Blackwater Gold Project

End Land Use Plan

November 2022

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ACRONYMS AND ABBREVIATIONS

Artemis	Artemis Gold Inc.
AWSC	Available Water Storage Capacity
BC	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
BGC	Biogeoclimatic
BW Gold or Proponent	BW Gold LTD.
CCME	Canadian Council of Ministers of the Environment
CEO	Chief Executive Officer
CFMP	Country Foods Monitoring Program
CM	Construction Manager
Code	Health, Safety and Reclamation Code for Mines in British Columbia
COO	Chief Operations Officer
CSFN	Carrier Sekani First Nations
DS	Decision Statement
EAC or Certificate	Environmental Assessment Certificate
EAO	Environmental Assessment Office
ECCC	Environment Climate Change Canada
ECD	Environmental Control Dam
EIS	Environmental Impact Statement
ELUP	End Land Use Plan
EM	Environmental Manager
EMC	Environmental Monitoring Committee
EMLI	Ministry of Energy, Mines and Low Carbon Innovation
EMP	Environmental Management Plan
EMPR	Ministry of Energy Mines and Petroleum Resources
EMS	Environmental Management System
ENV	Ministry of Environment and Climate Change Strategy
EOR	Engineer of Record
EPCM	Engineering, Procurement and Construction Management

EPT	Ephemeroptera, Plecoptera, and Trichoptera
ERM	ERM Consultants Canada, Ltd.
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FSR	Forest Service Road
FWR	Freshwater reservoir
GM	General Manager
ha	Hectare
HHRA	Human Health Risk Assessment
IEG	Integral Ecology Group
Indigenous nations	Lhoosk'uz Dené Nation, Ulkatcho First Nation, Nadleh Whut'en First Nation, Stellat'en First Nation, Saik'uz First Nation and Nazko First Nation (as defined in the Project's Environmental Assessment Certificate #M19-01)
ITRB	Independent Tailings Review Board
Joint MA/EMA Application	Joint *Mines Act / Environmental Management Act* Permits Application
km	Kilometre
KP	Knight Piésold
kV	Kilovolt
LDN	Lhoosk'uz Dené Nation
LGO	Low-grade ore
MERP	Mine Emergency Response Plan
MOE	Ministry of Environment
MPs	Management plans
Mtpa	Million tonnes per annum
MWLAP	Ministry of Water, Land and Air Protection
PCOC	Potential contaminants of concern
Project	Blackwater Gold Project
PSD	Particle Size Distribution
RCP	Reclamation and Closure Plan
SMR	Soil Moisture Regime
SNR	Soil Nutrient Regime
SOPs	Standard operating procedures

t/d	Tonnes per day
TEM	Terrestrial Ecosystem Mapping
TSF	Tailings Storage Facility
UFN	Ulkatcho First Nation
VP	Vice President
WMMP	Wildlife Mitigation and Monitoring Plan
WMOP	Wetland Management and Offsetting Plan
WMP	Water Management Pond
WQG-AL	Water quality guideline for the protection of aquatic life
WQM	Water Quality Model
WTP	Water Treatment Plant
YDWL	Yinka Dene Water Law

1. PROJECT OVERVIEW

The Blackwater Gold Project (the Project) is a gold and silver open pit mine located in central British Columbia (BC), approximately 112 kilometres (km) southwest of Vanderhoof, 160 km southwest of Prince George, and 446 km northeast of Vancouver.

The Project is presently accessed via the Kluskus Forest Service Road (FSR), the Kluskus-Ootsa FSR and an exploration access road, which connects to the Kluskus-Ootsa FSR at km 142. The Kluskus FSR joins Highway 16 approximately 10 km west of Vanderhoof. A new, approximately 13.8 km road (Mine Access Road) will be built to replace the existing exploration access road, which will be decommissioned. The planned new access is at km 124.5 km. Driving time from Vanderhoof to the mine site is about 2.5 hours.

Major mine components include a tailings storage facility (TSF), ore processing facilities, waste rock, overburden and soil stockpiles, borrow areas and quarries, water management infrastructure, water treatment plants, accommodation camps and ancillary facilities. The gold and silver will be recovered into a gold-silver doré product and shipped by air and/or transported by road. Electrical power will be supplied by a new approximately 135 km, 230 kilovolt (kV) overland transmission line that will connect to the BC Hydro grid at the Glenannan substation located near the Endako mine, 65 km west of Vanderhoof.

Project construction is anticipated to take two years. Mine development will be phased with an initial milling capacity of 15,000 tonnes per day (t/d) or 5.5 million tonnes per annum (Mtpa) for the first five years of operation. After the first five years, the milling capacity will increase to 33,000 t/d or 12 Mtpa for the next five years, and to 55,000 t/d or 20 Mtpa in Year +11 until the end of the 23-year mine life. The Closure phase is from Year +24 to approximately Year +45, ending when the Open Pit has filled to the target Closure level and the TSF is allowed to passively discharge to Davidson Creek via a Closure spillway. Post-closure phase begins in Year +46.

New Gold Inc. received Environmental Assessment Certificate #M19-01 (EAC) on June 21, 2019, under the 2002 *Environmental Assessment Act* (EAO 2019c) and a Decision Statement (DS) on April 15, 2019, under the *Canadian Environmental Assessment Act, 2012* (CEA Agency 2019). In August 2020, Artemis Gold Inc. (Artemis) acquired the mineral tenures, assets and rights in the Blackwater Project that were previously held by New Gold Inc. On August 7, 2020, the Certificate was transferred to BW Gold LTD. (BW Gold), a wholly-owned subsidiary of Artemis, under the 2018 *Environmental Assessment Act*. The Impact Assessment Agency of Canada notified BW Gold on September 25, 2020, to verify that written notice had been provided within 30 days of the change of proponent as required in Condition 2.16 of the DS, and that a process had been initiated to amend the DS.

The Blackwater mine site boundary corresponds to the Certified Project Description (CPD) boundary in Schedule A of the EAC and is located within the traditional territories of Lhoosk'uz Dené Nation (LDN), Ulkatcho First Nation (UFN), Skin Tyee Nation and Tsilhqot'in Nation. The Kluskus and Kluskus-Ootsa FSRs and Project transmission line cross the traditional territories of Nadleh Whut'en First Nation, Saik'uz First Nation, and Stellat'en First Nation (collectively, the Carrier Sekani First Nations [CSFNs]) as well as the traditional territories of the Nazko First Nation, Nee-Tahi-Buhn Band, Cheslatta Carrier Nation and Yekooche First Nation (EAO 2019a, 2019b).

2. PURPOSE AND OBJECTIVES

The purpose of the End Land Use Plan (ELUP) is to document land use objectives and reclamation targets for the Project site that will ultimately guide reclamation through implementation of the Reclamation and Closure Plan (RCP). The RCP is currently included as Chapter 4 of the Project *Joint Mines Act/Environmental Management Act Permit* Application and will become a standalone document following permit acquisition.

The objectives of the ELUP are to:

- Establish end land use objective(s);
- Assess the potential for end land use objective success based on the pre- and post-mine land and aquatic environment conditions;
- Establish a feedback mechanism to incorporate Indigenous community perspectives and knowledge about end land use goals and reclamation objectives (to be gained through engagement in future end land use planning workshops and surveys, participation in onsite reclamation trials, and through regular community meetings);
- Outline foreseeable challenges to objective(s) achievement; and
- Address EAC Condition 25 and relevant provisions of the *Health Safety and Reclamation Code for Mines in British Columbia* (Code; BC EMLI 2021).

Ultimately BW Gold's goal is to reclaim ecosystems similar to pre-development conditions; however, the new landforms created by the mine will be leveraged and considered to maximize reclamation success. This document represents an initial ELUP; BW Gold envisions the ELUP to be an iterative and multi-variant process, and will incorporate reclamation research results, site knowledge and experience and information gained through continued community engagement.

3. ROLES AND RESPONSIBILITIES

3.1 Construction and Operations

BW Gold has the obligation of ensuring commitments are met and that relevant obligations are made known to mine personnel and site contractors during all phases of the mine life. A clear understanding of the roles, responsibilities, and level of authority that employees and contractors have when working at the mine site is essential to meet Environmental Management System (EMS) and therefore ELUP objectives.

Table 3.1-1 provides an overview of general environmental management responsibilities during construction and operations life for key positions that will be involved in environmental management. Other positions not specifically listed in Table 3.1-1 but who will provide supporting roles include independent environmental monitors, an Engineer of Record (EOR) for each tailings storage facility and dam, an Independent Tailings Review Board (ITRB), TSF qualified person, geochemistry qualified professional, and other qualified persons and qualified professionals.

Table 3.1-1: Blackwater Roles and Responsibilities

Role	Responsibility
Chief Executive Officer (CEO)	The CEO is responsible for overall Project governance. Reports to the Board.
Chief Operating Officer (COO)	The COO is responsible for engineering and Project development and coordinates with the Mine Manager to ensure overall Project objectives are being managed. Reports to CEO.
Vice President (VP) Environment & Social Responsibility	The VP Environment & Social Responsibility is responsible for championing the Environmental Policy Statement and EMS, establishing environmental performance targets and overseeing permitting. Reports to COO.
General Manager (GM) Development	The GM is responsible for managing project permitting, the Project's administration services and external entities, and delivering systems and programs that ensure Artemis's values are embraced and supported, Putting People First, Outstanding Corporate Citizenship, High Performance Culture and Rigorous Project Management and Financial Discipline. Reports to COO.
Mine Manager	The Mine Manager, as defined in the *Mines Act*, has overall responsibility for mine operations, including the health and safety of workers and the public, EMS implementation, overall environmental performance and protection, and permit compliance. The Mine Manager may delegate some of their responsibilities to other qualified personnel. Reports to GM.
Construction Manager (CM)	The CM is accountable for ensuring environmental and regulatory commitments/ and obligations are being met during the construction phase. Reports to GM.
Environmental Manager (EM)	The EM is responsible for the day-to-day management of the Project's environmental programs and compliance with environmental permits, updating EMS and management plans (MPs). The EM or designate will be responsible for reporting non-compliance to the CM, and Engineering, Procurement and Construction Management (EPCM) contractor, other contractors, the Company and regulatory agencies, where required. Supports the CM and reports to Mine Manager.
Departmental Managers	Departmental Managers are responsible for implementation of the EMS relevant to their areas. Report to Mine Manager.
Indigenous Relations Manager	Indigenous Relations Manager is responsible for Indigenous engagement throughout the life of mine. Also responsible for day-to-day management and communications with Indigenous groups. Reports to VP Environment & Social Responsibility.

Role	Responsibility
Community Relations Advisor	Community Relations Advisor is responsible for managing the Community Liaison Committee and Community Feedback Mechanism. Reports to Indigenous Relations Manager.
Environmental Monitors	Environmental Monitors (includes Environmental Specialists and Technicians) are responsible for tracking and reporting on environmental permit obligations through field-based monitoring programs. Reports to EM.
Aboriginal Monitors	Aboriginal Monitors are required under EAC Condition 17 and will be responsible for monitoring for potential effects from the Project on the Indigenous interests. Indigenous Monitors will be involved in the adaptive management and follow-up monitoring programs. Reports to EM.
Employees and Contractors	Employees are responsible for being aware of permit requirements specific to their roles and responsibilities. Reports to departmental managers.
Qualified Professionals and Qualified Persons	Qualified professionals and qualified persons will be retained to review objectives and conduct various aspects of environmental and social monitoring as specified in EMPs and social MPs.

BW Gold will employ a qualified person as an EM who will ensure that throughout the Post-closure phase the EMS requirements are established, implemented, and maintained, and that environmental performance is reported to management for review and action. The EM is responsible for retaining the services of qualified persons or qualified professionals with specific scientific or engineering expertise to provide direction and management advice in their areas of specialization. The EM will be supported by a staff of Environmental Monitors that will include Environmental Specialists and Technicians and by a consulting team of subject matter experts in the fields of environmental science and engineering.

The CM is accountable for ensuring that environmental and regulatory commitments/obligations are being met during the construction phase. The EM will be responsible for ensuring that construction activities are proceeding in accordance with the objectives of the EMS and associated MPs. In relation to the ELUP this will entail soil / vegetation salvage, storage, and inventory to protect these resources for future reclamation, and the mitigation of effects on aquatic resource capability. The EM or designate will be responsible for reporting non-compliance to the CM and EPCM contractor, other contractors, and regulatory agencies, where required. The EM or designate will have the authority to stop any construction activity that is deemed to pose a risk to the environment or is conducted without regard to established standard operating procedures (SOPs); work will only proceed when the identified risk and concern have been addressed and rectified.

Environmental management during operation of the Project will be integrated under the direction of the EM, who will liaise closely with departmental managers and will report directly to the Mine Manager. The EM will be supported by the VP of Environment and Social Responsibility in order to provide an effective and integrated approach to environmental management and ensure adherence to corporate environmental standards. The EM will be accountable for implementing the approved MPs and reviewing them periodically for effectiveness. Departmental area managers (e.g., mining, milling, and plant/site services) will be directly responsible for implementation of the EMS and EMPs relevant to their areas. All employees and contractors are responsible for daily implementation of the practices and policies contained in the EMS.

Pursuant to Condition 19 of the Project's EAC, BW Gold has established an Environmental Monitoring Committee (EMC) to facilitate information sharing and provide advice on the development and operation of the Project, and the implementation of EAC conditions, in a coordinated and collaborative manner.

Committee members include representatives of the Environmental Assessment Office (EAO), LDN, UFN, Nadleh Whut'en First Nation, Saik'uz First Nation, Stellat'en First Nation, Nazko First Nation, Ministry of Energy, Mines and Low Carbon Innovation (EMLI), Ministry of Environment and Climate Change Strategy (ENV) and Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD).

3.2 Closure and Post-Closure

BW Gold will allocate the appropriate human resources to manage the mine site during the Closure and Post-closure phases. During Closure, personnel will be retained to, at minimum, cover the following roles: Mine Manager, EM, Environmental Technician(s) and Aboriginal Group Monitors. Contractors may be used as required to fulfill the requirements of the RCP.

4. COMPLIANCE OBLIGATIONS

4.1 Legislation

Section 10.7.4 (Land Use) of the Health, Safety and Reclamation Code for Mines in British Columbia (Code) requires:

> *The land surface shall be reclaimed to an end land use approved by the chief permitting officer that considers previous and potential uses.*

Section 10.7.5 (Capability) of the Code requires:

> *Excluding lands that are not to be reclaimed, the average land capability to be achieved on the remaining lands shall not be less than the average that existed prior to mining, unless the land capability is not consistent with the approved end land use or compromises long-term physical and/or geochemical stability.*

4.2 Environmental Assessment Certificate and Decision Statement Conditions

The ELUP is developed to address the requirements in Condition 25 of the Project's EAC #M19-01. A concordance table that identifies where each requirement in Condition 25 is addressed is provided in Appendix A.

The ELUP also references requirements from the Mitigation Table (referred to as 'MT'), submitted to the EAO to address EAC Condition 43 (approved by the EAO in November 2020). Table 4.2-1 lists the mitigations measures to be addressed in the ELUP.

The federal DS does not contain specific conditions related to end land use.

Table 4.2-1: Proposed Mitigation Measures Addressed in the End Land Use Plan

Mitigation ID	Mitigation
3-20 (Wetlands)	Implement a LSVMRP (draft plans provided in Section 12.2.1.18.4.4 of the Application/EIS), ISMP (draft plan in Section 12.2.1.18.4.5 of the Application/EIS), and End Land Use Plan, including progressive reclamation using local native vegetation, or appropriate commercially grown, weed-free native species.
4-6 (Ecosystem Composition)	Implement an ELUP, including plans for progressive reclamation and reforestation, and use of weed-free seed for reclamation.
5-11 (Plant Species and Ecosystems and Risk)	Implement an ELUP that describes reclamation of mine landforms using whitebark pine, including the west waste rock dump in the context of the end land use objectives.
5-13 (Plant Species and Ecosystems and Risk)	Transplantation of healthy trees from impacted areas to undisturbed areas or designated reclamation areas, as will be described in the ELUP.
5-18 (Plant Species and Ecosystems and Risk)	Implement an ELUP, including use of weed-free seed for reclamation.
6-7 (Amphibians)	Implement a LSVMRP (draft plans provided in Section 12.2.1.18.4.4 of the Application/EIS), ISMP (draft plan in Section 12.2.1.18.4.5 of the Application/EIS), and End Land Use Plan to provide wildlife habitat including for amphibians, including progressive reclamation using local native vegetation, or appropriate commercially grown, weed-free native species.
6-25 (Amphibians)	Final pit walls will be left steepened to limit littoral zone and discourage emergent and wetland vegetation growth, as will be described in the ELUP.

Mitigation ID	Mitigation
7-8 (Bats)	Implement a LSVMRP (draft plans provided in Section 12.2.1.18.4.4 of the Application/EIS), ISMP (draft plan in Section 12.2.1.18.4.5 of the Application/EIS), and End Land Use Plan, including progressive reclamation using local native vegetation, or appropriate commercially grown, weed-free native species.
7-9 (Bats)	Implement an ELUP, including plans for progressive reclamation and reforestation.
8-5 (Caribou)	Implement progressive reclamation using local native vegetation or appropriate commercially grown, weed-free native species pursuant to the ELUP (Section 2.6 of the Application/EIS).
8-16 (Caribou)	Place natural cover including rock piles and woody debris piles in open areas to reduce predator efficiency and create temporary visual cover for caribou pursuant to ELUP (draft plan provided in Section 2.6 of the Application/EIS).
9-7 (Forest and Grassland Birds)	Implement progressive reclamation using local native vegetation or appropriate commercially grown, weed-free native species, including use of conifers and whitebark pine in suitable sites, pursuant to the LSVMRP (draft plan provided in Section 12.2.1.18.4.4 of the Application/EIS), and the ELUP (draft plan in Section 2.6 of the Application/EIS).
9-25 (Forest and Grassland Birds)	Maintain habitat diversity including vegetation age/successional structure and refrain from monocultural stocking when revegetating.
10-9 (Furbearers)	Implement progressive reclamation using local native vegetation or appropriate commercially grown, weed-free native species pursuant to the ELUP.
10-10 (Furbearers)	Restore disturbed habitats or develop appropriate habitats capable of supporting furbearers pursuant to the ELUP.
11-8 (Grizzly Bear)	Restore disturbed habitats at mine closure or develop habitats capable of supporting grizzly bears as described in the End Land Use Plan and Wildlife Management and Monitoring Plan (draft plan provided in Section 12.2.1.18.4.6 of the Application/EIS) and avoid using species that attract bears.
11-18 (Grizzly Bear)	Implement an ELUP (draft plan provided in Section 2.6 of the Application/EIS), including seeding and progressive reclamation of exposed slopes to improve slope stability.
13-20 (Moose)	Restore disturbed habitats at mine closure or develop habitats capable of supporting moose pursuant to the ELUP.
14-5 (Waterbirds)	Restore disturbed habitats and develop habitats capable of supporting waterbirds pursuant to the ELUP.
14-24 (Waterbirds)	Water quality of the pit lake will be monitored during Closure and Post-closure to validate model predictions and to provide opportunity for adaptive management for wildlife.
14-29 (Waterbirds)	Final pit walls will be left steepened to limit littoral zone and discourage emergent and wetland vegetation growth, as will be described in the ELUP.
15-6 (Non-traditional Land and Resource Use)	Inform the public (including through signage) that consumption of surface water in the TSF and pit lake is not advisable during closure and post-closure, and that Davidson Creek may not be potable during the months of April and May during post-closure.
15-28 (Non-traditional Land and Resource Use)	Implement an ELUP, including plans for progressive reclamation and reforestation.

Mitigation ID	Mitigation
15-36 (Non-traditional Land and Resource Use) 16-15 (Visual Resources)	Re-vegetate with native vegetation and establish a composition consistent with the surrounding undisturbed landscape when construction is within line of sight of a known viewpoint, as will be described in the ELUP.

Notes: LSVMRP =Landscape, Soils and Vegetation Management and Restoration Plan; EIS = Environmental Impact Statement; TSF = Tailings Storage Facility; ISMP = Invasive Species Management Plan; ELUP = End Land Use Plan

4.3 Existing Permit Requirements

The Project's *Mines Act* permit authorizing Early Works activities (Permit #M-246) includes the following conditions with respect to end land use:

> *D (1) Land Use*
>
> *(a) The Permittee must ensure that the land surface is reclaimed with the intent of re-establishing average pre-mining capability to the following end land use objectives: wildlife habitat, and opportunities for traditional use of the land by the LDN and UFN.*
>
> *(b) The Permittee must ensure that borrow pits and quarries belonging to the mine development and operations, are reclaimed by the Permittee to the approved end land use once no longer required*.

It is anticipated that conditions in the *Mines Act* permit for Major Works, once issued, may supersede the above and this ELUP will be updated accordingly.

5. IMPLEMENTATION

5.1 End Land Use and Capability Objectives

The Closure and end land use goals for the Project on lands and waters disturbed by mine activities are to reclaim ecosystems to achieve an average land and water capability in these areas not less than that existing prior to Project development (see Section 4 for more detail). It is a further goal of the Project to meet the EAC Condition 25 (End Land Use Plan) and mutual aspirations for end land use with Indigenous nations[1] affected by the Project. To meet this goal, the following end land use objectives are proposed:

Objective 1 A mix of sustainable conditions supporting wildlife habitat, traditional and current use by Indigenous peoples. The end land use objectives do not require new access from trails or roads, consequently, use of the closed mine site will not include adding or maintaining trails for recreation purposes.

Objective 2 Self-sustaining vegetation that will progress to plant communities similar to pre-disturbance ecosystems as supported by the results of the ecohydrological modelling.

Objective 3 Physical stability of Post-closure mining landforms designed to incorporate controls to minimize erosion of surficial materials.

Objective 4 Control of geochemical sources to achieve stable surface and groundwater geochemical conditions.

Objective 5 Water quality and flow that support aquatic life and fish habitat downstream from the mine site and reclamation objectives.

Per Objectives 1 and 2, one focus of the reclamation program is to re-establish vegetated ecosystems that mitigate Project effects on wildlife. BW Gold engaged with UFN and LDN on the end land use objectives, target plant and wildlife species, and reclamation priorities. The wildlife habitat end land use objectives for the Blackwater Project are currently and will continue to be based on this continual engagement, as an iterative process, on pre-development site conditions and wildlife habitat (Appendix B), and the potential to recreate these conditions through reclamation. Ecohydrological modelling has been used as a tool to support achievement of this goal, thereby addressing the use of lands and resources for valued components that were assessed in the Project's *Application for an Environmental Assessment Application / Environmental Impact Statement* (Application / EIS; New Gold 2015), such as wildlife, water quality, aquatic resources, air quality, and plants. The general priorities for reclamation given these end land use objectives are summarized in Table 5.1-1.

Baseline aquatic ecosystem information and information on traditional and current use of aquatic resources are incorporated into reclamation targets, and the closure and reclamation designs, to achieve end land use Objective 5. Fish use of the Project area is largely restricted to juveniles, spawning, and passage from larger lakes to Davidson Creek, Creek 7054454, Lake 01682LNRS, and the lower reaches and tributaries of Creek 661. The nearest viable fishery to the mine site is Tatelkuz Lake which supports a number of recreational areas and Tatelkuz Resort. Tatelkuz Lake supports angling species including kokanee (*Oncorhynchus nerka*) and rainbow trout (*Oncorhynchus mykiss*). Mountain whitefish (*Prosopium williamsoni*), longnose sucker (*Catostomus catostomus*), and burbot (*Lota lota*) are also incidentally angled but are generally not considered target species. In consideration of end land use Objective 5, the general priorities for reclamation are summarized below.

[1] Indigenous nations replaces the term 'Aboriginal Groups' defined in the Project's Environmental Assessment Certificate #M19-01 as: Lhoosk'uz Dené Nation, Ulkatcho First Nation, Nadleh Whut'en First Nation, Stellat'en First Nation, Saik'uz First Nation, and Nazko First Nation.

Table 5.1-1: Reclamation Priorities

Ecosystem Type	Site Unit	Mine Features	Wildlife Priorities**/ Valued Components
Subxeric and drier ESSFmv1* site series	ESSFmv1-02, ESSFmv1-03	Uppermost portions of Upper and Lower Waste stockpiles; camp and infrastructure areas; upper elevation borrow areas; Low Grade Ore stockpile; TSF beaches	Caribou (*Rangifer tarandus*), Clark's nutcracker (*Nucifraga columbiana*), grizzly bear (*Ursus arctos*), wolverine (*Gulo gulo*), olive-sided flycatcher (*Contopus cooperi*)
Submesic and wetter ESSFmv1 site series	ESSF mv1-03, ESSFmv1-01, ESSFmv1-04	Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; surface soil stockpile footprints	Caribou, Clark's nutcracker, grizzly bear, wolverine, olive-sided flycatcher, hare (*Lepus americanus*), marten (*Martes americana*), bat species
Subxeric and drier SBSmc3 site series	SBSmc3-02, SBSmc3-03	Freshwater Reservoir; lower elevation borrow areas	Caribou, grizzly bear, grouse species
Submesic and wetter SBSmc3 site series	SBSmc3-01/05, SBSmc3-04/05	Surface soil stockpile footprints	Caribou, grizzly bear, wolverine, olive-sided flycatcher, hare, marten, bat species

** The ESSFmvp is not listed because the majority of the ESSFmvp that is lost during mine development overlaps the open pit mine and other structures that will not be reclaimed or will be required during Closure.*

*** Appendix B contains the November 17, 2021 Memo (0575928-0014) that provides background material on the consideration of wildlife communities that have informed reclamation priorities and prescription development.*

Activities associated with the construction, operation, and closure of tailings and waste stockpiles have the potential to negatively alter surface water hydrology and quality with consequent effects on waterbodies (e.g., streams, lakes, and wetlands) and on terrestrial and aquatic species and habitat. These potential effects are in addition to instream and riparian habitat loss resulting from project development. In turn, these changes can impact fish and other aquatic life, including the aquatic life that fish depend on for growth and reproduction, and those that depend on fish for food.

Reclamation priorities for water use at Post-closure consider the traditional and current pre-mine land uses. LDN fish for trout preferably in Tatelkuz Lake, because trout caught in rivers "taste muddy" (New Gold 2015 [Vol. 6 Section 14]). Other fishing locations downstream of the mine site include middle Chedakuz Creek (the portion of Chedakuz Creek between Kuyakuz and Tatelkuz Lakes) and lower Chedakuz Creek. For the one family that resides at Tatelkus Lake IR 28, fish, including rainbow trout, suckers (*Catostomidae*), and kokanee from Tatelkuz Lake, lower Davidson Creek, and lower and middle Chedakuz Creek, are an important source of food. UFN indicated they also fish at Chedakuz Creek and Tatelkuz Lake. Species fished include suckers, salmon (*Salmonidae*), rainbow trout, and burbot, also historically referred to by locals/fisher people as lingcod, freshwater lingcod, freshwater ling, and bubbot.

5.1.1 Capability Assessment

To assess land capability, the pre-mine distribution of terrestrial ecosystems (i.e., biogeoclimatic [BGC] units and site series) was compared to the predicted distribution of ecosystems after the completion of mine site reclamation.

An ecohydrological model was used to determine the reclaimed ecosystems that the post-mine landscape is most likely to support (Appendix C; IEG 2022)[2]. The purpose of the ecohydrological model is to predict

[2] A public version of the model used is available at gea.iegsoil.com.

optimal conditions for the successful distribution of ecosystems on Post-closure landforms and to develop associated reclamation treatments for each type of ecosystem based on the soil moisture and nutrient regimes that will be reconstructed on reclaimed lands (Baker et al. 2020). The steps involved in the modelling process are to first understand the pre-development (baseline) conditions in terms of soil and ecosystem presence, and then to assess the volumes and types of soil and other reclamation cover materials that will need to be salvaged to reclaim the post-mine landscape to a state that is as equivalent as possible to pre-development given the expected changes to surficial materials, topography, and hydrology.

The use of an ecohydrological model to define soil water and ecosystem occurrence for reclamation in BC is relatively recent (Straker et al. 2014, 2015; Baker et al. 2020). The model uses the concept of relative soil moisture regime (SMR) in the biogeoclimatic ecosystem classification (BEC) system to quantify soil water availability in the post-mine reclaimed soil cover. The SMR is a relative measure of the annual soil water available to plants (Pojar et al. 1985) and includes seven classes from 0 (very xeric) to 7 (subhygric; Delong et al. 1993[3]). The ecohydrological model uses three principal inputs (Straker et al. 2014, 2015; Baker et al. 2020):

- Available water storage capacity (AWSC) based on particle size distribution (PSD), organic-matter content, and bulk density in the upper metre (m) of soil;
- Post-closure topography (i.e., slope and aspect); and
- Climatic information (regional climate as characterized by the BGC unit and historic data; Wang et al. 2016).

In support of mine permitting, an updated Life of Mine water balance model was developed describing anticipated conditions at the Project over a 125-yr period (KP 2021a; KP 2022). A site-wide water quality model is coupled to the water balance model and encoded within a GoldSim modelling framework (WQM; Lorax 2021, 2022).

5.1.1.1 Pre-mine Land and Aquatic Capability

Pre-mine land capability was determined through Terrestrial Ecosystem Mapping (TEM). This mapping was completed on the mine site to document the existing ecosystems, provide information for characterizing pre-mine land capability, and inform the development of land capability objectives for reclamation (AMEC 2013a, 2013b). The primary influences on soil moisture and nutrient regimes are (1) climate, (2) topography, and (3) soil properties (soil particle-size distribution, organic-matter and nutrient content). While climate continues to shift due to climate change, the baseline soil properties are expected to be relatively static. The temporal resolution of the climate models used to project ecosystem shifts with climate change in the ecohydrological modeling is not sufficient to quantitively compare 2013 with current conditions, but it is anticipated that climate change will have limited effects on this ecosystem type (i.e., BGC subzone variants and sites series) over the life of mine.

Ecosystems in BC are described using the provincial BGC units and site series are described in the classification guidebooks for regional climates (Delong et al. 1993).

The pre-mining TEM for the mine site footprint includes three BGC units (Table 5.1-2; Figure 5.1-1):

- SBSmc3 (Kluskus Moist Cold Sub-Boreal Spruce variant);
- ESSFmv1 (Nechako Moist Very Cold Engelmann Spruce-Subalpine Fir variant); and
- ESSFmvp (Nechako Moist Very Cold Engelmann Spruce-Subalpine Fir Parkland).

[3] More recent classifications include 8 classes, including a hygric class. However, Land Management Handbook 24, which describes ecosystems in the Project study area, contains a seven-class system (Delong et al. 1993).

Table 5.1-2: Summary of Pre-mine Ecosystem Areas Arranged by Biogeoclimatic Unit and Abundance

BGC Unit	Site Unit	Name	Area (ha)	%	
				Unit[1]	FP[2]
ESSFmv1	01	Subalpine fir - Rhododendron - Feathermoss	887.3	57.5	41.9
	03	Subalpine fir - Huckleberry - Feathermoss	237.1	15.4	11.2
	02	Lodgepole pine - Huckleberry - Cladonia	217.1	14.1	10.3
	Swamp	Swamp	107.1	6.9	5.1
	04	Subalpine fir - Glow moss	74.7	4.8	3.5
	Bog	Bog	14.0	0.9	0.7
	Fen	Fen	3.5	0.2	0.2
	Marsh	Marsh	1.3	0.1	0.1
	LA, PD, RI, OW	Water (Lake, Pond, River, Shallow Open Water)	0.8	0.1	0.0
ESSFmvp	WW	Whitebark pine avens	14.8	53.5	0.7
	PC	Subalpine fir / whitebark pine - Crowberry parkland	12.3	44.4	0.6
	FH	Subalpine fir - Indian hellebore	0.3	1.2	0.0
	LA, PD, RI, OW	Water (Lake, Pond, River, Shallow Open Water)	0.2	0.9	0.0
SBSmc3	03	Lodgepole pine - Feathermoss - Cladina	292.6	53.5	13.8
	01	Hybrid white spruce - Huckleberry	122.5	22.4	5.8
	Swamp	Swamp	60.5	11.1	2.9
	04	Hybrid white spruce - Huckleberry – Soopolallie	37.5	6.9	1.8
	02	Lodgepole pine - Juniper - Dwarf huckleberry	10.2	1.9	0.5
	06	Black spruce - Lodgepole pine – Feathermoss	6.6	1.2	0.3
	Fen	Fen	5.8	1.1	0.3
	Bog	Bog	5.4	1.0	0.3
	07	Hybrid white spruce - Twinberry	3.3	0.6	0.2
	LA, PD, RI, OW	Water (Lake, Pond, River, Shallow Open Water)	2.7	0.5	0.1

[1] *Percent of area within each Biogeoclimatic site unit for the given time period.*

[2] *Percent of total area within the disturbance mine site footprint as shown in Figure 5.1-1.*

The SBSmc3 occurs from 975 to 1,200 metres above sea level (masl) in elevation and has a cold climate with a short growing season. Forests are typically dominated by hybrid spruce and subalpine fir with lodgepole pine occurring on drier sites (Delong et al. 1993). The ESSFmv1 occurs above the SBSmc3 from 1,150 to 1,550 masl and is the coldest forested BGC unit in the southwest portion of the Prince George Forest Region. It supports the same tree species as the SBSmc3. The ESSFmvp ('parkland') occurs at higher elevation than the ESSFmv1 in subalpine habitat where tree cover becomes discontinuous, interspersed with open herb or heather dominated meadows, krummholz, and tree islands. Section 5.1.2, Habitat for Focal Reclamation Species discusses wildlife habitat in relation to BGC units.

