BMC MINERALS (NO.1) LTD

KUDZ ZE KAYAH PROJECT

PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING

March 2017

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ACKNOWLEDGEMENTS

The Kudz Ze Kayah (KZK) Project Proposal was prepared by BMC Minerals (No.1) Ltd. (BMC) for submission to the Yukon Environmental and Socio-economic Assessment Board (YESAB) for Executive Committee Screening.

Preparation of the KZK Project Proposal has involved significant effort on the part of many contractors, leading consulting firms, specialists and supporting companies. Key supporting documents and chapters have been developed by Alexco Environmental Group Inc. (AEG), Contango Strategies Limited, Dialectic Research Services, Ecofor Consulting Ltd., Knight Piesold Ltd., Minnow Environmental Inc., Tetra Tech EBA Inc. (EBA), Malcom Taggart and Luigi Zanasi. BMC wish to acknowledge them for their important contributions to this Project Proposal. The authors by component/discipline are listed in the table below.

BMC and the authors also wish to acknowledge the valuable input that the Ross River Dena Council (RRDC) has contributed to the planning and preparation of the Project Proposal.

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EXECUTIVE SUMMARY

INTRODUCTION

BMC Minerals (No.1) Ltd. (BMC) proposes the development of the Kudz Ze Kayah Project (the Project) in southeast Yukon and within the Kaska First Nation (Kaska) Traditional Territory. The Project is a proposed open pit/underground copper, lead, and zinc mine located approximately 115 kilometres (km) southeast of Ross River, Yukon. This submission and its appendices (the Project Proposal) have been developed to meet the requirements for a screening pursuant to the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) by the Yukon Environmental and Socio-economic Assessment Board (YESAB) Executive Committee in Whitehorse, Yukon. The general organization of the Project Proposal is shown in the figure below.

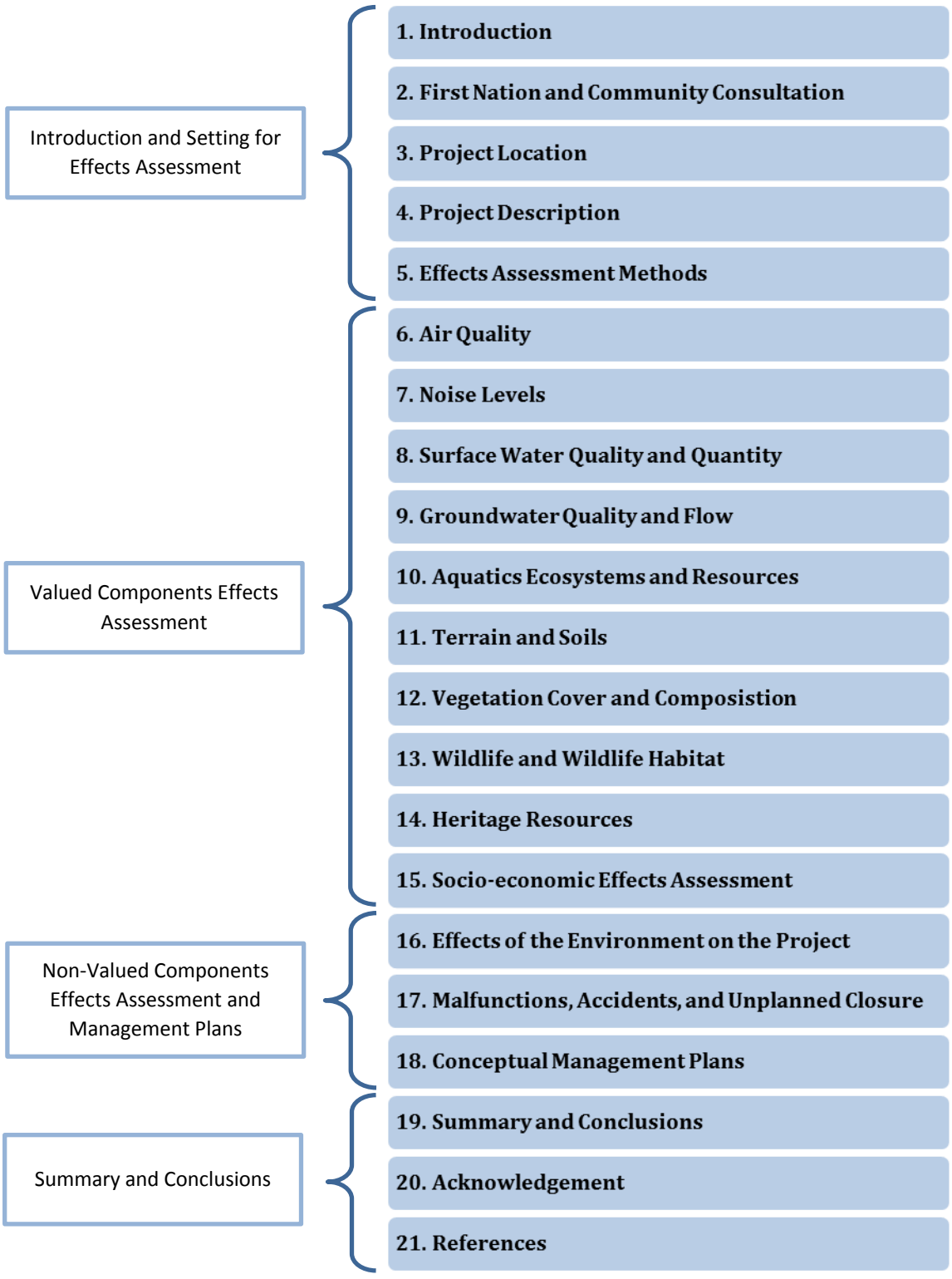
Project Location

BMC is a private company, incorporated in Canada (BC Registration number BC 1014247), its parent company BMC (UK) Limited was established in 2014 to take advantage of emerging opportunities in mining and exploration projects with major shareholder Global Natural Resource Investments (GNRI). BMC is engaged in the assessment, acquisition, and development of base metals projects which the Directors believe to be of a quality that are capable of maintaining a mining project that is economically robust and likely to have a positive legacy outcome for both the company and the local community.

