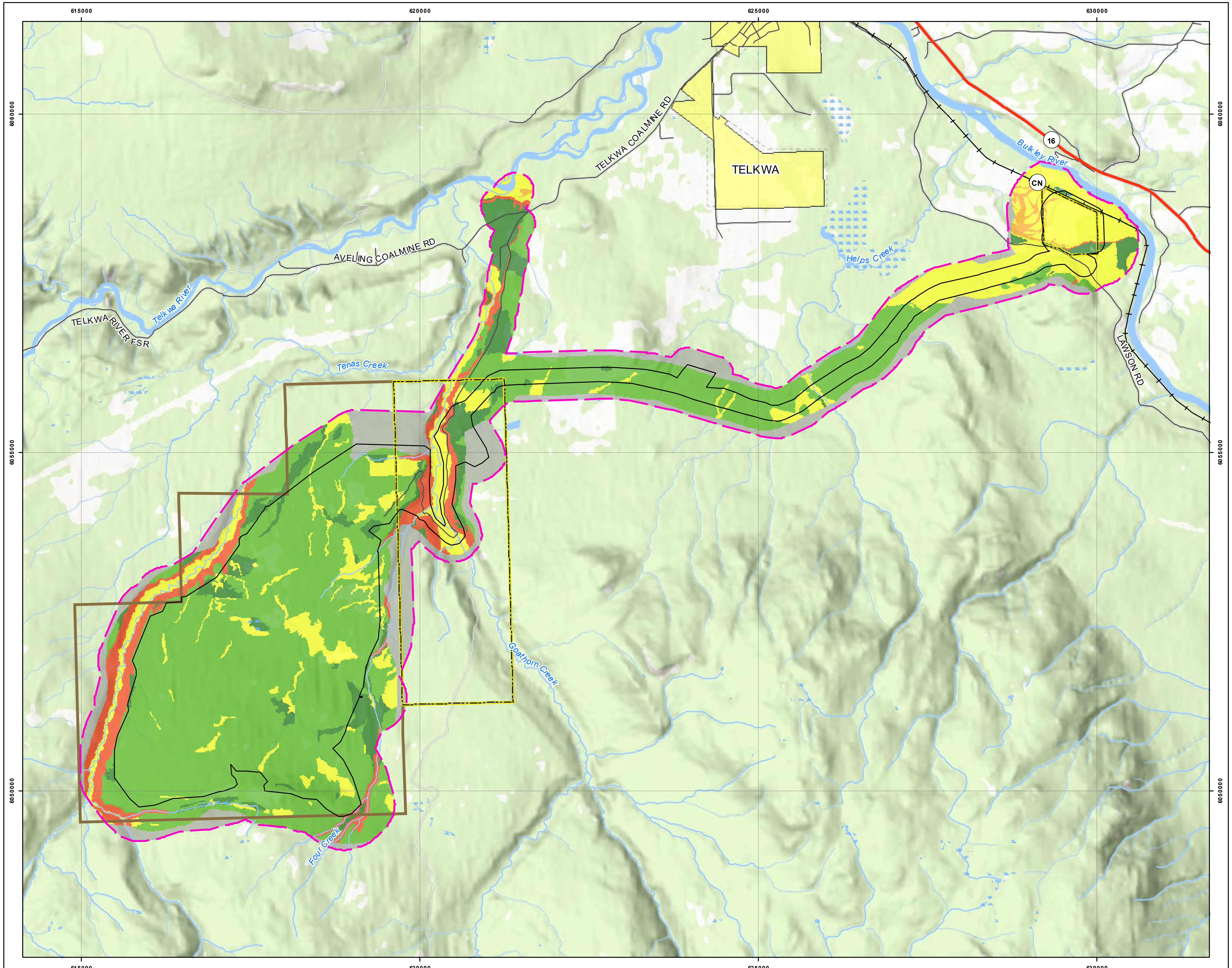

Tenas Project

Area extent of Soil Erosion Potential within the Project Area and Terrain and Soils Local Study Area

Legend

- Rail Line
- Highway
- Road
- Watercourse
- Wetland
- Waterbody
- Municipal Area
- Telkwa Coal Limited Private Property
- Tenas Coal Licenses
- Project Area
- Terrain and Soils Local Study Area

Erosion Potential

- Very High
- High
- Moderate to High
- Low to Moderate
- Low
- No Data

Notes

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4.2.2.3 Agricultural Capability Units

Agricultural Capability ratings were assigned to polygons for portions of the LSA and Project Area located within the ALR (**Figure 4.2-5**). Descriptors for Agricultural Capability ratings, ranging from Class 1 to Class 7, are presented in **Table 4.2-9**. The spatial extents for these Agricultural Capability ratings for portions of the LSA and Project Area within the ALR are summarized in **Table 4.2-10.**

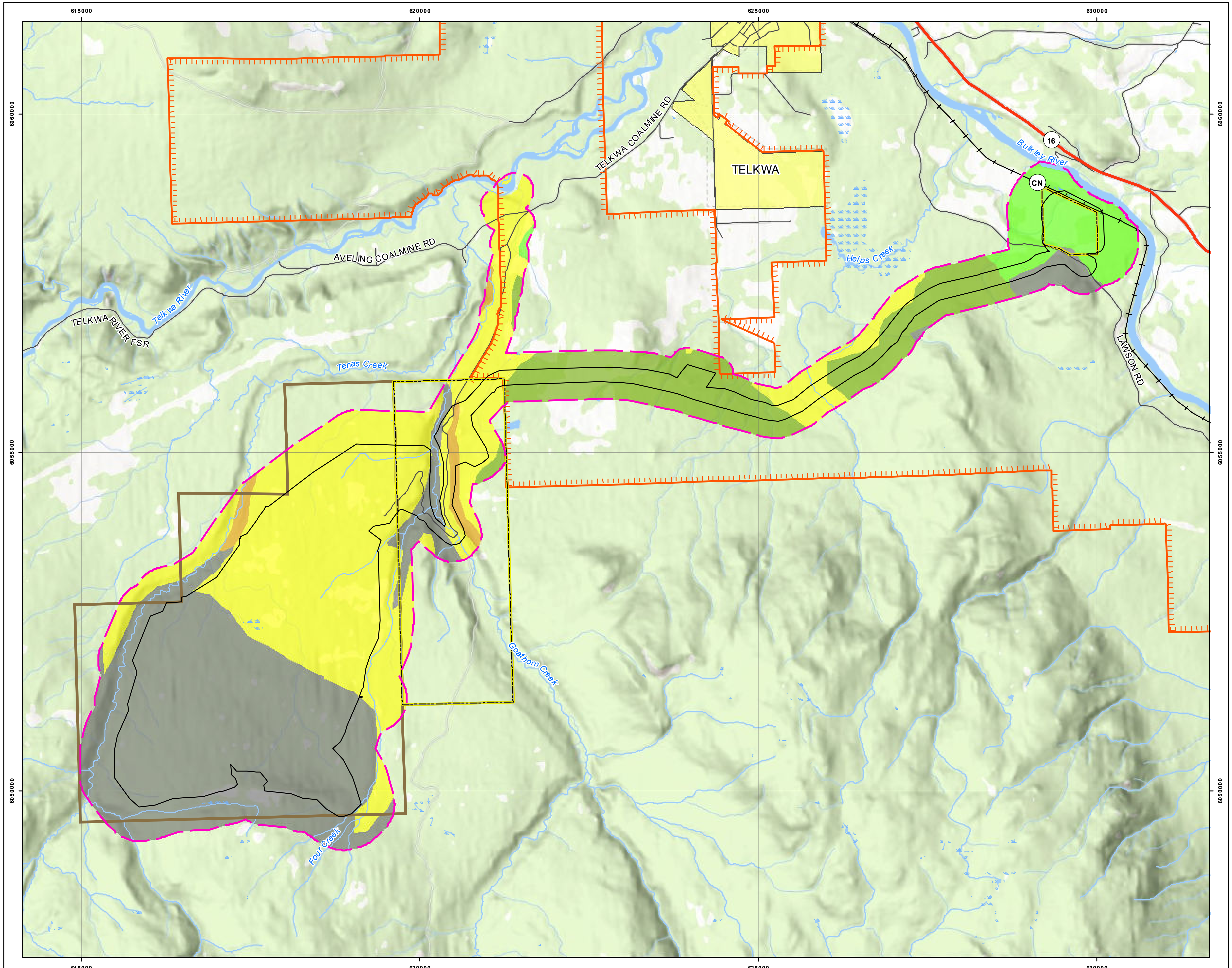
Table 4.2-9: Descriptors for Agricultural Capability Classes

Class	Description
1	No or slight limitations that restrict its use in the production of common agricultural crops.
2	Minor limitations that require good ongoing management practices or slightly restrict the range of crops, or both.
3	Limitations that require moderately intensive management practices or moderately restrict the range of crops, or both.
4	Limitations that require special management or severely restrict the range of crops, or both. Land in this classification is often suitable for a few crops. The yield may be low or the risk of crop failure may be high for a wider range of crops.
5	Capability is limited to producing perennial forage crops or other specially adapted crops.
6	Non-arable but capable of producing native and/ or uncultivated perennial forage.
7	No capability for arable culture or sustained natural grazing. Local climate results in unsuitable natural vegetation. Also included are rockland, other non-soil areas, small waterbodies.

Table 4.2-10: Area Extent of Agricultural Capability Classes within Portion of Terrain and Soils Local Study Area in the Agricultural Land Reserve (ALR)

Agricultural Capability Class	Project Area (ha) within ALR	LSA (ha) within ALR	Project Area Relative to Study Area		
			% of Project Area	% of Total LSA	% of RSA
1	0	0	0	0	0
2	0	0	0	0	0
3	13.66	41.00	0.74	0.37	0.04
4	171.29	450.08	9.22	4.67	0.48
5	29.69	196.57	1.22	0.62	0.06
6	0	0	0	0	0
7	96.93	320.91	5.16	2.51	0.27
Total	**303.58**	**1,017.51**	**16.34**	**8.28**	**0.85**

Notes: *%=percent; ALR=Agricultural Land Reserve; ha=hectare; LSA=Local Study Area; Project=Tenas Project; RSA=Regional Study Area*



Tenas Project

Area extent of Agricultural Capability Classes within the Project Area and Terrain and Soils Local Study Area in the Agricultural Land Reserve

Legend

- Rail Line
- Highway
- Road
- Watercourse
- Wetland
- Waterbody
- Municipal Area
- Telkwa Coal Limited Private Property
- Tenas Coal Licenses
- Project Area
- Terrain and Soils Local Study Area
- Agricultural Land Reserve

Agricultural Capability Class

- 3 - Moderate/Severe Limits
- 4 - Severe Limits
- 5 - Forage Crops/Feasible
- 6 - Forage Crops/Not Feasible
- 7 - No Capability

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Map

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4.2.2.4 Soil Metal Analysis

Soil samples (number [n] = 42) were collected from a representative cross-section of plots and soil types within the LSA. Soil samples were analysed to determine baseline essential and non-essential trace metal content/concentration[1]. Values were compared with the 2007 Canadian Council of Ministers of the Environment (CCME) guidelines for land use categories pertaining to industrial sites and agricultural and residential/parkland areas.

Most soil samples collected at the Minesite were below threshold or within an acceptable range as defined under the CCME guideline for industrial sites, with some discrete exceedances. One (1) soil sample (collected from a Spruce-Horsetail Forest type) was found to be above the industrial guideline for arsenic. Two (2) samples (along the Bypass Road and Rail Infrastructure alignment) were above agricultural exceedance guidelines for arsenic. Multiple sample sites indicated exceedances for boron.

[1] Aluminum (Al), Antimony (An), Arsenic (As), Barium (Ba), Beryllium (Be), Bismuth (Bi), Boron (B), Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silver (Ag), Sodium (Na), Strontium (Sr), Thorium (Th), Tin (Sn), Titanium (Ti), Uranium (U), Tungsten (W), Vanadium (V), Zinc (Zn), and Zirconium (Zr).

5. Assessment of Project-related Effects

The information provided within this subsection includes:

- identification of potential interactions between the Project and the Terrain and Soils VC;
- description of potential adverse Project effects on the Terrain and Soils VC;
- identification of mitigation measures to eliminate, reduce, or control the potential adverse Project effects on the Terrain and Soils VC; and
- characterisation of Project residual effects on the Terrain and Soils VC.

5.1 Potential Project-related Interactions with the Terrain and Soils Valued Component (VC)

This subsection focuses the assessment on those interactions with potential to affect the Terrain and Soils VC. Project-related interactions with the Terrain and Soils VC were determined by evaluating Project components and activities in relation to the Terrain and Soils VC and associated subcomponents. Project-related interactions and the likelihood of the interaction were determined with spatial analysis of the extent of the Project's potential effects and existing conditions related to the Terrain and Soils VC as outlined in **4. Existing Conditions**. Each potential interaction is rated using the terms provided in **Table 5.1-1**. Based on the evaluation, potential interactions between the Project and the Terrain and Soils VC were carried forward into the assessment to determine the effects of the interaction.

Table 5.1-2 provides a summary of potential interactions between Project components or activities and Terrain and Soils VC subcomponents. Interactions expected to result in potential effects on the Terrain and Soils VC are discussed further in **5.2.** Where an interaction is possible, the anticipated potential effect(s) is identified and carried forward in the assessment to determine the effects of the interaction.