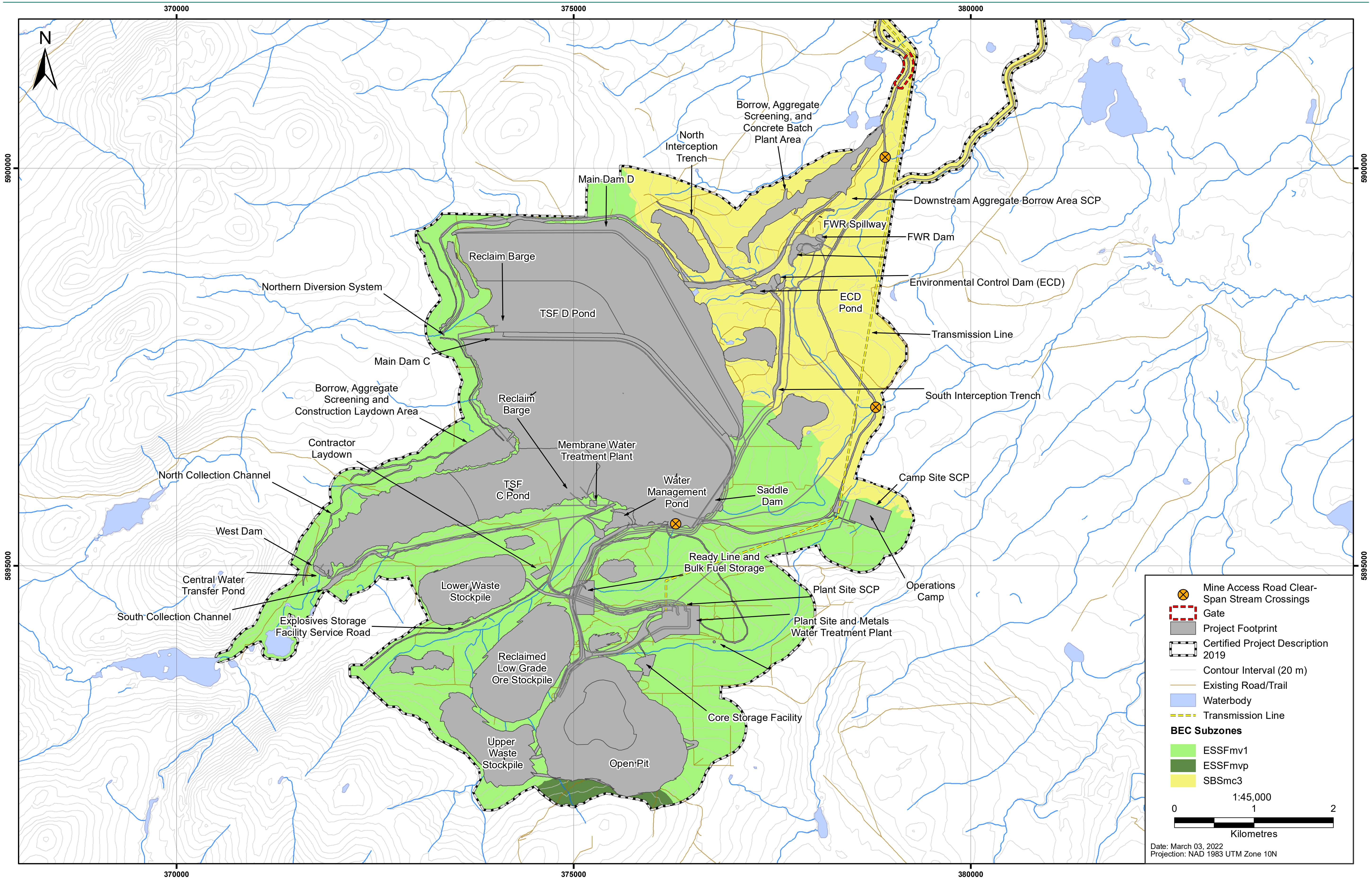

Figure 5.1-1: Biogeoclimatic Units within the Mine Site Footprint

There are unique site series within each BGC unit, which are derived from edaphic conditions, including relative SMR and soil nutrient regime (SNR). Site series have seral and climax plant communities (ecosystems) that reflect the local edaphic and climatic conditions. As site series are based on SMR and SNR, they provide a basis for identifying plant species suitable for reclamation and potential future plant communities that may be established on reclaimed soils, and for defining potential future climax vegetation community composition. Figure 5.1-2 Pre-mine Land Capability shows the area of all pre-disturbance site series in the mine site.

To support the identification of target wildlife species for reclamation and corresponding habitat types required in the reclaimed landscape, a review of existing data and recent field data was completed and is presented in Appendix B. This document provides a framework for designing the target ecosystems at Closure by:

- Identifying representative wildlife species on the Project site and providing an overview of habitat requirements;
- Describing the current vegetation communities and BGC units on the mine site and how wildlife are using these communities;
- Describing reclamation species for each BGC unit and site series at Closure; and
- Identifying representative wildlife and plant species present in these BGC and site units in the pre-mine landscape. High-level vegetation and management prescriptions are indicated to meet the pre-mine landscape wildlife and plant community objectives.

The pre-mine aquatic ecosystem capability was determined by considering baseline aquatic ecosystem conditions to inform the targeted post-mining aquatic conditions both on the mine site and the aquatic receiving environment within the Project area. The mine site is located in the upper extents of the Davidson Creek and Creek 661 watersheds (Figure 5.1-3). Hydrological data were collected from the spring of 2011 through 2020 with 12 active hydrology stations (KP 2013, 2021b) and is ongoing. The long-term records are used to define the hydrological inputs required for water management and engineering design and to facilitate the assessment of long-term hydrologic impacts on aquatic ecosystems due to mine operations.

Streams in the area are generally characterized by high flows in late spring and early summer due to rain and snowmelt, and low flows in the winter. The baseline data suggests that higher elevation stations and smaller catchments tend to experience higher runoff during spring high flows (KP 2021b). Runoff attenuation at stations directly downstream of a lake are related to the storage capacity of the upstream lake.

Surface water quality monitoring within the Project area was initiated in 2011, and is ongoing, to provide baseline water quality prior to Project development (AMEC 2013c; ERM 2021a). Water quality results from samples collected from streams suggest that waters have neutral to low alkalinity, low hardness, low total dissolved solids, and low concentration of nitrogen species; however, these constituents tend to increase during low flow periods. Total suspended solids and turbidity were generally low, except during periods of increased runoff in freshet and during fall. Mean concentrations of metals were low, typically one to several orders of magnitude below guidelines (BC and Canadian Council of Ministers of the Environment [CCME] Water Quality Guidelines for the protection of aquatic life [WQG-AL]). However, some exceedances of BC and/or CCME WQG-AL were observed as a result of natural environmental conditions, with exceedances most frequently observed in the upper Creek 661 and Davidson Creek watersheds, proximal to the mineralized deposit area.

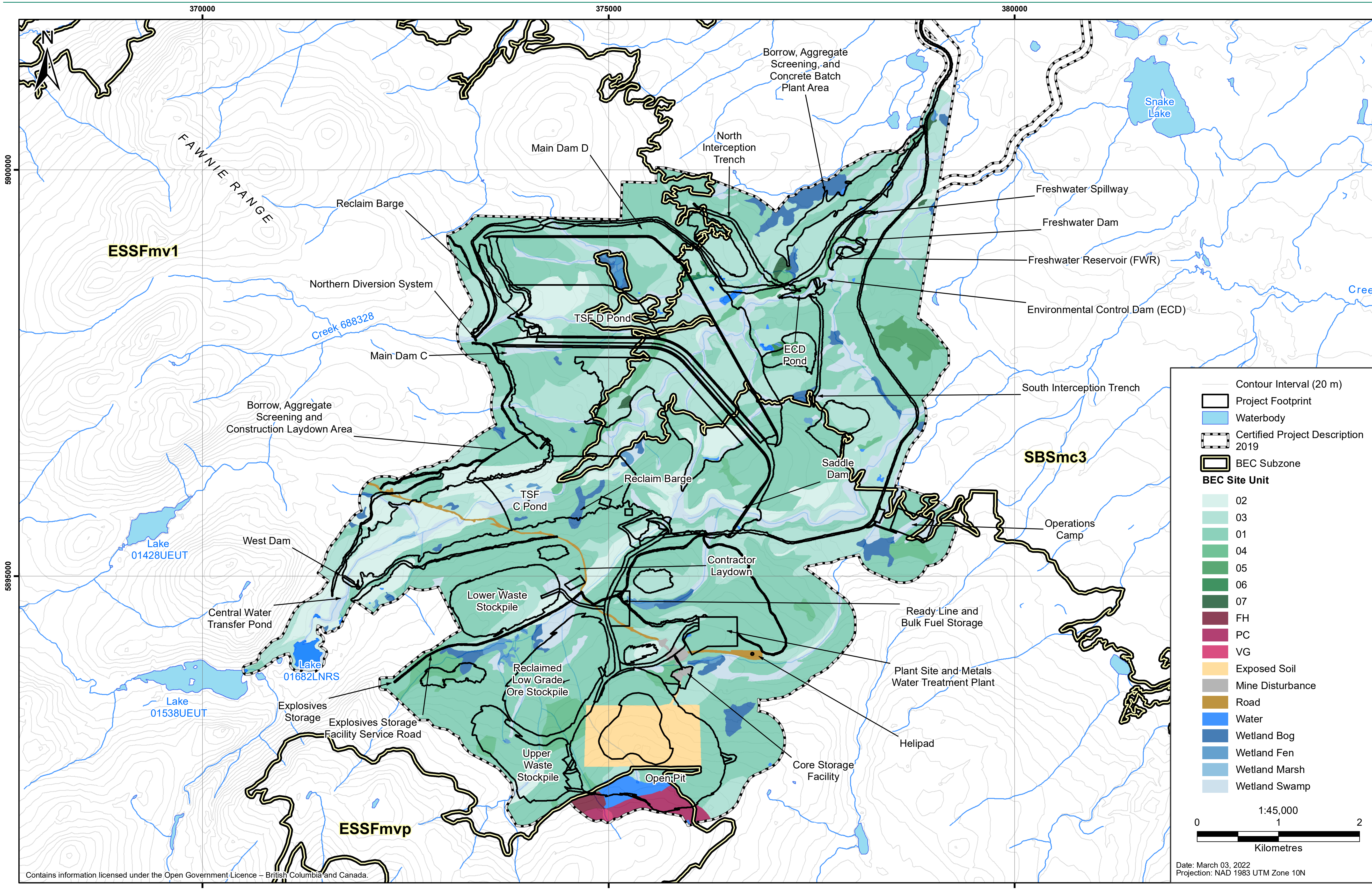

Figure 5.1-2: Pre-mine Land Capability

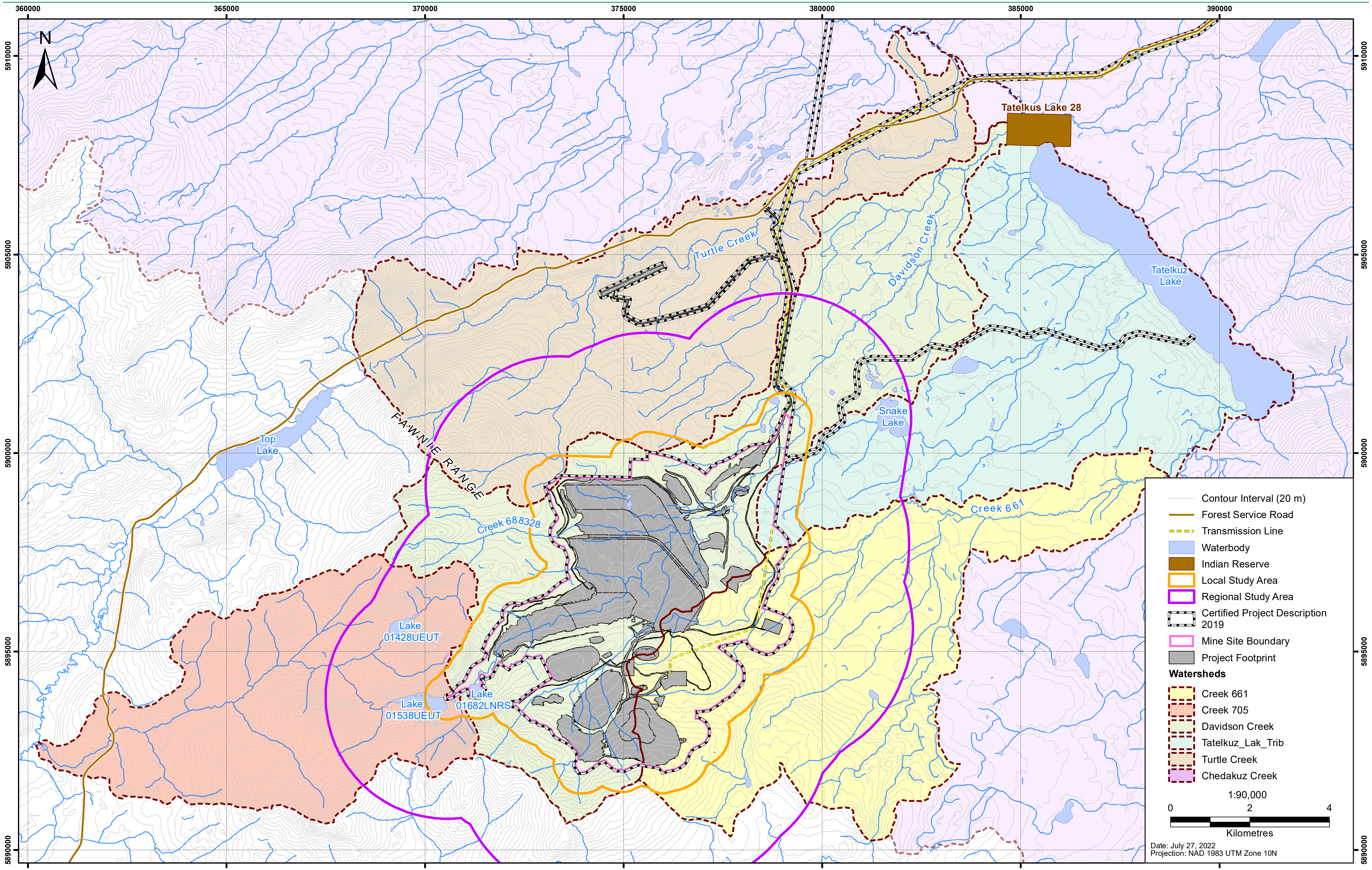

Figure 5.1-3: Pre-Development Watershed Boundaries and Major Waterbodies

Water quality samples were also collected on a quarterly basis in Tatelkuz Lake between 2012 to 2014 and beginning in 2021 (ERM 2021a). Results of the Tatelkuz Lake baseline sampling indicated that the lake is near-neutral to slightly alkaline in pH and classified as a moderately hard lake. Total dissolved solids were typically higher during winter months (representing under-ice measurements) than when measured in summer and early fall. Total suspended solids and turbidity were typically low exhibited minor seasonal variability. Nutrient concentrations were generally low, except for occasional elevated nitrate and phosphorus concentrations in samples from the lower layer of lakes, which may have been influenced by capture of lake bottom sediments. Phosphorus concentrations indicated conditions ranging from mesotrophic (0.01 to 0.02 mg/L) to meso eutrophic (0.02 to 0.035 mg/L) and exhibited minimal variability with depth. The majority of total organic carbon was in the dissolved phase as dissolved organic carbon. Chloride, fluoride, and sulphate concentrations tended to be low and less than CCME and BC WQG-AL. Tatlekuz Lake water quality exceeded the long-term WQG-AL for total cadmium, total lead, and total zinc in the January 2013 samples only.

Water temperature within the Project area streams is monitored at hydrology stations. The results indicate that streams are typically characterized by near freezing temperatures prior to spring freshet, followed by a gradual warming period until July and August, which are the warmest months at between 10 ºC and 14 ºC (KP 2021b). Temperatures then decrease steadily back to near freezing temperatures by November or December.

Aquatic resources (periphyton and benthic invertebrate) baseline sampling was completed in 2011, 2012, and 2017 (ERM 2019) and will be completed in 2022 in streams potentially affected by the Project. Periphyton biomass (as chlorophyll *a*) was typically low throughout all sampled streams. Overall, periphyton biomass and density data suggest that streams have low to moderate primary productivity. All sites were dominated by blue-green algae and/or diatoms. The greatest abundance of benthic invertebrates was observed in Davidson Creek and richness and diversity generally increased with downstream distance. Benthic invertebrate communities were generally diverse with a high abundance of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa and dominated by mayflies, chironomids, and stoneflies.

Plankton (phytoplankton and zooplankton) and lake benthic invertebrates were sampled in Tatelkuz Lake in mid-August 2013 (AMEC 2013d) to measure of lake productivity and ecosystem health. Surface waters of Tatelkuz were characterized as more productive than the headwater lakes as indicated by zooplankton and mean phytoplankton biomass. Zooplankton communities in Tatelkuz Lake were dominated by copepods, though rotifers accounted for a substantial proportion of the zooplankton community. Mean littoral benthic invertebrate abundance in Tatelkuz Lake was an order of magnitude greater when compared to the headwater lakes, while the abundance of EPT taxa, which are sensitive to nutrients, were significantly lower. In general, the benthic invertebrate communities (littoral and profundal) of Tatelkuz Lake are distinct from the sampled headwater lakes likely as a result of the nutrient-enriched condition and the unique morphology and habitat heterogeneity of Tatelkuz Lake relative to the smaller headwater lakes.

Surveys of stream fish habitat were conducted as part of baseline studies to identify, characterize, and quantify the available habitat for fish within the mine site area (AMEC 2013d,e). Twelve species of fish were captured in the Project area streams, including kokanee (*Oncorhynchus nerka*), rainbow trout (*Oncorhynchus mykiss*), lake chub (*Couesius plumbeus*), longnose sucker (*Catostomus catostomus*), brassy minnow (*Hybognathus hankinsoni*), mountain whitefish (*Prosopium williamsoni*), burbot (*Lota lota*), longnose dace (*Rhinichthys cataractae*), slimy sculpin (*Cottus cognatus*), northern pikeminnow (*Ptychocheilus oregonensis*), largescale sucker (*Catostomus macrocheilus*), and white sucker (*Catostomus commersonii*; Palmer 2021a).

Baseline study results indicated a habitat distribution pattern typical of the central BC interior—steep, subalpine headwaters of naturally poor-quality fish habitat, in general, draining to lower gradient reaches of higher quality habitat that flow into large, overwintering lakes (e.g., Tatelkuz Lake).

Aquatic baseline sampling has also taken into consideration the Yinka Dene Water Law (YDWL) as required by EAC Condition 30 and is described in the following documents:

- *Yinka Dene 'Uza'hné Surface Water Management Policy* (Nadleh Whut'en and Stellat'en 2016a); and
- *Yinka Dene 'Uza'hné Guide to Surface Water Quality Standards* (Nadleh Whut'en and Stellat'en 2016b).

BW Gold has been collaborating with the CSFNs regarding the implementation of the YDWL, and discussions with the CSFNs are ongoing. The YDWL describes a system that classifies waters into three categories based on their cultural and ecological significance, including:

- High Cultural or Ecological Significance (Class I Waters);
- Sensitive Waters (Class II Waters); and
- Typical Waters (Class III Waters).

Baseline characterization requirements for implementation of the *Yinka Dene 'Uza'hné Surface Water Management Policy* (Nadleh Whut'en and Stellat'en 2016a) include sampling frequency recommendations provided by CSFNs representatives (ERM 2021a).

5.1.1.2 Post-mine Land and Aquatic Capability

As described above, the post-mine land capability was estimated based on climatic information, Post-closure topography, and the AWSC of reclamation materials. However, BW Gold acknowledges that there will be challenges for reclaiming target ecosystems. This includes unfavourable post-mining soil characteristics affecting reclamation success and successional trajectories, including soil depth, texture, bulk density, moisture availability, nutrient contents and cycling capabilities, and erosion losses. Thus, while the ultimate goal of reclamation will be to achieve a positive or equal ecosystem quality when compared to pre-mine capability (allowing for natural variation) there will be limitations and challenges. Therefore, closure and end land use goals on lands and waters that have been disturbed by mine activities are defined as to "...reclaim ecosystems to achieve an average land and water capability in these areas not less than that existing prior to Project development." (Section 5.1). With this target it is expected that some reclaimed ecosystems may be better and some worse with the overall average being not less than pre-development conditions.

The AWSC of salvaged soils was calculated using soil information collected during baseline studies (AMEC 2013a). Three groups of reclamation materials have been identified for reclamation: glaciofluvial surface soil, mixed-mineral surface soil (i.e., non-glaciofluvial mineral soils), and organic surface soil. These reclamation material groupings were selected through iterative modelling to reduce differences between pre- and post-mining ecosystem distributions. Glaciofluvial surface soils are to be targeted for salvage to restore drier, open forest site series with lichen, which contribute to components of caribou habitat. Other salvaged mineral surface soils, which are dominated by morainal material (till), are considered as one group ("mixed") due to expected soil mixing during salvage and placement. Mixed-mineral surface soils will be used to reclaim wetter submesic to mesic site series. Organic surface soils will be used opportunistically to reclaim low-lying and wetland ecosystems or used as a soil amendment.

Post-closure topography was classified according to slope position, slope gradient and aspect classes[4] to adjust for the effects of run-on and run-off water, as well as variation in potential evapotranspiration demand due to insolation (i.e., solar radiation). Modelling of soil cover depths was completed using 10-cm intervals to determine the optimal soil cover depths (up to 1 m) to create favourable SMR conditions for the establishment of target ecosystems.

Ecohydrological modelling will be periodically updated (coinciding with the five-year Mine Plan and Reclamation Program submissions; Section 7) to reflect significant changes to the mine plan disturbance areas, to reflect model improvements where predicted outcomes vary significantly, and to incorporate results from ongoing sampling and laboratory testing during surface soil salvage operations. Model updates will also incorporate the results of research on reclamation covers and the ability of the prescribed depths and reclamation material types to achieve the desired edaphic conditions (i.e., site series vegetation trials). Operational reclamation monitoring will assess the ability of reclaimed areas to support the desired habitats and land capability targets in the long-term and inform maintenance and adaptive management measures. Reclamation research plans and reclamation monitoring will be detailed in the RCP.

The post-mine aquatic capability considered the predicted long-term Project-related effects on surface water quality in the receiving environment, and loss of instream aquatic habitat and riparian habitat (Table 5.1-3). Surface water quality is predicted to change in the Post-closure aquatic ecosystems when compared to baseline. Overall, surface water quality was identified as the main pathway through which potential effects on aquatic resources in the aquatic receiving environment may occur.

The mine site aquatic environment (waterbodies) at Post-closure will be the TSF ponds, Lake 01682LNRS, Pit Lake, and Environmental Control Dam (ECD) Pond (Figure 5.1-4). Mercury concentrations in tissue of rainbow trout residing in Lake 01682LNRS had the potential to increase as a result of mobilization of mercury from flooded soils with the enlargement of Lake 01682LNRS. The Project no longer includes enlargement of Lake 01682LNRS, and therefore this is no longer a residual effect of the Project to be carried forward for pre- or post-mine capability. The ECD pond predicted water quality indicates elevated total ammonia-N, sulphate, and total zinc concentrations as a result of the TSF D pond seepage through Operations (Lorax 2021). The concentrations are relatively stable through Post-closure. However, ECD pond water will require treatment in Post-closure to meet water quality objectives (KP 2022). Sulphate concentrations in the TSF C pond also decrease notably but remain slightly elevated in Closure due to loadings from tailings beach runoff, TSF D pump-back water, and the water from the Lower Waste Stockpile. Applying a cover to the tailings beach and a reduction in pumping from TSF D pond results in lower sulphate concentrations in Post-closure.

During Post-closure, water discharges to the receiving environment (Davidson Creek) via the Membrane Water Treatment Plant (WTP) and the TSF Spillway. The TSF Spillway discharges to the Plunge Pool in Davidson Creek.

Post-closure Membrane WTP effluent shows minor exceedances of the short-term BC WQG-AL for fluoride (Lorax 2022). Total silver concentrations are predicted to be equal to the long-term BC WQG-AL. Screening showed exceedances of short-term WQG-AL and long-term CCME WQG-AL was limited to fluoride.

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[4] Slope positions for modelling purposes were delineated as crest, mid and toe positions. Slope gradients were defined by 8-degree bins. Aspects were sectioned into 45-degree bins centred on cardinal and ordinal directions. Modelled settings for slope gradient and aspect were equal to the midpoint of the bin intervals.

Table 5.1-3: Summary of Pre-mine and Post-closure Aquatic Capabilities in the Aquatic Receiving Environment

Waterbody	Description[1]	Yinka Dene Water Law	Pre-Mine			Post-closure		
			Stream Flow[2]	Water Quality[3]	Aquatic Resources and Fish Community[4]	Stream Flow (Predictions)[5]	Water Quality (Predictions)[6]	Aquatic Resources and Fish Community[7]
Davidson Creek	Davidson Creek is a third order stream draining the mine site, flowing northeast into Chedakuz Creek north of Tatelkuz Lake. Davidson Creek watershed contains the majority of the Project facilities, including TSF, Open Pit, and related mine site water management structures.	Lower reaches of the stream have been classified as a Class III waterbody.	■ peak streamflow occurs in May, with low flows in August and September as well as November through March ■ annual hydrograph is typical based on watershed size and elevation (see Figure A 2.8, Figure A 2.13, Figure A 2.18 in KP 2021b)	■ WQG-AL exceedances associated with deposit mineralization Davidson Creek included total and dissolved cadmium, dissolved iron, and total and dissolved zinc ■ total and dissolved aluminum concentrations were elevated throughout Davidson Creek	■ periphyton biomass and density data suggest low to moderate primary productivity and community composition varied among sampling years ■ benthic invertebrate densities indicate low to moderate productivity and community composition was dominated by pollution sensitive taxa (EPT) ■ fish species observed include: RB, MW, KO	■ average annual streamflow is predicted to be similar to baseline streamflow ■ annual hydrograph is predicted to be subdued so that freshet flows are lower and all other monthly streamflow is higher than baseline flows	■ predicted CCME WQG-AL exceedances: fluoride, total aluminum, total cadmium ■ predicted BC WQG-AL exceedances: dissolved aluminum, dissolved cadmium, and total mercury ■ elevated total mercury predictions related to use of high detection limit loadings in source terms ■ dissolved cadmium exceedances are infrequent (< 1% of modelled months) and low magnitude (< 1.2x) ■ total and dissolved aluminum exceedances driven by naturally elevated background concentrations	■ loss and isolation of fish and fish habitat (instream and riparian habitat) as a result of mine site infrastructure that will be offset through a fisheries offsetting plan ■ potential to reduce the availability of suitable habitat for Rainbow Trout and Kokanee as result of changes in surface water flow in the receiving environment ■ potential effects to aquatic health (Rainbow Trout and Kokanee, the primary and secondary producers that support fish populations) and fish habitat as a result of changes in surface water quality in the receiving environment ■ potential effects to toxicity in aquatic biota (i.e., primary producers, secondary producers, and fish) due to changes in water chemistry as a result of changes in surface water quality in the receiving environment
Creek 661	Creek 661 is a third order stream with two branches originating east of the mine site. Two tributaries of Creek 661 are located within the footprint of mining facilities (Camp Site Sediment Control Pond, Open Pit and TSF).	Class III waterbody	■ peak streamflow occurs in May, with low flows in August and September as well as November through March ■ annual hydrograph is typical based on watershed size and elevation (see Figure A 4.3 in KP 2021b)	■ at a site in upper Creek 661 adjacent to the footprint of the Open Pit had the greatest number of parameters with WQG-AL exceedances for total and dissolved metals and elevated sulphate concentrations ■ WQG-AL exceedances for total and dissolved aluminum, total cadmium, and total zinc persisted to the downstream monitoring sites	■ periphyton biomass and density data suggest low to moderate primary productivity and community composition varied among years and was dominated by cyanobacteria and green algae ■ benthic invertebrate densities indicate low to moderate productivity and community composition was dominated by pollution sensitive taxa (EPT) ■ fish species observed include: RB, KO	■ average annual streamflow is predicted to be slightly lower than in closure (43% decrease from baseline flows), attributed to runoff from the reclaimed plant site being directed to the sub-catchment consistent with baseline conditions	■ predicted CCME WQG-AL exceedances: total aluminum, total cadmium, and total iron ■ predicted BC WQG-AL exceedances: dissolved aluminum, and dissolved zinc ■ total and dissolved aluminum exceedances driven by naturally elevated background concentrations	■ loss and isolation of fish and fish habitat (instream and riparian habitat) as a result of mine site infrastructure that will be offset through a fisheries offsetting plan ■ no predicted effects to fish and fish habitat (including primary producers and secondary producers) as a result of changes in surface water quality in the receiving environment

Waterbody	Description[1]	Yinka Dene Water Law	Pre-Mine			Post-closure		
			Stream Flow[2]	Water Quality[3]	Aquatic Resources and Fish Community[4]	Stream Flow (Predictions)[5]	Water Quality (Predictions)[6]	Aquatic Resources and Fish Community[7]
Chedakuz Creek	Upper Chedakuz Creek is approximately 15 km long and flows into Kuyakuz Lake. Middle Chedakuz Creek is approximately 12 km long and flows between Kuyakuz and Tatelkuz lakes. Downstream of Tatelkuz Lake, Lower Chedakuz Creek flows northwest to the Nechako Reservoir for approximately 53 km.	Class II waterbody	▪ peak streamflow occurs in May, with low flows in August and September as well as November through March ▪ annual hydrograph is typical based on watershed size and elevation (see Figure 2.3 in KP 2021b)	▪ sporadic (i.e., not associated with seasonal influences) and infrequent WQG-AL exceedances for total and dissolved cadmium, total and dissolved copper, dissolved iron, total mercury, total silver, and total and dissolved zinc. ▪ frequent WQG-AL exceedances (generally limited to May and November) were observed for total and dissolved aluminum	▪ periphyton biomass and density data suggest moderate primary productivity and community composition varied among years and was dominated by diatoms and cyanobacteria ▪ benthic invertebrate densities indicate moderate productivity and community composition was dominated by pollution sensitive taxa (EPT) ▪ fish species observed include: RB, LSU, KO, CCG, LNC	▪ streamflow is predicted to be slightly reduced compared to baseline (1% reduction) due to the TSF closure spillway diverting contributing catchment area from Creek 661 to Davidson Creek	▪ predicted CCME WQG-AL exceedances: fluoride and total aluminum ▪ predicted BC WQG-AL exceedances: dissolved aluminum ▪ magnitude of predicted exceedances is relatively low ▪ total and dissolved aluminum exceedances driven by naturally elevated background concentrations	▪ no predicted effects to fish and fish habitat (including primary producers and secondary producers) as a result of changes in surface water quality in the receiving environment
Creek 705	Creek 705 is a third order stream on the western side of Mount Davidson, flowing into Fawnie Creek approximately 8 km downstream of Top Lake. Creek 705 watershed contains a moderately-sized lake (Lake 1538) near the headwaters of the southern drainage and receives flow from a number of small tributaries in the middle to upper watershed. Creek 705 is located outside of the Project footprint but will receive diverted flows from the headwaters of Davidson Creek from construction onwards.	Has not received a classification	▪ peak streamflow occurs in May, with low flows in August and September as well as November through March ▪ annual hydrograph is typical based on watershed size and elevation (see Figure A 6.3 in KP 2021b)	▪ WQG-AL exceedances were observed and associated with mineralization near the Blackwater deposit: total and dissolved aluminum, total cadmium, total chromium, total copper, dissolved iron, total mercury, and total and dissolved zinc	▪ periphyton biomass and density data suggest low to moderate primary productivity and community composition varied among years and was dominated by diatoms and cyanobacteria ▪ benthic invertebrate densities indicate moderate productivity and community composition was dominated by pollution sensitive taxa (EPT) ▪ fish species observed include: RB, LSU, MW, BB	▪ streamflow is predicted to be greater compared to baseline (43% in the upstream Creek 705 and 4% in downstream Creek 705) as a result of diverted flows from Davidson Creek	▪ Not modelled because will not receive Project discharge.	▪ there are no predicted changes to water quality therefore no predicted effects to fish and fish habitat (including primary producers and secondary producers)