Where no interaction between the Project and a subcomponent is anticipated or the interaction is considered minor (i.e., not expected to have a substantive influence on the short- or long-term integrity of the subcomponent as the effect would not be measurable or detectable using the identified Indicator) the interaction is not considered further in the assessment. For these reasons, Project activities that have been excluded from the assessment include: employment and labour (during all Project Phases), maintenance of administration buildings, fuel and lubricant storage facilities, the 25 kV powerline and 600 V substation, maintenance and use of the Rail Infrastructure, operation of the water supply (including wells, storage, and distribution system), operation of the spillway, operation of solid waste management systems (including recycling and composting facilities), maintenance of the Explosive Magazine, maintenance of post-mining systems and ongoing monitoring, and Post-closure Phase transportation of equipment, materials and personnel.

Table 5.1-1: Potential for an Interaction between the Vegetation Valued Component (VC) and the Tenas Project

Term	Definition
No Interaction	Tenas Project (Project) activity will not interact with the Terrain and Soils Valued Component (VC). No adverse effect is expected; no further consideration is warranted.
Interaction	Interaction between the Project activity and the Terrain and Soils VC may have a substantive influence on the short- or long-term integrity of the VC (i.e., measurable, or detectable using the identified indicator). Potential effect(s) of the interaction is considered further in the effects assessment.

Table 5.1-2: Potential for an Interaction between the Terrain and Soils Subcomponents and the Tenas Project

Project Activities	Terrain and Soils Subcomponent	
	Terrain Stability	Soil Quality
Construction		
Transportation of equipment, materials, and personnel		X
Site clearing (surveying, clearing, grubbing, soil salvaging)	X	X
Construction of Surface Water Management Infrastructure, including channels and ponds (sedimentation, control, management, storage)	X	X
Construction of Bypass Road and quarries from the Minesite to the Rail Infrastructure	X	X
Improvements to existing private road and Forest Service Roads	X	X
Construction of haul roads and service roads within the Minesite	X	X
Construction of the permanent Goathorn Bridge Crossing over Goathorn Creek	X	X
Construction of the Coal Processing Plant	X	X
Construction of fuel and lubricant storage facilities and distribution network	X	X
Construction of administration buildings (first aid, maintenance, mine dry, warehouse, laboratory, parking, and vehicle wash facilities)	X	X
Construction of a 25 kilovolt (kV) powerline and a 600 volt (V) substation adjacent to the Coal Processing Plant	X	X
Construction of Rail Infrastructure including Rail Loop and Loadout connecting to the existing main Canadian National Railway line	X	X
Installation of water supply wells, storage, and distribution system	X	X
Construction of the water discharge infrastructure	X	X
Construction of storage piles for overburden, rock separated from coal in Coal Processing Plant, and stockpiles for topsoil and vegetation management	X	X
Construction of material handling systems for Minesite, including run-of-mine coal, processed coal, process rock conveyors, and stockpiles	X	X
Construction of solid waste management systems including recycling and composting facilities	X	X
Construction of Explosives Magazine (storage building)	X	X
Employment and labour		

Project Activities	Terrain and Soils Subcomponent	
	Terrain Stability	Soil Quality
Operation		
Mining the open pit (soil salvaging, drilling and blasting, excavation of material, dewatering, loading, hauling, unloading)		X
Operation of Surface Water Management Infrastructure including channels and ponds (sedimentation, control, management, storage)		X
Maintain and use Bypass Road and quarries from the Minesite to the Rail Infrastructure		X
Maintain improved private and Forest Service Roads		X
Maintain haul roads within the Minesite, including service roads		X
Maintain permanent bridge over Goathorn Creek		X
Operate Coal Processing Plant		X
Maintain fuel and lubricant storage facilities		
Maintain administration buildings (first aid, maintenance, mine dry, warehouse, laboratory, and vehicle wash facilities)		
Maintain 25 kV powerline and a 600 V substation adjacent to the Coal Processing Plant		
Transportation of equipment, materials, and personnel		X
Maintain and use Rail Infrastructure including Rail Loop and Loadout connecting to the existing main Canadian National Railway line		
Operate water supply wells, storage, and distribution system		
Operate the water discharge infrastructure		
Maintain storage piles for overburden, rock separated from coal in Coal Processing Plant, and stockpiles for topsoil and vegetation management		X
Operate material handling systems for Minesite, including run-of-mine coal, processed coal, process rock conveyors, and stockpiles		X
Operate solid waste management systems including recycling and composting facilities		
Maintain Explosives Magazine (storage building)		
Progressive reclamation	X	X
Employment and labour		

Project Activities	Terrain and Soils Subcomponent	
	Terrain Stability	Soil Quality
Decommissioning and Reclamation		
Dismantle and remove mining equipment and facilities (including powerline, Rail Infrastructure)		X
Transportation of equipment, materials, and personnel		X
Reclamation and closure activities at Minesite	X	X
Reclamation and closure of Bypass Road and haul roads, including quarries	X	X
Reclamation and closure of permanent bridge over Goathorn Creek	X	X
Reclamation and closure of powerlines	X	X
Reclamation and closure of Rail Infrastructure	X	X
Implement post-mining systems and monitoring	X	X
Employment and labour		
Post-closure		
Maintain post-mining systems and ongoing monitoring		
Transportation of equipment, materials, and personnel		
Employment and labour		

Notes:

Interaction (X): Interaction between the Project activity and the VC may have a substantive influence on the short- or long-term integrity of the VC (i.e., measurable, or detectable using the identified indicator). The potential effect(s) of the interaction is considered further in the effects assessment.
No interaction (Blank): Project activity will not interact with the VC; no adverse effect is expected; no further consideration is warranted.

5.2 Potential Project-related Effects

Based on the timing and nature of the interactions identified in **Table 5.1-1**, the following effects have a potential to occur:

- Terrain Stability: changes to terrain from vegetation and rock removal; and
- Soil Quality: loss of soils and changes to soil quality due to changes in chemical and physical characteristics.

Changes to terrain are defined by the net alteration to landscape stability and morphology from baseline conditions. Loss of soil and changes to soil quality is defined by the net reduction and degradation of soil chemical and physical characteristics to the extent that they change pre-existing land capability.

Construction and Operation phase activities involving clearing vegetation, stripping, stockpiling, and otherwise handling soil, and siting and developing the Minesite and Minesite Infrastructure (including components such as the Rail Infrastructure, TAC, water discharge infrastructure, powerline, and substation) have the potential to result in direct Project-related effects on the Terrain and Soils VC subcomponents. Decommissioning and Reclamation Phase activities involving reclamation earthworks (i.e., backfilling and re-grading), topsoil replacement and other surficial preparations have the potential for similar Project-related effects. Except for isolated spill or contamination events (i.e., that have the potential to occur sporadically during all Project phases) and dust deposition, Post-closure Phase activities are not anticipated to result in any major measurable Project-related effects on the Terrain and Soils VC.

Potential effects (both direct and indirect) pertaining to the Terrain and Soils VC are described in the following subsections according to Project phase; the level detail corresponds to the specificity of the effects, their potential of occurrence and severity. Proposed mitigation measures to address each potential effect are then described under **5.3.2.**

5.2.1 Terrain Stability Subcomponent

This subsection describes the nature of the potential adverse effect on the Terrain Stability subcomponent in relation to each Project phase. Mitigation measures are described in **5.3 Mitigation Measures.**

5.2.1.1 Construction Phase

Activities completed during the siting and development of the Minesite, and Mine Infrastructure have potential to result in Project-related effects on terrain morphology (including changes in slope, aspect, and exposure) and subsequent effects on terrain stability depending on the nature of construction and its location. Potential effects are associated with major earthworks involving site clearing of vegetation, stripping of soil (described further in **5.2.2.1**) and rock removal, mining, and development of the Project (namely blasting, excavation and any disturbance of subsoil or parent materials) and/or subsequent landscape recontouring and re-grading.

Mining and development of the open pit represents the primary Project activity affecting terrain morphology due to the development of novel (or non-natural) landform features such as the open-pit, overburden stockpiles, and potentially acid generating (PAG) storage cells (Cooke and Johnson 2002; Doley and Audet 2013, 2017). Development of roads and ancillary features will result in temporary surficial fragmentation of the landscape; however, changes to terrain morphology caused by these features are anticipated to be low. Portions of the Project Area that do not involve site clearing, e.g., utility distribution system for water, water discharge infrastructure, and clear-span areas along the powerline right-of-way (ROW), are not expected to result in any changes to terrain morphology. As such, construction of any Project features will affect terrain stability to varying extents depending on the initial site characteristics and sensitivity to disturbance. Terrain stability classes provide a ranking for flagging unstable or potentially hazardous areas. In this respect, approximately 94.64% of the Project Area within the RSA will occur on land with Class 1 and 2 stability rankings, referring to land where no significant stability problems are likely to occur (Class 1) or where there is a very low likelihood for minor stability problems (Class 2). Approximately 1.5 % within the RSA will occur on land with a Class 3 stability ranking where there is a low likelihood for minor stability problems and where planning should incorporate mitigation measures to protect sensitive environments (e.g., waterbodies and water crossings). A portion of the Project area within the RSA (<1 %) will occur on land with Class 4 and 5 stability, referring to land with a moderate (Class 4) to high likelihood (Class 5) for stability problems and where planning should incorporate detailed geotechnical evaluation and recommended mitigations to protect highly sensitive environments. The remaining 1.71 % of the Project Area are undefined.

Corresponding generally with these stability rankings, areas characterised by a combination of uniform and well-drained terrain with level or gentle slopes (e.g., plateaus and benches) are less susceptible to Project-related effects; whereas irregular or variably draining terrain with moderate to very steep slopes (e.g., ridges and gullies along or in proximity to rivers and creeks) are more susceptible to Project-related effects. This applies especially to areas prone to potential fluvial and hydrogeomorphic hazards along the Bulkley River, Telkwa River, Goathorn Creek, and Helps Creek. During cut and fill and related terrain recontouring activities (especially road construction, widening, and upgrades) landform types characterised by non-level slopes can be prone to isolated or discrete landslide events, slope failures and/or slumping[2] depending on slope grade, slope position and aspect (Montgomery 1994; Wemple et al. 2000). Likewise, infilling/backfilling of excavated features can result in subsidence[3] depending on the subsoil/parent materials, subsoil hydrology and stability (Bell et al. 2000; Wang et al. 2017). Avalanches can cause and/or exacerbate similar effects on terrain morphology and stability (e.g., landslides, slope failures and/or slumping). Although no avalanche tracks were identified in the Project Area, slopes steep enough to allow an unstable snowpack to slide have been identified.

If built to the appropriate design specifications and appropriately maintained (i.e., ensuring safe/stable end-landscapes), Project components are not directly expected to alter terrain stability (Hancock et al. 2003). That said, alteration of existing topographical contours and changes in surface drainage patterns (both within and adjacent to the Project Area) can, over time, cause indirect and/or downgradient effects toward terrain stability by increasing the potential for discrete slope failures, slumping or subsidence (Duncan et al. 2014; Hancock and Willgoose 2004; Nyssen and Vermeersch 2010). Construction may alter the magnitude, timing, and flashiness of surface drainage patterns which can change surface drainage during the life of the Project. Given the characteristics of soil (i.e., fine-textured soil with integrated coarse fragments) and its inherent erodibility (further described in **5.2.2**), changes in overland surface water flow will increase the potential for loss of soil via erosion and sediment mobilization with the potential to further affect downgradient terrain stability and morphology. Likewise, these changes can affect soil infiltration and groundwater recharge resulting in alterations in the permanence of surface water (e.g., pooling) and/or the likelihood of inundation. Construction of surface water management systems (e.g., channels, ponds) and installation of permanent erosion and sediment controls are intended to mitigate these effects and facilitate hydrologic continuity; however, diversion of natural drainage patterns (i.e., associated with the mitigation) can also cause similar effects. To varying extent and severity, any potential changes to hydrology and/or surface drainage patterns may then interact with and result in adverse effects on other VCs, such as

[2] A mass wasting event that happens when loose materials or layers of rock move a short distance down a slope.
[3] Gradual caving or sinking of an area of land.

Vegetation (re-establishment/growth), Surface Water (run-off), Groundwater (inundation), Fish and Fish Habitat (habitat – surface run-off) and Wildlife (browsing).

5.2.1.2 Operation Phase

New construction (i.e., involving site clearing and siting/developing the Minesite and Mine Infrastructure) is anticipated to have the same potential Project-related effects as described above. Failure to maintain surface water management systems (e.g., channels, ponds, water collection and diversion channels) and mitigate changes in drainage patterns may exacerbate these direct and indirect effects.

Potential effects associated with progressive reclamation activities are described (below) as part of the Decommissioning and Reclamation and Post-closure phases.