Waterbody	Description[1]	Yinka Dene Water Law	Pre-Mine			Post-closure		
			Stream Flow[2]	Water Quality[3]	Aquatic Resources and Fish Community[4]	Stream Flow (Predictions)[5]	Water Quality (Predictions)[6]	Aquatic Resources and Fish Community[7]
Tatelkuz Lake	Tatelkuz Lake is the second largest lake near the headwaters of Chedakuz Creek. It has a surface area of 927 ha, a volume of 188 Mm3, and a mean depth of 20 m. Tatelkuz Lake has six inlets and one outlet. Tatelkuz Lake will be the source of make-up water for Davidson Creek IFN via discharge from the FWR and is located downstream of Creek 661 which will receive discharge from a sediment control pond during Construction phase and seepage from the TSF in Operations (or Closure and Post-closure	Class I waterbody	▪ Tatelkuz Lake levels are the lowest in September and highest in May during freshet ▪ results of a bathymetric survey indicated that the point of zero flow from the Tatelkuz Lake outlet was estimated to be 926.48 masl, with the water depth at the lake outlet at the time of the bathymetric survey estimated to be 1.12 ▪ outflow to Chedakuz Creek to be about 7.13 cubic metres per second	▪ near-neutral to slightly alkaline and classified as moderately hard water ▪ Concentrations of nutrients and anions were generally low, except for occasional ammonia and phosphorus concentrations in samples from the lower layer (may have been influenced by capture of lake bottom sediments) ▪ Nutrient concentrations and anions did not exceed any applicable WQG-AL ▪ sporadic exceedance of the WQG-AL were observed for total cadmium, total lead, and total zinc	▪ surface waters were characterized productive with regard to zooplankton and mean phytoplankton biomass. Zooplankton communities were dominated by copepods, though rotifers accounted for a substantial proportion of the zooplankton community ▪ mean littoral benthic invertebrate abundance was high and community composition tended to be dominated by EPT with distinct benthic invertebrate communities (littoral and profundal) from the sampled headwater lakes likely as a result of the nutrient-enriched condition and the unique morphology and habitat heterogeneity of Tatelkuz Lake relative to the smaller headwater lakes ▪ fish species observed include: RB, LSU, MW, KO, CSU, NSC, BB, CCG, BMC, WSU	▪ Tatelkuz Lake water levels was predicted to remain within the range of natural variability through Operations and Closure as a result of the water withdrawal for the FWR ▪ There will be no water withdrawals in Post-closure.	▪ Water quality predictions were not completed for Tatelkuz Lake however the outlet Tatelkuz Lake in Chedakuz Creek can be considered to be representative of Tatelkuz Lake water quality ▪ No exceedance of federal or BC WQG-AL were predicted at the outlet of Chedakuz Creek	▪ there are no predicted changes to water quality therefore no predicted effects to fish and fish habitat (including primary producers and secondary producers) ▪ there are no water withdrawals in Post-closure therefore no predicted effects on the area and composition of the littoral fish habitat

Notes: TSF = Tailings Storage Facility; FWR = freshwater reservoir; IFN = Instream Flow Needs; CCME = Canadian Council of Ministers of the Environment; WQG-AL= Water quality guideline for the protection of aquatic life; EPT = Ephemeroptera, Plecoptera, and Trichoptera; RB = rainbow trout; LSU = longnose sucker; MW = mountain whitefish; KO = kokanee; CSU = largescale sucker; NSC = northern pikeminnow; BB = burbot; CCG = slimy sculpin; BMC = brassy minnow; WSU = white sucker; LNC = longnose dace

[1] *See Figure 5.1-3*

[2] *Source: KP 2021b*

[3] *Source: AMEC 2013c and ERM 2021a*

[4] *Source: ERM 2019 and Palmer 2021*

[5] *Source: KP 2021a, 2022*

[6] *Source: Lorax 2022*

[7] *Source: CEA 2019 and ERM 2022*

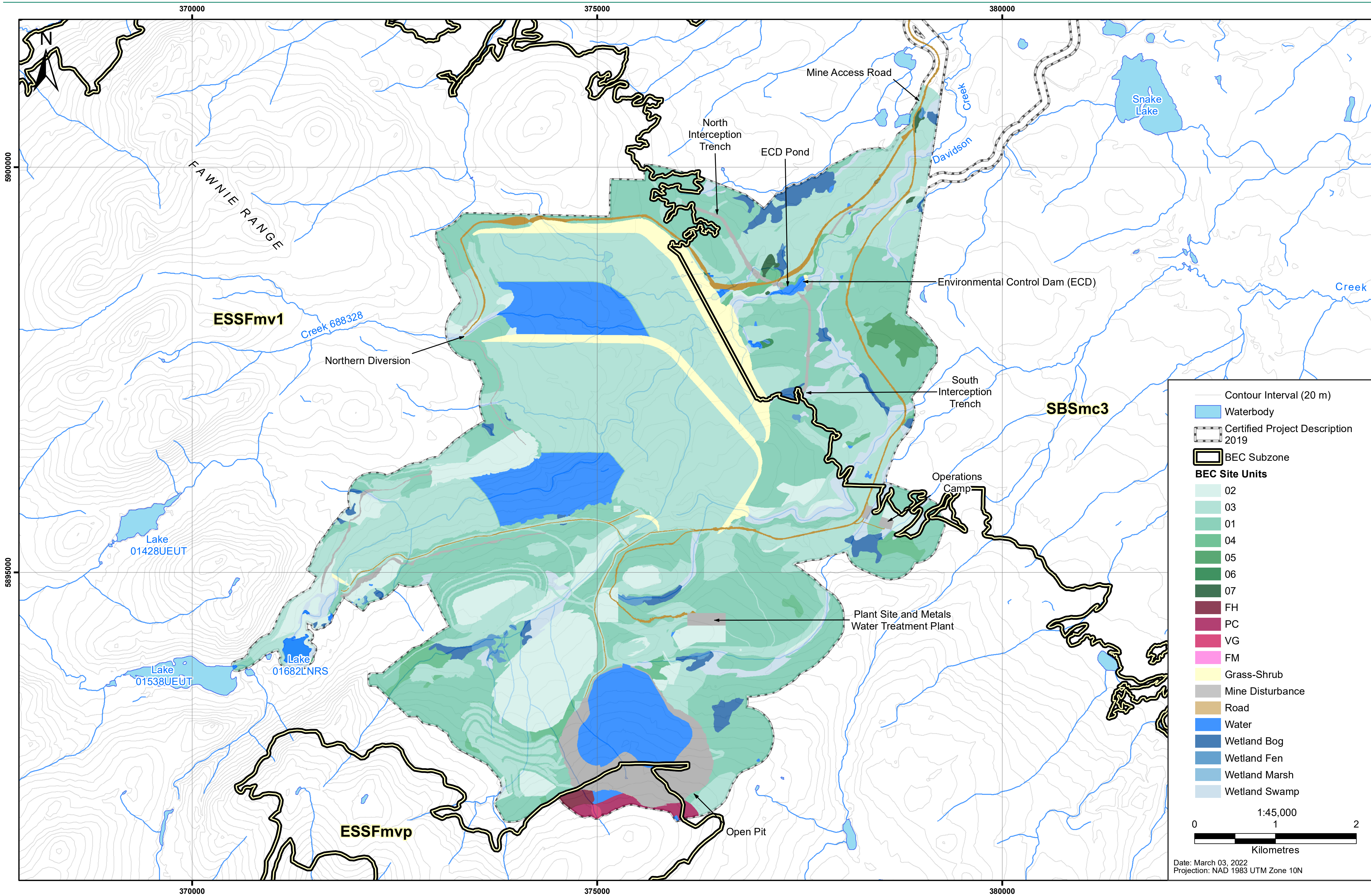

Figure 5.1-4: Post-Mine Land Capability

The TSF Spillway receives passive overflow from the TSF C and TSF D ponds in Post-closure and short-term WQG-AL exceedance are predicted for total ammonia-N, total arsenic, dissolved aluminum, and dissolved cadmium (Lorax 2022). Post-closure TSF Spillway predictions for total ammonia-N, fluoride, sulphate, total silver, aluminum, arsenic, beryllium, cadmium, cobalt, mercury, antimony, and zinc, and dissolved aluminum, copper, and zinc exceed long-term BC and CCME WQG-AL in less than or equal to 100 months of the 893 months modelled. Parameters that are predicted to exceed long-term BC WQG-AL are low magnitude exceedances (range from less than 2x to 8.5x for total ammonia-N). Exceedances of beryllium and mercury can be linked to the use of high detection limits in the calculation of loadings from humidity cell data used in the derivation of source terms.

As a result of the predicted elevated concentrations in water discharged to the receiving environment, there will be guideline exceedances for some parameters in Davidson Creek; however factors of exceedance are commonly within a factor of three of the screening value (Lorax 2022; Table 5.1-3). Overall, the increases in the concentrations of some mine-related parameters in Post-closure can primarily be attributed to TSF C pond overflow. Seepage from the Pit Lake and the TSF has the potential to enter Davidson Creek and Tatelkuz Lake (via Creek 661; KP 2022).

Predicted changes in post-mine surface water quality have improved since 2021 predictions (Lorax 2021) as a result of changes to mine water management in Closure and Post-closure (Lorax 2022; KP 2022). During Closure, in addition to water from the ECD pond and the TSF C pond, water from the Water Management Pond (WMP) will be directed to filling the Open Pit. This will result in the Pit Lake being filled more quickly, therefore reducing the active Closure phase. During Post-closure, the Pit Lake will be maintained as a groundwater sink to mitigate potential seepage from entering Davidson Creek and Creek 661 via the TSF C pond and TSF Spillway. Seepage from the waste stockpiles will report to the TSF Spillway in closure rather than the TSF C Pond. Non-contact water diversions around the TSF will be optimized during Post-closure to increase the proportion of water from the North Diversion to the TSF Spillway.

The Membrane WTP treatment efficiencies were also optimized during Post-closure with the use of reverse osmosis rather than nanofiltration (Lorax 2022). Thus, the treatment rates for ammonia, sulphate, nitrogen (N)-species, and trace heavy metals in mine contact water were assumed to be the same in the Operations and Post-closure phases. The selection for the reverse osmosis Membrane WTP was based on the results of best available technology evaluation for the treatment of excess water from the TSF C pond prior to conveyance to the WMP (BQE 2021).

Several opportunities exist to refine and improve the water quality predictions before Post-closure. Specifically, the collection of on-site monitoring data during the Operations phase will allow for the refinement of source term predictions and identify the need for further mitigation, if required. Additionally, the results of proposed reclamation studies will be used to refine the RCP and further reduce the likelihood of WQG-AL exceedances during the Post-closure phase.

As required by Condition 27 of the EAC, site-specific comparisons of predicted water quality data with water quality standards, calculated using the YDWL guidance, was also completed for one sampling location in Chedakuz Creek in the 2011 to 2020 Baseline Water Quality Report (ERM 2021a). Updates to the site-specific comparisons of predicted water quality data with water quality standards will be updated to coincide with the five-year Mine Plan and Reclamation Program submissions.

At present, Davidson Creek and Creek 661 are not known sources of potable water for domestic use (e.g., residential drinking water). Although recreational or traditional land users may access the streams potentially affected by the Project and may incidentally consume surface water, it is unlikely that water will be consumed consistently and over a long-term. Quantification of potential risks to human health from exposure to parameters of potential concern in streams potentially affected by the Project was completed in a Human Health Risk Assessment (HHRA; ERM 2022). The results of the HHRA indicated the measurable changes in human health due to the Project are unlikely.

5.1.1.3 Summary of Changes to Landscape Capability

The results of ecohydrological modelling of post-mine ecosystems and land capability and comparisons between this information and pre-mine conditions are summarized in Table 5.1-4 and presented on maps in Figure 5.1-2 and Figure 5.1-4.[5] This work indicates a shift toward drier ecosystems compared to pre-mine conditions, but that the reclamation targets identified in the summary table and post-mine map are likely achievable.

The decrease in available soil moisture results from the model assumption that water inputs will be primarily from precipitation on reclaimed landforms, without significant areas receiving rooting-zone seepage inputs from local upslope areas. This will result in the loss or decrease in prominence from the disturbance footprint of site series that have subhygric and wetter SMRs (i.e., wet forests and non-forested wetlands reliant on input of shallow groundwater). The Wetland Management and Offsetting Plan (ERM 2021b) provides details on addressing wetland losses. Potential impacts on caribou habitat (e.g., loss of the ESSFmvp) are addressed in the Caribou Monitoring and Mitigation Plan (ERM 2021c).

Because ecohydrological modelling assumes uniform reclamation cover treatments within polygons, projected reclamation polygons are larger and less heterogeneous than the pre-mine landscape. However, it is anticipated that reclamation in practice will result in more diversity and heterogeneity. This will occur through the differential timing of reclamation and revegetation programs, natural variation in cover-material properties, patterns in wind and snow redistribution, and variation in reclamation prescriptions (e.g., use of diverse planting treatments to break up large polygons with similar ecohydrological characteristics). This latter process (i.e., development and refinement of detailed planting prescriptions) will be informed by reclamation research conducted throughout the mine life. Revegetation within the Project footprint is focused on the return of locally common native plants which support wildlife, thus the focus will be on the use of native plants or certified weed-free seed mixes appropriate to the disturbed site selected in consultation with Indigenous nations (MT 3-20, 5-18, 6-7, 7-8, 9-25).

Current land use for traditional purposes (e.g., hunting and gathering) is predicted to change in the Post-closure phase when compared to the baseline due to changes in post-mine ecosystems (Table 5.1-4) and land capability. There is potential for decreased hunting and trapping success due to localized changes to wildlife availability (ERM 2017). Changes in hunting and trapping success will depend on the location and level of hunting and trapping activities, relative to locations where local wildlife populations may decline.

The following subsections describe ecohydrological modelling results in more detail for each BEC subzone variant, comparing the projected post-mining ecosystems with pre-mine conditions.

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[5] The names in Table 5.1-4 do not reflect the full suite of plant species that will be used to reclaim these ecosystems, for example the ESSFmv1 02 (Lodgepole pine - Huckleberry – Cladonia) will include planting of whitebark pine.

Table 5.1-4: Summary of Pre-mine and Post-closure Ecosystem Areas Arranged by BGC Unit and Post-closure Abundance

BGC Unit	Site Unit	Name	Pre-mine			Post-closure			Difference		
			Area (ha)	%		Area (ha)	%		Area (ha)	%	
				Unit[1]	FP[2]		Unit	FP		Unit	FP
ESSFmv1	03	Subalpine fir - Huckleberry - Feathermoss	237.1	15.4	11.3	813.7	44.4	38.7	576.6	29.00	27.4
	02	Lodgepole pine - Huckleberry - Cladonia	217.1	14.1	10.3	239.7	13.1	11.4	22.6	-1.0	1.1
	01	Subalpine fir - Rhododendron - Feathermoss	887.3	57.5	42.2	220.5	12.0	10.5	666.8	45.5	31.7
	PD, OW, RE	Mine water (tailings pond, other ponds, Freshwater Reservoir)	0	0	0	208.2	11.4	9.9	208.2	11.4	9.9
	LA	Pit Lake	0	0	0	121.9	6.7	5.8	121.9	6.7	5.8
	ES, MI	Permanent mine disturbance***	0	0	0	104.3	5.7	5.0	104.3	5.7	5.0
	Grass-shrub	Grass-shrub (dams)	0	0	0	83.6	4.6	4.0	83.6	4.6	4.0
	RZ	Road (non-reclaimed)	0	0	0	30.2	1.7	1.4	30.2	1.7	1.4
	04	Subalpine fir – Huckleberry – Gooseberry	74.7	4.8	3.56	11.8	0.6	0.6	-63.0	-4.2	-3.0
	Swamp	Swamp	107.1	6.9	5.1	0	0	0	-107.1	-6.9	-5.1
	Bog	Bog	14.0	0.9	0.7	0	0	0	-14.0	-0.9	-0.7
	Fen	Fen	3.5	0.2	0.2	0	0	0	-3.5	-0.2	-0.2
	Marsh	Marsh	1.3	0.1	0.1	0	0	0	-1.3	-0.1	-0.1
	LA, PD, RI, OW	Natural water (lake, pond, river, shallow open water)	0.8	0.1	< 0.1	0	0	0	-0.8	-0.1	< 0.1
		Sub-total	***1,543.0***	***100***	***73.4***	***1,833.9***	***100***	***87.3***	***290.9***	***0***	***13.8***
ESSFmvp	ES, MI	Permanent mine disturbance[3]	0	0	0	27.5	99.7	1.3	27.5	99.7	1.3
	FM	Subalpine fir - Heather parkland	0	0	0	0.1	0.3	< 0.1	0.1	0.3	0.0
	WW	Whitebark pine avens	14.8	53.5	0.7	0	0	0	-14.8	-53.5	-0.7
	PC	Subalpine fir / whitebark pine - Crowberry parkland	12.3	44.4	0.6	0	0	0	-12.3	-44.4	-0.6
	FH	Subalpine fir - Indian hellebore	0.3	1.2	< 0.1	0	0	0	-0.3	-1.2	0.0
	LA, PD, RI, OW	Natural water (lake, pond, river, shallow open water)	0.2	0.9	< 0.1	0	0	0	-0.2	-0.9	0.0
		Sub-total	***27.6***	***100***	***1.3***	***27.6***	***100***	***1.3***	***0***	***0***	***0***

BGC Unit	Site Unit	Name	Pre-mine			Post-closure			Difference		
			Area (ha)	%		Area (ha)	%		Area (ha)	%	
				Unit[1]	FP[2]		Unit	FP		Unit	FP
SBSmc3	01	Hybrid white spruce - Huckleberry	122.5	22.4	5.8	64.7	25.3	3.1	-57.8	2.9	-2.7
	Grass-Shrub	Grass-Shrub (dams)	0	0	0	64.2	25.1	3.1	64.2	25.1	3.1
	RZ	Road	0	0	0	40.2	17.9	1.9	40.2	17.9	1.9
	03	Lodgepole pine - Feathermoss - Cladina	276.6	53.5	13.2	39.6	15.5	1.9	-237.0	-38.0	-11.3
	ES, MI	Permanent mine disturbance[3]	0	0	0	14.5	9.7	0.7	14.5	9.7	0.7
	02	Lodgepole pine - Juniper - Dwarf huckleberry	10.2	1.9	0.5	10.6	4.1	0.5	0.4	2.3	< 0.1
	PD, OW, RE	Mine water (tailings pond, other ponds, FWR)	< 0.1	< 0.1	< 0.1	4.3	1.7	0.2	4.3	1.7	0.2
	04	Hybrid white spruce - Huckleberry - Soopolallie / Black spruce - Huckleberry - Spirea	37.5	6.9	1.8	2.1	0.8	0.1	-35.4	-6.0	-1.7
	Swamp	Swamp	60.5	11.1	2.9	0	0	0	-60.5	-11.1	-2.9
	06	Black spruce - Lodgepole pine - Feathermoss	6.6	1.2	0.3	< 0.1	< 0.1	< 0.1	-6.6	-1.2	-0.3
	Fen	Fen	5.8	1.1	0.3	0	0	0	-5.8	-1.1	-0.3
	Bog	Bog	5.4	1.0	0.3	0	0	0	-5.4	-1.0	-0.3
	07	Hybrid white spruce - Twinberry	3.3	0.6	0.2	0	0	0	-3.3	-0.6	-0.2
	LA, PD, RI, OW	Natural water (lake, pond, river, shallow open water)	2.7	0.5	0.1	0	0	0	-2.7	-0.5	-0.1
		Sub-total	***531.0***	***100***	***25.3***	***240.1***	***100***	***11.4***	***-290.9***	***0***	***-13.8***
		Total	**2,101.5**	**-**	**100**	**2,101.5**	**-**	**100**	**0**	**-**	**0**

[1] *Percent of area within each BGC site unit for the given time period.*

[2] *Percent of total area within the disturbance footprint.*

[3] *Permanent mine disturbance includes: Open Pit, Plant Site, Camp, Central Diversion North, Central Diversion South and Northern Diversion Channel (ESSFmv1); Open Pit (ESSFmvp); and ECD Diversion structures, ECD spillway and Freshwater Reservoir (FWR) spillway (SBSmc3).*

SBSmc3

Site series associated with subhygric and wetter SMRs, including wetlands, are projected to be lost from disturbed areas due to changes to surface hydrology (the SBSmc3 edatopic grid is shown in Figure 5.1-5). The Post-closure reclaimed topography is generally not expected to have mechanisms to retain near-surface water and release this water as seepage at lower slope positions and depressions.[6] The SBSmc3-06 (Black spruce – Lodgepole pine – Feathermoss; pre-disturbance: 6.6 ha) and SBSmc3-07 (Hybrid white spruce – Twinberry; 3.3 ha) site series will be lost from the disturbance footprint. All wetland units will also be lost as hydrologic conditions will not be conducive to replacement or maintenance of wet, organic-rich soils, including swamps (60.5 ha), bogs (5.4 ha), and fens (5.8 ha). This is based on the results of the ecohydrological model, that includes the assumption that seepage inputs to the rooting zone will be lost due to changes in substrate and topography (e.g., not possible on mine-rock in the waste stockpiles). Thus, the wetlands are projected to be lost from disturbed areas due to changes to surface hydrology. The post-closure reclaimed topography is generally not expected to have mechanisms to retain near-surface water and water will therefore flow to lower slope positions and depressions as seepage. This will be exacerbated given that the site is anticipated to be drier overall. Consequently, the objective is to make the best possible quality caribou habitat given the constraints of this drier environment of the Post-closure landscape.

The most extensive pre-mine site series in the SBSmc3 is the 03 (Lodgepole pine – Feathermoss – Cladina; pre-disturbance: 277 ha), a drier site series associated with glaciofluvial surface soil that is favoured caribou habitat. The 03 site series, as well as the similar 02 (Lodgepole pine – Juniper – Dwarf blueberry; pre-disturbance: 10 ha), are intended to be reclaimed using salvaged soils from glaciofluvial deposits. Since the overall area of the SBSmc3 is being reduced on the Post-closure landscape due to increases in elevation in the TSF area, which transition the TSF beach areas to the ESSFmv1 variant, it is not possible to replace all the drier site series area in the SBSmc3.

There are 287 ha of SBSmc3-02 and -03 in the pre-mine landscape compared to 240 ha of total SBSmc3 area in the Post-closure landscape, 123 ha of which are non-reclaimed roads, infrastructure and water features, or dams that cannot be reclaimed to natural site series since trees and deep-rooted shrubs are not permitted due to geotechnical constraints. Of the remaining area, 50 ha of the SBSmc3 in the post-mine plan is reclaimed to the drier site series (SBSmc-02 and 03) that provide caribou (*Rangifer tarandus*) habitat. On lower elevation surface-soil stockpile footprints, the zonal 01 site series (Hybrid white spruce – Huckleberry; pre-disturbance: 123 ha) is predicted to cover 65 ha and the submesic 04 site series (Hybrid white spruce – Huckleberry – Soopolallie; pre-disturbance: 38 ha) will cover 2 ha.

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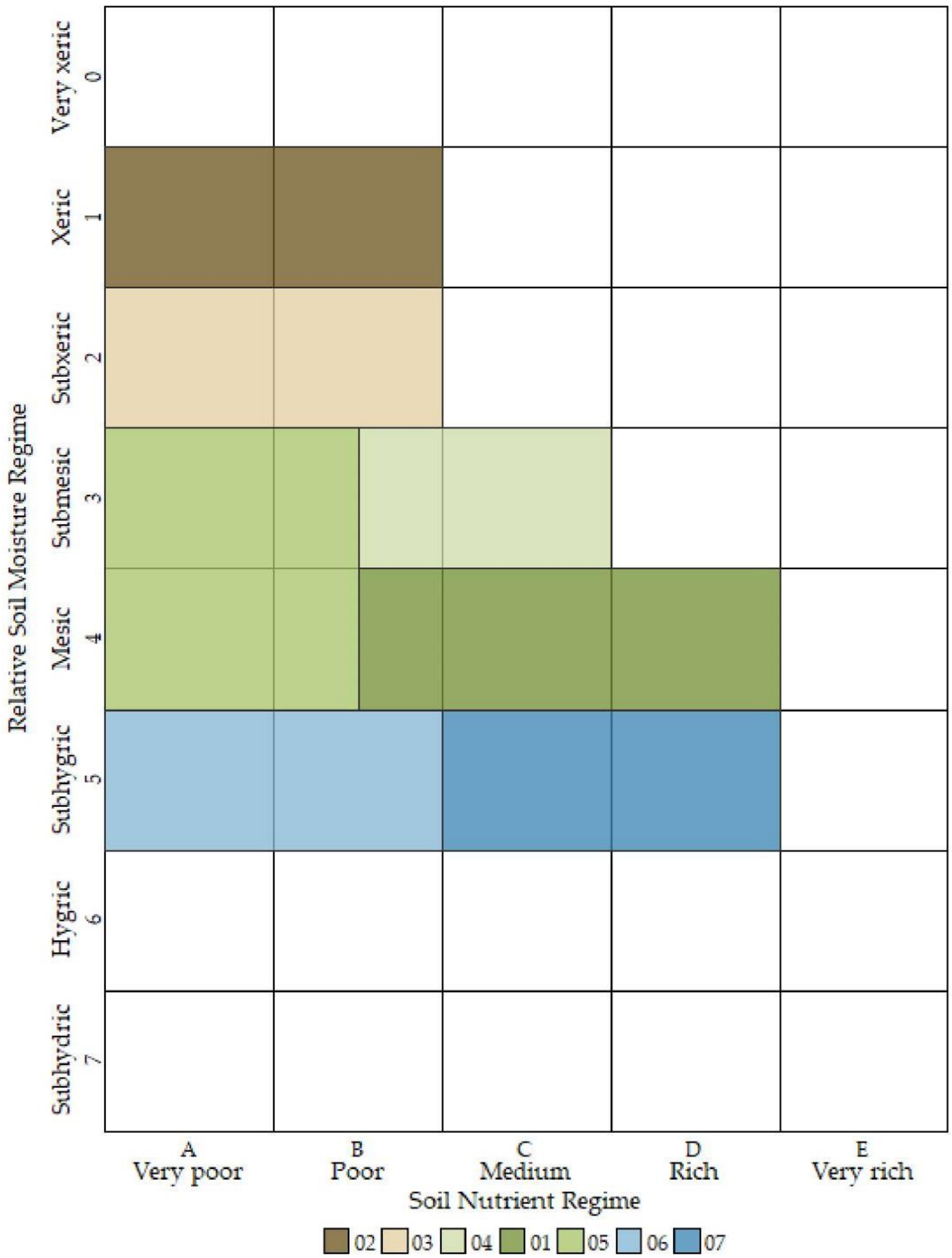
[6] Generally, waste-rock facilities do not support lateral downslope flow of shallow groundwater the way that landscapes on basal till do, with the exception of toes where mine wastes meet pre-existing ground, which are expected to produce near-surface seepage. These toes have been delineated on the Post-closure map and treated accordingly for predicting Post-closure ecosystems.



Source: adapted from Delong et al. 1993

Figure 5.1-5: Edatopic Grid for the SBSmc3 Variant Showing Edaphic Characteristics of Ecosystems

ESSFmv1

For upland (non-seepage-associated) ecosystems, submesic to mesic SMRs and their associated ecosystems are expected to increase on the Post-closure landscape, with a slight increase in subxeric to xeric ecosystems and a loss of subhygric or wetter ecosystems. As with the SBSmc3, the decrease in available soil moisture resulting in the loss of wetter ecosystems is due to the model assumption that water inputs will be primarily from precipitation on mine reclaimed landforms without significant areas of localized rooting-zone seepage inputs (Figure 5.1-6 shows the ESSFmv1 edatopic grid). The subhygric to hygric ESSFmv1-04 (Subalpine fir – Huckleberry – Gooseberry; pre-disturbance: 75 ha) site series will be reduced in size, occurring only in depressional areas of the TSF beach and on toes and lower slopes of the Upper and Lower Waste stockpiles (12 ha). All wetland units will also be lost as hydrologic conditions and will not be conducive to replacement or maintenance of wet, organic-rich soils. These wetland losses include swamps (107 ha), bogs (14 ha), fens (3.5 ha), and marshes (1 ha).[7] Non-reclaimed roads, infrastructure and water features, or dams that cannot be reclaimed to natural site series (since trees and deep-rooted shrubs are not permitted due to geotechnical constraints) will represent 548 ha of the Post-closure landscape. Within the disturbance footprint, the loss or decrease in prominence of site series that have subhygric and wetter SMRs (i.e., wet forests and non-forested wetlands reliant on input of shallow groundwater) will be addressed in the Wetland Management and Offsetting Plan (WMOP). The WMOP provides details on addressing wetland losses and will evolve over the mine life as opportunities for wetland creation are identified through improved understanding of site conditions and research identified in the RCP.

Mesic or drier ecosystems dominate pre-mine conditions in the ESSFmv1 (1,342 ha or 87% of the ESSFmv1). The zonal 01 (Subalpine fir – Rhododendron – Feathermoss; pre-disturbance: 887 ha), which has a mesic SMR, will be less abundant on the post-mine landscape (221 ha). The next most common pre-mine site series is the 03 (Subalpine fir – Huckleberry – Feathermoss; pre-disturbance: 237 ha), which has a submesic to mesic SMR. The 03 will be the most prominent reclaimed ESSFmv1 site series as the primary component of TSF beaches and comprise 814 ha of the Post-closure landscape. The 02 (Lodgepole pine – Huckleberry – Cladonia; pre-disturbance: 217 ha) is the driest site series in the ESSFmv1 and will be established in reclamation using glaciofluvial surface soil on the tops of the Upper and Lower Waste stockpiles, as well as on reclaimed camp and infrastructure areas (240 ha).

The increase in the total area of submesic or drier ecosystems in the ESSFmv1 will favour lower tree densities and drought-tolerant tree species such as whitebark pine (*Pinus albicaulis*),[8] particularly where coarse-textured glaciofluvial surface soils are used for reclamation (Section 4.2.1 Soil Resources, Joint Application for MA/EMA permits). The increase in the drier ESSFmv1-02 and -03 site series on the Post-closure landscape relative to pre-disturbance conditions (1,053 ha versus 454 ha) represents an overall increase in potential caribou habitat that compensates for the decreases of 253 ha (51 ha versus 287 ha) and 28 ha (0 ha versus 28 ha) in the SBSmc3 and ESSFmvp, respectively.

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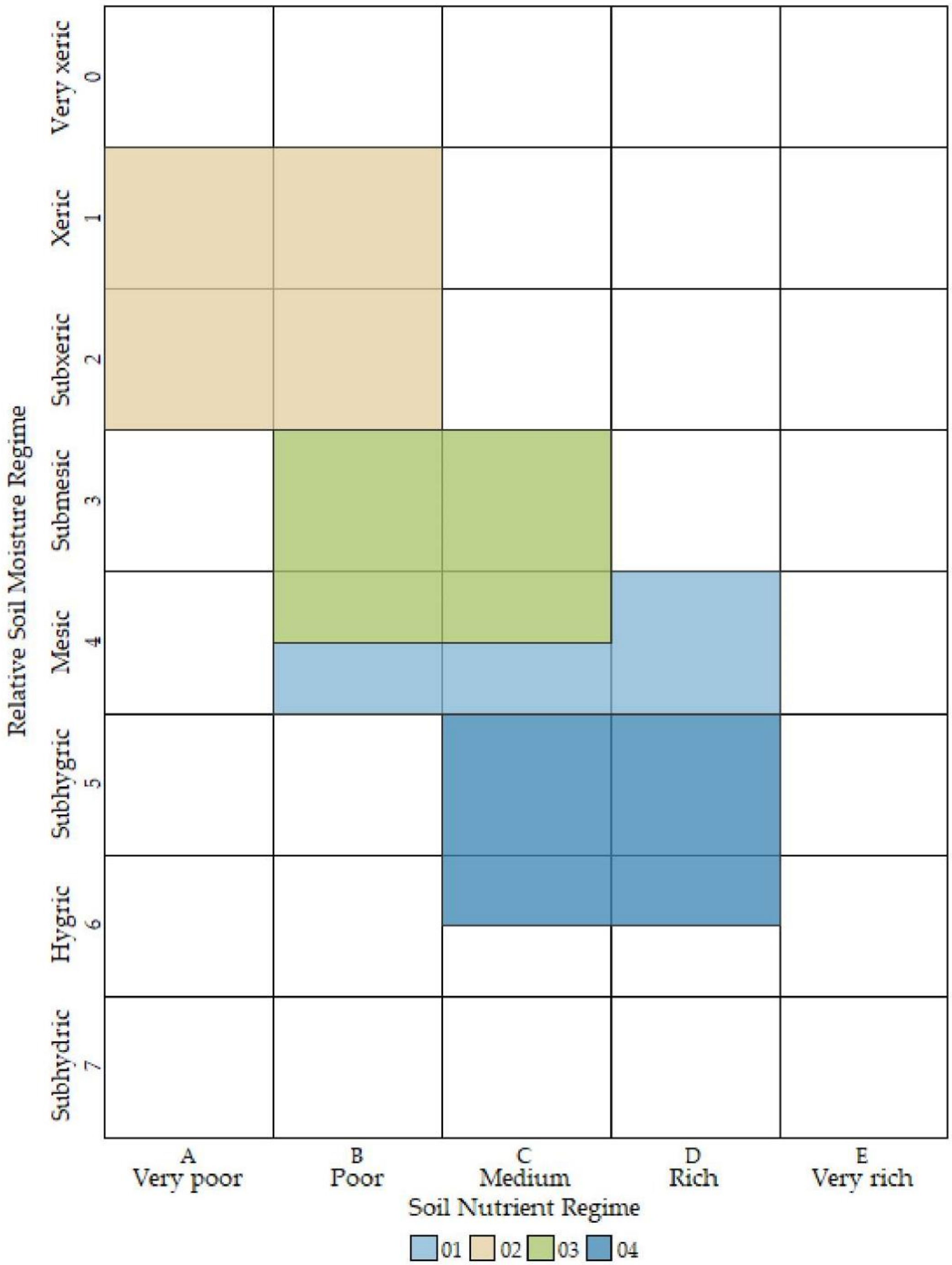
[7] Marshes are the easiest wetland type to replace in reclamation, and it is likely possible to construct at least 1 ha of marsh on the Post-closure landscape. Plans to do so will be based on evolution of the mine plan, and/or observation of water retention in candidate areas.

[8] Provided that future climate continues to support whitebark pine in the mine area—see Section 5.1.3.5.



Source: adapted from Delong et al. 1993

Figure 5.1-6: Edatopic Grid for the ESSFmv1 Variant Showing Edaphic Characteristics of Ecosystems

ESSFmvp

There is no edatopic grid for parkland units such as the ESSFmvp[9] in the BEC system, nor are there formal ecosystem descriptions based on soil moisture and nutrient regimes. Table 5.1-5 shows the relative moisture and nutrient regimes based on field data descriptions and professional experience for the ESSFmvp. In the post-mine landscape, all but 0.1 ha of the ESSFmvp will be either non-reclaimed or exempt from reclamation as part of roads, the pit footprint, or water-diversion structures. The small parkland area (0.1 ha) that will be reclaimed is projected to support the FM site unit (Subalpine fir – Heather parkland), which was not present on the reclaimed footprint prior to mining. The WW site unit (Whitebark pine – white mountain-avens; pre-disturbance: 15 ha, 54%) was the most prevalent site unit on the pre-development landscape and is drier and nutrient-poorer than the reclaimed FM site unit. Whitebark pine was also supported by the PC site unit (Subalpine fir / whitebark pine – Crowberry parkland; pre-disturbance: 12 ha, 44%) in the pre-development landscape, which is also drier and nutrient-poorer than the reclaimed FM unit. The PC site unit is the most analogous pre-disturbance unit to the reclaimed FM site unit, so species from the PC unit (e.g., whitebark pine and heather species) will be used for this area. The wetter FH site unit (Subalpine fir – Indian hellebore; pre-disturbance: 0.3 ha, 1.2%) occurs on subhydric to hygric sites and will not be present on the reclaimed ecosystems as these ecosystems require subsurface water inputs. The remainder of the ESSFmvp (0.1 ha, 0.9%) was open water on the pre-development landscape.

Table 5.1-5: Relative Soil Moisture and Nutrient Regimes of ESSFmvp Site Units and their Presence in the Pre-mine and Post-closure Landscape

Site Unit	Description	Soil Moisture Regime	Soil Nutrient Regime	Presence	
				Pre	Post
KC	Kinnikinnick – Cladonia	0-1	A-B		
ML	White mountain-avens – Lichen	0-1	A-B		
WW	Whitebark pine – white mountain-avens	1	A-B	x	
WK	Whitebark pine krummholz	1-2	A-B		
FB	Subalpine fir – Dwarf blueberry – Dicranum parkland	1-2	B		
TW	Two-toned sedge – Dwarf snow willow	2-3	A-B		
PC	Subalpine fir / whitebark pine – Crowberry parkland	2-3	B-C	x	
SF	Scrub birch – Altai fescue shrub steppe	3	B		
FM	Subalpine fir – Heather parkland	3-4	B-C		x
FC	Altai fescue – Cladonia lichen grassland	3-4	C-D		
MH	Mountain-heather – Slender hawkweed meadow	3-5	C-D		
VG	Sitka valerian – globeflower moist meadow	5	C-D		
FH	Subalpine fir – Indian hellebore	5-6	D	x	

Note:

Soil Moisture Regime and Soil Nutrient Regime are taken directly where provided or estimated using professional judgment from baseline Terrestrial Ecosystem Mapping (AMEC 2013b).

Table 5.1-4 also shows the changes in non-ecosystem site units due to mine development. Grass-shrub ecosystems on dams total 148 ha of the Post-closure area, of which 84 ha are in the ESSFmv1 and 64 ha

[9] The pre-mine baseline survey classified upper-elevation parkland sites in both the ESSFmvp and ESSFxvp1 BEC variants. Given the parkland units occur above the ESSFmv1 and their limited portion of the disturbance footprint (30 ha), the ESSFmvp unit is used in this report for both pre- and post-mine summaries.

are in the SBSmc3. Natural water bodies, such as ponds, lakes, streams, and shallow open water on wetlands were 4 ha of the footprint prior to mine development and all will be lost. However, anthropogenic water bodies will increase due to construction of the pit lake (122 ha), tailings ponds (208 ha), and the ECD Pond (4 ha). Tailings deposition to strategically create the TSF C and TSF D final pond configuration is based on current water balance and hydrology modelling. BW Gold will consider options for reducing the proportion of open water as Operations progress. Permanent, reclamation-exempt mine disturbances such as the WTP, water management infrastructure such as ditches and interception trenches, office areas, and part of the operations camp account for 153 ha. Roads that will remain after Closure total 70 ha.

5.1.2 Habitat for Focal Reclamation Species

Comprehensive reclamation and restoration measures will be implemented upon mine closure. Habitat restoration upon mine closure will assess appropriate habitats capable of supporting caribou, moose, grizzly bear, forest and grassland birds, and waterbirds. Reclamation measures will include consideration of caribou habitat restoration measures in *Recovery Strategy for the Woodland Caribou, Southern Mountain Population* (EC 2014; MT 8-22, 10-9, 13-21, 14-5, 11-8). For migratory birds and species at risk (forest birds, bats, western toads), securing the Capoose HE-UWR mineral leases will provide an incremental benefit of habitat protection from mineral exploration for 50 years.

In addition, the restoration of forestry roads will have a benefit to migratory birds and species at risk, primarily through reducing habitat fragmentation and improving wetland hydrology and sediment transport. Prior to the boom in forestry operations that began in the 1980s, the area surrounding the Blackwater project would have consisted largely of mature stands of forest in the ESSF and SBS BEC zones. With forest harvesting, the forest landscape has been heavily fragmented by forestry roads and cut blocks of early and mid-seral trees. In addition, edge effects from roads and cut blocks have further degraded stands of mature forests.

The proposed revegetation strategy is based on the projected post-closure ecosystems and the corresponding wildlife habitats (described in detail in Appendices B and C). Each post-closure ecosystem has an associated suite of plant species that are adapted to its climatic and edaphic conditions, and thus, there are specific revegetation strategies linked to each post-closure ecosystem.

Reclamation of the post-closure landscape will re-establish basic ecological processes (e.g., biochemical functions, water cycling) and relatively simple structural diversity and native plant communities that will support end land uses. Ecohydrological modelling results indicate edaphic conditions required to support a given ecosystem in the long-term; however, ecosystems will take a long period to resemble their climax potential. The processes, structure, and plant communities established through early reclamation will create conditions for the development of the targeted native plant communities (i.e., site series) to become self-sustaining over the long-term. The objective for all reclamation treatments is to establish a diverse landscape with habitats that will persist and continue to develop into more complex communities over time based on natural successional pathways to support wildlife species.

A holistic approach and strategy to restoring biodiversity through habitat regeneration for Closure is being implemented through the Project's RCP. This holistic approach is highlighted in Table 5.1-6 which compares and contrasts pre-mining ecosystems with projected post-mining ecosystems. Considerations include BGC unit, site series, SMR/SNR, area (ha), representative species, community members, key habitat features and vegetation species, focal reclamation species, expected species present at different stages of habitat regeneration, where regeneration is expected to occur on the closed mine site, and applicable reclamation research.

Table 5.1-6: Reclamation and Closure Plan Ecosystem Summary for Vegetation and Wildlife – Comparing Pre-disturbance Ecosystems with Projected Post-closure Ecosystems

Biogeoclimatic Unit	Pre-disturbance Ecosystems							Projected Post-closure Ecosystems							Mine Features	Research[2]
	Site Series	SMR/ SNR	Area (ha)	Representative spp.	Community Members	Key Habitat Features and Vegetation Species	Reclamation Objective Species	Area (ha)	Focal Species[1]	Other Reclamation Considerations	Initiation (Structural Stages 1-3, Sparse - Shrub/Herb)	Short-term (Structural Stages 4-5, Young Forest)	Medium-term (Structural Stage 6, Mature Forests)	Long-term (Structural Stage 7, Old Growth Forest)		
ESSFmv1	02	1, 2/A, B	217.1	Caribou, grizzly bear, wolverine, olive-sided flycatcher	hare, vole, squirrel	Dry lodgepole pine forest (Subalpine fir, Engelmann spruce) upper-crest; black huckleberry, Sitka alder, common juniper, birch-leaved spirea, dwarf blueberry, bluejoint reedgrass, cladina spp., Stereocaulon spp.; wind swept edge potential	Caribou, grizzly bear, wolverine, olive-sided flycatcher	239.7	Whitebark pine, lichen spp., black huckleberry, dwarf blueberry	Alder spp.	Hare, rodents, birds, pollinators	Caribou, hare, rodents, birds, Clark's nutcracker	Caribou, grizzly bear, wolverine, olive-sided flycatcher	Caribou, grizzly bear, wolverine, olive-sided flycatcher	Uppermost portions of Upper and Lower Waste stockpiles; camp and infrastructure areas; upper elevation borrow areas; Low Grade Ore (LGO) stockpile; TSF beaches	Native spp. Revegetation and Lichen; Whitebark Pine
	03	3,4/B, C	237.1	Grizzly bear, hare, wolverine, marten, olive-sided flycatcher	hare, vole, squirrel, grouse	Mesic lodgepole pine forest (Subalpine fir, Engelmann spruce); upper slope-level; black huckleberry, rhododendron, subalpine fir, fireweed, twinflower, mosses, no terrestrial lichen; coarse woody debris potential; snow interception, boulders	Grizzly bear, hare, wolverine, marten, olive-sided flycatcher	813.7	Whitebark pine, lodgepole pine, subalpine fir, kinnikinnick, black huckleberry	Addition of boulders and CWD to provide structure and denning opportunities	Hare, rodents, birds, pollinators	Hare, rodents, birds, Clark's nutcracker	Grizzly bear, hare, wolverine, marten, olive-sided flycatcher	Grizzly bear, hare, wolverine, marten, olive-sided flycatcher	Uppermost portions of Upper and Lower Waste stockpiles; camp and infrastructure areas; upper elevation borrow areas; LGO stockpile; TSF beaches; Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; topsoil stockpiles	Native spp. Revegetation and Lichen; Whitebark Pine
	01	4/B-D	887.3	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	hare, squirrel, shrews-voles-mice, grouse	Moist fir/Engelmann spruce forest (lodgepole pine); mid-upper slope; black huckleberry, Sitka alder, rhododendron, fireweed; high moss, arboreal lichen spp.; CWD potential; snow interception; security, boulders	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	220.5	Subalpine fir, Engelmann spruce, highbush cranberry, black huckleberry	Addition of boulders and CWD to provide structure and denning opportunities	Hare, rodents, birds, pollinators	Hare, rodents, birds, pollinators	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; topsoil stockpiles	Native spp. Revegetation
	04	5, 6/C, D	74.7	Caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	squirrel, rodents	Moist to wet lodgepole pine/Engelmann spruce (Subalpine fir); forest, mid-toe slope and depressions; black twinberry, black huckleberry, black gooseberry, western mountain ash, subalpine fir, arboreal lichen; high herb; CWD; security, boulders	Caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	11.8	Subalpine fir, spruce, black twinberry, black huckleberry	Deciduous tree species; addition of boulders and CWD to provide structure and denning opportunities	Hare, rodents, birds, pollinators, western toad	Hare, rodents, birds, pollinators	Caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	Caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; topsoil stockpiles	Native spp. Revegetation
	Wetlands	5, 6, 7	125.9	Western toad, waterbirds, rusty blackbird				0								
	New: Riparian areas						Moose, grizzly bear, invertebrates, pollinators, songbirds, western toad, bat spp.		Spruce, willow spp., black twinberry, cow parsnip, horsetail, sedge spp., bluejoint reedgrass, prickly rose	Invite pollinators; addition of CWD to provide structure	Pollinators, grizzly bear, western toad, rodents, birds	Pollinators, moose, grizzly bear, western toad, rodents, birds			In areas adjacent to water, where extended periods of water in rooting zone observed (e.g., adjacent to TSF ponds and interception ditches)	Riparian Reclamation

Biogeoclimatic Unit	Pre-disturbance Ecosystems							Projected Post-closure Ecosystems							Mine Features	Research[2]
	Site Series	SMR/ SNR	Area (ha)	Representative spp.	Community Members	Key Habitat Features and Vegetation Species	Reclamation Objective Species	Area (ha)	Focal Species[1]	Other Reclamation Considerations	Initiation (Structural Stages 1-3, Sparse - Shrub/Herb)	Short-term (Structural Stages 4-5, Young Forest)	Medium-term (Structural Stage 6, Mature Forests)	Long-term (Structural Stage 7, Old Growth Forest)		
ESSFmv1 (*cont'd*)	New: Grass-shrub (dams)		0	Moose, grizzly bear, invertebrates, pollinators, dragonflies, grassland birds, deer		Water, spring feeding for bears, browse for moose	Moose, grizzly bear, invertebrates (dragonflies), pollinators, grassland birds, deer	83.6	Native grass - shrub spp.		Moose, grizzly bear, invertebrates, pollinators, grassland birds	Moose, grizzly bear, invertebrates, pollinators, grassland birds	Moose, grizzly bear, invertebrates, pollinators, grassland birds	Moose, grizzly bear, invertebrates, pollinators, grassland birds	Dams	Grass spp.
ESSFmvp	WW	1	14.8	Caribou, Clark's nutcracker, birds, grizzly bear	voles	Krummholz, whitebark pine, lichen spp., security, food, nesting		0								
ESSFmvp	PC	2, 3	12.3	Caribou, Clark's nutcracker, birds, grizzly bear	voles	Whitebark pine, crowberry, security, food, nesting		0								
ESSFmvp	FM	3, 4	0	Grizzly bear, deer		Feeding for bears in spring/summer	Grizzly bear, deer	0.1			Grizzly bear	Grizzly bear, deer	Grizzly bear, deer	Grizzly bear, deer		Native spp. Revegetation
ESSFmvp	FH	5, 6	0.3	Caribou, deer, grizzly bear, birds	voles	Krummholz, security, food, nesting		0								
SBSmc3	02	1/A, B	10.2	Caribou, grizzly bear, grouse, birds	hare, vole, squirrel	Dry lodgepole pine open forest upper slope; saskatoon berry, dwarf blueberry, strawberry, kinnikinnick, common juniper	Caribou, grizzly bear, grouse, birds	10.6	Lodgepole pine, kinnikinnick, common juniper, saskatoon berry, dwarf blueberry		Rodents, birds, pollinators	Rodents, birds, pollinators	Caribou, grizzly bear, grouse, birds	Caribou, grizzly bear, grouse, birds	Freshwater Reservoir; lower elevation borrow areas, mine site access road	Native spp. Revegetation
SBSmc3	03	2/A, B	276.6	Caribou, grizzly bear, grouse, birds	hare, vole, squirrel	Dry lodgepole pine forest upper slope, crest or level; dwarf blueberry, strawberry, kinnikinnick, soopallalie, common juniper, herbs; high terrestrial lichen cover, windswept	Caribou, grizzly bear, grouse, birds	39.6	Hybrid white spruce, lodgepole pine, dwarf blueberry, soopolallie		Rodents, birds, pollinators	Rodents, birds, pollinators	Caribou, grizzly bear, grouse, birds	Caribou, grizzly bear, grouse, birds	Freshwater Reservoir; lower elevation borrow areas, mine site access road	Native spp. Revegetation
SBSmc3	04	3, 4/A, B	37.5	Caribou, grizzly bear, moose, marten, fisher, olive-sided flycatcher, grouse	squirrel, rodents, grouse	Mesic lodgepole pine (hybrid spruce) forest mid-upper slope; highbush cranberry, black huckleberry, sitka alder, arboreal lichen spp.; very high herb; CWD; security	Caribou, grizzly bear, moose, marten, fisher, olive-sided flycatcher, grouse	2.1	Hybrid white spruce, lodgepole pine, highbush cranberry, soopolallie, black huckleberry	Alder spp.	Moose, hare, rodents, birds, pollinators, western toad	Moose, rodents, birds, pollinators	Caribou, grizzly bear, moose, marten, olive-sided flycatcher, grouse	Caribou, grizzly bear, moose, marten, olive-sided flycatcher, grouse	Topsoil stockpiles, mine site access road	
SBSmc3	01	4/B-D	122.5	Caribou, grizzly bear, hare, wolverine, marten, fisher, olive-sided flycatcher, bat spp.	hare, squirrel, shrews-voles-mice, grouse	Moist hybrid spruce/lodgepole pine forest; mid- slope or level; black huckleberry, subalpine fir, highbush cranberry, hybrid spruce, black twinberry, bluejoint reedgrass, dwarf blueberry, trailing raspberry; high moss, arboreal lichen spp.; CWD potential; security	Caribou, grizzly bear, hare, wolverine, marten, fisher, olive-sided flycatcher, bat spp.	64.7	Hybrid white spruce, lodgepole pine, highbush cranberry, soopolallie, black huckleberry, trailing raspberry		Moose, hare, rodents, birds, pollinators, western toad	Moose, rodents, birds, pollinators	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	Topsoil stockpiles, mine site access road	
SBSmc3	05	3, 4/A, B		Caribou, grizzly bear, hare, wolverine, fisher, marten, olive-sided flycatcher, bat spp., western toad		Mesic mixed coniferous forest (lodgepole pine, black spruce, hybrid white spruce) upper slope or level; terrestrial lichen spp., dwarf blueberry, twinflower, crowberry, soopalallie, birch-leaved spirea; CWD; snow interception; security	Caribou, grizzly bear, hare, wolverine, marten, fisher, olive-sided flycatcher, bat spp., western toad		Hybrid white spruce, lodgepole pine, highbush cranberry, soopolallie, black huckleberry, crowberry		Caribou, moose, hare, rodents, birds, pollinators, western toad	Caribou, moose, rodents, birds, pollinators	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	Topsoil stockpiles, mine site access road	

Biogeoclimatic Unit	Pre-disturbance Ecosystems							Projected Post-closure Ecosystems								Mine Features	Research[2]
	Site Series	SMR/ SNR	Area (ha)	Representative spp.	Community Members	Key Habitat Features and Vegetation Species	Reclamation Objective Species	Area (ha)	Focal Species[1]	Other Reclamation Considerations	Initiation (Structural Stages 1-3, Sparse - Shrub/Herb)	Short-term (Structural Stages 4-5, Young Forest)	Medium-term (Structural Stage 6, Mature Forests)	Long-term (Structural Stage 7, Old Growth Forest)			
SBSmc3 (*cond't*)	06	5/A, B	6.6	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad		Moist to wet mixed coniferous forest (lodgepole pine, black spruce, hybrid white spruce) lower slope or level; terrestrial lichen spp., black huckleberry, crowberry, dwarf blueberry, twinflower, coltsfoot and other herbs, soopalallie, Labrador tea; CWD; snow interception; security	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	< 0.1	Lodgepole pine, black spruce, hybrid white spruce, lichen spp., black huckleberry, crowberry, dwarf blueberry, twinflower, soopalallie, labrador tea		Caribou, moose, hare, rodents, birds, pollinators, western toad	Caribou, moose, rodents, birds, pollinators	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	Caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad		
SBSmc3 (*cond't*)	07	5/C, D	3.3	Grizzly bear, moose, rodents, hare, western toad				0								
SBSmc3 (*cond't*)	Wetlands		71.7	Waterbirds, western toad, rusty blackbird, pollinators, dragonflies, moose				0								
SBSmc3 (*cond't*)	New: Riparian areas		0				Moose, grizzly bear, invertebrates, pollinators, songbirds, western toad, bat spp.		Spruce, willow spp., black twinberry, cow parsnip, horsetail, sedge spp., bluejoint reedgrass, prickly rose	Invite pollinators; addition of CWD to provide structure	Pollinators, grizzly bear, western toad, rodents, birds, bats	Pollinators, moose, grizzly bear, western toad, rodents, birds, bats	Fisher, moose, grizzly bear, western toad, rodents, birds, bats	Fisher, moose, grizzly bear, western toad, rodents, birds, bats	In areas adjacent to water, where extended periods of water in rooting zone observed (e.g., adjacent to TSF ponds and interception ditches)	Riparian Reclamation
SBSmc3 (*cond't*)	New: Grass-shrub (dams)		0	Moose, grizzly bear, invertebrates, pollinators, grassland birds, deer		Water, spring feeding for bears, browse for moose	Moose, grizzly bear, invertebrates, pollinators, grassland birds, deer	64.2	Native grass - shrub spp.		Moose, grizzly bear, invertebrates, pollinators, grassland birds	Moose, grizzly bear, invertebrates, pollinators, grassland birds	Moose, grizzly bear, invertebrates, pollinators, grassland birds	Moose, grizzly bear, invertebrates, pollinators, grassland birds	Dams	Grass spp. use

Notes:

Pre-disturbance ecosystems that are not projected to be present post-mine are greyed out.

This table is focused on terrestrial habitats and does not include pre-mine water bodies.

Reclaimed areas in the SBSmc3 01, 04, 05, 06, which are all located on soil stockpile footprints, and special ecosystems (e.g., grass/shrubs on dams and riparian ecosystems) are not available until Closure and will not have research trials.

[1] Refer to Table 5.1-5 for a list of all vegetation species included in each Biogeoclimatic and site unit.

[2] References to reclamation research plans will be provided upon completion of the Blackwater Reclamation and Closure Plan.

Due to their federal and provincial status and value to Indigenous nations, caribou, whitebark pine and Clark's nutcracker are the primary focal species guiding reclamation decisions, as well as rainbow trout and kokanee in relevant aquatic ecosystems. The RCP also considers creating habitat for moose (non-focal species) in view of the species' importance to Indigenous nations. Wildlife studies and recent field work were used to identify current habitat use. Representative species were chosen because they are a species at risk, have been identified as culturally important by the LDN or UFN, or have been chosen as an indicator species (Appendix B; MT 6-7, 7-8, 7-9, 8-5, 9-7, 9-25, 10-9, 10-10, 11-8, 13-20, and 15-28).

5.1.2.1 Whitebark Pine

Coarser glaciofluvial surface soils are planned to be used as soil covers to create drier site series with sparser tree canopies that will support whitebark pine and higher lichen cover favoured by caribou. Whitebark pine will be used as a revegetation species to the greatest extent possible, including in lower elevation areas, where they tend to be less common in the pre-mine landscape, and on submesic SMRs, where they are typically outcompeted by more vigorous tree species (MT 4-6, 5-11, 7-9, and 15-28). While competition from other tree species may preclude them from abundant growth, whitebark pine will be given opportunities to extend their range in the Project footprint. This effort will be aided by the planned whitebark pine nursery and reclamation trials to determine optimal planting treatments, with long-term maintenance and adaptive management measures informed by reclamation monitoring. All planned forested site series provide conifer stands, especially the drier 02 and 03 site series in the ESSFmv1 and SBSmc3, which have both lodgepole pine (*Pinus contorta*) and whitebark pine as planned revegetation species. In the vicinity of the FWR and camp areas, roughly 50 ha of SBSmc3 02 and 03 site series are planned using glaciofluvial surface soil. These are drier and relatively low-density forested ecosystems where lichen and whitebark pine will be prioritized for revegetation based on research trial outcomes (see RCP) and caribou and Clark's nutcracker are expected to find foraging opportunities.

Surveys of the Project footprint will be conducted in 2022 to identify seedling or sapling candidates for transplanting (MT 5-13) (BW Gold 2022b). Only healthy trees and those small enough to dig up without damage will be selected for transplanting. Only trees with no chlorotic foliage, foliage covering >25% of crown area (assessed in small trees is subjective), and no active rust infections will be considered for transplanting. Other indicators such as bark damage and other stressors may also exclude a seedling or sapling. Results of 2022 surveys will be reported to Environment and Climate Change Canada (ECCC) and UFN/LDN and the final locations and number of whitebark pine seedlings and saplings to be salvaged will be communicated, along with a plan for replanting these seedlings. Consideration will be given in the plan to a phased approach to transplanting based on the mine development schedule.

5.1.2.2 Clark's Nutcracker

The reclamation plan also considers Clark's nutcracker as a focal species. Clark's nutcracker prefers conifer stands with significant pine components for nesting and foraging.

5.1.2.3 Southern Mountain Caribou (Tweedsmuir Herd)

In the higher elevation sections of the mine, TSF beaches, the tops of the Upper and Lower Waste stockpiles, ore stockpile footprints, and infrastructure areas are planned to provide 1,053 ha of ESSFmv1-02 and ESSFmv1-03 site series, the majority of which (663 ha) are 03 site series occurring on TSF beaches. The ESSFmv1-03 site series is more densely forested with less lichen than the ESSFmv1-02 and thus is a lower quality foraging habitat for caribou but is still expected to provide some foraging opportunities and shelter for caribou, as well as pine to support Clark's nutcracker.

The ESSFmv1-02 is planned for 240 ha of the reclaimed area and of all ESSFmv1 site series, provides the best habitat for lichen, caribou, and whitebark pine (MT 8-5).

Non-reclaimed roads present a risk to caribou as they can be used by humans for hunting access and wolves as travel corridors, leading to increased predation. While some roads must be left on the mine site after Closure to facilitate ongoing monitoring and management, any reclaimed roads are planned to be revegetated as quickly as possible. Revegetation will use till-dominated, mixed-parent-material surface soil rather than glaciofluvial surface soil as it has the highest water storage capacity of available reclamation materials and, therefore, is best suited to support quicker revegetation and denser forest coverage. BW Gold also intends to place woody debris on these corridors to facilitate faster revegetation through creation of sheltered microsites, inhibit predator travel, reduce predator sight lines, and enhance protection of caribou (MT 8-16).

5.1.2.4 Rainbow Trout and Kokanee

Rainbow trout and kokanee are focal species and important for traditional land use. Planned fish habitat compensation/offsetting works focus on known limitations to fisheries productivity in the affected watersheds (Palmer 2021a; Palmer 2021b). Compensation measures have been designed to alleviate productivity bottlenecks as well as restore and enhance degraded habitat.

5.1.3 Challenges for Reclaiming Target Ecosystems

This subsection provides primary limiting factors that may affect revegetation success and long-term successional trajectories, and the approaches to address these factors. Two key components for addressing these reclamation challenges are a comprehensive reclamation research program (Section 5.1.4) as well as the rigorous implementation of an ongoing reclamation monitoring program for soil, vegetation, and water (Section 5.1.5).

5.1.3.1 Soils

The potential for unfavourable post-mining soil characteristics is one of the main challenges that can affect reclamation success and successional trajectories. These characteristics can include inadequate soil depth, coarse texture, high bulk density, low moisture availability, low nutrient contents and cycling capabilities, and erosion losses. The ecohydrological model is a quantitative, data-based method to objectively estimate reclamation soil properties (i.e., depth and texture) required to develop target ecosystems, given local climate, ecology, and available soil materials. Using this modelling approach is a key component to ensure reclamation soil covers are capable of supporting the planned vegetation communities in terms of moisture and nutrient availability.

Potential reclamation challenges relating to properties of soil covers will be addressed through reclamation research, ongoing monitoring, and refinement of ecohydrological modelling based on updated information collected through these programs. Soil monitoring (see Section 5.1.5) will be conducted in reclaimed areas to track ecosystem development trajectories over time. Areas identified as potential regeneration/recovery habitat will be based on site suitability and potential success for whitebark pine. Site factors such as well drained mineral soil with less than 30% coarse fragments, soil depth greater than 30 cm, mesic to submesic soil moisture regime, and an absence of detrimental factors such as frost heaving, late season snow presence, and cold air accumulation will also be considered.

5.1.3.2 Post-mining Landforms

Creation of ecological and floristic diversity through reclamation can be challenging but is important to achieving end land use goals of creating self-sustaining ecosystems utilized by wildlife and integrated into the surrounding landscape (MT 15-36 and 16-15). This challenge has been addressed through targeted approaches for the Upper and Lower Waste stockpiles, dam slopes, low-grade ore (LGO) stockpile, roads, and infrastructure pads, as discussed below.

The Upper and Lower Waste stockpiles are the major sloped components on the Post-closure landscape (MT 5-11). These sites have been designed with sigmoidal slopes to create topography similar to natural landforms that will help typical vegetation patterns along soil catenas to be expressed, and reduce erosion, which is a major threat to revegetation success on slopes. Slopes will support a diversity of ecosystems, with the most common being the ESSFmv1-01 (25 ha). Slope gradient and aspect will determine the balance of other ecosystem types: ESSFmv1-03 (18 ha), ESSFmv1-04 (9 ha), and ESSFmv1-02 (< 1 ha). The toes of the stockpile sites are predicted to support mostly wetter ESSFmv1-04 (2 ha) with lesser amounts of ESSFmv1-01 (< 1 ha) and ESSFmv1-03 (< 1 ha).

Soil placement and preparation for planting will be done in a manner that minimizes compaction and leaves surfaces uneven. Woody debris will be used strategically on dump sites to restrict corridors for predators to access, move within, and see across stockpile-top caribou habitat, as well as create sheltered microsites for vegetation establishment and provide erosion control on sloped areas. Reclamation trials are planned for the Lower Waste Stockpile and near the existing camp site, where both glaciofluvial and mixed-soil cover systems and their associated revegetation prescriptions can be tested with findings feeding into subsequent reclamation of waste stockpiles. Of particular interest for these trials will be strategies for lichen establishment and whitebark pine planting on plateau and upper crest areas, as well as the use of woody debris to facilitate quicker revegetation and reduce erosion (MT 11-18).