5.2.1.3 Decommissioning and Reclamation Phase

Activities pertaining to reclamation earthworks (i.e., backfilling and re-grading), topsoil replacement and other associated surficial preparations may result in similar Project-related effects previously described, but to a lesser extent. Mining and development of the open pit is expected to result in novel landform features (e.g., an end-pit lake, overburden stockpiles, and management ponds) that will be decommissioned and reclaimed (along with roads and ancillary features) as per the **Reclamation and Closure Plan (S13.0-C15**) **(RCP).**

If reclaimed to design specifications (i.e., safe/stable end-landscapes and desired end-land capability use function) these features are not expected to directly alter terrain stability. That said, Project-related changes to terrain stability and morphology are expected to be associated with the re-instatement of topographical contours (i.e., which can alter surface drainage patterns) and the potential for discrete/isolated slumping or subsidence. The resulting effects will depend on the types of reclamation activity (e.g., full reclamation versus partial reclamation versus decommissioning) for a given feature and predominant landscape characteristics. As mentioned, portions of the Project Area designated as having steep or unstable terrain or areas prone to landslides and slumping are more susceptible to these effects. Features subject to backfilling are prone to subsidence depending on the subsoil/parent materials and/or seasonality of reclamation earthworks.

5.2.1.4 *Post-closure Phase*

Reclamation earthworks and/or maintenance activities (as listed in **5.2.1.1**, **5.2.1.2** and **5.2.1.3)** are not anticipated to occur during the Post-closure Phase. There are no activities that are expected to result in changes to terrain morphology and/or stability.

5.2.2 Soil Quality Subcomponent

This subsection describes the nature of the potential adverse effect on the Soil Quality subcomponent. Mitigation measures are described in **5.3 Mitigation Measures.**

5.2.2.1 Construction Phase

Activities involving clearing of vegetation and soil prior to the siting and development of the Minesite and Mine Infrastructure have the potential to result in Project-related effects on soil quality (i.e., changes in physical and chemical properties of soils). The size and scale of these potential effects is contingent on the ability to effectively strip and salvage soil prior to construction, and minimize incidental effects associated with handling and stockpiling of soil to be replaced during the Decommissioning and Reclamation Phase.

Soil stripping and estimated soil salvage volumes will be guided by SMU rankings. Approximately 83% of the Project area will occur on land with SMUs 1.1, 1.2, 1.3, 3.2, and 4.2 that generally hold good-to-fair soil salvage potential and low-to-moderate erosion potential. Approximately 12.32% will occur on land with SMUs 2, 3.1, 4.3, and 5 that hold variable soil salvage potential with moderate-to-high erosion potential. Approximately 2.90% will occur on SMUs 4.1, 8.1, and 8.2 where soil salvage is unsuitable and/or where there is a high potential for erosion and instability (e.g., bedrock outcrops, heterogeneous terrain, and steep slopes). The remaining 1.55% of the Project Area are undefined.

If soil stripping, handling, and stockpiling procedures are followed, there should be no net change in soil quantity, e.g., due to under-stripping (i.e., resulting in loss of soil), over-stripping (i.e., resulting in a dilution of soil quality) or admixing (i.e., intermixing of soil horizons). However, stripping or otherwise exposing soil by clearing vegetation can cause structural degradation (e.g., changes in soil micro- and macro-aggregates) and loss of soil carbon and nitrogen (Fen et al. 2019; Larney and Angers 2012; Liu et al. 2017; Sheoran et al. 2010; Shrestha and Lal 2011; Ussiri and Lal 2005). Meanwhile, excessive overland vehicle and equipment travel within the Project Area can increase incidental disturbance of intact soils due to rutting and compaction. Site clearing activities during wet or extremely dry conditions will likely exacerbate these effects, potentially leading to ‘hardsetting’ soil (referring to hard, dry/cracking, and structureless soil) (Daniells 2012). Degradation of soil structure, including changes in porosity, aggregation, and textural composition, can affect water holding capacity, root infiltration and vegetation re-establishment. These effects can cause general changes in soil function and integrity to the detriment of end land-use capability (Cooke and Johnson 2002; Doley and Audet 2013, 2017).

Site clearing conducted within the boundaries of the Project Area will increase the area of exposed soils and thereby increase the potential for wind erosion, especially during extremely dry conditions (Cooke and Johnson 2002). Soil stockpiles may also be susceptible to potential wind erosion until vegetation is fully established. Excessive travel and deposition of dust (i.e., primarily generated during construction at the time of stripping and handling of soil [Sheoran et al. 2010]) can cause soil loss and dissemination of soil particulates outside of the Project Area, and likely within the Project LSA. It is expected that there will be a potential for these effects to alter soil physical properties (i.e., changes in texture and structure) and soil integrity and quality.

Activities involving vehicle and equipment travel and construction within the Project Area have the potential to cause inadvertent, discrete, isolated spills, leaks, or contamination events involving hydrocarbons and organic compounds (Gudin and Syratt 1970). The highest potential will be associated with high traffic areas. Depending on their properties, reactivity, and concentration, the incidental release(s) of hydrocarbons and organic compounds can result in a wide range of effects, from acute toxicity to altered soil chemical properties (e.g., pH, nutrient availability). Potential metal leaching is considered low as any excavated bedrock and borrowed rock fill used for construction is assumed to be non-PAG. Potential effects of trace metals deposition on soils resulting from dust generation during the Project Operation Phase are described below. Changes to soil chemical properties and soil capacity to sustain vegetation can alter land capability. Soil contamination could also represent a hazard to nearby downgradient environments and thereby interact with and result in effects on other VC’s, such as Vegetation (vegetation establishment), Surface Water, and Groundwater (quality – introduction of heavy metals), Fish and Fish Habitat and Wildlife (habitat – water quality).

5.2.2.2 Operation Phase

New construction (i.e., involving site clearing and siting/developing the Minesite and Mine Infrastructure Complex [MIC]) will likely have the same Project-related effects as described above; however, soil stripping and handling is not expected to occur as frequently during the Operation Phase. Given the characteristics of soil and its inherent erodibility (described in **4. Existing Conditions**), exposed (i.e., unvegetated) soil stockpiles will be susceptible to erosion and sediment transport. Relocating and recontouring soil stockpiles may result in further degradation of soil properties and alteration of soil quality.

As described above (**5.2.2.1**), excessive travel and deposition of dust during construction and operation/maintenance activities (e.g., grading of the Bypass Road and high-traffic access roads) can cause soil loss and distribution of soil particulates outside of the Project Area. There is also a potential for trace metals deposition on soils resulting from dust generation during the Project Operation Phase. Prolonged and diffuse deposition of dust containing trace metals[4] can alter soil chemical properties (e.g., pH, nutrient availability) as described above. Likewise, operation and maintenance of the Wastewater Storage Pond (especially reactive materials and those containing trace metals) may result in leaching of metals and/or contamination of soils. Depending on the extent and severity of soil contamination, these effects could then result in effects on nearby downgradient environments altering future land capabilities and interact with and potentially adversely affect other VCs, such as Vegetation (vegetation establishment), Surface Water and Groundwater (quality – introduction of heavy metals), Fish and Fish Habitat and Wildlife (habitat – water quality).

5.2.2.3 Decommissioning and Reclamation Phase

Reclamation earthworks involving the reinstatement of landscape contours and surface drainage patterns, followed by the replacement and redistribution of soil (i.e., topsoil) have the potential to result in Project-related effects on soil physical and chemical properties. Project-related effects are associated with excessive soil handling and overland vehicle and equipment travel. Completion of reclamation earthworks during wet or extremely dry conditions would increase the potential for these effects to occur. Depending on the soil properties, exposed soils are susceptible to erosion and sediment transport. Degradation of soil structure, including changes in porosity, aggregation, and textural composition, can affect water holding capacity, root infiltration and vegetation re-establishment and thereby cause general changes in soil function and integrity that affect land capability.

5.2.2.4 *Post-closure Phase*

Reclamation earthworks and/or maintenance activities (as listed in **5.2.2.1**, **5.2.2.2** and **5.2.2.3**) are not anticipated to occur during the Post-closure Phase. There are no activities that are expected to result in loss of soils or changes in soil quality.

5.3 Mitigation Measures

This subsection describes the mitigation measures to address the potential effects of the Project on the Terrain and Soils VC. The mitigation measures are consistent with the mitigation definition provided by the BC EAO (2013) and encompass practical means or measures taken to avoid, minimize, rehabilitate onsite, and if required, compensate, or offset the potential adverse effects of a project. The mitigation measures are based on proven and accepted mitigation using standard industry guidelines and BMPs. In general, the mitigation measures are expected to be effective immediately following implementation. Understanding of the duration of residual effects and the temporal characteristics of reversibility will be known within the timeframe of the life of the Project.

TCL has incorporated several mitigation measures in the Project’s design and/or operational procedures to reduce the magnitude, duration, and extent of effects due to the Project. These Project mitigation measures

[4] Primarily generated during mining of the open pit, operating the Coal Processing Plant and material handling systems for raw coal, coarse and fine rock, and washed product coal, and maintaining material storage piles.

are outlined in **S1.0 Overview of Project Proponent Description** of the **EAC Application.** Project mitigation measures that are relevant to minimizing potential Project-related effects to both the Terrain Stability and Soil Quality subcomponents are listed below in **5.3.1** to **5.3.7** with further context as to how each measure is expected to mitigate potential effects on the Terrain and Soils VC. Project mitigation measures pertaining to the Terrain Stability subcomponent are intended to establish and maintain a safe and stable landscape by limiting and/or minimizing potential changes to terrain stability. Project mitigation measures pertaining to the Soil Quality subcomponent are intended to facilitate re-instatement of equivalent land capability by limiting the loss of soils and changes to soil quality.

Additional mitigation measures specific to the Terrain and Soils VC and tailored to Project features are described in **5.3.8** to **5.3.13** and have been incorporated into the various Project management plans such as the **Air Quality Management Plan (S13.0-C2) (AQMP)**, **Fuel Management and Spill Control Plan (S13.0-C7) (FMSCP)**, **Mine Emergency Response Plan (S13.0-C9) (MERP)**, **Minesite Traffic Control Plan (S13.0-C10) (MTCP)**, **Minesite Water Management Plan (S13.0-C11) (MWMP)**, **RCP**, **Surface Erosion Protection and Sediment Control Plan (S13.0-C17) (SEPSCP)**, and the **Vegetation Management Plan (S13.0-C18) (VMP)** of the **EAC Application**.

Mitigation measures (described below) are based on proven and accepted mitigation used in BC following standard industry guidelines and BMPs such as those listed in **2.3 Strategies, Guidelines, Plans, and BMPs**. The management plans provide further guidance to the standard of the day for minimizing changes to terrain from vegetation and rock removal and minimizing the loss of soils and changes to soil quality due to change in chemical and physical properties. The management plans provide direction on sequencing, monitoring, and adaptive management to ensure that measures are timely and effective. The mitigation measures are expected to be effective immediately following implementation.

The following measures are commitments that TCL has applied through Project design and to the operating principals through the life cycle of the Project. All mitigation measures are summarized in **Table 5.3-1**.

5.3.1 Avoid Sensitive Environments

The Project has been designed to:

- avoid known wetlands and sensitive ecosystems (such as riparian areas); and
- avoid activities within watercourses.

5.3.2 Limit Project Footprint and Project Area

To limit the Project footprint and Project Area the Project has been designed to:

- Cluster Project components, including the open pit, stockpiles for run-of-mine (ROM) coal, processed coal and processed rock, Coal Processing Plant (CPP), management ponds, and ancillary facilities such as the Maintenance Facility and Administration Building;
- Align linear Project features (such as powerlines, roads, water distribution) into a common ROW;
- Place Project features within existing or planned Project component footprints to limit the clearing of vegetation and the salvage of reclamation materials (surface soil, wood debris, and overburden). For example, the Minesite buildings will be built in areas previously cleared by forestry activity;
- Minimize the length of haul roads, access roads, and rail line where possible. Use or improve existing roads where practical;

- Utilize a loop design configuration for the rail that requires half the space and subsequent footprint compared to the standard teardrop shape seen at other operating or proposed coal mines in western Canada;
- Place reclamation material (surface soil and woody debris) stockpiles within development areas such as the open pit and haul roads to avoid disturbance, while overburden is directly placed on Project components for future reclamation activities;
- Limit the Tenas Access Corridor (TAC) to a single lane width for long distances and utilize existing FSRs or private roads where appropriate;
- Backfill approximately 50 percent (%) of non-coal material back into the open pit; and
- Place processed rock from the CPP within the management ponds versus a separate permanent pile to avoid any potential Acid Rock Drainage (ARD) from this material and reduce the Project footprint.

5.3.3 Reclamation Measures

The following reclamation measures have been incorporated into the mine design:

- Use progressive reclamation techniques to limit the amount of disturbance at any given time (e.g., by sequencing the open pit and stockpiles to the extent feasible, backfilling of open pit where possible, directly placing reclamation materials, and placing excavated materials on previously disturbed areas;
- Salvage reclamation materials (surface soil, woody debris, and overburden), for later use, in accordance with the **RCP**;
- Vegetate all temporary surface soil and overburden stockpiles to minimize the potential for erosion and sediment generation, to prevent subsequent potential effects on water quality, and to prevent losses of surface soils;
- Implement progressive reclamation on embankments, buttresses, backfills, TAC cut and fill slopes, and other Project components where possible to minimize fugitive dust emissions and reduce erosion and sediment generation;
- The reclaimed landscape will be shaped and contoured to achieve variations of slope steepness, slope length, aspect, and form to assist in creating landform diversity suitable for the establishment of varied plant communities and to reduce visual effects;
- PAG material deposited in the management ponds will be flooded to prevent acid mine drainage but will also be covered with an engineered cover consisting of non-PAG rock, overburden, and surface soils to allow for terrestrial revegetation;
- Majority of open pit features (e.g., highwalls and footwalls) are covered/resurfaced/recontoured with non-potentially acid generating (PAG) rock and overburden; and
- Revegetate with native plant species appropriate for the target ecosystems, which will include species for merchantable timber, subsistence foods, and ceremonial purposes in consultation with the Wet'suwet'en.