Dam reclamation presents an unavoidable challenge for the re-establishment of pre-mine ecosystems. These challenges relate to the requirement to maintain dam geotechnical stability that preclude landforming (i.e., slopes will be planar although non-planar microsites may be possible) and the restriction on re-establishing trees and deep-rooted shrubs. The proposed revegetation species for dams are based primarily on compatibility with ensuring slope stability, erosion control, and ability to inspect rather than creation of habitat value. Although native shrubs will be included in the revegetation of dams, the ecosystems that will be supported are not analogous to those present on the site prior to mining. As outlined in Section 5.1.1.3, 150 ha of these novel Grass-Shrub ecosystems are predicted for dams.

By the end of mine life, the LGO stockpile will be milled, fully exhausting all remaining ore, and its footprint will require reclamation. The liner beneath the stockpile components will be removed and disposed of in accordance with the RCP. The site will be covered in 50 cm of glaciofluvial surface soil and is expected to support the ESSFmv1-02 site series (117 ha), which is lichen-rich, open-forest caribou habitat, and ESSFmv1-03 (6 ha). Revegetation species for these site series are detailed in the RCP. Landforming will be completed in a manner that creates continuity with the surrounding landscape, and the contours of the underlying landscape should be utilized to create heterogeneous landform features, such as undulations, swales, berms, and mounds, in order to break predator sightlines and to create microsites to encourage vegetation diversity. Irregular placement of woody debris across the area is expected to similarly enhance ecosystem diversity, inhibit use by predators, and create sheltered microsites to boost revegetation success (BW Gold 2022a).

As much as operationally feasible, the LGO stockpile footprint will be progressively reclaimed as ore is milled. This will offer opportunities to develop methods for liner removal and site preparation and soil placement to efficiently create landform diversity, and to assess and adjust planting prescriptions for subsequent reclamation. Additionally, the use of glaciofluvial covers to create caribou habitat, will be tested in progressive reclamation and research trials near the existing exploration camp (ESSFmv1) and in the vicinity of the FWR (SBSmc3) beginning in the first few years of the mine life, which will help to refine reclamation plans for the LGO stockpile (see Section 5.1.4).

Further opportunities for landforming are intended to be pursued, where possible, as facilities are built. Topographical features on the scale of a few metres (mesotopography) to create landscape diversity are not featured in design at this stage of Project planning but can be implemented during construction and decommissioning, particularly on level and gently sloping areas, such as roads or camp and infrastructure areas, where geotechnical stability and erosion are not of concern.

5.1.3.3 Succession

For vegetation succession, the primary challenge is the presence of weedy, invasive, and persistent non-native species, particularly perennial agronomic grasses, which can outcompete native species and prevent desired successional patterns. To avoid this outcome, native species have been selected for use during revegetation with a preference toward trees, shrubs, and herbs, with limited use of grasses (MT 3-20, 4-6, 5-18, 6-7, 7-8, 8-5, 9-7, 9-25, 10-9, 11-8, 15-28). The Invasive Plant Management Plan and Post-closure monitoring plan have been developed to monitor and treat undesired plant species should they occur on the site. In addition to the planned revegetation research trials (Section 5.1.4), the reclamation monitoring program will provide information on establishment of native vegetation and initiation of desired successional trajectories, with results informing implementation of maintenance and adaptive management measures.

Additional vegetation succession challenges may result from dependency of certain species (e.g., black huckleberry [*Vaccinium membranaceum]*, twinflower [*Linnaea borealis]*) on soil and site conditions associated with later successional stages, such as well-developed soil humus layers and shade from larger vegetation. Vegetation trials will be conducted to assess suitability of target species and adjust the species lists and planting densities (design of vegetation trials will be detailed in the RCP).

5.1.3.4 Water Quality – Reclaimed Mine Site and Receiving Environment

The long-term Project-related effects on surface water quality, and loss of instream aquatic habitat and riparian habitat, will limit reclamation targets on the Project site.

The Open Pit will be flooded at closure (see KP 2022). The Pit Lake water levels will be maintained as a groundwater sink through the Post-closure to prevent seepage from leaving the Pit Lake (KP 2022). The mine site water balance and water quality models will be updated with observed water quality as the Pit Lake fills and water management will be updated accordingly (MT 14-24). Current water quality predictions suggest that maintenance of Pit Lake water levels will require treatment of the Pit Lake water at the Membrane WTP prior to discharge to the receiving environment (KP 2022). Reclamation research trials are planned to assess if treatment of Pit Lake *in situ* can reduce the need for water treatment through Post-closure (see Section 5.1.4.4)

Any remaining exposed highwalls of the Pit Lake are exempt from reclamation requirements but will be examined for opportunities to create unique habitat features (MT 6-25, and 14-29). With time, ravelling or small local slope failures will create fine talus slopes that will accumulate on benches. These features may provide habitat to wildlife such as small mammals and birds, in addition to non-vascular plant species. Natural ingress of woody species and slow development of xeric, rock outcrop ecosystems (BGC site unit RO) are expected on any unsubmerged pit highwalls. Limited re-vegetation is proposed given the inaccessibility of these areas, however, helicopter seeding with an appropriate native seed mix suitable for the dry conditions common on these sites will be considered, particularly for areas of exposed overburden. Any riparian areas adjacent to Pit Lake edges will be reclaimed using riparian treatments, and those for grass-shrub ecosystems should be followed for any areas requiring erosion control. Reclamation treatments to establish aquatic vegetation will be developed for any littoral areas associated with the Pit Lake. Trace element uptake in vegetation will be assessed in accordance with the RCP, and qualified professionals consulted to develop management and mitigation plans, as necessary.

The TSF ponds water quality is also predicted to require treatment through Post-closure. However, as summarized in Section 5.1.1.2, water management has been optimized to improve predicted water quality and there will be opportunities to further optimize strategies as Operations proceed and tailings beaches are reclaimed (KP 2022; Lorax 2022). Water will be treated at the Membrane WTP prior to discharge to the receiving environment (plunge pool) via the TSF Spillway. Predicted changes in post-mine surface water quality is summarized in Section 5.1.1.2 (Lorax 2022). Results of water quality modelling suggest that although there are BC and CCME WQG-AL exceedances these are related to naturally elevated background concentrations (i.e., total and dissolved aluminum), as a result of high detection limits for source terms, or exceedances are infrequent and low magnitude. With optimizations to mine site water management (and improvements in water quality) it is anticipated that receiving water quality will also improve in Post-closure.

Recreational or traditional land users may access the reclaimed mine site in Post-closure; thus, signs will be posted to indicate that the consumption of surface water in the TSF and Pit Lake is not advisable during Closure and Post-closure, and that Davidson Creek may not be potable during the months of April and May during Post-closure (MT 15-6).

The YDWL is considered in the Aquatic Effects Monitoring Plan and Mine Site Water and Discharge Monitoring and Management Plan, and the results of those monitoring programs will be used as a basis to confirm and assess aquatic predictions as well as to facilitate updates to the ELUP as warranted.

5.1.3.5 Climate Change

An additional challenge is shifting precipitation, temperature and related growing conditions due to climate change. Climate change modelling of the current and future climatic envelopes in BC has been developed to predict how the BGC units will shift spatially under future climatic regimes across three timeframes (2011 to 2040, 2041 to 2070, 2071 to 2100) (Wang et al. 2016). Since reclamation will occur after a 25-year construction and operation period, the 2041 to 2070 (i.e., 2050s) modelling of BGC units was chosen to identify potential changes in the unit distribution as this is the time period during which most reclamation and early ecosystem succession will occur.

Projections for the study area indicate that, in comparison to the historical 1961 to 1990 normal, expected conditions in the 2041 to 2070 period include warmer temperatures (in the range of 1 to 3 ˚C in all seasons) and increased precipitation (in the range of 5 to 15% in each season) (Wang et al. 2016).[10] Predictions of lesser snowpacks in the future (and the corresponding decrease in meltwater runoff during the spring) will be offset to some degree by the expected increase in precipitation during the growing season. The climate modelling predicts that the Project areas currently mapped as SBSmc3 and ESSFmv1 will have a regional climate more similar to the SBSdk and SBSmc2, respectively (Wang et al. 2016). The ESSFmvp on Mount Davidson will be replaced by the ESSFmv1, beginning close to the upper elevation extent of the mine disturbance footprint (Figure 5.1-7). These shifts in climate envelopes have particular relevance to whitebark pine that occur on Mount Davidson where increases in annual temperature will result in increased tree density and competition.

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[10] Modelled climate data obtained from http://www.climatewna.com based on the methods of Wang et al. (2016). Differences between historical conditions and future projections vary according to the elevation of interest and the climate change trajectory (i.e., shared socioeconomic pathway) selected.

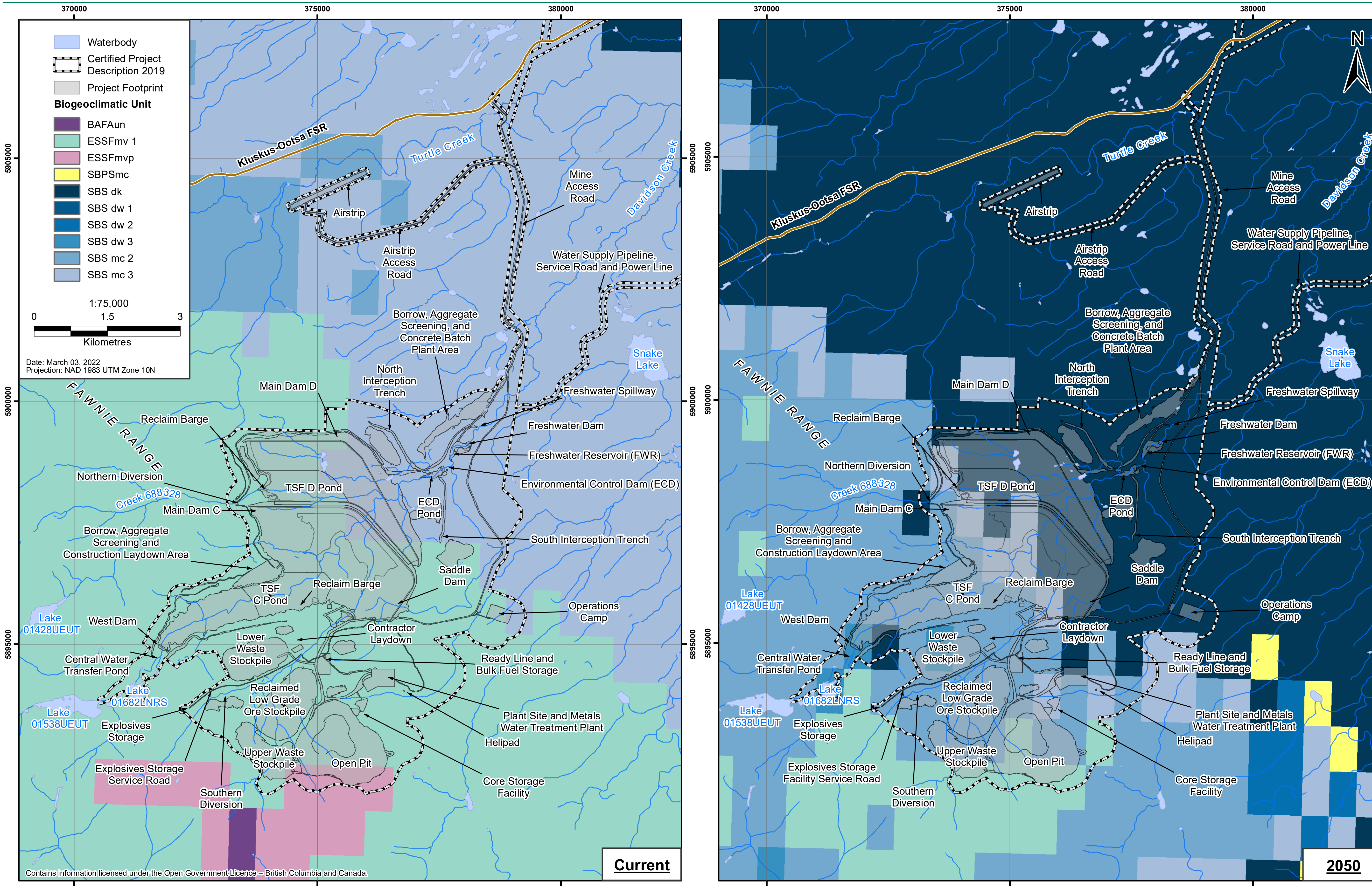

Figure 5.1-7: Predicted Climate Change Effects to Current and 2050 Biogeoclimatic Unit Distribution

The future projected BGC unit distributions for the 2050s (2041 to 2070) were not used to identify reclamation ecosystem targets for Closure. Rather, the current BGC units and site series have been used. This option was chosen as it provides a clearer assessment of changes to current land capability due to mining activities and reclamation practices. This is not considered to be a risk to the validity of the ecohydrological modelling, as the primary outputs from the model are related to relative SMR, which can be transferred to new BGC units as appropriate.[11]

As climate modelling predictions evolve over time and site level predictions become more refined, the ecohydrological modelling and revegetation prescriptions provided in this plan will be updated along with the updates described in Section 5.1.1.2. As detailed mine closure and reclamation planning is developed in the years immediately preceding reclamation (i.e., prior to mine closure, or earlier for any areas of progressive reclamation), climate modelling predictions may have more certainty and may be used in combination with the results of reclamation research on the site in the intervening years to further refine the reclamation practices.

The plant species selected for the reclamation prescriptions (see Section 5.1.4.1 and RCP) were primarily selected because they will contribute to meeting end land use objectives. In addition, they were selected based on drought tolerance for predicted warmer conditions and because they have wide ecological amplitudes which make them suitable for changing conditions. Many of these species also occur in the SBSmc2, which is predicted for much of the upper mine elevations in the 2050s. The species that are exceptions to this include alpine fescue (*Festuca altaica)* and whitebark pine.

Whitebark pine is included in the reclamation prescriptions on sites in the ESSmv1 with SMR classes drier than mesic, as these conditions will reduce competition with other tree and shrub species (McCaughey et al. 2009). If available, rust resistant whitebark pine stock will be used to improve the probability of survival. Whitebark pine occurs in the mine vicinity primarily in the ESSFmvp, as well as in the ESSFmv1. However, as above, climate change projections indicate that the ESSFmvp BGC unit will be mostly lost from the mine site by 2050 (Figure 5.1-7) and conditions in the higher elevations of the SBSmc3 variant may not be as suitable for whitebark pine under future climate conditions. These implications will be considered and accommodated as much as possible in future iterations of the RCP, but some whitebark pine habitat loss appears inevitable due to climate change processes external to the impact of Project development. Considerations to address the shift in climate and potential effects to whitebark pine include the use of whitebark pine to reclaim exploration roads in the ESSmvp in areas that currently do not have whitebark pine.

The influence of potential changes in future climate on surface water and fish and fish habitat reclamation has been considered in the development of the prediction models (water balance and water quality). The capacity of the WTP is expected to be sufficient for treatment of water from the TSF C Pond and Pit Lake under variable climate conditions through Post-closure.

[11] Relative SMR is strictly derived from site and soil characteristics and is explicitly defined as independent of climate. For example, a moderately coarse soil on a moderate slope is always classified as a submesic SMR, no matter the regional or temporal climate, and changing climate does not alter the SMR classification rules in the ecohydrological model. Depending on the climate, this submesic site may support different vegetation communities, which means that the predicted site series and vegetation prescriptions for the Post-closure area may change in time, but, most importantly for this exercise, the site's inherent capability and SMR is unaffected. The fixed nature of the SMR concept allows isolation of the impact of mine development on site capability from the wider effects of climate change.

5.1.4 Reclamation Research

The focus of the reclamation research and monitoring programs is the reduction of reclamation gaps and uncertainties, and testing of reclamation assumptions over time. The objective of these programs is to investigate opportunities to improve the RCP, with the overall intent of refining reclamation and closure designs to meet the end land use objectives (as defined in Section 2). The sequence of the research and monitoring programs starts with the RCP; key reclamation uncertainties and assumptions are identified, and research and monitoring programs are planned—and implemented as early as feasible—to address these key uncertainties and assumptions. Over time, results are evaluated against these key uncertainties: results are interpreted with respect to identified uncertainties, and updates on remaining/new uncertainties and assumptions are provided regularly through the reporting cycle (e.g., in five-year updates). Through this process the amount of information related to reclamation increases over time, and uncertainties are decreased. Thus, reclamation research presented in the ELUP is the initiation of this sequence, there are still uncertainties related to the details of reclamation implementation, but the clear intent is to treat this as an active, iterative and adaptive process.

Table 5.1-7 provides the summary of uncertainties identified, and the approach(es) for addressing these uncertainties. Uncertainties will be addressed through three primary work streams: (1) research trials, (2) monitoring, and (3) off-site work including desktop studies and community engagement. Monitoring is an inherent component of research trials and the monitoring referred to in this context is planned operational monitoring conducted outside of research trials.

As discussed above, reclamation research planning and implementation at the Project will be based on the following process:

- Identify current key gaps, uncertainties, and assumptions in the reclamation plan;
- Develop research and monitoring programs to reduce these uncertainties and test assumptions;
- Interpret research and monitoring results to assess the current state of knowledge;
- Collaborate with local Indigenous nations and regulators to review results and revisit uncertainties on a regular basis (through the Environmental Monitoring Committee, Annual Reclamation Reporting and every five years, updates to the Mine Plan and Reclamation Plan);
- Use results to re-evaluate remaining key uncertainties and assumptions, and revise/renew research and monitoring programs; and
- Regularly and formally update and communicate results in the Annual Reclamation Report and five-year updates to the Blackwater Mine Plan and Reclamation Plan.

The following subsections provide an overview of the reclamation research program and the reclamation research studies proposed to address uncertainties. The RCP will provide detailed methodology for the programs. Item numbers from Table 5.1-7 are referenced to link the various research trials with identified uncertainties. Research trial results will be presented in Annual Reclamation Report and incorporated into future reclamation planning. BW Gold will continue to look for additional opportunities for progressive reclamation during the life of mine and will describe these in subsequent revisions of the ELUP and RCP.

Table 5.1-7: Uncertainties and Approaches for Addressing

Category	Item No.	Uncertainty	Approach for Addressing Uncertainty
Reclamation materials	1	Properties of overburden and surface soil at baseline and following stockpiling (see parameters in Table 5.1-8)	Monitoring
	2	Available volumes of reclamation materials (i.e., accuracy of baseline mapping and estimates of operational accessibility on which estimates are based)	Monitoring
	3	Concentrations of metals and other elements in overburden and surface soil at baseline, following stockpiling, and over time at reclamation sites	Monitoring
Ecohydrological model/cover design	4	Tailings Storage Facility cover ■ Effectiveness of geochemical barrier ■ Reclamation cover design and vegetation prescriptions	Research
	5	Accuracy of waste and reclamation-cover properties used in modelling	Monitoring
	6	Accuracy of ecohydrological modelling (i.e., if cover designs will achieve the projected SMRs)	Research
	7	Effects of climate change on projected post-closure ecosystems	Desktop (modelling)
Revegetation	8	Additional Traditional Use information that may become available	Engagement
	9	Appropriate seed mix for sediment and erosion control	Monitoring
	10	Appropriate native species revegetation prescriptions that will be successful in primary successional conditions and support end land use objectives	Research
	11	Potential for implementation of an operational-scale seed collection and propagation program	Research
	12	Fertilization requirements	Monitoring
	13	Ability to re-establish lichen	Research
	14	Ability to re-establish whitebark pine	Research
	15	Understanding of successional trajectories	Monitoring
	16	Risk of invasive plant establishment	Monitoring
	17	Detailed plan for creation of ecosystem heterogeneity within ecohydrological model projections (i.e., within areas projected to be a single site series)	Desktop (modelling)
	18	Identify new areas for reclamation research	Desktop

Category	Item No.	Uncertainty	Approach for Addressing Uncertainty
Land capability/ habitats	19	Ability to reclaim ecosystems to achieve the end land use and capability objectives	Research Monitoring
	20	Confirmation of pre-existing habitats through wildlife monitoring outlined in the WMMP	Monitoring
	21	Ability to create drier, low-density forests that support lichen and whitebark pine (for caribou and Clark's nutcracker)	Research Monitoring
	22	Potential of areas for wetland reclamation and appropriate revegetation prescriptions	Monitoring/mapping Research
	23	Potential areas for riparian reclamation	Monitoring/mapping
Water treatment	24	Potential for using wetlands to treat water	Research
	25	Potential for amendments to pit lakes to reduce concentrations of PCOC	Research

Notes:

SMRs = soil moisture regime; WMMP = Wildlife Mitigation and Monitoring Plan; PCOC = Potential Contaminant of Concern

5.1.4.1 Vegetation and Cover Trials

Vegetation and cover trials will test the reclamation prescriptions provided in Table 5.1-8 for projected Post-closure site series (as well as other species identified as important by Indigenous nations) in small-scale trials and will test growing media and cover designs to improve the likelihood of success when these prescriptions are applied at an operational scale. Initial species establishment and ecosystem development will be monitored to identify species that are good operational reclamation candidates and demonstrate that the proposed species will be successful in supporting the end land use objectives for traditional land use by Indigenous nations, and/or self-sustaining vegetation habitats that support wildlife. These research trials will help address uncertainties 6, 10, and 19 in Table 5.1-7.

Table 5.1-8: Revegetation and Cover Research Trial Site Characteristics

Trial Area	Size (ha)	Year Available	BGC Unit	Elevation (masl)	Slope	Slope Position	Aspect
Existing Camp	1.6	Y-2	ESSFmv1-02, 03	1,460	Flat	LV	NA
Lower Waste Stockpile	3	Y+2	ESSFmv1-01, 02, 03, 04	1,420–1,440	Flat, 8–24°	LV, CR, MD, TO	NA, NE, E, SE
Freshwater Reservoir[1]	6	Y+1	SBSmc3-02, 03	1,160–1,175	Flat	LV	NA
North Collection Channel	2	Y+3	ESSFmv1-01, 03	1,290	Flat	LV	NA
TSF Beach Cover	TBD	Y+3	ESSFmv1 (site series TBD)	1,344–1,353	Flat	LV	NA
TSF Wetlands for Vegetation	TBD	Y+2	NA	1,344–1,353	Flat	LV	NA
Whitebark Pine	TBD	Ongoing since 2016	ESSFmv1 / ESSFmvp	1,650–1,740	8-24°	CR	NE, N, SE

Note:

LV = level; CR = crest; MD = mid-slope; TO = toe

[1]*The FWR has a terrace and bench design and is primarily flat areas separated by steep (> 45°) sections.*

Vegetation trials will be an opportunity to assess the feasibility of seed collection programs in areas adjacent to the mine site (ideally with LDN and UFN involvement; uncertainty 11 in Table 5.1-7). Small-scale nursery trials may supplement the field trials described above to test germination and vigour of seedlings grown from collected seed.

The ability of different reclamation cover depths and materials to support vegetation assemblages associated with target site series will also be assessed to validate ecohydrological modelling projections. Different vegetation prescriptions will be paired with varying cover depths and/or materials to support validation and refinement of cover designs. While site preparation methods are not proposed to be explicitly tested, site preparation to reduce compaction and create improved microsites for revegetation will be applied at all sites, with the appropriate site preparation method selected by a qualified professional (as described in the RCP).

Data collected from reference ecosystems as part of the reclamation monitoring program will also be compared to vegetation trial data to evaluate ecosystem trajectories between reclaimed and reference ecosystems at similar seral stages. If recommended species for a given reclaimed ecosystem consistently perform poorly, they will be removed from the prescription for that site series, or reclamation approaches will be adapted to improve species survival (e.g., delaying planting species that require shade until a forest canopy has been established).

Detailed assessment approaches will be developed specifically for each reclamation trial list in Table 5.1-8; however, these will likely include evaluation of soil properties, vegetation species, diversity and abundance, and element concentrations in soils and vegetation. Where possible, assessment of research trials will use methods that are consistent with proposed monitoring methods for operational reclamation areas to facilitate comparison between reclamation areas across the mine (see Section 5.1.5). A summary of each vegetation and cover trial is provided below (and detailed in the RCP).

Existing Camp – This 1.6-ha trial area located near the existing exploration camp will be available for research in Y-2. This trial will provide an opportunity to test the ability of glaciofluvial surface soil to create drier site series that support sparser tree canopies, greater terrestrial lichen cover, and provide caribou habitat (uncertainties 13 and 21 in Table 5.1-7). If trials are trending toward the development of dense conifer stands over time that do not support lichen establishment, tree thinning could be used to provide slow-growing species more time to become established, or other reclamation approaches may need to be investigated to create drier ecosystems, such as decreasing the cover thickness or mixing non-potentially acid generating waste rock with overburden to create a coarser reclamation cover. This trial area will also evaluate if whitebark pine can be grown on site and support ongoing use by Clark’s nutcracker (uncertainties 14 and 21 in Table 5.1.7).

Lower Waste Stockpile – This 3-ha trial location will receive a mixed-mineral surface soil cover, and the bench and slope design of the stockpile will allow testing of multiple ESSFmv1 vegetation prescriptions (01, 02, 03, 04) depending on slope position and aspect. In addition to helping refine cover designs and vegetation prescription for the waste stockpiles, this trial will evaluate:

- Methods for placing overburden to avoid compacting the surface and creating material densities that are not conducive to rooting;
- Whether additional site preparation is required for successful vegetation establishment and erosion control, for example, mounding or using coarse woody debris (CWD) to create microsites for seedlings;
- The ability of the designed covers to create 02 and 03 site series and the success of whitebark pine prescriptions on these sites;
- Whether organic amendments are needed to support vegetation; and
- How the development of vegetation on waste stockpiles influences runoff and infiltration of water into underlying materials.

This trial will commence in Y+2 and be disturbed once reclamation cover-material is required to reclaim final landforms in the Closure phase.

Freshwater Reservoir – Two areas around the FWR provide opportunities for research and are available in Y+1: a borrow area used for construction of the FWR (~3 ha) and a material stockpile from the excavation of the FWR (~3 ha). The FWR trial locations will provide an opportunity to test the ability of glaciofluvial surface soil to create drier site series that support sparser tree canopies and higher lichen cover favoured by caribou (uncertainties 13 and 21 in Table 5.1-7). Whitebark pine will be included in the trial to assess the potential survival and establishment of whitebark pine in the SBSmc3 (uncertainties 14 and 21 in Table 5.1-7). This will provide information on whitebark pine survival given the uncertainties of survival associated with climate change that will affect the ESSFmv1 and parkland.

North Collection Channel – This 2-ha tailings deposition area near the North Collection channel will be used to test the ability of vegetation to establish on a cover of overburden, or overburden and surface soil, placed on NAG waste rock and overburden slurried over PAG tailings (as detailed in the RCP). Vegetation species from the ESSFmv1-03 site series and, to a lesser extent, vegetation from the ESSFmv1-01 site series, will be planted. This trial will commence in Y+3 and be covered by tailings after five years as the TSF fills. However, information from the first phase of this trial will be incorporated into the second phase, which will begin after construction of TSF D is completed and will last through the majority of the Operations phase.

TSF Beach Cover – This research will help address uncertainty 4 in Table 5.1-7 and describes research that will be conducted to demonstrate that the TSF closure strategy will serve to reduce net percolation and oxygen ingress into unsaturated tailings, as well as generate clean runoff (i.e., runoff with water quality characteristics acceptable for discharge to local receiving environments). The functionality of the overburden with respect to preventing oxidation and supporting vegetation needs to be assessed with field studies. Research trials will be conducted to refine design specifications for the cover to be placed on the TSF tailings beaches. It is envisioned that field trials can commence within the first three years of operation upon identification of suitable areas within TSF C and/or upstream of the ECD. Test plots can be initiated once mill tailings become available. Test plots will be installed and monitored to evaluate:

- Net percolation and oxygen ingress with varying depths of overburden thickness;
- Net percolation and oxygen ingress with varying degrees of compaction;
- If vegetation can be planted given observed geochemical conditions;
- If overburden is a suitable growing medium or if application of surface soil and/or other organic amendments is required (this will also inform opportunities for varied soil covers to support ecosystem diversity);
- Revegetation prescriptions (i.e., species selection); and
- Element uptake in vegetation.

The trial will also provide an opportunity to assess trafficability of the tailings and test construction approaches for applying cover material to TSF beaches.

Tailings Wetland Trial – This trial will help address uncertainties 10 and 22 identified in Table 5.1-7. Wetlands and wetter site series are projected to decrease on the post-closure landscape compared to pre-mining. Trials to create such ecosystems on tailings are proposed to occur initially at the greenhouse and/or mesocosm scale, with further research scaled up, if appropriate, depending on the results. The trial will evaluate:

- Geochemical characteristics of the tailings and pore water;
- The potential for tailings to retain sufficient water to support vegetation characteristic of wetlands and or wetter site series (e.g., subhygric to hydric SMRs);
- Revegetation prescriptions; and
- Vegetation element uptake.

5.1.4.2 Whitebark Pine

Trials and monitoring for whitebark pine commenced during exploration work and are scheduled to continue throughout Construction and Operations to inform reclamation practices during closure and provide ongoing assessments of the health of whitebark pine on Mount Davidson. This research is being conducted to help address uncertainty 14 in Table 5.1-7. The ongoing trials and monitoring being conducted on Mount Davidson are listed below (proposed trials that include whitebark pine are discussed in Section 5.1.4.1):

- White Pine Blister Rust Monitoring - The data collected in the inventory plots provides data to support ongoing assessments of stand health and identify changes to whitebark pine health and survival related to white pine blister rust. The transects will be re-measured prior to construction and every five years throughout operations.
- Mountain Pine Beetle Monitoring - Mountain pine beetle (MPB) (*Dendroctonus ponderosae*) incidence will be monitored to inform the use of verbenone patches, if required, and to address effects of the mountain pine beetle on whitebark pine.
- White Pine Blister Rust Resistance Screening Trials - Whitebark pine screening rust trials have been initiated using two separate screening programs to assist in intensive screening.
- Whitebark Pine Reclamation Trials - Reclamation trials were initiated in 2016 on Mount Davidson (Whitebark trial area in Table 5.1-8) to determine the suitability of reclaimed material and soils for whitebark pine reclamation. Planting whitebark pine is proposed during mine reclamation on dry to mesic sites related to mine infrastructure that will be reclaimed in the ESSFmv1. Based on the results of the reclamation and rust screening trials, BW Gold will consider the reclamation potential of historic exploration areas in the ESSmv1 and ESSFmvp for future reclamation work.
- Whitebark Pine On-site Nursery - A whitebark pine nursery will be established either on the mine site or in one of the nearby communities to grow seed collected from the local area and adapted to local climatic conditions. These seedlings will be used in reclamation planting. The location of the nursery has not yet been confirmed.

BW Gold will report on the trials and monitoring and share this information with relevant agencies and stakeholders to ensure that the dissemination of the findings assists in meeting the goals of the *Recovery Strategy for Whitebark Pine in Canada* (ECCC 2017). During monitoring, additional factors affecting whitebark pine will be noted, such as mountain pine beetle attacks. Reporting will be included in the Annual Reclamation Report.

5.1.4.3 Use of Wetlands to Treat Water

Research planned to investigate if wetlands can be used for Post-closure water treatment will help address uncertainty 24 in Table 5.1-7. Although a specific area has not yet been designated for reclamation research, wetland trials will be conducted within TSF C and upstream of the ECD during operations to assess:

- The ability of wetland systems to remove potential contaminants of concern (PCOCs);
- The uptake of PCOCs by wetland vegetation;
- Operational costs for managing wetlands; and
- Hydrologic and hydraulic limitations for wetland treatments.

Laboratory trials can commence during early operations once tailings pond supernatant becomes available. Field trials can commence within first three years of operation in suitable area(s) identified within TSF C and/or upstream of the ECD. Results from research trials will help guide the approach to constructing both passive treatment wetlands and habitat-focused wetlands on the post-closure landscape.