5.3.4 Project Footprint Boundaries

The following apply to Project footprint boundaries:

- Implement no-activity buffers for identified features such as riparian areas and watercourses that were that are previously documented or identified by methodologies provided in the related management plans (e.g., **Construction Environmental Management Plan (S13.0-C4) (CEMP)**, **Wildlife Management Plan (S13.0-C21) (WMP), VMP**;

- Clearly delineate the boundaries of no-activity for sensitive features in the proximity of planned disturbances to facilitate avoidance during all phases of the Project, where possible; and
- Clearly delineate Project Footprint boundaries adhering to construction plans and restricting identified machine use to defined areas within the Project footprint.

5.3.5 Transport Measures

The following mitigation measures refer to transport measures:

- Build, maintain, and use the TAC hauling processed coal to the Rail Infrastructure for the duration of all Project phases after the Construction Phase to minimize traffic on existing, residential roads;
- Build, maintain, and use the TAC for transport of personnel, goods, and services for the duration of all Project phases after the Construction phase to minimize traffic on existing, residential roads;
- Repair and/or replace and/or upgrade existing FSRs or private roads that will be used as part of the TAC.
- Repair and replace new and existing culverts as required for all Project related transport corridors including the TAC;
- Design and build a permanent clear span bridge over Goathorn Creek and Helps Creek and its related tributaries to provide vehicular access to the Project that will be controlled by TCL;
- Use buses and/or vans for employees and contractors as much as practical to reduce the risk of traffic incidents, and to reduce noise and fugitive dust emissions generated by the Project. Bussing options to Witset and/or Houston to be provided (if requested and based on sufficient employees in these locations) to facilitate potential employees accessing opportunities for the Project;
- Use dust supressing agents on the rail cars to reduce fugitive dust emissions;
- Cover super B-train trucks when hauling processed coal from CPP to Rail Infrastructure to reduce fugitive dust emissions from trucks;
- Use water and chemical agents on the TAC to reduce fugitive dust emissions, where and when appropriate; and
- Use water and chemical agents, as required, on processed coal and ROM coal stockpiles to reduce fugitive dust emissions resulting from storage and handling.

5.3.6 Forest Management Practices

The following refers to forest management practices:

- Follow guidelines and requirements for clearing, handling, and hauling any beetle infested wood such as: Guidance on Landscape and Stand-level Structural Retention in Large-scale Mountain Pine Beetle, Salvage Operation (British Columbia Ministry of Land, Natural Resource Operations and Resource Development [BC MFLNRORD] 2005) and Bark Beetle Management Guidebook (BC MFLNRORD 1995), Spruce Beetle Management in BC (BC MFLNRORD n.d.); and
- Follow guidelines and requirements for clearing, handling, and hauling merchantable timber resources within the Project Area in consultation with the tenure holders.

5.3.7 Blasting Measures

The following mitigation measures apply to blasting:

- Use best management stemming techniques (e.g., type of material, size consistency, loading method, and thickness) that will minimize effects of noise and fugitive dust from blast patterns and assist in the complete detonation of drill holes to reduce the introduction of nitrogen species into the surrounding rock per the **EMP**;
- Correctly time blast to minimize effects of noise, vibration, and fugitive dust from blast patterns;
- Keep blast patterns small to minimize effects of noise, vibration, and fugitive dust and to reduce the time that patterns need to sleep or wait until they are blasted which reduces the introduction of nitrogen species into the surrounding rock;
- Monitor actual blast results and implement improvements as required as per the adaptive management process to reduce effects of noise, vibration, fugitive dust and reduce the introduction of nitrogen species into the surrounding rock; and
- Use electronic detonators to minimize effects of noise, vibration, and fugitive dust from blast patterns and manage misfires to reduce the introduction of nitrogen species into the surrounding environment.

5.3.8 Project Siting and Construction

To the extent possible, the Project has been sited on stable and gently sloping terrain. The Project components directly associated with the mine such as the open pit, management ponds, water management structure and Mine Infrastructure will then be constructed to design-specifications and follow applicable management plans, regulatory requirements, and BMPs. Project Area/footprint boundaries will be clearly delineated (e.g., with the use of fencing, staking, or flagging and on maps) prior to the Construction Phase; construction will closely adhere to construction plans and schedules. Temporary features will be sited within existing disturbed areas characterised by predominantly level or gently sloping terrain. Areas prone to instability (e.g., slumping or subsidence) and areas in proximity to water bodies and drainage features will be identified/flagged prior to construction if Project components are within 100 metres (m).

5.3.9 Vegetation Clearing and Soil Salvage

Clearing of vegetation and the salvage of surface soils will be restricted to the Project Footprint however the effects assessment is based on the clearing of vegetation and the salvage surface soils within the Project Area. In areas requiring clearing only, grubbing will be avoided, and roots and groundcover will be retained to the extent feasible. Surface soils and suitable overburden will be salvaged and stockpiled separately in accordance with the **CEMP**; **RCP** and **Soil Management Plan (Appendix 13.15-B** of the **RCP**); surface soils and vegetative matter will be retained to the extent feasible for areas not requiring surface soil salvage in accordance with the **VMP** and **RCP**. Surface soil and overburden stockpiles will be constructed to design specifications and incorporate appropriate erosion and sediment control measures. Stockpiles will be revegetated as soon as practical to stabilize exposed surface soils to reduce the potential for wind and precipitation erosion and loss of material.

5.3.10 Erosion and Sediment Control

Sediment and erosion control measures will be implemented in accordance with the **SEPSCP** and **CEMP**. Areas prone to instability and areas in proximity to water bodies and drainages will be further reinforced/stabilized via construction of abutments and permanent erosion controls, if specified.

Hydrological connectivity will be maintained by providing unobstructed passage of water in existing drainage channels through fill materials (i.e., using free-span bridges or culverts at waterbody crossings) in accordance with the **MWMP**.

5.3.11 Additional Valued Component (VC)-specific Reclamation Measures

The Project will be decommissioned and reclaimed to design-specifications to create a safe and stable end-landscape that aligns with end-land use objectives in accordance with the **RCP**. The Decommissioning and Reclamation Phase will closely adhere to reclamation plans and schedules. Reclaimed areas will be re-sloped to approximate pre-Project contours, or stable contours, and revegetated as soon as practicable following sloping and surface soil replacement. Post-Project terrain will be re-contoured and scarified to create terrain diversity, variation in slope steepness, length, aspect, and shape to promote seed retention and establishment of an average land capability which is not less than the pre-development capability in accordance with the **RCP**.

Surface soils and selected overburden will be directly placed or stockpiled for later use. Once placed as growth medium it will be decompacted to establish suitable conditions for revegetation by native species. Revegetation will occur as soon as practical to stabilize exposed surface soils in accordance with the **VMP, RCP** and the **Soil Management Plan (Appendix 13.15-B of the RCP)**. Areas prone to instability (especially in proximity to watercourses and drainage features) will be identified/flagged prior to reclamation earthworks; if/where reclamation earthworks must occur in these areas, erosion, and sediment control BMPs will be implemented in accordance with the **SEPSCP** and **CEMP**.

5.3.12 Dust Suppression and Air Emissions

Dust generation and subsequent deposition on exposed soils and plants because of Project activities will be limited through dust suppression techniques and implementation of the **AQMP**. The primary approach to reducing road dust re-entrainment within the Project Footprint is watering when conditions require. If required, alternative and additional approaches include chemical agent application, such as calcium chloride, designed to alter the surface of the roadway, cementing loose material into a hardened surface. Air emissions will be reduced to the extent practical through implementation of the **AQMP** and the **MTCP**.

5.3.13 Spill Prevention and Response

Spill prevention and response measures will be implemented during vehicle and equipment travel/operations in accordance with the **FMSCP** and any hazardous materials management in accordance with the **FMSCP** as well.

5.3.14 Summary of Mitigation Measures

A summary of the mitigation measures to avoid or reduce potential Project-related adverse effects on the Terrain and Soils VC is provided in **Table 5.3-1.** An indication of whether a residual effect is anticipated for each potential effect following implementation of the listed mitigation measures is provided in the table. Potential effects that are predicted to be residual effects are carried forward in the assessment.

Table 5.3-1: Summary of Potential Effects and Mitigation Measures for Terrain and Soils Valued Component (VC)

Potential Effect	Contributing Activities within the Project Phases (C, O, D, P)	Proposed Mitigation Measure	Applicable VC Subcomponent	Residual Effect (Yes/No)
Changes to Terrain from Vegetation and Rock Removal	All Activities (C, O)	▪ Avoid sensitive environments; ▪ Limit Project footprint and Project Area; ▪ Reclamation measures (refer to **RCP**); ▪ Project footprint boundaries; ▪ Transport measures; ▪ Forest management practices; ▪ Project siting and construction; and ▪ Vegetation clearing and soil salvage. Refer to **CEMP**, **RCP** and **VMP**).	Terrain Stability	Yes
	All Activities (D, P)	Additional VC-specific reclamation measures (Refer to **RCP**, **VMP, CEMP,** and **SEPSCP**)	Terrain Stability	Yes
	All Activities (C, O, D, P)	Erosion and Sediment Control (Refer to **CEMP** and **SEPSCP**)	Terrain Stability	Yes
Loss of Soils and Changes to Soil Quality Due to Changes in Chemical and Physical Characteristics	All Activities (C, O)	▪ Avoid sensitive environments; ▪ Limit Project footprint and Project Area; ▪ Reclamation measures (refer to **RCP**); ▪ Project Footprint boundaries; ▪ Transport measures; ▪ Forest management practices; ▪ Project siting and construction; and ▪ Vegetation clearing and soil salvage (Refer to **CEMP**, **RCP** and **VMP**).	Soil Quality	Yes
	All Activities (D, P)	Additional VC-specific reclamation measures (Refer to **RCP**, **VMP, CEMP,** and **SEPSCP**)	Soil Quality	Yes
	All Activities (C, O, D, P)	▪ Erosion and sediment control (Refer to **CEMP** and **SEPSCP**); and ▪ Spill prevention and response (Refer to **FMSCP**).	Soil Quality	Yes
	All Activities (C, O, D)	▪ Transport measures; ▪ Blasting measures (refer to **EMP**); and ▪ Dust suppression and air emissions (Refer to **AQMP**, **MTCP**).	Soil Quality	Yes

Notes: *C, O, D, P represent Project Phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
AQMP=Air Quality Management Plan (S13.0-C2); CEMP=Construction Environmental Management Plan (S13.0-C4); FMSCP=Fuel Management and Spill Control Plan (S13.0-C7); MERP=Mine Emergency Response Plan (S13.0-C9); MTCP=Minesite Traffic Control Plan (S13.0-C10); MWMP=Minesite Water Management Plan (S13.0-C11); RCP=Reclamation and Closure Plan (S13.0-C15); SEPSCP=Surface Erosion Protection and Sediment Control Plan (S13.0-C17); VMP=Vegetation Management Plan (S13.0-C18); VC=Valued Component
*See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table.*

5.4 Residual Effects and Significance of Residual Effects

This subsection describes the likely residual effects of the Project on the Terrain and Soils VC. Residual effects are effects that remain after the implementation of all mitigation measures and management strategies and are the expected consequences of the Project for the Terrain and Soils VC. The approach to assessing residual Project effects on the Terrain and Soils VC follows the methodology outlined in **S3.0** of the **EAC Application**. For each subcomponent of the Terrain and Soils VC, each residual effect is assessed in the context of the Project activities that will occur within each Project phase. Based on the potential Project-related effects listed in **5.2**, the assessment focuses on the Construction, Operation, Decommissioning and Reclamation phases. Residual effects are then characterised based on the combined predicted residual effect for these Phases. The assessment includes a determination of Likelihood, Significance and the Level of Confidence associated with the prediction. Activities during the Post-Closure Phase are not considered since they are not expected to result in residual effects.

5.4.1 Description of Evaluation Criteria

5.4.1.1 Residual Effects Characteristics

Residual effects on the Terrain and Soils VC subcomponents Terrain Stability and Soil Quality have been characterised in terms of Magnitude, Geographical Extent, Frequency, Duration, Reversibility, and Context (**Table 5.4-1**). For each subcomponent, guidelines were used to evaluate the Magnitude of each residual effect. These guidelines are based on the ability to detect changes due to Project effects. Quantitative guidelines were used to evaluate the Magnitude for each predicted residual effect and have been defined based on data in EAs for similar approved projects, existing technical knowledge, and professional judgement.

Table 5.4-1: Effects Characteristics Considered When Determining the Significance of Residual Effects on Terrain and Soils Valued Component (VC)

Residual Effects Characteristic	Definition	Rating
Magnitude	The amount of change in a measurable parameter relative to baseline conditions.	***Subcomponent – Terrain Stability*** **Low** ▪ Measurable change in terrain morphology and stability where spatial extent of change is <5% of the area within the RSA ▪ Morphology is within the natural range of variation with no net change in terrain stability **Moderate** ▪ Measurable change in terrain morphology and stability where spatial extent of change ranges between 5-10% of the area within the RSA, and/or ▪ Morphology differs from the original baseline conditions and is at the limit of the natural range of variation; Change in terrain stability (1 ranking unit) **High** ▪ Measurable change in terrain morphology and stability where spatial extent of change >10% of the area within the RSA, and/or

Residual Effects Characteristic	Definition	Rating
		▪ Morphology differs from baseline conditions and is outside of the natural range of variation; Change in terrain stability (>1 ranking unit)
		Subcomponent – Soil Quality **Low** ▪ Measurable change in soil quality where spatial extent of change is <5% of the area within the RSA ▪ <20% loss of soil quantity (volume); Soil characteristics are similar to baseline conditions or within the natural range of variation and end-land use capability. **Moderate** ▪ Measurable change in soil quality where spatial extent of change ranges between 5-10% of the area within the RSA, and/or ▪ 20-50% loss of soil quantity (volume); Soil characteristics differ from baseline conditions and are at the limit of the natural range of variation and end-land use capability. **High** ▪ Measurable soil quality where spatial extent of change is >5% of the area within the RSA, and/or ▪ >50% soil quantity (volume); Soil characteristics differ from baseline conditions and are outside of the limit of the natural range of variation and end-land use capability.
Geographic Extent	The geographic area within which the residual effect is expected to occur.	**Project Area:** Effect is limited to the Project Area. **Local:** Effect is limited to the Terrain and Soil LSA. **Regional:** Effect extends into the Terrain and Soil RSA.
Duration	Length of time over which the residual effect is expected to persist.	**Short-term:** <2 years (e.g., effect strictly occurs during the Construction Phase). **Medium-term:** 2-52 years (e.g., effect occurs during the Construction Phase and extends to the end of the Post-Closure Phase). **Long-term:** >52 years (e.g., effect occurs during the Construction Phase and extends beyond the Post-Closure Phase).
Frequency	How often the residual effect is expected to occur.	**Infrequent:** Effect occurs sporadically (i.e., occasionally and/or at irregular intervals). **Frequent:** Effect occurs often and/or at regular intervals. **Continuous:** Effect occurs continuously.
Reversibility	Whether or not the residual effect can be reversed once the activity causing the residual effect ceases.	**Fully Reversible:** A residual effect that diminishes to baseline conditions **Partially Reversible:** A residual effect that partially diminishes to baseline conditions **Irreversible:** A residual effect that will not diminish to baseline conditions
Context	The extent to which Terrain and Soil VC has been affected by past	***Level of Disturbance***

Residual Effects Characteristic	Definition	Rating
	and present environmental and socio-economic processes and conditions, its potential sensitivity to the to the Project-related residual effect; also related to the inherent ability to recover from that effect (i.e., resilience).	**Low:** Subcomponent is mostly undisturbed or slightly/discretely affected by past and present environmental and socio-economic processes and are conditions (i.e., high level of natural integrity) **Moderate:** Subcomponent has been somewhat disturbed or moderately affected by past and present environmental and socio-economic processes and conditions (i.e., moderate level of natural integrity) **High:** Subcomponent has been highly affected by past and present environmental and socio-economic processes and conditions (e.g., low level of natural integrity)
		Sensitivity **Low:** Subcomponent has low sensitivity and propensity to change due to the effect (i.e., high resilience) **Moderate:** Subcomponent has moderate sensitivity and propensity to change due to the effect (i.e., moderate resilience) **High:** Subcomponent has high sensitivity and propensity to change due to the effect (i.e., weak resilience)

Notes: *>=greater than; <=less than; %=percent; LSA=Local Study Area; RSA-Regional Study Area; VC=Valued Component*

5.4.1.2 Likelihood

Likelihood refers to the probability that the predicted residual effect will occur while considering that the mitigation will be successful. Likelihood is defined as Likely or Unlikely:

- **Likely:** Moderate-to-High Likelihood of an effect; or
- **Unlikely:** Low probability of an effect.

5.4.1.3 Significance Determination

Characterisation of residual effects is based on the review of publicly available information on existing trends and conditions described in **4. Existing Conditions** and assessment of potential Project-related effects in **5.2**, other relevant scientific information, and the professional judgement of the assessor. The Significance of the residual effect is rated as **Not Significant** or **Significant**:

Not Significant A residual effect that does not result in changes to the integrity of the Terrain and Soils VC and its subcomponents within the Terrain and Soils RSA beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to ecological function) is deemed **Not Significant**. For example: residual effect is a combination of Low Magnitude, Local Geographic Extent, Short-Term Duration, Infrequent, etc.; or

Significant A residual effect that results in changes to the integrity of the Terrain and Soil VC and its subcomponents within the Terrain and Soils RSA beyond an acceptable level (e.g., where it is not sustainable or is unavailable to contribute to ecological function) is deemed **Significant**. For example: residual effect is a combination of High Magnitude, Regional Geographic Extent, Long-Term Duration, Frequent or Continuous, etc.

Confidence estimates allow the decision-maker to evaluate risk associated with the residual effects of the Project. The Level of Confidence is a measure of how well residual effects are understood based on the quality of the input data (i.e., taking into account the reliability of data inputs and analytical methods used to predict Project effects, the confidence in the effectiveness of mitigation measures and certainty of the predicted outcome). The Level of Confidence is rated as Low, Moderate or High:

- **Low Confidence:** Cause-effect relationships between the Project and Terrain and Soils VC are not fully understood and/or necessary data are not entirely available to support the assessment. For example, there are a number of unknown external variables and/or data for the Project is incomplete, the effectiveness of the mitigation measures is not yet be proven, and the modelling results hold a high degree of variance given the data inputs. Consequently, there is generally a high degree of uncertainty in the conclusions of the assessment;
- **Moderate Confidence:** Cause-effect relationships between the Project and Terrain and Soils VC are not fully understood, but most of the necessary data are available to support the assessment. For example, there are several unknown external variables and/or data for the Project is incomplete. However, the effectiveness of the mitigation measures is moderately-well or highly proven and the modelling results hold a moderate or low degree of variance given the data inputs. Consequently, there is generally a moderate degree of uncertainty in the conclusions of the assessment; or
- **High Confidence:** Cause-effect relationships between the Project and Terrain and Soils VC are fully understood and all the necessary data are available to support the assessment. For example, external variables and/or data for the Project is both complete and comprehensive, the effectiveness of the mitigation measures is highly proven, and the modelling results hold a low degree of variance given the data inputs. Consequently, there is generally a high degree of uncertainty in the conclusions of the assessment.

Based on these criteria, it was determined that an additional risk analysis was not required.

5.4.2 Terrain Stability Subcomponent

The definition of the Terrain Stability subcomponent used within this assessment is provided in **3.2.2.** After the mitigations outlined in **5.3** have been applied, residual measurable changes to terrain from vegetation and rock removal are predicted to occur. The assessment considered residual effects to terrain morphology and stability during Project phases, with emphasis on direct effects associated with site clearing of vegetation and soil, major earthworks (including landscape recontouring and re-grading, and rock removal), mining and ancillary development of the Project, and final reclamation.

5.4.2.1 Residual Effect Characteristics

The summary of the residual effects characterisation for changes to terrain from vegetation and rock removal due to the Project is presented in **Table 5.4-2.**

The Project is predicted to result in discrete and/or isolated changes in terrain morphology and stability. The size and scale of these potential effects is contingent on the ability to identify unstable terrain and implement engineered mitigations that ensure safe and stable end-landscapes and minimize incidental effects associated with development of the Project. As such, the Magnitude of these changes was evaluated in terms of their maximum spatial extent within the RSA and their amplitude toward the given indicators for changes in stability and morphology. Accordingly, changes to terrain morphology and stability are expected to be <5% of the spatial extent of the RSA. Changes in morphology are primarily expected to be within the limits of the natural range of variation, although some features are expected to be at the limits of natural variation due to the development of novel/non-natural landscape attribute. Since most of the Project Area and LSA occurs on land designated as Class 1 and 2 stability rankings, no expected changes in the net terrain stability rankings are expected to occur. Discrete portions of the Project Area and LSA occurring on land designated as Class 3, 4 or 5 are appropriately characterised and proven mitigations have been identified/planned for Project activities in these locations. For these reasons, the Magnitude has been rated as Low-to-Moderate.

The residual effect is expected to be Local in Geographic Extent. Changes in terrain morphology and stability will be restricted to the Project Area with a potential for indirect effects to extend within the Terrain and Soils LSA. The duration of these changes is predicted to occur over the Long-term (>52 years). The Project has been designed to be safe and stable and (where possible) incorporate engineered mitigations (outlined in **5.3**) to address these effects over this timeframe.

The Frequency of changes to terrain morphology and stability is expected to be Infrequent. Most changes will occur because of major earthworks during the Construction Phase and (to a lesser extent) during the Decommissioning and Reclamation Phase. There is a low potential for indirect effects (e.g., retraining of surface drainage patterns) to occur gradually and/or irregularly during all Project phases.

The change to terrain morphology and stability is expected to be Partially Reversible. TCL is committed to reclaiming the Project Area and reversing Project effects to facilitate reinstatement of any changes to terrain stability and morphology and to an equivalent land capability. That said, the development of novel landscape features (e.g., end-pit lake, management ponds) within the RSA are not fully reversible. Instead, these features will be reclaimed to an alternative state at the limits of the natural range of variation. Project features will be reclaimed to design-specifications to ensure a safe and stable end-landscape. Reclamation design will involve landscape re-contouring to tie-in to the predominant terrain and reinstate surface drainage patterns and incorporate construction approaches and mitigations that minimize the potential for erosion, slumping and/or subsidence. No changes in the net Terrain Stability rankings are expected.

Lastly, the Project is situated in an area where Terrain Stability holds a moderate-to-high level of natural integrity. The RSA is mostly undisturbed by past and present environmental and socio-economic processes and conditions (i.e., rural residential development, agricultural activity, and/or forestry). Changes to terrain morphology and stability hold a low sensitivity and propensity to change due to the effect (i.e., high resilience). The Context has been rated Low.

Table 5.4-2: Summary of Residual Effects Characteristics Ratings for Changes to Terrain Stability Subcomponent from Vegetation and Rock Removal

Residual Effect Characteristic	Rating	Rationale for Rating
Magnitude	Low-to-Moderate	Changes to terrain morphology and stability are expected to be <5% of the spatial extent of the RSA. Changes in morphology are mostly expected to be within the limits of natural variation, but some features at the limits of natural variation due to the development of novel/non-natural landscape attributes. Project Area and LSA mostly occur on land with Class 1 and 2 stability rankings; No expected changes in the net terrain stability rankings.
Geographic Extent	Local	Changes to terrain morphology and stability will be restricted to the Project Area, with discrete potential to extend within the LSA.
Duration	Long-term	Changes to terrain morphology and stability expected to occur during the Construction Phase and extend beyond the Post-closure Phase.

Residual Effect Characteristic	Rating	Rationale for Rating
Frequency	Infrequent	Changes to terrain morphology and stability primarily expected to occur due to site clearing and major earthworks during the Construction Phase and site re-contouring during the Decommissioning and Reclamation Phase. Low potential for indirect effects (e.g., retraining of surface drainage patterns) to occur gradually and/or irregularly during all Project phases.
Reversibility	Partially Reversible	Commitment to reclaiming the Project Area and reversing Project effects to facilitate re-instatement of terrain morphology and stability to an equivalent land capability. However, development of novel landscape features (e.g., end-pit lake, PAG storage cells) within the RSA not fully reversible; Instead, these features will be reclaimed to an alternative state at the limits of the natural range of variation. No expected changes in the net terrain stability rankings.
Context	Low	Terrain holds a moderate-to-high level of natural integrity; RSA is somewhat undisturbed by past and present environmental and socio-economic processes and conditions (i.e., rural residential development, agricultural activity and/or forestry). Terrain holds a low sensitivity and propensity to change due to the effect (i.e., high resilience)

***Notes**: >=greater than; <=less than; %=percent; LSA=Local Study Area; RSA=Regional Study Area; PAG=potentially acid generating*

5.4.2.2 Likelihood

Based on professional judgement and knowledge and understanding of other similar projects and activities, the Project is Likely to cause adverse residual effects within the Terrain and Soils RSA. There is a moderate-to-high probability that the residual effect will occur after mitigation.

5.4.2.3 Significance Determination

The residual effects related to changes to terrain from vegetation and rock removal are expected to be of Low-to-Moderate Magnitude, Local in Geographic Extent, Infrequent, and Partially Reversible. Cause-effect relationships between the Project and terrain are fully understood and the necessary data are available to support the assessment. As such, residual effects on the Terrain Stability subcomponent are expected to be **Not Significant** as they are not expected to alter the integrity of terrain to the point where it is not sustainable or is unavailable to contribute to ecological function. The Level of Confidence in this prediction is High.