5.1.4.4 Pit Lake Water Treatment

Research is planned to assess if treatment of Pit Lake water *in situ* offers a potentially effective means to reduce soluble metal concentrations, thereby reducing loadings to the WTP and local groundwater system through seepage pathways. This research will address uncertainty 25 in Table 5.1-7. In-pit treatment may be conducted during the filling period and/or in the long-term (when the pit is at maximum operating water level). The proposed closure water management strategy includes treating pit lake water before it is discharged to Davidson Creek and managing the pit lake surface water elevation. In the long term, Pit Lake water treatment will reduce reliance on the membrane WTP. The objective of this research will be to demonstrate if and how amendments can be added to the Pit Lake to reduce concentrations of PCOCs from the surface layer of the Pit Lake.

In-pit treatment options include both biological and chemical methods. The *in situ* bioremediation of mine site pit lakes typically involves the addition of organic matter and/or nutrients to create conditions conducive to contaminant removal. This form of remediation removes metals from the surface layer through a two-stage process: (1) phase transfer from dissolved to particulate via algal assimilation and/or adsorption to organic surfaces; and (2) particle agglomeration and settling. The *in situ* bioremediation of pit waters has been applied at full scale for a number of sites world-wide to treat a spectrum of metals and metalloids (McCullough 2008; Wielinga 2009). Chemical methods involve the addition of inorganic reagents to promote metal removal through adsorption and/or precipitation. Chemical amendments applied at full scale in pit lakes include lime, ferric salts, and alum (Serediak et al. 2002; Delgado et al. 2016).

The time scales of pit filling (greater than 25 years) offer the ability to conduct field trials during the filling period. Specifically, whole-lake experiments and/or discrete manipulations of the water column using mesocosms could be used to address the following:

- The ability of algae to proliferate in response to nutrient addition;
- The magnitude of metal removal in response to biological and chemical amendments;
- The best means to distribute the amendment to the Pit Lake; and
- The potential for generation of harmful by-products in response to in situ treatment.

Field trials can commence within the first three to five years in the Post-closure phase once a pit lake of suitable size has formed. Results from research trials will help guide the approach to inform the design and merits of full-scale application.

5.1.5 Reclamation Monitoring

The primary objective of the reclamation monitoring program is to track reclamation development trajectories over time and compare these trajectories to selected success criteria based on data from reference ecosystems.

Details of the monitoring plan, including criteria and indicators of reclamation success and associated measures and thresholds will be developed as more detailed reclamation planning and implementation is conducted, and based on ongoing collaboration with Indigenous nations. The reclamation research and monitoring programs are outlined below and detailed in the RCP.

5.1.5.1 Reclamation Material Monitoring during Salvage and Stockpiling

Physical properties of mine waste (e.g., tailings and waste rock) and reclamation-materials (e.g., salvaged soil and overburden) will be determined through *in situ* sampling. Ongoing sampling of reclamation-material stockpiles during salvage will assist in capturing the range of variability in material properties.

These data will be used to update the ecohydrological modelling and, if necessary, re-evaluate reclamation cover designs and the reclamation-material balance.

5.1.5.2 Permanent Sample Plots

To assess the success of reclamation and compare the trajectory of reclaimed sites relative to baseline and reference conditions, permanent sample plots will be established on site in reclaimed areas and at reference locations offsite.

Permanent sample plots will be installed in reclaimed areas as soon as they are established to track ecosystem development over time. Reference plots will be installed early in the Operation phase to support the development of success criteria to evaluate reclamation on the mine site. The site series projected to occur on the post-closure landscape will be targeted for reference locations. Site selection will target recently disturbed reference sites, where possible, to provide insight on successional trajectories.

On-site plots will be visited following reclamation in Year +1, +2, +3 and +5 and every five years thereafter, to capture potential rapid changes in vegetation during early establishment, allow for early intervention if required, and measure vegetation development trajectories over time. Reference sites will be visited at 5-year intervals. Monitoring will continue in Post-closure until monitoring criteria have been achieved and agreed-upon reclamation objectives met.

The following data will be collected at each permanent sample plots:

- Site characteristics (elevation, aspect, coordinates, etc.)
- Soil profile description and sampling
- Vegetation cover
- Forest characterization
- Soil and forage tissues chemical composition

A detailed description of measures that could be assessed and used to develop reclamation success indicators is provided in Appendix D.

5.1.5.3 Water Quality Monitoring

The Mine Site Water and Discharge Monitoring and Management Plan and Aquatic Effects Monitoring Program describe water quality monitoring during the Construction, Operations, Closure, and Post-closure phases, which will provide (or will be refined to provide) an evaluation of the effectiveness of reclamation activities.

5.1.5.4 Trace Element Uptake in Soils and Vegetation

Monitoring of trace element uptake in soils and vegetation during the Construction, Operations, and Closure phases will include sampling programs both within the mine site as part of the Reclamation Monitoring Program and in areas surrounding the mine site. The objectives of the trace element monitoring in soil and vegetation are described below.

For the reclamation monitoring program (within the mine site):

- To establish baseline concentrations of trace elements in cover materials recently placed in reclaimed areas of the mine site;
- To monitor potential effects of windblown dust transported from mine-related dust sources on the concentrations of elements in soil and vegetation in reclaimed areas; and

- To determine the degree to which metals accumulate in specific plant species proposed for use in reclamation, with the intent to use these data to guide the selection of appropriate species for use in revegetation during reclamation and closure.

For the outside of the Project boundary for the purpose of the Country Foods Monitoring Program (CFMP):

- To determine whether concentrations of metals have changed in soil or vegetation tissue because of Project activities; and
- To determine whether concentrations of metals measured in the future are within the range expected based on predictive modelling completed to support the HHRA.

For both programs:

- To determine if the metal concentrations measured in soil or vegetation will be suitable for achieving end land use objectives; and
- To confirm that metal concentrations measured in soil or vegetation tissue will not adversely affect vegetation, wildlife, or human health.

The objectives listed above will be achieved by robust soil and vegetation sampling programs as defined in the RCP. Soil samples will be collected from the surface and at regular intervals down the soil profile when the permanent sample points are initially established, with further soil samples collected as required to characterize any dust deposition. Target vegetation species will be synchronized between reclaimed areas and outside the mine site boundary where possible and/or selected based on evidence of wildlife browsing.

Results and adaptive management responses for sampling within the mine site will be reported in the Annual Reclamation Report in each year that data are collected, while sampling outside of the Project boundary will be reported in the CFMP reports.

5.1.6 Adaptive Management Framework

The ELUP is a living document that will evolve over time in response to monitoring and research trial results and findings and regulatory changes. Adaptive management is a tool that is used within all stages of the Project based on analysis using the best available information or during the life of the Project. The ELUP incorporates adaptive management as follows:

- **Plan –** Use the results of analysis or monitoring to inform the need to adjust reclamation activities. Adaptive management measures to meet reclamation success criteria and end land use objectives are expected to come out of several activities listed in the ELUP including but not necessarily limited to:
  - Reclamation Research
  - Reclamation Monitoring
- **Do –** Once an activity has been identified and planned it will be carried out to determine what information can be gained and applied to updating the ELUP.

  The investigation will involve either a desktop study or monitoring results obtained from an activity or program. The results of the investigation then inform if adjustments are required to improve reclamation and closure initiatives or to avoid ineffective implementation of closure strategies.

  Corrective actions, if needed, are then put in place.

Adaptive management measures are expected to come out of several activities listed in the ELUP including but not necessarily limited to:

- Reclamation Research
- Reclamation Monitoring
- Trace Metal Uptake in Soils and Vegetation and the Monitoring program as part of the CFMP
- Implementation of Habitat Compensation works (see RCP)

- **Monitor –** Monitoring will occur based on the following sections outlined in the ELUP:
  - Reclamation Monitoring
  - Trace Metal Uptake in Soils and Vegetation and the Monitoring program as part of the CFMP

  Follow-up monitoring may also be required to verify the efficacy of additional mitigation measures.
- **Adjust –** A review of the effectiveness of management measures by the EM. Appropriate adjustments to the ELUP will be made according to the research and monitoring findings from the Planning, Doing, and Monitoring Sections outlined above. The ELUP will also be adjusted at least at a minimum on 5-year intervals in alignment with the requirements in the following sections:
  - Reporting and Record Keeping – gathering feedback from Indigenous nations and government agencies on the annual reclamation reports
  - RCP Plan Updates

Additionally, results from Post-closure monitoring programs will be evaluated to assess the effectiveness of the programs to measure if success criteria based on data from reference ecosystems and end land use objectives have been achieved and agreed-upon reclamation objectives are met. As data are collected and analyzed through each monitoring program, an adaptive management framework including triggers for different action levels of responses (none, low, medium, and high) will be developed to guide any required changes. In this manner, the knowledge and application of adaptive management becomes more refined with successive cycles of evaluation.

5.2 Interaction with Other Management Plans

The ELUP is linked to a number of other management plans, primarily through integration of long-term monitoring results (and as input to model updates in the case of water quality) relevant to the refinement of end land use capability, as follows:

- Fish Habitat Compensation Plan:
  - Offsetting plan for unavoidable habitat loss from Project development due to the deposition of mine waste into fish-bearing watercourses.
- Fisheries Habitat Offsetting Plan:
  - Offsetting plan for unavoidable habitat loss from Project development due to impacts to fish-bearing watercourses not associated with deposition of mine waste.
- Country Foods Monitoring Plan:
  - Comprehensive Life of Mine monitoring plan for contaminates of potential concern in environmental media or food.
- Caribou Mitigation and Monitoring Plan:
  - Offsetting plan for caribou habitat loss from Project development; and

  - Progressive reclamation of the existing exploration access road and the Mt. Davidson exploration road, both located within caribou habitat.
- Wildlife Management and Monitoring Plan:
  - Comprehensive Life of Mine (including baseline and pre-construction) wildlife monitoring program to determine wildlife usage.
- Water Quality Management (Mine Site Water and Discharge Monitoring and Management Plan):
  - Mine site water quality and quantity monitoring program, the results of which contribute to WQM updates.
- Wetland Management and Offsetting Plan:
  - Pre-construction wetland surveys and mapping to supplement existing baseline information, and BW Gold's plan to meet federal no-net-loss requirements.

5.3 Community Engagement

Community engagement is a key pillar of end land use planning, and BW Gold will implement a number of tools to facilitate continued refinement of this plan. Beginning in early Operations (approximately Year 3) BW Gold will initiate a focused engagement campaign to solicit further input from Indigenous nations prior to the first cyclical revision to the ELUP in Year 5 (see Section 7). The engagement tools that BW Gold may implement during this engagement period include:

- Community meeting(s);
- Mine tour(s);
- Face-to-Face or electronic survey(s); and
- Technical workshop(s).

Depending on the success and utility of previous engagement campaigns, similar events may be planned for subsequent ELUP update periods based on availability of new relevant information or at the community's request.

5.4 Schedule

The ELUP is a 'living document'; a long-term commitment by BW Gold to actively collaborate with Indigenous nations on end use planning for the mine site. The ELUP is primarily applicable to the Project's Construction and Operation phases. During these phases BW Gold will implement planning aspects of the ELUP such as community engagement and model updates based on reclamation research results and operational data. These activities will be used to refine and update the ELUP during Operations (see Section 7). Toward the end of Operations, once the ELUP has been fully developed, it will inform a final RCP that will be implemented during Closure.

6. REPORTING AND RECORD KEEPING

Reporting and record keeping will continue as per conditions in federal and provincial authorizations and regulatory requirements. The EM will be responsible for maintaining compliance and training records. The records will be made available upon request.

As required by EAC Condition 5, compliance self-reports will be submitted to EAO and Indigenous nations within the following timelines as follows:

a. At least 30 days prior to the start of Construction;

b. On or before March 31 in each year after the start of Construction;

c. At least 30 days prior to the start of Operations;

d. On or before March 31 in each year after the start of Operations;

e. At least 30 days prior to the start of Closure;

f. On or before March 31 in each year after the start of Closure until the end of Closure;

g. At least 30 days prior to the start of Post-closure; and

h. On or before March 31 in each year after the start of Post-closure until the end of Post-closure.

7. PLAN REVISION

The ELUP is a living document and updates, as warranted, will coincide with the five-year Mine Plan and Reclamation Program submissions. Potential drivers of revision will include:

- Changes to regulatory requirements (ex. permit conditions);
- Updates to the mine plan, in particular changes to footprint over time;
- Reclamation research results;
- Progressive reclamation monitoring;
- Updates to the ecohydrological model; or
- Community engagement results.

Revisions to the ELUP will be completed in consultation with EMPR, ENV, FLNRORD, and Indigenous nations, unless otherwise authorized by the EAO. Revised versions of the plan will be filed with EAO, EMLI, ENV and FLRNORD, and provided to Indigenous nations. The ELUP, and any amendments thereto, must be implemented to the satisfaction of Qualified Professionals throughout Construction, Operations, Closure, and Post-Closure, and to the satisfaction of the EAO.

8. QUALIFIED PROFESSIONALS

This management plan has been prepared by, or under the direct supervision of, the following qualified professionals:

Rolf Schmitt, P.Geo.
ERM Consultants Canada, Ltd.

Justin Straker, M.Sc, P.Ag.
Integral Ecology Group

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APPENDIX A CONCORDANCE TABLE WITH ENVIRONMENTAL ASSESSMENT CERTIFICATE #M19-01 CONDITIONS (JUNE 21, 2019)

Condition	Condition	Location in Plan
Condition 2 (Plan Development)	Where a condition of this Certificate requires the Holder to develop a plan, program or other document, any such plan, program or other document must, at a minimum, include the following information: a) purpose and objectives of the plan, program or other document;	Section 2
	b) roles and responsibilities of the Holder and Employees;	Section 3
	c) names and, if applicable, professional certifications and professional stamps/seals, of those responsible for the preparation of the plan, program, or other document;	Section 8
	d) schedule for implementing the plan, program or other document throughout the relevant Project phases;	Section 5.4
	e) means by which the effectiveness of the mitigation measures will be evaluated including the schedule for evaluating effectiveness;	Table 4.2-1 (Proposed Mitigation Measures Addressed in the End Land Use Plan) See sections 5.1.1.3, 5.1.2, and 5.1.3 for evaluation of effectiveness and schedule is provided in Section 5.1.5.
	g) schedules and methods for the submission of reporting to specific agencies, Aboriginal Groups and the public and the required form and content of those reports; and	Section 6
	h) process and timing for updating and revising the plan, program or other document, including any consultation with agencies and Aboriginal Groups that would occur in connection with such updates and revisions.	Section 7
Condition 3 (Adaptive Management)	Where a condition of this Certificate requires the Holder to develop a plan, program or other document that includes monitoring, including monitoring of mitigation measures or monitoring to determine the effectiveness of the mitigation measures, the Holder must include adaptive management in that plan. The objective of the adaptive management is to address the circumstances that will require the Holder to implement alternate or additional mitigation measures to address effects of the Project if the monitoring shows that those effects: a) are not mitigated to the extent contemplated in the Application; b) are not predicted in the Application; or c) have exceeded the triggers identified in paragraph g) of this condition. The adaptive management in the plan must include at least the following: a) the monitoring program that will be used including methods, location, frequency, timing and duration of the monitoring;	See Section 5.1.6, Adaptive management measures to meet reclamation success criteria and end land use objectives are expected to come out of several activities listed in the ELUP.

Condition	Condition	Location in Plan
Condition 3 (Adaptive Management; *cont'd*)	b) the baseline information that will be used, or collected where existing baseline information is insufficient, to support the monitoring program;	Section 5.1.1.1
	c) the scope, content and frequency of reporting of the monitoring results;	Section 5.1.5
	d) the identification of qualitative and quantitative triggers, which, when observed through monitoring required under paragraph d), will require the Holder to alter existing, or develop new, mitigation measures to avoid, reduce, and/or remediate effects;	A detailed description of measures that could be assessed and used to develop reclamation success indicators is provided in Appendix D. As data are collected and analyzed through each monitoring program, an adaptive management framework including triggers for different action levels of responses (none, low, medium, and high) will be developed to guide any required changes.
	e) the methods that will be applied to detect when a numeric trigger, or type or level of change referred to in paragraph g), has occurred;	
	f) a description of the process for and timing to alter existing mitigation measures or develop new mitigation measures to reduce or avoid effects;	
	g) identification of the new and/or altered mitigation measures that will be applied when any of the changes identified in paragraphs a) to c) occur, or the process by which those will be established and updated over the relevant timeframe for the specific condition;	
	h) the monitoring program that will be used to determine if the altered or new mitigation measures and/or remediation activities are effectively mitigating or remediating the effects and or avoiding potential effects; and	
	i) the scope, content and frequency of reporting on the implementation of altered or new mitigation measures.	
	j) identification of the new and/or altered mitigation measures that will be applied when any of the changes identified in paragraphs a) to c) occur, or the process by which those will be established and updated over the relevant timeframe for the specific condition;	
	k) the monitoring program that will be used to determine if the altered or new mitigation measures and/or remediation activities are effectively mitigating or remediating the effects and or avoiding potential effects; and	
	l) the scope, content and frequency of reporting on the implementation of altered or new mitigation measures. If there are any requirements or mitigation measures required in the plan, program or other document for which adaptive management, or elements of adaptive management listed in paragraphs d) to l) are assessed to be not appropriate or applicable, the plan must include identification of those requirements and measures, and the rationale for that assessment.	

Condition	Condition	Location in Plan
Condition 4 (Consultation)	Where a condition of this Certificate requires the Holder consult a particular party or parties regarding the content of a plan, program or other document, the Holder must, to the satisfaction of the EAO: a) provide written notice to each such party that: i) includes a copy of the plan, program or other document; ii) invites the party to provide its views on the content of such plan, program or other document; and iii) indicates: I. if a timeframe for providing such views to the Holder is specified in the relevant condition of this Certificate, that the party may provide such views to the Holder within such time frame; or II. ii. if a timeframe for providing such views to the Holder is not specified in the relevant condition of this Certificate, specifies a reasonable period during which the party may submit such views to the Holder; b) undertake a full and impartial consideration of any views and other information provided by a party in accordance with the timelines specified in a notice given pursuant to paragraph (a); c) provide a written explanation to each such party that provided comments in accordance with a notice given pursuant to paragraph (a) as to: i) how the views and information provided by such party to the Holder have been considered and addressed in a revised version of the plan, program or other document; or ii) why such views and information have not been addressed in a revised version of the plan, program or other document; d) maintain a record of consultation with each such party regarding the plan, program or other document; and e) provide a copy of such consultation record to the EAO, the relevant party, or both, promptly upon the written request of the EAO or such party. The copy of such consultation record must be provided to the EAO, relevant party, or both, no later than 15 days after the Holder receives the request for a copy of the consultation record, unless otherwise authorized by the EAO.	A draft of the ELUP was provided as part of Chapter 4 (Reclamation and Closure) of the joint *Mines Act*/EMA permit application to Indigenous groups on September 19, 2021 and to the MRC (including EMLI, ENV, FLNRORD and Indigenous groups) for review and comment on November 29, 2021. The ELUP was subsequently provided to EAO, EMLI, ENV, FLNRORD and Indigenous groups on December 20, 2021. Comments on Chapter 4 (that included the ELUP) were received from LDN and UFN on October 21, 2021 and from the CSFNs on October 27, 2021. A tracking table with responses to these comments was provided to Indigenous groups for review on November 30, 2021 and subsequently to EAO, EMLI, ENV, FLNRORD and Indigenous groups on December 20, 2021. The comments received from parties were considered in developing version (A.1) of the ELUP. Review comments received from LDN and UFN on June 6 and July 22, 2022 and from the CSFNs on June 6, 2022 were considered in developing version (B.1) of the ELUP. Screening review and comment is ongoing.

Condition	Condition	Location in Plan
Condition 25 (End Land Use Plan)	The Holder must retain one or more QPs to develop an End Land Use Plan, consistent with Section 10 of the Health, Safety and Reclamation Code for Mines in British Columbia (June 2017, or as updated or replaced from time to time) at a minimum, for all disturbance areas within the Project Area, in consultation with EMPR, ENV, FLNRORD, and Aboriginal Groups. a) The plan must include at least the following: a definition and description of the pre-mining land and water capability and land and water use conditions, using maps and tabular inventories, with respect to ecosystems and habitats and other uses in the area of the Project Area disturbances;	Section 5.1.1.1
	b) a definition and description of the predicted Post-closure land and water capability and land and water use conditions (based on changes that are expected to occur to topography and soil conditions due to mine development), using maps and tabular inventories, with respect to ecosystems and habitats, ability to exercise Aboriginal Interests and other uses for the Project Area disturbances;	Section 5.1.1.2 Section 5.1.1.3
	c) modelling, or other planning exercises, to reconcile or minimize differences between the pre-mining conditions (as per paragraph a) and post-mining projections (as per paragraph b) accounting for, but not limited to, Project design, terrain profiling and contouring, and optimization of soil conditions;	Section 5.1.1
	d) documentation of the forecasted net changes in land capability between pre- and post-mining conditions and how any opportunities to improve land capability from its previous state were considered and incorporated;	Section 5.1.1.3
	e) incorporation of mitigation targets related to valued components examined in the Application, including but not limited to wildlife and wildlife habitat, vegetation, and ecosystems, and monitoring for those targets;	Table 4.2-1 (Proposed Mitigation Measures Addressed in the End Land Use Plan) See sections 5.1.1.3, 5.1.2, and 5.1.3 for incorporation of mitigations and Section 5.1.5 for Reclamation Monitoring
	f) how the plan will take into consideration the Caribou Mitigation and Monitoring Plan (Condition 22), Wildlife Management and Monitoring Plan (Condition 23), Water Quality Management (Condition 26), and Wetland Management and Offsetting Plan (Condition 24); and	Section 5.2
	g) consideration of how water quality may affect the Holder's ability to achieve the end land use.	Section 5.1.1.2 Section 5.1.3.4

Condition	Condition	Location in Plan
Condition 25 (End Land Use Plan; *cont'd*)	The Holder must provide the draft plan that was developed in consultation with EMPR, ENV, FLNRORD, and Aboriginal Groups to the EAO, EMPR, ENV, FLNRORD, and Aboriginal Groups for review a minimum of 60 days prior to the planned commencement of Construction or as listed in the Document Submission Plan required by Condition 10 of this Certificate.	A draft of the ELUP was provided as part of Chapter 4 (Reclamation and Closure) of the joint *Mines Act*/EMA permit application to Indigenous groups on September 19, 2021 and to the MRC (including EMLI, ENV, FLNRORD and Indigenous groups) for review and comment on November 29, 2021. The ELUP was subsequently provided to EAO, EMLI, ENV, FLNRORD and Indigenous groups on December 20, 2021.
	The plan, and any amendments thereto, must be implemented to the satisfaction of the QP throughout Construction, Operations, Closure and Post-closure, and to the satisfaction of the EAO.	Section 7

APPENDIX B RECLAMATION AND CLOSURE PLANNING FOR WILDLIFE

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Memo

To	Travis Desormeaux, Artimis Gold
From	Lis Rach, E.P. Bio, ERM
Date	24 November 2021
Reference	0575928-0014
Subject	Reclamation and Closure Planning for Wildlife

This memo provides an overview of the existing wildlife communities at the Blackwater site, and provides wildlife habitat considerations for the Blackwater Reclamation Plan V2.

1. INTRODUCTION

By focusing on creating an environment conducive to the establishment and persistence of a wildlife community, we can reclaim sites that are more likely to function naturally. With an understanding of the sites and systems within the current landscape, we can replicate their structure and composition to facilitate the establishment of self-sustaining vegetation communities. It is these communities that will foster the return of functioning habitat communities.

This document provides a framework for designing the ecosystems at closure by:

- Identifying representative species on the project site and providing an overview of habitat requirements (Table 1);
- Describing the current vegetation communities (using Biogeoclimatic Classification (BGC) subzones) on the project site in detail and how wildlife are using these communities; and
- Setting the objectives and describing reclamation of each subzone at closure (Table 2). Objectives are defined as the representative species present in these subzones pre-mine. The high-level vegetation and management prescriptions are then listed to meet these objectives.

Table 1: Overview of Wildlife Representative Species and Habitat Requirements

Species	Representative Species	Reason	Habitat Requirements
Caribou	Woodland caribou (*Rangifer tarandus caribou*)	SAR, cultural	Mature and old coniferous forests, parkland, wetlands, mineral licks
Bears	Grizzly bear (Ursus arctos)	SAR, cultural	Mature and old forests, parkland-subalpine, riparian
Moose	Moose (*Alces americanus*)	Cultural	Wetlands, ponds, riparian areas, semi-open young forests and closed canopy mature forests, mineral licks
Furbearers (marten, beaver, fisher, wolverine)	American marten (*Martes americana*) and American beaver (*Castor Canadensis*)	Ecological, cultural, as well as the economic importance	Old forests, riparian
Raptors (short-eared owl, red-tailed hawk)	Red-tailed hawk (*Buteo jamaicensis*)	Indicator species	Coniferous forest – late successional in close proximity to wetlands, burns, clearcuts
Forest/Grassland Birds	Olive-sided flycatcher (*Contopus cooperi*) / Clark's nutcracker (*Nucifraga columbiana*)	SAR, indicator species	Forest habitat consisting of mid to late successional coniferous forest in close proximity to wetlands, burns, or clearcuts / whitebark pine habitats
Bats	little brown myotis (*Myotis lucifugus*)	SAR, indicator species	Riparian, forests – old, wildlife trees
Waterbirds (ring-necked duck, yellow rail, Wilson's snipe, greater yellowlegs, horned grebe)	Ring-necked duck (*Aythya collaris*) and yellow rail (*Coturnicops noveboracensis*)	Indicator species, SAR	Wetland, riparian, shallow water
Amphibians	Western toad (*Anaxyrus boreas*)	SAR	Wetlands, shallow water, streams, riparian
Invertebrates (butterflies and dragonflies)	Jutta artica (*Oeneis jutta chemocki*), American emerald (*Cordulia shurtleffii*)	Indicator species, SAR	Wetlands, shallow water, streams, riparian

Note:

Indicator species list includes species of interest listed in Keefer Ecological Services Ltd. Ulkatcho First Nation and Lhoosk'uz Dené Nation Part C – Blackwater Gold Mine Project - Appendix 2 (April 2019)

Table 2: RCP Ecosystem Summary for Vegetation and Wildlife

BGC Unit	Pre-disturbance Ecosystems							Projected Post-Closure Ecosystems							Mine Features	Research
	Site Series	SMR/SNR	Area (ha)	Representative spp.	Community Members	Key Habitat Features and Vegetation spp.	Reclamation Objective spp.	Area (ha)	Focal spp.*	Other Reclamation Considerations	Initiation (Structural Stages 1-3, Sparse - Shrub/Herb)	Short-term (Structural Stages 4-5, Young Forest)	Medium-term (Structural Stage 6, Mature Forests)	Long-term (Structural Stage 7, Old Growth Forest)		
ESSFmv1	02	1, 2/A, B	217.1	caribou, grizzly bear, wolverine, olive-sided flycatcher	hare, vole, squirrel	Dry lodgepole pine forest (Subalpine fir, Engelmann spruce) upper-crest; black huckleberry, Sitka alder, common juniper, birch-leaved spirea, dwarf blueberry, bluejoint reedgrass, cladina spp., Stereocaulon spp.; wind swept edge potential	caribou, grizzly bear, wolverine, olive-sided flycatcher	239.7	whitebark pine, lichen spp., black huckleberry, dwarf blueberry	alder spp.	hare, rodents, birds, pollinators	caribou, hare, rodents, birds, Clark's nutcracker	caribou, grizzly bear, wolverine, olive-sided flycatcher	caribou, grizzly bear, wolverine, olive-sided flycatcher	Uppermost portions of Upper and Lower Waste stockpiles; camp and infrastructure areas; upper-elevation borrow areas; Low Grade Ore (LGO) stockpile; TSF beaches	Native spp. Revegetation and Lichen Section 4.2.5.1; Whitebark Pine Section 4.2.5.2 and Section 4.2.6.2
	03	3,4/B, C	237.1	grizzly bear, hare, wolverine, marten, olive-sided flycatcher	hare, vole, squirrel, grouse	Mesic lodgepole pine forest (Subalpine fir, Engelmann spruce); upper slope-level; black huckleberry, rhododendron, subalpine fir, fireweed, twinflower, mosses, no terrestrial lichen; CWD potential; snow interception, boulders	grizzly bear, hare, wolverine, marten, olive-sided flycatcher	813.7	whitebark pine, lodgepole pine, subalpine fir, kinnikinnick, black huckleberry	addition of boulders and CWD to provide structure and denning opportunities	hare, rodents, birds, pollinators	hare, rodents, birds, Clark's nutcracker	grizzly bear, hare, wolverine, marten, olive-sided flycatcher	grizzly bear, hare, wolverine, marten, olive-sided flycatcher	Uppermost portions of Upper and Lower Waste stockpiles; camp and infrastructure areas; upper-elevation borrow areas; Low Grade Ore (LGO) stockpile; TSF beaches; Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; topsoil stockpiles	Native spp. Revegetation and Lichen Section 4.2.5.1; Whitebark Pine Section 4.2.5.2 and Section 4.2.6.2
	01	4/B-D	887.3	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	hare, squirrel, shrews-voles-mice, grouse	Moist fir/Engelmann spruce forest (lodgepole pine); mid-upper slope; black huckleberry, Sitka alder, rhododendron, fireweed; high moss, arboreal lichen spp.; CWD potential; snow interception; security, boulders	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	220.5	subalpine fir, Engelmann spruce, highbush cranberry, black huckleberry	addition of boulders and CWD to provide structure and denning opportunities	hare, rodents, birds, pollinators	hare, rodents, birds, pollinators	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; topsoil stockpiles	Native spp. Revegetation Section 4.2.5.1
	04	5, 6/C, D	74.7	caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	squirrel, rodents	Moist to wet lodgepole pine/Engelmann spruce (Subalpine fir); forest, mid-toe slope and depresions; black twinberry, black huckleberry, black gooseberry, western mountain ash, subalpine fir, arboreal lichen; high herb; CWD; security, boulders	caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	11.8	subalpine fir, spruce, black twinberry, black huckleberry	deciduous tree species; addition of boulders and CWD to provide structure and denning opportunities	hare, rodents, birds, pollinators, western toad	hare, rodents, birds, pollinators	caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	caribou, grizzly bear, moose, marten, olive-sided flycatcher, western toad, bat spp.	Upper and Lower Waste stockpiles; roads; fringes of TSF ponds; topsoil stockpiles	Native spp. Revegetation Section 4.2.5.1
	Wetlands	5, 6, 7	125.9	western toad, waterbirds, rusty blackbird				0								
	New: Riparian areas						moose, grizzly bear, invertebrates, pollinators, songbirds, western toad, bat spp.		spruce, willow spp., black twinberry, cow parsnip, horsetail, sedge spp., bluejoint reedgrass, prickly rose	Invite pollinators; addition of CWD to provide structure	pollinators, grizzly bear, western toad, rodents, birds	pollinators, moose, grizzly bear, western toad, rodents, birds			In areas adjacent to water, where extended periods of water in rooting zone observed (e.g., adjacent to TSF ponds and interception ditches)	Riparian Reclamation Section 4.7.1.1
	New: Grass-shrub (dams)		0	moose, grizzly bear, invertebrates, pollinators, dragonflies, grassland birds, deer		Water, spring feeding for bears, browse for moose	moose, grizzly bear, invertebrates (dragonflies), pollinators, grassland birds, deer	83.6	native grass - shrub spp.		moose, grizzly bear, invertebrates, pollinators, grassland birds	moose, grizzly bear, invertebrates, pollinators, grassland birds	moose, grizzly bear, invertebrates, pollinators, grassland birds	moose, grizzly bear, invertebrates, pollinators, grassland birds	Dams	Grass spp. Section 4.2.2.3