5.4.3 Soil Quality Subcomponent

The definition of the Soil Quality subcomponent used within this assessment is described in **3.2.2.** After the mitigations outlined in **5.3** have been applied, residual measurable loss of soil and change to Soil Quality due to changes in physical and chemical properties are predicted to occur. The assessment considered residual loss and changes to Soil Quality during all Project phases associated with major earthworks involving site clearing of vegetation and soils, mining and ancillary development of the Project, dust deposition, spills and final reclamation (including landscape recontouring, re-grading, and vegetation re-establishment).

5.4.3.1 Residual Effect Characteristics

The summary of the residual effects characterisation for the loss of soils and changes to Soil Quality due to the Project is presented in **Table 5.4-3.**

The Project is predicted to result in changes in Soil Quality. The size and scale of these potential effects is contingent on the ability to effectively salvage soil prior to construction, and minimize incidental effects associated with handling and stockpiling of soil. The Magnitude of these changes was evaluated in terms of the maximum spatial extent within the RSA and the amplitude of changes toward Soil Quality. As such, it is anticipated that changes to Soil Quality are expected to be <5% of the spatial extent of the RSA. Changes in Soil Quantity during soil salvage are mostly expected to amount to <20% loss of soil, with a potential for up to >50% loss of soil in some locations depending on soil salvage potential. Changes in Soil Quality are expected to be within the natural range of variation and end-land use capability, with a potential to be at the limits of the natural range of variation (again, depending on the soil salvage potential during the Construction Phase).

The residual effect is expected to be Local in Geographic Extent. Direct effects to Soil Quality will be restricted to the Project Area. However, there is a potential for indirect effects associated with the deposition of dust and dissemination of soil particulates to extend within the Terrain and Soil LSA. Changes to Soil Quality are predicted to occur over the Long-term (>52 years). The Project has defined environmental management procedures and mitigations (outlined in **5.3**) to address these effects over this period.

The Frequency of changes in Soil Quality is expected to be Infrequent. Changes to Soil Quality will primarily be associated with land clearing and major earthworks during the Construction Phase and replacement of soil and surficial recontouring during the Decommissioning and Reclamation Phase. As such, there is a potential for loss of soil as an indirect effect due to erosion and sediment transport to occur gradually and/or irregularly during all Project phases. There is also a potential for changes in soil quality due to spills and contamination events to occur sporadically during all Project phases. Likewise, Soil Quality can be affected by dust generation during all Project phases; but the potential for trace metals deposition on soils (i.e., due to dust associated with materials from the open pit) is more acute during the Project Operation Phase.

The loss of soils and changes to Soil Quality are expected to be Partially Reversible. TCL is committed to reclaiming the Project Area and reversing Project effects by replacing soil (to the extent possible) to facilitate reinstatement of an equivalent land capability. As mentioned, the reversibility of Project effects is contingent on the ability to effectively salvage soil prior to construction. Soil Quality is expected to be within the natural range of variability, or otherwise at the limits of the natural range of variability, for equivalent land capability. Since discrete portions of the Project Area hold a low or no soil salvage potential, loss of soil and/or degradation of soil quality is inevitable in some locations and, therefore, considered non-reversible. All Project features will be reclaimed to design-specifications to ensure a safe and stable end-landscape. Reclamation design will involve landscape re-contouring to tie-in to the predominant terrain and reinstate surface drainage patterns and incorporate construction approaches and mitigations that minimize the potential for soil erosion and sediment transport.

Lastly, the Project is situated in an area where soil resources hold a moderate-to-high level of natural integrity. The RSA is somewhat undisturbed by past and present environmental and socio-economic processes and conditions (i.e., rural residential development, agricultural activity and/or forestry). Given the soil characteristics within the RSA (i.e., in terms of erodibility and susceptibility to disturbance), soil resources are considered to hold moderate sensitivity and propensity to change due to the Project effects (i.e., moderate resilience). The Context has been rated Moderate.

Table 5.4-3: Summary of Residual Effects Characteristics Ratings for Loss of Soils and Changes in Quality Due to Changes in Physical and Chemical Properties

Residual Effect Characteristic	Rating	Rationale for Rating
Magnitude	Low-to-Moderate	Changes to Soil Quality are expected to be <5% of the spatial extent of the RSA. Changes in Soil Quantity are mostly expected to amount to <20% loss of soil, with a discrete potential for up to and >50% loss of soil depending on soil salvage potential. Changes in Soil Quality are expected to be within the natural range of variation and end-land use capability, with a discrete potential to be at the limits of the natural range of variation depending on the soil salvage potential.
Geographic Extent	Local	Changes to Soil Quality will be restricted to the Project Area, with some potential to extend within the Terrain and Soils LSA
Duration	Long-term	Changes to Soil Quality expected to occur during the Construction Phase and extend beyond the Post-closure Phase.
Frequency	Infrequent	Changes to Soil Quality primarily expected to occur due to site clearing during the Construction Phase and soil replacement and surface recontouring during the Decommissioning and Reclamation Phase. Potential for indirect effects (e.g., erosion, dust, spills) to occur gradually and/or irregularly during all Project phases
Reversibility	Partially Reversible	Commitment to reclaiming the Project Area and reversing Project effects by replacing salvaged topsoil to facilitate reinstatement of Soil Quality. However, reversibility of Project effect is contingent on the ability to effectively salvage soil prior to construction, and minimize incidental effects associated with soil handling and stockpiling. Discrete areas with low or no soil salvage potential susceptible to soil loss and/or degradation of soil quality; effect is not reversible.
Context	Moderate	Soil Quality holds a moderate level of natural integrity; RSA is somewhat undisturbed by past and present environmental and socio-economic processes and conditions (i.e., rural residential development, agricultural activity and/or forestry). Soil Quality holds moderate sensitivity and propensity to change due to the effect (i.e., moderate resilience)

Notes: *>=greater than; <=less than; %=percent; LSA=Local Study Area; RSA=Regional Study Area*

5.4.3.2 Likelihood

Based on professional judgement and knowledge and understanding of other similar projects and activities, the Project is Likely to cause adverse residual effects within the Terrain and Soils RSA. There is a moderate-to-high probability that the residual effect will occur after mitigation.

5.4.3.3 Significance Determination

The residual effects related to the loss of soils and changes to Soil Quality are expected to be of Low-to-Moderate Magnitude, Local in Geographic Extent, Infrequent, and Partially Reversible. Cause-effect relationships between the Project and Terrain and Soils VC are fully understood and all the necessary data are available to support the assessment. As such, residual effects on the Soil Quality subcomponent are characterised as **Not Significant** as they are not expected to alter the integrity of soil to the point where it is not sustainable or is unavailable to contribute to ecological function. The Level of Confidence in this prediction is High.

5.5 Summary of Project–related Residual Adverse Effects and Significance

The following potential residual effects of the Project were identified as residual effects on the Terrain and Soils VC:

- Terrain Stability: changes to terrain from vegetation and rock removal; and
- Soil Quality: loss of soils and changes to quality due to changes in physical and chemical properties.

The results of the residual effects characterisation for the Terrain and Soils subcomponents are summarized in **Table 5.5-1**. The residual effects of the Project on Terrain Stability and Soil Quality subcomponents were expected to be **Not Significant**. The Project effects are not expected to alter the integrity of the Terrain and Soils VC within the RSA beyond an acceptable level (i.e., it remains sustainable and is available to contribute to ecological function).

Table 5.5-1: Summary of Residual Adverse Effects for Terrain and Soils Valued Component (VC) Subcomponents

Residual Effects	Contributing Activities Within the Project Phases (C, O, D, P)	Proposed Mitigation Measures	Subcomponent	Residual Effects Characterisation								
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Changes to Terrain from Vegetation and Rock Removal	All Activities (C, O, D, P)	▪ Avoid sensitive environments; ▪ Limit Project footprint and Project Area; ▪ Reclamation measures (refer to RCP); ▪ Transport measures; ▪ Project footprint boundaries; ▪ Forest management practices; ▪ Project siting and construction; ▪ Vegetation clearing and soil salvage (Refer to **CEMP**, **RCP** and **VMP**); and ▪ Erosion and sediment control (Refer to **CEMP** and **SEPSCP**). ▪ Additional VC-specific reclamation measures (Refer to **RCP**, **VMP, CEMP,** and **SEPSCP**)	Terrain Stability	M	LSA	LT	IF	PR	L	L	NS	H
Loss of Soils and Changes to Quality Due to Changes in Physical and Chemical Properties	All Activities (C, O, D, P)	▪ Avoid sensitive environments ; ▪ Limit Project Footprint and Project Area; ▪ Reclamation measures (refer to **RCP**); ▪ Project Footprint boundaries; ▪ Transport measures; ▪ Forest management practices ▪ Blasting measures (refer to **EMP**); ▪ Project siting and construction; ▪ Vegetation clearing and soil salvage (Refer to **CEMP**, **RCP** and **VMP**); ▪ Erosion and sediment control (Refer to **CEMP** and **SEPSCP**);	Soil Quality	M	LSA	LT	IF	PR	L	L	NS	H

Residual Effects	Contributing Activities Within the Project Phases (C, O, D, P)	Proposed Mitigation Measures	Subcomponent	Residual Effects Characterisation								
				Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
		▪ Additional VC-specific reclamation measures (Refer to **RCP**, **VMP, CEMP,** and **SEPSCP**) ▪ Dust suppression and air emissions (Refer to **AQMP**, **MTCP**); and ▪ Spill prevention and response (Refer to **FMSCP**)										

Notes: *C, O, D, P represent Project phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
AQMP=Air Quality Management Plan (S13.0-2); EMP= Explosives Management Plan (S13.0-C6); CEMP=Construction Environmental Management Plan (S13.0-C4); RCP=Reclamation and Closure Plan (S13.0-C15); SEPSCP=Surface Erosion Protection and Sediment Control Plan (S13.0-C17); VMP=Vegetation Management Plan (S13.0-C18); VC=Valued Component

Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Project Area (PA), Local (LSA), Regional (RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully reversible (FR), Partially reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (UL), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), or Low (L) based on professional judgement to be defined by Discipline Lead

See ***Table 5.1-2*** *for list of applicable activities for each listed Project phase, unless otherwise noted in this table.*

6. Cumulative Effects Assessment (CEA)

Cumulative effects are the overall effects on a VC due to the Project's residual effects overlapping both spatially and temporally with those of other projects and activities. This subsection presents an assessment of the cumulative effects on the Terrain and Soils VC. The environmental effects of past and present projects are captured in the baseline conditions in **4. Existing Conditions.** The focus of the CEA is to determine the likelihood of cumulative effects on Terrain and Soils subcomponents associated with ongoing and future projects. The spatial boundaries of the CEA for the Terrain and Soils VC refer to the Terrain and Soils RSA described in **3.2.4.1**. Projects and activities that are outside of the Terrain and Soils RSA but had residual effects that extended into the RSA were also considered. The temporal boundaries within which cumulative effects were considered include past, present, and reasonably foreseeable future activities inclusive of the life of the Project including Construction, Operation, Decommissioning and Reclamation, and Post-closure phases (**3.2.4.2**). As outlined in **5.2**, the following Project-related residual effects were considered for their potential to interact cumulatively with the residual effects of reasonably foreseeable projects and activities identified within, or extending into the Terrain and Soil RSA:

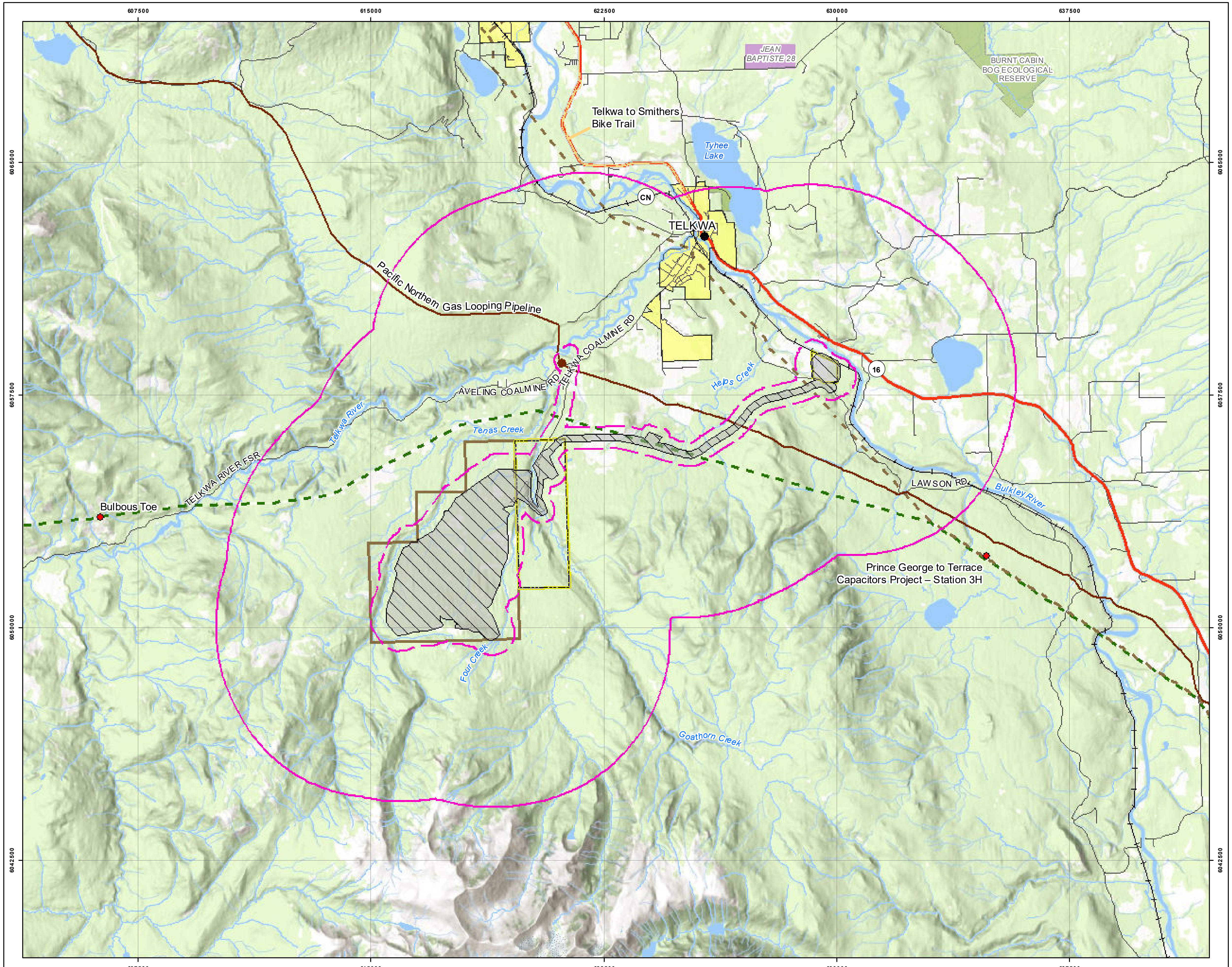
- Terrain Stability**:** changes to terrain from vegetation and rock removal; and
- Soil Quality**:** loss of soil and changes to soil quality due to changes in chemical and physical characteristics.