BGC Unit	Pre-disturbance Ecosystems							Projected Post-Closure Ecosystems							Mine Features	Research
	Site Series	SMR/SNR	Area (ha)	Representative spp.	Community Members	Key Habitat Features and Vegetation spp.	Reclamation Objective spp.	Area (ha)	Focal spp.*	Other Reclamation Considerations	Initiation (Structural Stages 1-3, Sparse - Shrub/Herb)	Short-term (Structural Stages 4-5, Young Forest)	Medium-term (Structural Stage 6, Mature Forests)	Long-term (Structural Stage 7, Old Growth Forest)		
ESSFmvp	WW	1	14.8	caribou, Clark's nutcracker, birds, grizzly bear	voles	Krummholz, whitebark pine, lichen spp., security, food, nesting		0								
ESSFmvp	PC	2, 3	12.3	caribou, Clark's nutcracker, birds, grizzly bear	voles	Whitebark pine, crowberry, security, food, nesting		0								
ESSFmvp	FM	3, 4	0	grizzly bear, deer		Feeding for bears in spring/summer	grizzly bear, deer	0.1			grizzly bear	grizzly bear, deer	grizzly bear, deer	grizzly bear, deer		Native spp. Revegetation Section 4.2.5.1
ESSFmvp	FH	5, 6	0.3	caribou, deer, grizzly bearbirds	voles	Krummholz, security, food, nesting		0								
SBSmc3	02	1/A, B	10.2	caribou, grizzly bear, grouse, birds	hare, vole, squirrel	Dry lodgepole pine open forest upper-slope; saskatoon berry, dwarf blueberry, strawberry, kinnikinnick, common juniper	caribou, grizzly bear, grouse, birds	10.6	lodgepole pine, kinnikinnick, common juniper, saskatoon berry, dwarf blueberry		rodents, birds, pollinators	rodents, birds, pollinators	caribou, grizzly bear, grouse, birds	caribou, grizzly bear, grouse, birds	Freshwater Reservoir; lower-elevation borrow areas, mine site access road	Native spp. Revegetation Section 4.2.5.1
SBSmc3	03	2/A, B	276.6	caribou, grizzly bear, grouse, birds	hare, vole, squirrel	Dry lodgepole pine forest upper-slope, crest or level; dwarf blueberry, strawberry, kinnikinnick, soopallalie, common juniper, herbs; high terrestrial lichen cover, windswept	caribou, grizzly bear, grouse, birds	39.6	hybrid white spruce, lodgepole pine, dwarf blueberry, soopolallie		rodents, birds, pollinators	rodents, birds, pollinators	caribou, grizzly bear, grouse, birds	caribou, grizzly bear, grouse, birds	Freshwater Reservoir; lower-elevation borrow areas, mine site access road	Native spp. Revegetation Section 4.2.5.1
SBSmc3	04	3, 4/A, B	37.5	caribou, grizzly bear, moose, marten, fisher, olive-sided flycatcher, grouse	squirrel, rodents, grouse	Mesic lodgpole pine (hybrid spruce) forest mid-upper slope; highbush cranberry, black huckleberry, sitka alder, arboreal lichen spp.; very high herb; CWD; security	caribou, grizzly bear, moose, marten, fisher, olive-sided flycatcher, grouse	2.1	hybrid white spruce, highbush cranberry, soopolallie, black huckleberry	alder spp.	moose, hare, rodents, birds, pollinators, western toad	moose, rodents, birds, pollinators	caribou, grizzly bear, moose, marten, olive-sided flycatcher, grouse	caribou, grizzly bear, moose, marten, olive-sided flycatcher, grouse	Topsoil stockpiles, mine site access road	
SBSmc3	01	4/B-D	122.5	caribou, grizzly bear, hare, wolverine, marten, fisher, olive-sided flycatcher, bat spp.	hare, squirrel, shrews-voles-mice, grouse	Moist hybridspruce/lodgpole pine forest; mid- slope or level; black huckleberry, subalpine fir, highbush cranberry, hybrid spruce, black twinberry, bluejoint reedgrass, dwarf blueberry, trailing raspberry; high moss, arboreal lichen spp.; CWD potential; security	caribou, grizzly bear, hare, wolverine, marten, fisher, olive-sided flycatcher, bat spp.	64.7	hybrid white spruce, lodgepole pine, highbush cranberry, soopolallie, black huckleberry, trailing raspberry		moose, hare, rodents, birds, pollinators, western toad	moose, rodents, birds, pollinators	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp.	Topsoil stockpiles, mine site access road	
SBSmc3	05	3, 4/A, B		caribou, grizzly bear, hare, wolverine, fisher, marten, olive-sided flycatcher, bat spp., western toad		Mesic mixed coniferous forest (lodgepole pine, black spruce, hybrid white spruce) upper slope or level; terrestrial lichen spp., dwarf blueberry, twinflower, crowberry, soopalallie, birch-leaved spirea; CWD; snow interception; security	caribou, grizzly bear, hare, wolverine, marten, fisher, olive-sided flycatcher, bat spp., western toad		hybrid white spruce, lodgepole pine, highbush cranberry, soopolallie, black huckleberry, crowberry		caribou, moose, hare, rodents, birds, pollinators, western toad	caribou, moose, rodents, birds, pollinators	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	Topsoil stockpiles, mine site access road	
SBSmc3	06	5/A, B	6.6	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad		Moist to wet mixed coniferous forest (lodgpole pine, black spruce, hybrid white spruce) lower slope or level; terrestrial lichen spp., black huckleberry, crowberry, dwarf blueberry, twinflower, coltsfoot and other herbs, soopalallie, Labrador tea; CWD; snow interception; security	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	< 0.1	lodgepole pine, black spruce, hybrid white spruce, lichen spp., black huckleberry, crowberry, dwarf blueberry, twinflower, soopalallie, Labrador tea		caribou, moose, hare, rodents, birds, pollinators, western toad	caribou, moose, rodents, birds, pollinators	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad	caribou, grizzly bear, hare, wolverine, marten, olive-sided flycatcher, bat spp., western toad		

BGC Unit	Pre-disturbance Ecosystems							Projected Post-Closure Ecosystems							Mine Features	Research
	Site Series	SMR/SNR	Area (ha)	Representative spp.	Community Members	Key Habitat Features and Vegetation spp.	Reclamation Objective spp.	Area (ha)	Focal spp.*	Other Reclamation Considerations	Initiation (Structural Stages 1-3, Sparse - Shrub/Herb)	Short-term (Structural Stages 4-5, Young Forest)	Medium-term (Structural Stage 6, Mature Forests)	Long-term (Structural Stage 7, Old Growth Forest)		
SBSmc3 *(cond't)*	07	5/C, D	3.3	grizzly bear, moose, rodents, hare, western toad				0								
	Wetlands		71.7	waterbirds, western toad, rusty blackbird, pollinators, dragonflies, moose				0								
	New: Riparian areas		0				moose, grizzly bear, invertebrates, pollinators, songbirds, western toad, bat spp.		spruce, willow spp., black twinberry, cow parsnip, horsetail, sedge spp., bluejoint reedgrass, prickly rose	Invite pollinators; addition of CWD to provide structure	pollinators, grizzly bear, western toad, rodents, birds, bats	pollinators, moose, grizzly bear, western toad, rodents, birds, bats	fisher, moose, grizzly bear, western toad, rodents, birds, bats	fisher, moose, grizzly bear, western toad, rodents, birds, bats	In areas adjacent to water, where extended periods of water in rooting zone observed (e.g., adjacent to TSF ponds and interception ditches)	Riparian Reclamation Section 4.7.1.1
	New: Grass-shrub (dams)		0	moose, grizzly bear, invertebrates, pollinators, grassland birds, deer		Water, spring feeding for bears, browse for moose	moose, grizzly bear, invertebrates, pollinators, grassland birds, deer	64.2	native grass - shrub spp.		moose, grizzly bear, invertebrates, pollinators, grassland birds	moose, grizzly bear, invertebrates, pollinators, grassland birds	moose, grizzly bear, invertebrates, pollinators, grassland birds	moose, grizzly bear, invertebrates, pollinators, grassland birds	Dams	Grass spp. use Section 4.2.2.3

Notes:

Pre-disturbance ecosystems that are not projected to be present post-mine are greyed out.

This table is focused on terrestrial habitats and does not include pre-mine water bodies

Reclaimed areas in the SBSmc3 01, 04, 05, 06, which are all located on soil stockpile footprints, and special ecosystems (e.g., grass/shrubs on dams and riparian ecosystems) are not available until closure and will not have research trials.

** Please refer to Table 4.2-6 of the* Joint *Mines Act/Environmental Assessment Act* Permits Application*. Vegetation Prescriptions for Projected Post-closure Ecosystems for a list of all vegetation spp. included in each BGC and site unit.*

2. OVERVIEW OF REPRESENTATIVE SPECIES

One of the primary objectives of the reclamation program is to re-establish a productive land use that mitigates project effects on wildlife and wildlife habitat, *and* is of value to wildlife. The end land use and capability objectives for the Blackwater project will be based on pre-development site conditions.

Wildlife studies conducted in the Local Study Area (LSA) and Regional Study Area (RSA) have identified current habitat use and important/critical habitats for Valued Components (VCs) and species at risk (SAR) within the project area.

Representative species were chosen because they are a species at risk (SAR), have been identified as culturally important by the Lhoosk'uz Dené Nation or Ulkatcho First Nation, or have been chosen as an indicator species (Table 1).

3. BASELINE ECOSYSTEMS AND WILDLIFE USE

As detailed in the Baseline Vegetation Report, six Biogeoclimatic Ecosystem Classification (BGC) zones occur in the Project LSA. The SBSmc3 and ESSFmv1 are the most abundant subzones, covering nearly 70% of the Project LSA. Other zones found within the mine infrastructure areas (Mine Area, Mine Access Road, Airstrip and the Fresh Water Pipeline) include SBSdk, SBSdw3, SBSmc2 and ESSFmv1p.

3.1 SBSmc3 Kluskus Moist Cold Sub-Boreal Spruce

SBSmc3 is found across the LSA at elevations between 975 and 1,300 m. It is typically cold with a short growing season.

Hybrid white spruce dominates the canopy of the moister and cooler sites with an understory of willows, black gooseberry, sweet coltsfoot, common miterwort and leafy mosses. Moist ecosystems include:

- 06 SbPl – Feathermoss;
- 07 Sxw – Twinberry;
- 08 Sxw – Horsetail; and
- 09 SbSxw – Scrub birch – sedge.

Species characteristic of the warmer, drier subzones include lodgepole pine as the dominant canopy species with an understory consisting of black huckleberry, one-sided wintergreen, bunchberry, heart-leaved arnica and feathermoss. Common juniper, prickly rose, kinnikinnick, black huckleberry, twinflower, dwarf blueberry and lichens are indicative of the drier sites. Drier ecosystems include:

- 02 Pl – Juniper – Dwarf Blueberry; and
- 03 Pl – Feathermoss – Cladina.

Mesic sites typically include hybrid white spruce and lodgepole pine in the canopy with a moderate understory of prickly rose, black twinberry, black huckleberry, highbush cranberry, birch-leaved spirea, hybrid white spruce and subalpine fir. The herb layer is diverse and consists of bunchberry, palmate coltsfoot, heart-leaved arnica, twinflower, one-sided wintergreen, bluejoint, trailing raspberry, dwarf blueberry and fireweed. Mesic ecosystems include:

- 01 Sxw – Huckleberry, 04 Sxw – Huckleberry – Soopolallie; and
- 05 Sb – Huckleberry – Spirea.

3.1.1 Wildlife Use

Ecological factors important for wildlife in this zone are the long snowy winters, the dominance of dense spruce — subalpine fir and pine forests on gently rolling terrain, and the abundance of wetland habitats.

Wildlife inhabiting the SBSmc3 are well adapted to survive its' harsh winters. While moose are the most common large ungulate to occur here, deer and caribou are also adapted to this subzone. Smaller mammals survive the winter by constructing burrows under the snow (e.g., deer mouse) or by travelling on top of the snow (e.g., snowshoe hare). While most birds migrate south in winter, pine grosbeak, boreal chickadee, red crossbill remain year-round. Grizzly and black bear avoid the winter by hibernating.

Sub-boreal coniferous forests are used by moose, mule deer, grizzly bear, black bear, white-tailed deer, spruce grouse, and furbearers such as wolverine, marten, and red squirrel.

Old-growth coniferous forests in this zone provide thermal and hiding cover for moose, as well as early winter habitat for caribou when it is adjacent to the higher elevation Engelmann Spruce — Subalpine Fir zone. These forests also provide abundant habitat and prey for several predators such as the gray wolf, fisher, marten, and ermine. Common prey species include southern red-backed vole, red squirrel, northern flying squirrel and deer mouse. Dry pine-dominated sites provide critical winter habitat for woodland caribou.

Mature coniferous forest provides nesting and feeding habitat for a variety of songbirds. Pine siskin, magnolia warbler, and yellow-rumped warbler all prefer coniferous trees for nesting, while the golden-crowned kinglet feeds on foliage insects, including the spruce budworm. Seeds from cones provide food for birds such as the pine siskin and pine grosbeak, and raptors feed on the rodent populations.

Young seral forests are created through forest canopy removal by logging and burning. These changes to the structure of wildlife habitat change the distribution and abundance of wildlife species. Species, such as snowshoe hare, become more abundant as natural succession proceeds to lodgepole pine and aspen forests, creating dynamic predator/prey relationships (e.g., snowshoe hare and lynx). Species such as porcupine, red crossbill, and spruce grouse occur in this type due to their association with pine.

Some wildlife species benefit from the early successional scrub that develops after disturbance. Moose and deer will browse available forage in these habitats and seek thermal and hiding cover in adjacent habitats. Avian predators that prefer to hunt open areas (e.g., red-tailed hawk, northern hawk-owl and great horned owl) do well in this successional stage due to an abundance of voles and mice.

Riparian areas, wetlands, meadows, floodplains, lakes, and streams are common throughout this zone. Wetlands support high breeding concentrations of aquatic birds such as horned grebe, Barrow's goldeneye, herring gull, and black tern. Moose forage on aquatic vegetation in shallow lakes and swamps, and on the early successional shrubs of active floodplains. Dense deciduous vegetation in riparian areas provides thermal and hiding cover for moose. The wetland and riparian habitats provide important forage for grizzly bear including roots, shoots, and small mammals. These habitats also provide critical breeding habitat for western toad, wood frog and spotted frog, as well as feeding habitat for common garter snake populations. Shrub-dominated wetlands below 1,000 m elevation provide important winter habitat for moose. Wetland habitat also supports furbearers such as beaver and muskrat year round.

3.2 ESSFmv1 Nechako Moist Very Cold Engelmann Spruce – Subalpine Fir

ESSFmv1 is found across the LSA at elevations between 1,150 and 1,550 m. This high elevation subzone is cold with most of the precipitation occurring as snow.

Climax forests are dominated by hybrid white spruce and subalpine fir. Lodgepole pine dominates on drier sites. Black spruce occurs in wetlands and also on upland sites on poor soils in combination with lodgepole pine. Black cottonwood occurs along streams and rivers and is often associated with hybrid white spruce.

The drier subzone is characterized by a sparse to moderate tree, shrub and herb cover, and a moderate to high moss cover. Lodgepole pine is the dominant tree species and black huckleberry, birch-leaved spirea, common juniper, lodgepole pine, subalpine fir and Sitka alder make up the shrub layer. The sparse herb layer is somewhat diverse with twinflower, heart-leaved arnica, one-sided wintergreen bluejoint and dwarf blueberry, the moss Layer is dominated by red-stemmed feathermoss, freckle lichen, juniper haircap moss, reindeer and woolly coral lichens. Drier ecosystems include:

- 02 Pl – Huckleberry – Cladonia.

Mesic sites typically include subalpine fir, Engelmann spruce, (lodgepole pine) in the canopy with moderate shrub and herb layers consisting of Sitka alder, subalpine fir, black huckleberry, white-flowered rhododendron, one-sided wintergreen, twinflower, bunchberry, stiff clubmoss, five-leaved bramble, heart-leaved arnica and Sitka alder. An extensive moss layer consists of red-stemmed feathermoss, knight's plume, freckle lichen and broom moss. Mesic ecosystems include:

- 01 Bl – Rhododendron – Feathermoss; and
- 03 Bl – Huckleberry – Feathermoss.

Engelmann spruce and lodgepole pine (~subalpine fir) occur in the canopy of the moister ecosystems with an understory of black huckleberry, black gooseberry, black twinberry, western mountain-ash and sub-alpine fir. Twinflower, fringed aster, heart-leaved arnica, green, rosy and one-sided wintergreen, palmate coltsfoot, mountain sweet-cicely, five-leaved bramble, Indian hellebore, bunchberry and three-leaved foamflower occur in the herb layer. The moss layer is diverse with 95% cover. The dominant species include red-stemmed feathermoss, knight's plume, curly heron's-bill moss and freckle lichen. Moist ecosystems include:

- 04 Bl – Huckleberry – Gooseberry, 05 Bl – Horsetail – Glow moss.

3.2.1 Wildlife Use

Coniferous forests are used by moose, grizzly bear, wolverine, marten, red squirrel, and grouse. Old-growth coniferous forests in this zone provide early winter thermal and hiding cover for moose and caribou. Moose browse on shrubs and young fir in the subalpine until late fall. Caribou feed on arboreal lichen in the pine - fir stands and accessible terrestrial lichens during the winter.

3.3 ESSFmvp1 Nechako Moist Very Cold Engelmann Spruce – Subalpine Fir Parkland Variant

ESSFmvp1 is found above the ESSFmv1 and occurs up to about 1,740 m. This high elevation parkland variant of the ESSFmv1 subzone is very cold and snowy. Climax parkland stands are dominated by subalpine fir and Englemann spruce on gentle terrain. Krummholz occurs on crests and upper slope positions at higher elevations (1,700 m and above). Understory vegetation in the mesic open forest include pink mountain heather, Sitka valerian, leafy aster, Indian hellebore, mountain sagewort and northern anemone. Dry open forests are dominated by Englemann spruce and pink and yellow mountain heathers. Common juniper, kinnikinnick, crowberry, alpine pussytoes, mountain sagewort, cinquefoils and white-mountain avens are found in the dry, more open forests. Drier ecosystems include:

- 00/FH Subalpine fir – Heather parkland;
- 00/KC Kinnikinnick – Cladonia;
- 00/MH Mountain Heather – Slender hawkweed;
- 00/PC Subalpine fir – Whitebark pine – Crowberry parkland;
- 00/SF Scrub birch – Altai fescue shrub steppe;
- 00/WK Whitebark pine – krummholz;
- 00/WW Whitebark pine – White Mountain avens;
- 00/FB Subalpine fir – dwarf blueberry – dicranum parkland; and
- 00/FC Altai fescue – Cladonia grassland.

Moist units have black huckleberry, Indian hellebore, Sitka valerian, mountain sagewort, heart-leaved arnica and mosses in the understory. Moist ecosystems include:

- 00/VG Sitka valerian – globeflower moist meadow; and
- 00/FM Subalpine fir – Indian Hellebore.

3.3.1 *Wildlife Use*

Caribou use tree-islands, krummholz, lee-slopes and broken terrain for thermal cover in sub-alpine parkland habitats. Caribou feed on terrestrial lichens. Grizzly bear feed on crowberry in late summer and fall, new forbs in spring and early summer and voles year round. Avalanche tracks are high use feeding areas in spring. White-tailed deer graze in the grasslands. The habitat patches in these ecosystems provide thermal and security opportunities and are often used as travel corridors.

4. CLOSURE OBJECTIVES

Table 2 lists the BGC subzones prior to the mine being built, including: representative wildlife species, community member wildlife species, and important vegetation species.

Reclamation objectives (representative species) for each BGC subzone are listed in Table 2. The reclamation prescriptions are also listed: revegetation species and other reclamation considerations. Finally, the wildlife communities that are projected to occupy the reclaimed site as it matures are listed.

To re-establish a productive land use that mitigates project effects on wildlife and wildlife habitat, and is of value to wildlife, the following reclamation considerations are listed:

- Preserve and maintain all possible vegetated areas (trees and shrub communities), wildlife trees and snags within the LSA to create habitat islands and corridors that will facilitate wildlife movement and promote a diverse, multi aged landscape;
- Preserve or replace large boulders in landscapes where they currently exist to provide denning opportunities for grizzly bear and other wildlife species;
- Add coarse woody debris (large logs and stumps) and rock piles as habitat features to reclaimed areas to provide microhabitats and visual breaks for wildlife moving through reclaimed areas;
- Add depressions on level sites and plant species that may foster the production of natural wetland areas to increase the functionality of wildlife habitat communities;
- Alternate dry and moist forests, and add deciduous shrubs and trees where possible to provide wildfire breaks;
- Consider the aspect when re-contouring surfaces to facilitate optimum plant production;
- Use native species that are common in the vicinity for long-term ecosystem function; and
- Plant native deciduous and coniferous tree and shrub species in variable densities and clumps to create habitat patches and forest openings that increase the function of the landscape (corridors, feeding and shelter/security).

APPENDIX C DETAILED POST-CLOSURE MAPPING METHODOLOGY

Appendix C: Detailed Post-Closure Mapping Methodology

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ACRONYMS AND ABBREVIATIONS

A&P	Arya and Paris
AET_{max}	maximum theoretical actual evapotranspiration
Artemis	Artemis Gold Inc.
ASMR	absolute soil moisture regime
AWSC	available water-storage capacity
BC	British Columbia
BEC	Biogeoclimatic Ecosystem Classification
Blackwater or Project	Blackwater Gold Project
BW Gold	BW Gold Ltd.
EAC	Environmental Assessment Certificate
ERM	ERM Consultants Canada Ltd.
ESSF	Engelmann Spruce – Subalpine Fir
ha	hectares
Indigenous Nations	Lhoosk’uz Dené Nation, Ulkatcho First Nation, Nadleh Whut’en First Nation, Saik’uz First Nation, Stellat’en First Nation and Nazko First Nation
IEG	Integral Ecology Group Ltd.
m	metre
McTavish	McTavish Resource & Management Consultants Ltd.
OM	organic matter
PET	potential evapotranspiration
PSD	particle-size distribution
RSMR	relative soil moisture regime
SBS	Sub-Boreal Spruce
S&R	Saxton and Rawls
SMP	Soil Management Plan
SNR	soil nutrient regime
Tfc	field capacity tension

TKN	total Kjehdahl nitrogen
TN	total nitrogen
TOC	total organic carbon
WRC	water-retention curve
WR	waste rock

1. POST-CLOSURE MAPPING

Post-Closure ecosystem mapping was based on information provided by ERM Consultants Canada Ltd. (ERM) and Blackwater Gold LTD. (BW Gold) on Post-Closure facility boundaries and topography, and on the Integral Ecology Group (IEG) Quantitative Ecohydrologic Analysis (QEA) model for estimating ecohydrologic conditions on post-mine landscapes (Baker et al. 2020). Post-mine ecohydrological analysis used reclamation cover-placement depths consistent with geotechnical and geochemical design parameters, but adjusted where possible to optimize the return to pre-mine conditions. The sequence of this analysis and mapping was as follows:

1. Establish initial Post-Closure ecosystem targets based on pre-mine mapping.
2. Establish a starting cover-placement scenario based on preliminary engineering designs and estimated cover material availability.
3. Apply the QEA model to post-mining landforms, as defined by ERM in shapefiles and project planning discussions, taking into account the:
   - physical properties of mine-waste and cover materials;
   - material layering in the upper 1 m rooting zone; and
   - energy effects on ecohydrological conditions of slope aspect.
4. Generate expected resultant relative and absolute soil moisture regimes.
5. Generate expected associated vegetation (ecosystem) types.
6. Modify the cover-placement scenario to optimize material placement for the return of pre-mine ecosystems and for meeting end land use and habitat objectives.

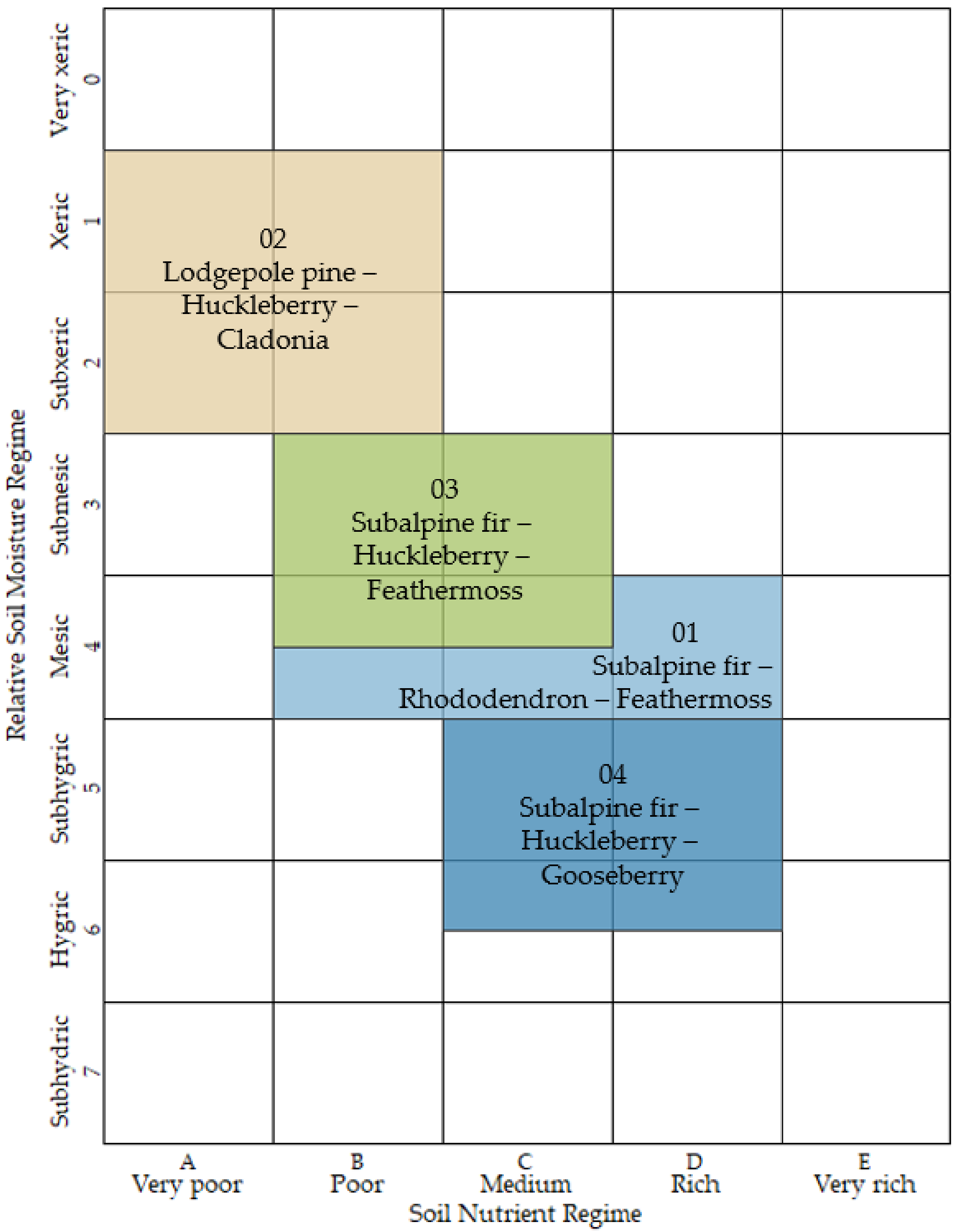
The process described above is intended to model the ecological benefits of surface soil application while keeping within parameters set by BW Gold's design consultants, which included the Post-Closure slope angles of waste dumps and the Tailings Storage Facility.

1.1 Modelling Context

The Blackwater Gold Project (Blackwater) site is located within the following subzone variants, as defined by the British Columbia (BC) Biogeoclimatic Ecosystem Classification (BEC) system:

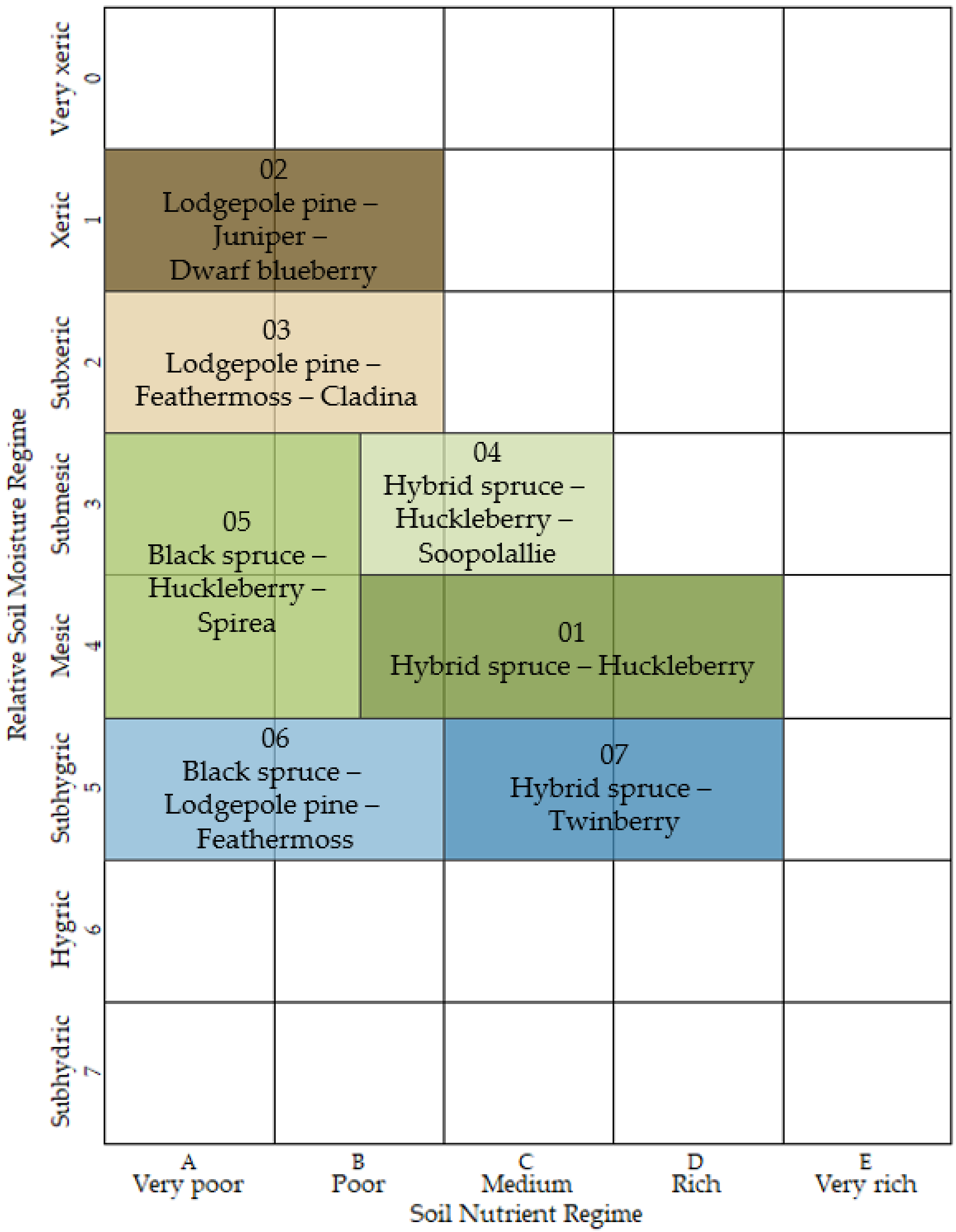
- Sub-Boreal Spruce Kluskus Moist Cold (SBSmc3);
- Engelmann Spruce – Subalpine Fir Nechako Moist Very Cold (ESSFmv1); and
- Engelmann Spruce – Subalpine Fir Moist Very Cold Parkland (ESSFmvp).

Results from the modelling process are interpreted in the context of the edatopic grids in Figures 1 (ESSFmv1) and 2 (SBSmc3), which apply the theory that characteristic vegetation communities develop on sites with given combinations of soil moisture and soil nutrient regimes (Pojar et al. 1987). In particular, soil water supply has an overarching control on the characteristics of an ecosystem, including its nutrient regime. For example, at Blackwater, in areas that experience moderate seasonal water deficits, such as south-facing slopes, lodgepole pine is dominant in the overstory (ESSFmv1 02 site series, SBSmc3 02 and 03 site series).Wetter forested areas that experience less significant water deficits are dominated by subalpine fir (ESSFmv1) or black and hybrid spruce (SBSmc3). There is no published edatopic grid for the ESSFmvp but relationships between site units and edaphic conditions are given in Table 4.1-3 of Chapter 4.



Source: DeLong et al. (1993)

Figure 1: Edatopic Grid for the Engelmann Spruce – Subalpine Fir Nechako Moist Very Cold (ESSFmv1) Subzone



Source: DeLong et al. (1993)

Figure 2: Edatopic Grid for the Sub-Boreal Spruce Kluskus Moist Cold (SBSmc3) Subzone

The edaphology described by edatopic grids reflects the long-term climax potential of a given set of site conditions, but does not necessarily describe the conditions to be expected immediately Post-Closure. The soils that support the climax ecosystems characteristic of site series—including conifer forests, diverse herb and shrub layers, and abundant moss or lichen—develop very slowly and will not be fully present in the decades, or even centuries, following mine closure, even though they are expected over time given the projected water-balance conditions. This will necessitate the use of revegetation prescriptions and criteria for reclamation monitoring and assessment that are reflective of successional ecological patterns rather than climax ecosystems.

We wish to emphasize that the projected vegetation types reflect our best estimate of Post-Closure edaphic conditions, particularly with respect to soil water, and the natural vegetation types associated with these conditions over the long term. These projected Post-Closure ecosystems can be used as targets to aid in revegetation planning and other site-specific reclamation prescriptions. The projections do not imply that these specific vegetation types or communities will be re-established in the short term, or that reclaimed ecosystems will be similar to or indistinguishable from natural ecosystems in the foreseeable future.

The projections in this report are subject to uncertainties due to climate change. Ecosystem modelling in BC using the BEC system indicates that at Blackwater, the ESSF zone is already transitioning to the SBS zone. By 2050 the ESSF zone will be minimally present, and by 2080, the Blackwater site will be primarily SBS with some Interior Cedar Hemlock zone present (Wang et al. 2016).[1] These trends are elaborated upon with maps in Section 4.1.4.1 of Chapter 4. It is recommended that future Post-Closure ecosystem modelling incorporates the effects of climate change on ecosite distribution using predictive models for BC ecosystems, such as Wang et al. (2016), especially as the timeframe for active reclamation nears.

[1] http://www.climatewna.com/ClimateBC_Map.aspx

2. WASTE AND TOPOGRAPHY ASSUMPTIONS

The outputs of the QEA model in this report are intended as a first step in an iterative process in which the model is refined based on evolving information. The following cover and topography assumptions have been applied in this iteration:

- **Tailings Storage Facility (TSF) surface** – this was modelled as a flat surface with 30 cm of surface soil placed on 70 cm of overburden. This cover would overlay a 30-cm geochemical barrier of slurried non-acid-generating tailings from which roots are excluded (Appendix 3-J, 3-K). However, substantial uncertainties exist regarding (1) the cover design required to manage geochemical risk of the potentially acid-generating (PAG) tailings and waste rock (WR) stored in the impoundment, (2) the proposed cover application method, and (3) if surface soil will be placed. If a membrane water treatment plant is required at closure, soil placement on and revegetation of the TSF surface would cause fouling of the treatment membrane and would not be permitted. A 10 m wide depressional area was modelled around the circumference of the pond. The surface area of the pond at closure may change as the TSF design and site water balance model are refined.
- **Dams** – the TSF dams were modelled as being constructed from WR with upper lifts of overburden (Appendix 3-J, 3-L) which was assumed to be ≥ 100 cm deep. Other site dams remaining in Post-Closure, including the Environmental Control Dam and water diversion structures, were modelled as WR covered with a lift of overburden, with overburden depth dictated by QEA model results.
- **Overburden/NAG dumps** – dumps were modelled as containing overburden in the upper 100 cm, with additional surface soil applied as a growing medium. We acknowledge that there may be further direction and iteration to finalize landform design and cover treatments on slopes, which should be represented in future ecohydrologic modelling (Appendix 3-N, 3-R).
- **Ore stockpiles** – ore stockpiles were assumed to be fully removed and returned to flat, uncompacted overburden surfaces with surface soil placed on top as a growing medium. These assumptions may evolve as designs are refined, including consideration of material and liner removal methods—it is possible that compaction will occur during material removal and the underlying surface for reclamation will be similar to the road and plant area material described below.
- **Topsoil stockpiles** – pads from areas used for storage of surface soil were modelled as flat, uncompacted overburden surfaces with surface soil remaining or re-placed on top as a growing medium. It was assumed that site preparation would be conducted to address any compaction present, however, it is possible that compaction caused during material removal and/or over-excavation of topsoil could result in the underlying surface for reclamation being similar to the road and plant area material described below.
- **Roads, plant areas and infrastructure** – a synthetic coarse sandy loam material containing 75–95% coarse fragments (> 2 mm) was used to represent mine site and haul roads not retained for Post-Closure access, along with plant and other infrastructure areas (laydowns, camp, and explosive and fuel storage areas). Borrow areas were conservatively placed in this category, but this assumption should be revisited during operations when substrate conditions are known, as potential substrates range from bedrock to coarse aggregate material to overburden. Road, plant, infrastructure and borrow areas were modelled as flat with surface soil placed on top as a growing medium.
- **Excluded areas** – modelling excluded areas exempt from reclamation (pit walls), areas expected to be covered by water, and infrastructure anticipated to be retained (water treatment plant, roads required for monitoring access, diversion structures and pipelines).

Slope, aspect, and slope position for all mine components were provided by ERM, with slopes assigned to the following groupings: 0° (flat, 0–8°), 12° (8–16°), 20° (16–24°), 28° (24–32°), 36° (32–40°), and 44° (40–48°).

Additional assumptions on the properties of waste and cover materials used in the QEA model are presented in Section 3.2. These are initial simplifying assumptions based on the objective of maximizing the return of pre-development ecosystems. Cover design can be further optimized as geotechnical and geochemical design work progresses, closure and end land use objectives are refined, site-specific research is conducted, and greater detail on reclamation material quality and quantity becomes available.

3. QUANTITATIVE ECOHYDROLOGIC ASSESSMENT MODEL

3.1 Data Sources

Data representing mine waste materials and cover (surface) soil sources were compiled from the following sources.

Waste rock – A hypothetical target particle-size distribution (PSD) curve was provided for WR by Moose Mountain Technical Services (Appendix 3-C). Data were not available for particle sizes < 10 mm, so the PSD curve was extended to 0.001 mm by IEG based on WR PSD curves at other comparable sites. The typical range of WR PSDs from other IEG projects was reviewed and applied to create a synthetic dataset of five WR samples to represent an expected PSD envelope. Organic matter (OM) content data were not available for the WR sample, so OM was estimated to be 0.5% by weight (fine-fraction basis) based on IEG's experience with WR at other mine sites.

Overburden – PSD data for 16 overburden samples from two geotechnical drill holes were available from Knight Piésold Ltd (2013, Appendix C). OM content data were not available for samples, so OM was estimated to be 0.5% by weight (fine-fraction basis) based on IEG's experience with overburden at other mine sites.

Surface soil – Soil survey data from 230 sites in the project area, originally collected by AMEC (2013), were provided in tabular format by McTavish Resource & Management Consultants Ltd. (McTavish). PSDs were determined based on (1) texture classes as assessed through hand texturing in the field and (2) the proportion of coarse fragments (particles > 2 mm). Sites without coarse fragment and/or texture data were removed.[2] Nutrient data were available for 45 surface soil samples. Average OM content for each horizon type (e.g., Ah, Bg) was assigned to the corresponding horizon type in the full soil survey dataset. Ahe was represented as an average of Ae and Ah OM content, and Bm was represented as an average of Bhf and Bg OM content. Where OM data from the site were not available (LFH layer, Ae horizon) or limited (only one C-horizon sample), supplementary data from the BC Soil Survey were used (Cotic 1974; Lord and Walmsley 1988). Soil profile depth at each site (i.e., for each soil pit) was trimmed to a salvage depth of 50 cm and OM content of the organic horizons (i.e., LFH) at each site was averaged over the salvage depth and added to the mineral horizons, assuming it would be incorporated during salvage. The dataset was weighted by the relative area of each terrain unit in the proposed project footprint excluding non-salvageable associations (i.e., bedrock and disturbed land). Given the projected surplus of cover material, the poorest 20% of sites were removed based on profile AWSC, assuming that higher quality material will be prioritized for salvage, as per the Soil Management Plan (Appendix 9-B).

3.2 Input Data Assumptions

The following assumptions were applied during preparation of data inputs for the QEA modelling:

- OM content data were not available for WR or overburden. QEA model outputs rely on assumptions of OM content based on IEG's experience with other mine sites. For surface soils, OM content data relied on averages and, where data were not available for specific horizons, off-site BC Soil Survey data from the Cariboo region. QEA model outputs can be refined as additional OM data, particularly for surface soil and overburden used as growing media, are collected during or prior to salvage.
- QEA model outputs for WR areas are based on a single, theoretical WR PSD curve. This PSD curve was assumed to be representative of average WR on site, however QEA model outputs can be refined as WR PSD data becomes known during operations.

[2] Where coarse fragment and/or texture data were missing only for one horizon, it was assumed to be the same as the adjacent horizon.

- QEA model outputs for overburden are based on samples from two geotechnical drill holes in morainal material, which may not be representative of overburden across the site. Additionally, the methods used for sample collection from drill holes may introduce error into the coarse fragment content data (e.g., by destruction or avoidance of coarse fragments). QEA model outputs could be refined by collecting additional overburden PSD data from representative areas during operations.
- QEA model outputs for surface soils rely on PSDs estimated from texture classes measured by hand texturing in the field. Textural classes can encompass a range of PSDs and do not distinguish between sand subclasses. Hand texturing is also subject to greater sampler error and bias than lab analysis. QEA model outputs could be refined by collecting additional surface soil samples for lab PSD analysis.
- The surface soil dataset used was representative of the full mine site, with sites representing the lowest 20% of AWSC in the dataset removed, given the projected surplus of surface soils. Future model iterations could refine the input data by only using soil data for areas that are slated for salvage.
- Organic associations were excluded because they lack a PSD (a necessary input for the QEA model). Additionally, the approach for applying salvaged organic soils in reclamation is currently unknown but will have differential outcomes on ecosystem recovery (e.g., targeted application vs. mixing organic soils in with mineral soils). Excluding organic associations, which make up ~5% of the salvageable soil volume, represents a conservative modelling approach. When organic soil salvage volumes are better understood, future reclamation design work can seek to selectively use organic materials to improve moisture and nutrient regimes in targeted areas. This can be reflected in updated ecohydrologic modelling.

3.3 Basic AWSC Calculations

A standardized method of estimating plant-available water-storage capacity (AWSC) from soil data using adaptations of peer-reviewed models was used (Baker et al. 2020, following Straker et al. 2015a, 2015b). The primary inputs to this model are soil PSD, OM content, soil depth, and topographical data, as well as layering arrangements within the soil profile. Two AWSC models are central to this approach: Arya & Paris (1981; Arya et al. 1999) and Saxton & Rawls (2006; Saxton 2005).

The Arya and Paris (A&P) approach is a physical model based on the capillary equation and uses only PSD and bulk density as inputs. The PSD-centric approach ignores the benefit of OM and soil structure on AWSC, and thus appears better suited to poorly-developed, low-OM soils. To adjust for this omission, the A&P value is adjusted by the percent increase in AWSC attributable to OM according to the Saxton and Rawls (S&R) model. The S&R approach is an empirical model built on regressions of soil survey data (PSD, OM content, and bulk density) against pressure-plate AWSC results to determine a best-fit prediction of AWSC. Since it is based on agricultural soil samples, this model is better suited to higher-OM, better-aggregated soils. Fine-fraction (< 2 mm) bulk density data was estimated based on texture classes (Saxton 2005). Whole-soil bulk density was calculated inclusive of coarse fragments (> 2 mm) using an assumed particle density value of 2,700 kg/m^3 for all mineral materials, with packing voids around coarse fragments estimated as per Zhang et al. (2011).

Both the S&R and A&P models, when combined with bulk density estimates, allow the estimation of water-retention curves (WRC, volumetric water content vs. tension) for each sample, from which the volumetric water content between field capacity and wilting point is taken, and then reduced according to volumetric coarse fragment contents. In the A&P model, which does not specify the field capacity tension (Tfc) for calculating AWSC from the WRC, Tfc is estimated between 5 and 33 kPa for each sample based on fine-fraction sand content, with coarser samples receiving a lower Tfc. This Tfc value is used in the profile layering corrections described below. In recognition of the different applicability of the two models

(A&P for unstructured vs. S&R for structured, natural soils), the final AWSC value for each layer is calculated as a weighted mean between the A&P and S&R results, with weighting derived from total-soil (as opposed to fine-fraction) OM and clay contents, which are used as proxies for aggregation.

3.4 Calculations of Soil Profile AWSC

The material AWSC values for each layer in the soil profile being modelled are depth-weighted and summed across the upper metre, or until a root-restricting layer (e.g., bedrock, basal till) occurs, to give a profile AWSC. As layers are compiled, the effects of layering on AWSC are estimated using the Clothier et al. (1977) model, again based on the capillary equation. The model does not account for AWSC effects of coarse-over-fine layering situations, which is a shortcoming of the current approach. However, the most common layering arrangement in mine reclamation is the fine-over-coarse type (e.g., topsoil over WR), so layering at most target sites is accounted for.

3.5 Classifying Reclamation Sites by RSMR and SNR

Final profile AWSC, mineral soil depth, and topographic information (slope and aspect) are used to estimate the relative soil moisture regime (RSMR) corresponding to the BC BEC hygrotope (Pojar et al. 1987) using linear regression classification models developed with over 5,700 plots in British Columbia (Baker et al. 2020; Table 1). Upland water-shedding slope positions (i.e., level areas and crests to lower slopes) are classified with one regression equation and toes with another. Note that these moisture regimes are intended to reflect dominant soil-water conditions over a multi-year period, consistent with the BEC hygrotope. The AWSC-based method for RSMR determination applies only to upland (very xeric to subhygric) SMRs, as wetter RSMRs require input of seepage water or the presence of a water table within 100 cm of the soil surface and are not solely dependent on soil water storage. Determination of RSMRs wetter than mesic in this system is based on the rules described in British Columbia Land Management Handbook 25, *Field Manual for Describing Terrestrial Ecosystems* (BCMFR and BCENV 2015). All sites in this study are projected to be subhygric or drier, with no evidence of seepage or water-table influences within the surface 100 cm.

A final slope-position-based correction factor is applied to results from the classification regression, with crest, upper, and lower slope positions receiving corrections of -0.5, -0.3 and +0.3 RSMR classes, respectively (Baker et al. 2020).

In order to plot sites on an edatopic grid, soil nutrient regime (SNR) must also be determined, which is done based on lab results for soil carbon, total Kjehdahl nitrogen (TKN), and the resulting C:N ratio. TKN is used in place of total Nitrogen (TN), as nitrate and nitrite concentrations, which are lacking from TKN results, are minimal in natural, acidic soils (Dail et al. 2001). Where N data are unavailable, soil carbon alone is used. The mean SNR classification resulting from all applicable rules is used for each site. Soil carbon content is converted from OM content where not directly measured using an OM:C ratio of 2.0 (Pribyl 2010). The rules relating soil nutrient contents to SNR classifications (Table 2) were developed through an extensive literature survey (IEG unpublished research).

Table 1: Determination of Relative Soil Moisture Regime (RSMR) from Available Water-storage Capacity (AWSC), Water Table Depth, and Primary Water Source for Sites with No Rooting Restrictions in the Upper 100 cm

RSMR	Primary Water Source	Water-table Depth (cm below ground surface)	Available Water Storage Capacity, Surface 100 cm (mm)		
			Water-shedding		Toes
			Flat	24˚ Slope	24˚ Slope
Very Xeric (0)	Precipitation	>100	< 1	< 2	< 0.3
Xeric (1)	Precipitation	>100	1 – 4	2 – 7	0.3 – 1.4
Subxeric (2)	Precipitation	>100	4 – 15	7 – 27	1.4 – 8
Submesic (3)	Precipitation	>100	15 – 57	27 – 103	8 – 51
Mesic (4)	Precipitation	>100	57 – 213	103 – 394	51 – 294
Subhygric (5)	Precipitation and/or seepage	>100	> 213	> 394	> 294
			(or with seepage contribution)		
Hygric (6)	Seepage	30-100	n/a		
Subhydric (7)	Seepage or permanent water table	0-30	n/a		
Hydric (8)	Permanent water table	Water table permanently at or above soil surface	n/a		

Note: the AWSC thresholds vary by slope angle but are presented here for the two dominant slope angles for water-shedding slope positions on the Post-Closure landscape, as well as toes of steeper slopes.

Table 2: Soil Nutrient Regime (SNR) Classification Rules

Soil Property	Specific Form Measured[3]	Units	SNR Classification Ranges				
			Very Poor	Poor	Medium	Rich	Very Rich
Carbon	TOC	%	< 0.35	0.35 – 1	1 - 4	4 – 10	> 10
Nitrogen	TN	%	< 0.025	0.025 - 0.1	0.1 - 0.25	0.25 - 1	> 1
C:N ratio	C:N	-	> 100	30 - 100	15 - 30	5 - 15	< 5

3.6 Predicting Ecosystem Occurrence

After each site has been classified with an RSMR and SNR position, it is plotted on an edatopic grid that is adjusted for the effects of slope and aspect using the R package EcoHydRology (Fuka et al. 2018), which provides slope-, aspect-, and latitude-adjusted potential evapotranspiration (PET) values. The soil AWSC data are then integrated with the historic climate data for the region from 1961–1990 (Wang et al. 2016) to adjust the edatopic grid. Using a filling-bucket approach based on the work of Spittlehouse and Black (1981) and outlined in greater detail in Baker et al. (2020), daily water balances are calculated for the AWSC corresponding to each RSMR position using the rules in Table 1 and absolute soil moisture regime (ASMR) classifications are made based on rules proposed by Pojar et al. (1987) and DeLong

[3] TOC – total organic carbon; TN – total nitrogen; C:N – carbon to nitrogen ratio

(2019; Table 3).[4] This process defines the entire RSMR axis and, consequently, each site series on the edatopic grid, according to water-balance-based ASMR classes.

Table 3: Classification of Absolute Soil Moisture Regime, following Pojar et al. (1987) and DeLong (2019)

Differentia	Class
Rooting-zone groundwater absent during the growing season *Water deficit occurs (soil-stored reserve water is used up and drought begins if current precipitation is insufficient for plant needs)*	
Deficit > 7 months (Maximum theoretical actual evapotranspiration (AETmax)/ Potential evapotranspiration (PET) ≤ 30%)	Extremely dry
Deficit > 5 months but ≤ 7 months (AETmax/PET ≤ 55% but > 30%)	Excessively dry
Deficit > 4 months but ≤ 5 months (AETmax/PET ≤ 65 but > 55%)	Very dry 1
Deficit > 3 months but ≤ 4 months (AETmax/PET ≤ 75 but > 65%)	Very dry 2
Deficit > 1.5 months but ≤ 3 months (AETmax/PET ≤ 85 but > 75%)	Moderately dry
Deficit > one week but ≤ 1.5 month (AETmax/PET ≤ 95 but > 85%)	Slightly dry
No water deficit occurs	
Utilization (and recharge) occurs (current need for water exceeds supply and soil-stored water is used) Deficit ≤ one week (AETmax/PET > 95%)	Fresh
No utilization (current need for water does not exceed supply, temporary groundwater table may present)	Moist
Rooting-zone groundwater present during the growing season (water supply exceeds demand)	
Groundwater table > 30 cm deep	Very moist
Groundwater table > 0 but ≤ 30 cm deep	Wet
Groundwater table at or above the ground surface	Very wet

To summarize, site-series assignments for each reclamation site are made in two interacting steps:

- RSMR and SNR classifications are made using site and soil characteristics that are relatively insensitive to climate conditions, and these are used to position sites on edatopic grids.
- The edaphic positions (i.e., RSMR and SNR coordinates) of site series upon an edatopic grid are shifted according to ASMR-related conditions (i.e., soil water deficits) because the plant species composing a given site series respond directly to soil water deficits (i.e., ASMR) rather than the soil texture and depth (i.e., RSMR) required to produce that ASMR. Therefore, variations in the water- and energy-balance parameters influencing soil water deficits (i.e., slope and aspect) shift the amount of potential water supply (i.e., RSMR) required to sustain a given ASMR and site series under those conditions.

[4] Due to ambiguities in the definition of the drought-length criteria, only AET_{max}:PET is used to categorize sites into ASMR classes in this project.

3.7 Projection of Reclamation Ecosystems for Planned Landforms

Projections of the ecosystems expected to result from reclamation with available materials are based on site series assignments generated with the above methods. For each material group (e.g., overburden) present in the study, its associated AWSC range is calculated from available datasets and samples representing the 5^{th}, 25^{th}, 40^{th}, 50^{th}, 60^{th}, 75^{th}, and 95^{th} percentiles of that range are generated with an assumed normal distribution. These samples are combined into two-layer (e.g., cover material over waste material) soil profiles and run through the QEA model for all BEC subzones or variants present (i.e., ESSFmv1, ESSFmvp, and SBSmc3) with iterations at 45-degree aspect intervals and 10-cm cover-depth intervals for all combinations of waste-percentiles and cover-percentiles and the slopes listed in Section 3.1.

Results from the QEA model iterations are weighted according to the sample percentiles represented in each run, with 50^{th}-percentile cover over 50^{th}-percentile wastes receiving the highest weight in data summaries and 5^{th}-over-5^{th} and 95^{th}-over-95^{th} percentile combinations receiving the lowest weights. For each reclamation unit (i.e., unique combination of slope gradient, aspect, mesoslope position, waste material and cover material), a range of projected site series are generated using this weighted approach, and results are analyzed to identify the cover depths at which transitions in the dominant site series occur. The model assigns up to four predicted site series for each cover depth setting according to the distribution of results upon the edatopic grid, with the percent of outcomes among all predicted site series summing to 100%. Conservatism[5] is built into these projections by reducing the estimated RSMR by 0.25 RSMR classes before site-series assignments are made, and by rounding up the cover depth required to achieve site-series transitions to the next 10-cm increment (e.g., anything between 50 and 60 cm is rounded to 60 cm).

[5] Conservatism in this context means to avoid underestimating the depth of cover material required to achieve a given site series.

4. COMPARISON OF PRE-DEVELOPMENT AND POST-CLOSURE ECOSYSTEMS

A final list of predicted Post-Closure ecosystems is determined through an iterative process in which area-based comparisons between pre-development and predicted Post-Closure ecosystems are made, and reclamation treatments (i.e., surface soil depths) are adjusted to reduce differences in ecosystem representation on the pre- and post-mining landscapes, to the extent possible. Further focus was given towards reducing the loss of drier site series through use of coarser glaciofluvial surface soils (as described in Sections 4.1, 4.2.1.1 and 4.2.1.5 of Chapter 4). The iterative process seeks to use only as much cover material as is predicted to be needed on a given reclamation unit to create the ecosystem assemblage that is modelled for a 100 cm cover placement. This method allows excess cover volume to be diverted to other reclamation units where it is predicted to have greater marginal benefit. For example, if results indicate that the same balance of site series will occur with 60 cm of surface soil as with 100 cm of surface soil, then a 60 cm surface depth is recommended. For this project, model comparisons found unconstrained surface soil depths (i.e., up to 100 cm) to be comparable to the following constrained scenarios:

- 50 cm of glaciofluvial surface soil on plant and infrastructure areas or overburden;
- 30 cm of non-glaciofluvial mineral surface soils on overburden; and
- 50 cm of non-glaciofluvial mineral surface soils on roads and infrastructure areas.

Therefore, the constrained scenarios were used to optimize surface soil allocation. The iterative optimization of cover depths was bounded by cover depth specifications prescribed in geotechnical and geochemical design work.

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APPENDIX D POSSIBLE RECLAMATION SUCCESS CRITERIA

Appendix D: Possible Reclamation Success Criteria

Potential ecosystem characteristics that could be measured during or after initial placement, or to evaluate reclamation success.

Assessment Type	Purpose	Plot Type	Indicator	Metric	Methodology	Rationale	Threshold	Frequency	Monitoring Stop	Performance Measure and Management Adaptation
Site	Post-placement audit	100-m^2 (5.64-m) radius permanent sampling plot	Woody Debris	Woody debris count and diameter and length measurements	Woody debris count and diameter and length measurements	Contributes to habitat diversity for plants and animals	Woody debris loading meets volumes or pieces/ha in prescriptions	Prior to planting but after woody debris placement	One time only	N/A
	Post-placement audit	100-m^2 (5.64-m) radius permanent sampling plot	Aspect	Degrees	Compass	Influences vegetation development and successional patterns	N/A	Same year as planting	One time only	N/A
	Post-placement audit	100-m^2 (5.64-m) radius permanent sampling plot	Slope	Slope %	Inclinometer	Influences vegetation development and successional patterns	N/A	One year after soil placement	One time only	N/A
	Post-placement audit	100-m^2 (5.64-m) radius permanent sampling plot	Slope position	Visual assessment	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015)	Influences vegetation development and successional patterns	N/A	One year after soil placement	One time only	N/A
	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Erosion and site stability	Visual assessment	Visual assessment / photos	Assess conformity with Reclamation Plan end land use objective	Minimal erosion and no sediment transport from the plot or signs of instability	One, two and five years following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Implement measures in the Surface Erosion Prevention and Sediment Control Plan and inform the site environmental manager if signs of instability are noted.
Soil	Post-placement audit	Soil Plot (8 m North of the 100-m^2 plot centre)	Soil density	Density kg/m^3	Measurement using a nuclear densometer or soil excavation method	May limit root development	Density ≤ 1,600 kg/m^3 (Zhao et al. 2008; USDA 2008)	Prior to planting	One time only	Decompact soil if density exceeds 1,600 kg/m^3
	Post-placement audit	Soil Plot (8 m North of the 100-m^2 plot centre)	Topsoil depth	Depth (cm)	Measurement to soil surface	Key determinant in plant survival and growth and selection of suitable plant species	N/A	One year after soil placement	One time only	Baseline data for assessing revegetation success and issues
	Post-placement audit	Soil Plot (8 m North of the 100-m^2 plot centre)	Soil particle-size distribution (texture)	Percent weight in critical particle-size classes (> 2, 0.5-2, 0.25-0.5, 0.1-0.5, 0.053-0.1, 0.002-0.053, and < 0.002 mm)	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015); Permanent Sample Plot Photos	Key metric for determining SMR (see Site Unit [series] indicator)	N/A	One year after soil placement	One time only	Baseline data for determining site SMR
	Post-placement audit	Soil Plot (8 m North of the 100-m^2 plot centre)	Coarse fragment content	Visual assessment	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015); Permanent Sample Plot Photos	Key determinant in plant survival and growth and selection of suitable plant species	N/A	One year after soil placement	One time only	Baseline data for assessing revegetation success and issues

Assessment Type	Purpose	Plot Type	Indicator	Metric	Methodology	Rationale	Threshold	Frequency	Monitoring Stop	Performance Measure and Management Adaptation
Soil *(cont'd)*	Post-placement audit	Soil Plot (8 m North of the 100-m^2 plot centre)	Soil elemental composition	Soil elemental concentrations	Collection and lab analysis of soil samples	Determine if elemental concentrations present are potentially harmful to plant establishment or wildlife	Below CCME parkland standards and BC CSR reverted wildland standards or reference/ baseline concentrations where they exceed guidelines	One year after soil placement, and as required based on results of vegetation sampling	One time only unless results elevated, vegetation tissue concentrations increase over time, and/or mine-affected dust deposition increases	Determination of root cause (e.g., mine-affected dust deposition; elevated metal concentrations in reclamation cover) and amelioration if possible (e.g., implementing tailings-dust mitigation measures)
	Post-placement audit and 10-year re-evaluation	Soil Plot (8 m North of the 100-m^2 plot centre)	Rooting restrictions	Visual assessment	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015); Permanent Sample Plot Photos	Key determinant in plant survival and growth and selection of suitable plant species	N/A	One and ten years after soil placement	One time only	Baseline data for assessing revegetation success and issues
	Post-placement audit and 10-year re-evaluation	Soil Plot (8 m North of the 100-m^2 plot centre)	Site Unit (series)	Soil moisture and nutrient regimes	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015)	Key determinant in plant survival and growth and selection of suitable plant species	Comparison to Site Unit SMR predicted in reclamation prescription	One and ten years after soil placement	Year 10	Adjust prescription for any supplemental planting to correct Site Unit and SMR range
	Post-placement audit and 10-year re-evaluation	Soil Plot (8 m North of the 100-m^2 plot centre)	pH	pH	pH using a portable pH/salinity probe	May limit plant development	pH 3.5-7.5 (Hope 2007 and AMEC data and soil ratings)	One year after soil placement, and as required based on results of vegetation sampling	Year 10	If outside the threshold values, identify the source of the out-of-spec material and develop actions to ensure that it is not placed within the rooting zone of further areas
	Reclamation success indicator	Soil Plot (8 m North of the 100-m^2 plot centre)	Litter accumulation and function	Depth (cm)	Measurement to soil surface	Long-term indicator of improving soil conditions	N/A	One, five and ten years after soil placement	Year 10	Monitor only to track successional development
Vegetation	Recurring audit	100-m^2 (5.64-m) radius permanent sampling plot	Vegetation chemical composition	Tissue concentrations of metals and other elements	Tissue collection and lab analysis of forage plant species	Determine if elemental concentrations present in forage vegetation are potentially harmful to plant establishment or wildlife	Below CCME parkland standards and BC CSR reverted wildland standards or reference/baseline concentrations where they exceed guidelines.	Years one, two, three and five following soil placement and every five years thereafter	Ten years; monitoring may need to be re-started if mine-affected dust deposition increases	Determination of root cause (e.g., mine-affected dust deposition; elevated metal concentrations in reclamation cover) and amelioration if possible (e.g., implementing tailings-dust mitigation measures)
	Recurring audit	100-m^2 (5.64-m) radius permanent sampling plot	Weed presence and distribution	% cover by species or number or individual	Visual assessment	Control invasive species that may affect revegetation success	Presence of regionally identified weeds (CCCIPC) or weeds identified as noxious under the *Weed Control Act*	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Implement the Invasive Species Management Plan
	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Vegetation species	Species presence	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015); Permanent Sample Plot Photos	Monitor convergence with reference ecosystems and successional trajectories	Species present that are suitable for SMR and Site Unit	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Fill plant with appropriate species

Assessment Type	Purpose	Plot Type	Indicator	Metric	Methodology	Rationale	Threshold	Frequency	Monitoring Stop	Performance Measure and Management Adaptation
Vegetation *(cont'd)*	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Cover	% cover by species	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015); Permanent Sample Plot Photos	Monitor convergence with reference ecosystems and successional trajectories	Trend of increasing native vegetation cover over time	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Fill plant with appropriate species
	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Vegetated area	% vegetated and type	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015); Permanent Sample Plot Photos	Monitor convergence with reference ecosystems and successional trajectories	Trend of decreasing bare area over time	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Fill plant with appropriate species
	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Vegetation layer cover	% cover by vegetation layer class (A1-3, B1-2, C, Dr-Dw, E)	Field Manual for Describing Terrestrial Ecosystems (BC MOFR and BC MOE 2015)	Monitor convergence with reference ecosystems and successional trajectories	Trend of increasing diversity in layer cover	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Fill plant with appropriate species
	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Vegetation layer height	Height (cm) by vegetation layer class	Measurement of average height by lifeform	Monitor convergence with reference ecosystems and successional trajectories	Trend of increasing vegetation height to typical height of the lifeform in exposed conditions	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Fill plant with appropriate species
	Reclamation success indicator	100-m^2 (5.64-m) radius permanent sampling plot	Vegetation health	Evidence by foliage condition (e.g., chlorosis, necrosis, wilting)	Visual assessment	Identify potential issues affecting vegetation (e.g., soil nutrition, soil moisture, animal or insect damage)	< 25% of vegetation has signs of potential health issues	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Determination of root cause and amelioration if possible (e.g., fertilization; browse control). If observations indicate only select species are affected, fill plant with alternate species
Aerial photos	Reclamation success indicator	NA	% vegetation cover	Annual comparison of % vegetation cover	Drone flight paths flown annually that include mine site monitoring plots to compare annual changes in % vegetation cover	Provide a broader assessment of revegetation trends across the mine site; use plot data to calibrate assessment of drone imagery	Trend of increasing cover over time	Years one, two, three and five following soil placement and every five years thereafter	For 10 years or when percent cover is greater than 30% and vegetation has been determined to be self-sustaining (e.g., the trend of cover of native species is increasing)	Fill plant with appropriate species

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