Baseline conditions represent past and present projects and activities, including all existing disturbance. A summary of the projects and activities identified within and/or predicted to have residual effects extending into the Terrain and Soils RSA is provided in **Table 6-1** and shown in **Figure 6-1**. It must be noted that other projects and activities listed in the Project and Activity Inclusion List (**S3.0 Assessment Methodology** of the **EAC Application***)* are not considered in the Terrain and Soils CEA as the residual effects of some of these developments are not anticipated to overlap spatially with the residual effects of the Project and are not in proximity to the Terrain and Soils RSA.

Table 6-1: Projects Included in the Assessment of the Terrain and Soils Valued Component (VC) Based on Spatial and Temporal Interaction

Project/Activity Name	Interacts with Project-related Effects on the VC as a Past, Present or Future Project/Activity	
	Past and Present	Future
Agriculture Activities	Yes	Yes
Bulbous Toe	No	Yes
Forestry – Forestry Activities	Yes	Yes
Harvest (including Fishing, Hunting, Trapping, and Outfitting)	Yes	Yes
Infrastructure Maintenance and Activities	Yes	Yes
Maple Leaf Cannabis Production Facility – Commercial	No	Yes
Pacific Northern Gas Looping Pipeline – Utilities	Yes	Yes
Recreation Activities	No	Yes
Recreation – Telkwa to Smithers Bike Trail	No	Yes
Traditional Land Use	Yes	Yes
Urban Development	Yes	Yes

Notes: *Project=Tenas Project; VC=Valued Component*



Tenas Project

Projects included in the Cumulative Effects Assessment for the Terrain and Soils VC

Legend

- Project
- Pacific Northern Gas Compressor Site
- City/Town
- Rail Line
- Highway
- Road
- 138 kV Transmission Line
- 500 kV Transmission Line
- Pacific Northern Gas Looping Pipeline
- Watercourse
- Waterbody
- Park or Protected Area
- First Nation Reserve
- Municipal Area
- Telkwa Coal Limited Private Property
- Tenas Coal Licenses
- Project Area
- Terrain and Soils Local Study Area
- Terrain and Soils Regional Study Area

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Project Area: Allegiance Coal, April 21, 2021
- Basedata: Government of British Columbia
- Basemap: World Topo Map

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6.1 Cumulative Effects Assessment (CEA) - Terrain Stability Subcomponent

In the absence of comprehensive activity details and spatial information, the projects and activities listed in **Table 6-1** were considered from a strictly qualitative perspective based on available information and understanding of the scope of these activities. Upon review of reasonably foreseeable projects and activities within the RSA, none of the listed projects and activities in **Table 6-1** are anticipated to result in changes in terrain morphology or stability within the RSA. There is no potential for cumulative effects pertaining to the Terrain Stability subcomponent to occur; therefore, there are no cumulative effects predicted to occur for Terrain Stability, and no further assessment is considered.

6.2 Cumulative Effects Assessment (CEA) - Soil Quality Subcomponent

In the absence of comprehensive activity details and spatial information, the projects and activities listed in **Table 6-1** were considered from a strictly qualitative perspective based on available information and understanding of the scope of these activities. Brief descriptions of the projects and activities are listed in **6.2.1**. Upon review of reasonably foreseeable projects and activities within the RSA, some of the listed projects and activities are expected to involve soil disturbances (e.g., salvage) that could affect soil quality and/or quantity. Consequently, there is a potential for cumulative effects pertaining to the Soil Quality subcomponent.

6.2.1 Potential Cumulative Effects

The following projects and activities were carried forward for the CEA. Brief descriptions of these projects and activities with potential cumulative effects are provided hereafter.

- Agricultural Activities: The northeast portion of the RSA is located within the boundaries of the ALR (refer to **4.2.3.4**) where agriculture is the preferred land use activity. In the past and at present, discrete agricultural land uses (e.g., cultivation, pasture, and hay land) have occurred within the RSA with limited spatial overlap with the Project Area. In future, there is a potential for expansion of agricultural activities within the RSA. Agricultural expansion would involve clearing vegetation and/or harvesting timber (depending on location); cultivation is expected to cause a surficial disturbance of soil, but no loss of soil. With sound agricultural land management (as supported by BMPs and guidelines determined by the ALC) present and future agricultural activities are expected to increase arable soil quantity and quality, and thereby enhance land use capability within the RSA;
- Forestry Activities: The RSA is located within the Bulkley Timber Supply Area (TSA) (refer to **4.2.3.4**) where forest resources are managed for potential timber harvest. In the past and at present, discrete forestry activities have occurred within the RSA. In future, approximately 7,000 ha within the RSA is estimated to be harvested between 2021 and 2073 (Refer to **S4.0-C7 Vegetation VC** of the **EAC Application** for further details). Clearing vegetation and harvesting timber should not result in the disturbance of soil, considering the application of required mitigation and BMPs for forestry practices. That said, the construction of roads and laydown areas to access cut-blocks and handle the timber will involve soil stripping; forestry activities will also increase vehicle and equipment traffic that can increase the potential for erosion and/or dust deposition, as well as the potential for soil contamination events (i.e., spills). The size/scale of these effects cannot be determined at this time. With sound forestry practices (as supported by BMPs and guidelines determined under the Bulkley LRMP) present and future forestry activities are expected to contribute minimally to the cumulative loss of soil and changes to soil quality within the RSA;

- Pacific Northern Gas Looping Pipeline: This pipeline construction project intersects the RSA. Pipeline construction would involve vegetation site clearing and soil salvage along the pipeline ROW during a specified timeframe; construction would also increase vehicle and equipment traffic that can increase the potential for erosion and/or dust deposition, as well as the potential for soil contamination events. With sound pipeline construction practices (as supported by BMPs and guidelines determined by the BC Oil and Gas Commission [BC OGC]) pipeline construction is expected to contribute minimally to the cumulative loss of soil and changes to soil quality within the RSA; and
- Recreation Telkwa to Smithers Bike Trail: This project, located along Highway 16, will be sited predominantly along an existing transportation ROW within the RSA. Construction of the project may involve discrete and isolated vegetation site clearing and/or soil salvage. With sound construction practices (as supported by BMPs and guidelines determined by the British Columbia Ministry of Transportation and Infrastructure [BC MOTI]) construction of the project is expected to contribute minimally to the cumulative loss of soil and changes to Soil Quality within the RSA.

The following projects and activities were not carried forward into the CEA:

- Bulbous Toe: This project is located outside of the RSA. However, the project involves periodic vehicle and equipment travel via the Village of Telkwa (i.e., as its nearest point of access that is within the RSA). This activity is not expected to involve any vegetation site clearing and/or salvage;
- Harvesting (Including Fishing, Hunting, Trapping, and Outfitting): Land within the RSA is used for harvesting activities (e.g., fishing, hunting, trapping, and outfitting). There is a potential for spatial overlap with the RSA via existing roads, trail networks and cleared-vegetation corridors. These activities are not expected to involve any vegetation site clearing and/or soil salvage;
- Infrastructure and Maintenance Activities: The municipality of Telkwa conducts ongoing municipal road works and other related construction projects within its jurisdiction (e.g., construction and maintenance of roads, bridges, water management infrastructure). There is a potential for spatial overlap with the RSA along existing roads. However, these projects are not expected to involve any major vegetation site clearing and/or soil salvage;
- Maple Leaf Cannabis Production Facility: This project, located within the municipal boundaries of the Village of Telkwa, will be sited on previously developed land. The project is not expected to involve any new vegetation site clearing and/or soil salvage;
- Urban Development: The municipality of Telkwa may develop land within its jurisdiction for urban development. Depending on project location there is a potential for spatial overlap with the RSA. Construction would involve vegetation clearing and/or soil stripping. However, there are no foreseeable major and/or large-scale urban development projects within the RSA (e.g., residential developments);
- Recreation Activities: Land within the RSA is used for recreation activities (e.g., hiking, off-road vehicle access, park yoga) via existing roads, trail networks and cleared-vegetation corridors. These activities are not expected to involve any vegetation site clearing and/or soil salvage; and
- Traditional Land Use: Land within the RSA is used for traditional land use; these activities may all or some of the activities described under harvesting and recreation (above). There is a potential for spatial overlap with the RSA via existing roads, trail networks and cleared-vegetation corridors. These activities are not expected to involve any vegetation site clearing and/or soil salvage.

6.2.2 Additional Mitigation Measures

The projects and activities included in the CEA (**6.2.1 Potential Cumulative Effects**) all include mitigation measures and requirements determined by their respective jurisdictions and regulatory agencies. Additional mitigation (i.e., that extends beyond the mitigation considered in the assessment of Project-related effects [**5.3 Mitigation Measures**]) is not considered to be necessary to avoid or minimize the predicted cumulative effects on the Soil Quality subcomponent.

6.2.3 Cumulative Effects and Characterisation of Significance

The interactions between the predicted Project residual effects (**5.5**) and the residual effects of other projects and activities (**6.2.1)** were evaluated to characterise potential cumulative effects on the Soil Quality subcomponent. The residual effects from other reasonably foreseeable projects and activities that would cumulatively affect the Soil Quality subcomponent within the RSA refer to events (either planned or unexpected) that could result in a decrease in the quantity and/or quality of the soil (i.e., such as those potential effects described in **5.2.2**) and that can reasonably be expected during Project phases. As the details of these reasonably foreseeable future projects and activities are not known, this CEA is strictly qualitative and intended to provide context related to the location and extent of the cumulative effects related to Soil Quality. A central assumption is that reasonably foreseeable future projects and activities are expected to be properly planned, have appropriate mitigation in place, and comply with applicable laws and regulations to protect soil resources in the RSA.

Cumulative effects were characterised following a similar framework (i.e., Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Context, Likelihood) used for characterising residual effects and assigning Significance and Confidence (**5.4.1** and **5.4.2**). Using this framework, cumulative effects on the Soil Quality subcomponent are as follows:

- **Magnitude: Low**
  - The Magnitude of effects related to the Soil Quality subcomponent within the RSA will depend on the size, scale and location of the projects and activities, and the status soil resources at these locations (e.g., baseline soil quality and composition, soil salvage potential). In the absence of specific details, all other projects and activities are predicted to result in discrete and/or isolated changes to the Soil Quality subcomponent. As per the definition of Significance (**5.4.1**) changes in soil quantity due to soil disturbance are expected to be <20% loss of soil depending on soil salvage potential; cumulative changes in the Soil Quality subcomponent are expected to be within the natural range of variation.
- **Geographic Extent: Regional**
  - In the absence of specific details, all other projects and activities are expected to be distributed throughout the RSA. Cumulative changes in the Soil Quality subcomponent due to soil disturbance have the potential to occur throughout the Terrain and Soil RSA.
- **Duration: Long-Term**
  - In the absence of specific details, other projects and activities are expected to occur over the Long-term (>52 years). There is a potential for cumulative indirect effects (i.e., within the limit of the natural range of variation) to occur after the Decommission and Reclamation Phase of all other projects and activities.
- **Frequency: Infrequent**
  - In the absence of specific details, changes in the Soil Quality subcomponent due to soil disturbance are expected to occur infrequently. There is the potential for soil disturbance

associated with land clearing and/or major earthworks during construction phases of all other projects and activities. As such, there is a potential for a cumulative loss of soil as an indirect effect due to erosion and sediment transport and/or dust generation during all phases of other projects and activities.

- **Reversibility: Partially Reversible**
  - Cumulative changes in the Soil Quality subcomponent due to soil disturbance are expected to be Partially Reversible. The reversibility of Project effects is contingent on the ability to effectively salvage soil prior to construction. The Soil Quality subcomponent is expected to be within the natural range of variability, or otherwise at the limits of the natural range of variability, for equivalent land capability. Since areas within the RSA hold a low or no soil salvage potential, cumulative loss of soil and/or degradation of the Soil Quality subcomponent is expected in some locations and, therefore, considered non-reversible.
- **Context: Moderate**
  - Soil resources within the RSA hold a high level of natural integrity. The RSA is mostly undisturbed by past and present environmental and socio-economic processes and conditions (i.e., rural residential development, agricultural activity and/or forestry). Given the characteristics of soil within the RSA (i.e., in terms of erodibility and susceptibility to disturbance), the Soil Quality subcomponent within the RSA is considered to hold moderate sensitivity and propensity to change as a result of future projects and activity effects (i.e., moderate resilience) in consideration of regulatory requirements.

Based on professional judgement and knowledge and understanding of other similar projects and activities, the cumulative effects listed above hold a Moderate-to-High Likelihood to occur. Given the spatio-temporal and environmental context for these changes (described above), the cumulative effects are characterised as **Not Significant** as they are not expected to alter the integrity of soil to the point where it is not sustainable or is unavailable to contribute to ecological function. The Level of Confidence for this prediction is High. See **Table 6.2-1**.

Table 6.2-1: Summary of Cumulative Effects for Soil Quality Subcomponent

Cumulative Effects	Contributing Activities Within the Project Phases (C, O, D, P)	Cumulative Effects Characterisation								
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood	Significance	Level of Confidence
Loss of Soil and Changes to Soil Quality	▪ Existing activities and reasonably foreseeable developments with potential for cumulative effects (**6.2.1 Potential Cumulative Effects**): ○ Agriculture ○ Forestry ○ Pacific Northern Gas Looping Pipeline ○ Telkwa to Smithers Bike Trail ▪ Project-related activities as outlined in **5.5 Summary of Project-related Residual Adverse Effects and Significance** (C, O, D, P)	L	RSA	LT	IF	PR	M	L	NS	H

Notes: *C, O, D, P represent Project Phases: Construction (C), Operation (O), Decommissioning and Reclamation (D), Post-closure (P)*

Magnitude: Low (L), Moderate (M), High (H)
Geographic Extent: Project Area (PA), Local (LSA), Regional (RSA)
Duration: Short-term (ST), Medium-term (MT), Long-term (LT)
Frequency: Infrequent (IF), Frequent (FF), Continuous (CF)
Reversibility: Fully reversible (FR), Partially reversible (PR), Irreversible (IR)
Context: Low (L), Moderate (M), High (H)
Likelihood: Unlikely (UL), Likely (L)
Significance: Not-Significant (NS), Significant (S)
Level of Confidence: High (H), Moderate (M), Low (L)

*See **Table 5.1-2** for list of applicable activities for each listed Project phase, unless otherwise noted in this table. Includes all existing and reasonably foreseeable projects as outlined in **Table 6.1-1.***

6.3 Summary of Cumulative Effects Assessment (CEA)

The summary of cumulative effects for the Terrain and Soil VC is provided in **Table 6.3-1**. For the Project to contribute to cumulative effects on the Terrain and Soil VC, the following criteria must be met:

- There must be a residual effect due to the Project;
- The predicted residual effects from the Project must be demonstrated to interact cumulatively with residual effects from other projects or activities;
- Any other projects and/or activities have been or will be carried out and are not hypothetical; and
- The cumulative change is likely to occur.

For the Terrain Stability subcomponent, and upon review of reasonably foreseeable projects and activities within the RSA, it was determined that there is no potential for Project residual effects to interact cumulatively; cumulative effects within the RSA are Not Likely to occur.

For the Soil Quality subcomponent, it was determined that there is potential for Project residual effects to interact cumulatively. Contributing activities are expected to occur during all Project phases, and cumulative change within the RSA is likely to occur. Based on the characterisation of cumulative effects on the Soil Quality subcomponent, and accounting for the nature and assumed size and environmental context for other projects and activities within the RSA, the cumulative effects on the Terrain and Soils VC are **Not Significant**. In the absence of specific details regarding other projects and activities within the RSA, the Level of Confidence for this prediction is High assuming that future/foreseeable projects and activities are expected to be properly planned, have appropriate mitigation in place, and comply with applicable laws and regulations to protect soil resources.

Table 6.3-1: Summary of Cumulative Effects on Terrain and Soils Valued Component (VC)

VC Subcomponent	Potential Cumulative Effect	Contributing Activities within the Project Phases (C, O, D, P)	Cumulative Effect (Yes/No)	Significant (Yes/No)
Terrain Stability	No	n/a	No	No
Soil Quality	Loss of soil and changes to soil quality	All activities (C, O, D, P)	Yes	No

Notes: *C, O, D, P represent Project Phases: (C)onstruction, (O)peration, (D)ecomissioning and Reclamation, (P)ost-closure*
n/a=not applicable; VC=Valued Component

See ***Table 5.1-2*** *for list of applicable activities for each listed Project phase, unless otherwise noted in this table. Includes all existing and reasonably foreseeable projects as outlined in* ***Table 6.1-1.***

7. SUMMARY OF EFFECTS ASSESSMENT FOR TERRAIN AND SOILS VALUED COMPONENT (VC)

The following potential adverse effects to the Terrain and Soils subcomponents include:

- Terrain Stability: change in stability and morphology; and
- Soil Quality: change in physical and chemical properties of soil in context of land use capability.

Changes to terrain are defined by the net alteration to landscape stability and morphology from baseline conditions. Changes to soil quality are defined by the net reduction and degradation of soil chemical and physical characteristics to the extent that they change current land capability. Potential Project effects on the Terrain and Soils subcomponents include:

- Terrain Stability: change to terrain from vegetation and rock removal; and
- Soil Quality: loss of soils and changes to soil quality due to change in chemical and physical properties.

The Project will be developed to design-specifications so that a safe and stable landscape exists during all Project phases. Project activities will be planned and sequenced to account for terrain stability, soil erosion and soil conservation to the extent practical. Mitigation measures (described in **5.3**) will be designed and implemented to monitor and maintain Terrain Stability and Soil Quality during all Project phases. The mitigation being proposed is based on industry BMP's, procedures, and proven/accepted mitigation used on other similar projects. After mitigation, Project residual effects are predicted for the Terrain Stability and Soil Quality subcomponents. For both the Terrain Stability and Soil Quality subcomponents, residual effects are expected to be mostly within the limits of the natural range of variability or, otherwise, at the limits of the natural range of variability. Upon characterisation and determination of Likelihood and Significance, the Project residual effects for the Terrain and Soils VC are **Not Significant.** The Level of Confidence for these predictions is High.

Project-related residual effects were assessed in terms of their cumulative effect within the RSA based on available information and understanding of other reasonably foreseeable projects and activities. Upon review of projects and activities within the RSA (past, present, and reasonably foreseeable future), and after determining that no additional mitigation measures are expected to be necessary, it was predicted that there is no potential for Project residual effects to interact cumulatively within the RSA for the Terrain Stability subcomponent, and that cumulative effects in the RSA are expected to occur but **Not Significant** for the Soil Quality subcomponent. Therefore, cumulative effects on the Terrain and Soils VC are Not **Significant**.

8. Follow-up Strategy

Follow-up refers to a range of activities (e.g., monitoring, auditing, and *ex post*[5] evaluations) used to further quantify and qualify Project effects against predictions (if/where necessary), assess the effectiveness of mitigation measures, provide a mechanism for modification and/or adaptation, identify new problems (should they arise), and implement additional mitigation (if/where applicable) including triggers and corrective actions. TCL is committed to:

- provide a safe and stable landscape during all Project phases; and
- reinstate terrain and soil to an equivalent land capability in a manner that aligns with the desired end-land use(s) and regulatory requirements at the completion of the mining tenure.

Project design and mitigation have been proposed to eliminate or reduce Project effects pertaining to the Terrain and Soils VC. A key step will be to appropriately implement applicable environmental management plans (**S3.0** of the **EAC Application)** during the given Project phases. A follow-up strategy is proposed to support existing mitigation and thereby minimize uncertainty in support of these commitments.

8.1 Geotechnical Monitoring

Providing a safe and stable landscape during all Project phases is, in part, contingent on identifying geotechnical risk and applying appropriate mitigation. The Project-specific **Terrain and Soil Baseline Study (Appendix 4.2-A)** has effectively ranked terrain stability throughout the Project Area and identified mapped polygons (e.g., Class 3, 4 and 5) and specific features/locations (e.g., along Goathorn Creek, Tenas Creek and Helps Creek) prone to instability and/or geohazards. Given the rigour of the Project-specific baseline study as well as the Project's proposed management plans and adaptive management approach, it was deemed that Terrain and Soils VC-specific follow-up programs to verify the accuracy of the residual effects and cumulative effects predictions are not warranted at this time.

Geotechnical monitoring will be conducted (e.g., during and immediately following the Construction Phase) in proximity to those areas and landscape features (listed above) prone to instability and/or geohazards. This will provide a mechanism to allow Project features to be constructed to design specifications (i.e., in a manner that meets geotechnical requirements) and verify that mitigation measures are both appropriate and effective in relation to the level of geotechnical risk. This will also provide a procedure to modify/adapt mitigation measures if/where necessary. Where mitigation measures are not deemed to be successful, adaptive management techniques will be employed to revise the environmental management plans (e.g., incorporating additional maintenance, monitoring, and/or BMPs) to reduce effects during the lifetime of the Project. Where applicable, key stakeholders, Indigenous groups, and government agencies will be involved in developing mitigation and adaptive management measures.

Geotechnical monitoring will be implemented in accordance with other mitigation and management plans specific to Terrain Stability, including the **SEPSCP**, **VMP**, and **RCP**. The timing/frequency of monitoring and reporting requirements will be determined in consultation with qualified personnel responsible for geotechnical oversight (e.g., Professional Geologist or Professional Geotechnical Engineer). Geotechnical monitoring procedures will clearly define and delineate indicators and descriptors to identify potential deficiencies (e.g., types of slopes failures and leading causes), triggers and corrective actions. These procedures will identify the key personnel (e.g., managers, superintendents, and technical leads) responsible for document review, approval, and implementation.

[5] *Ex post* evaluations are done after the Project has closed.

8.2 Soil Monitoring

Reclamation of the Project Area and reinstatement of Terrain and Soils to an equivalent land capability is contingent (in part) on effectively salvage soil and then maintaining soil quantity and quality as a viable growth substrate until implementation of the Reclamation and Decommissioning Phase. The Project-specific **Terrain and Soil Baseline Report (Appendix 4.2-A)** has effectively delineated and characterised SMUs throughout the Project Area and provided recommendations for soil salvage and reclamation suitability. Given the rigour of the Project-specific **Terrain and Soil Baseline Report (Appendix 4.2-A)**, as well as the Project's proposed management plans (**S13.0** of the **EAC Application**) and adaptive management approach, it was deemed that Terrain and Soils VC-specific follow-up programs to verify the accuracy of the residual effects and cumulative effects predictions are not warranted at this time.

Soil monitoring during soil salvage and stockpiling activities will be conducted prior to the Construction Phase. This will provide a mechanism to verify that soil is stripped, handled, and stockpiled as recommended, and that there is an inventory of salvaged soil resources at the Project. Monitoring of soil stockpiles (including soil-metals monitoring and **SEPSCP** monitoring) will then be conducted during the Operation Phase. These monitoring activities will provide a mechanism to verify that mitigation measures are both appropriate and effective and provide a procedure to modify/adapt mitigation measures if/where necessary. Where mitigation measures are not deemed to be successful, adaptive management techniques will be employed to revise the environmental management plans (e.g., incorporating additional maintenance, monitoring and/or best management practices) to reduce effects during the lifetime of the Project. Where applicable, key stakeholders, Indigenous groups, and government agencies will be involved in developing mitigation and adaptive management measures

Monitoring of Parameters of Potential Concern/Contaminants of Potential Concern (POPC/COPC) and Parameters of Concern/Contaminants of Concern (POC/COC) identified for aquatic life, wildlife, terrestrial vegetation, human health, and land uses will be conducted for soils, vegetation, sediment, and surface and groundwater.

Monitoring of soil salvage activities will be implemented in accordance with other mitigation and management plans specific to Terrain Stability including the **SEPSCP**, **VMP**, and **RCP**. Soil salvage will be conducted under the guidance and supervision of a qualified environmental professional with experience interpreting SMUs and ground-truthing site conditions to confirm/verify soil salvage depths and identify potential hazards (e.g., Professional Agrologist or Registered Professional Biologist with dedicated expertise in soil science). Soil inventory data, including volume and location, will be recorded by construction supervisors at the time of soil stockpiling. Soil monitoring procedures will clearly define and delineate indicators and descriptors to identify potential deficiencies (e.g., soil salvage hazards and leading causes), triggers, and corrective actions. These procedures will identify the key personnel (e.g., managers, superintendents, and technical leads) responsible for document review, approval, and implementation.

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