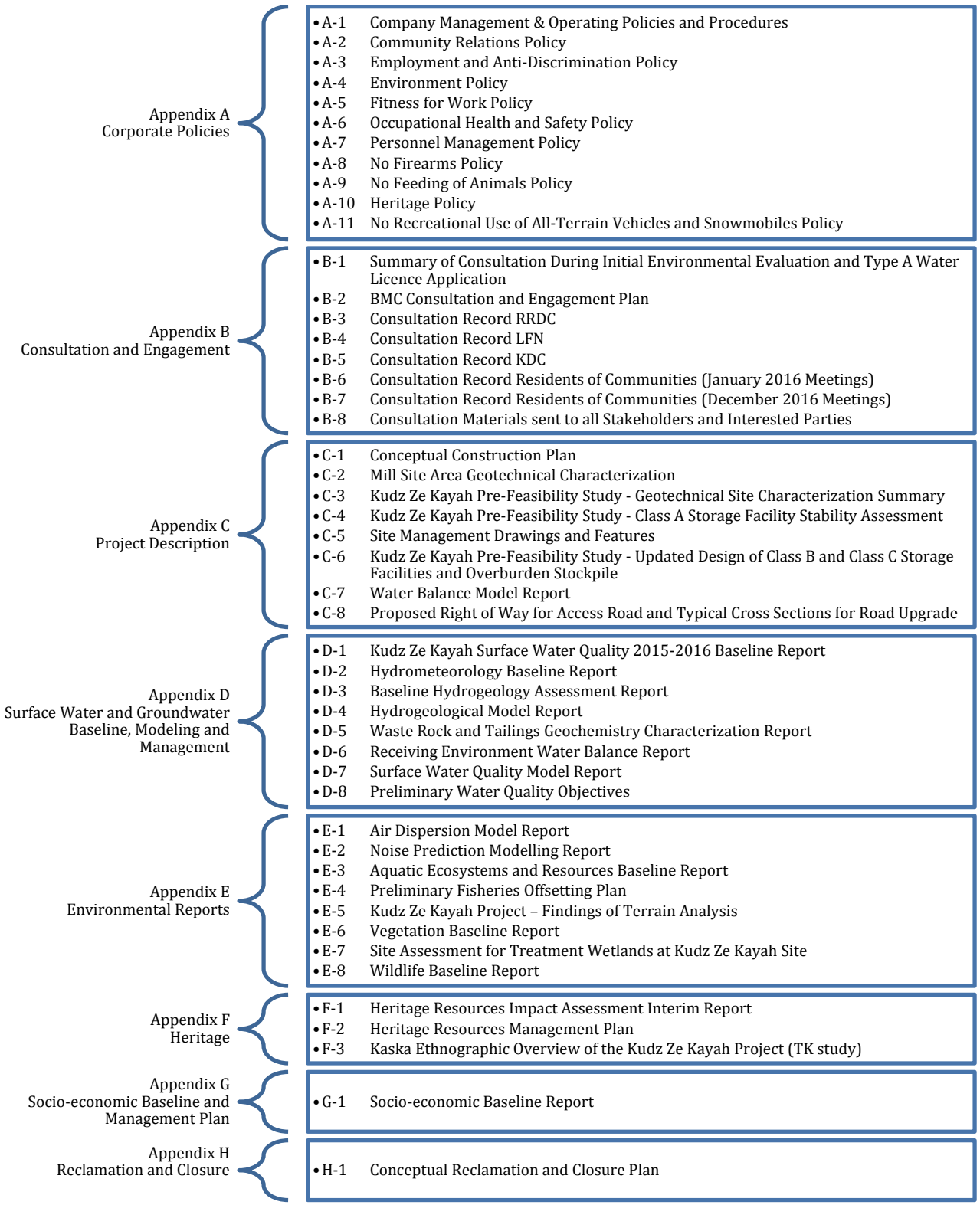
The Project encompasses the ABM Deposit of which there are two zones: the ABM Zone and the Krakatoa Zone. The ABM Deposit is a polymetallic volcanogenic massive sulphide (VMS) deposit containing economic concentrations of copper, lead, zinc, gold, and silver. Mining is planned to be conducted via both open pit and underground mining methods, with ore processed into separate copper, lead, and zinc concentrates via sequential flotation through a nominal 2 million tonnes per year (Mtpa) processing plant.

The Project will have a nominal 5,500 tonne per day (tpd) throughput over an approximate 10-year mine life. The mine is planned to produce an average of 180,000 tonne (t) zinc, 60,000 t copper, and 35,000 t lead concentrates annually. Concentrate is proposed to be transported to the port of Stewart for export via Highway 4 south (Robert Campbell Highway) to Watson Lake and Highway 37 south to Stewart, British Columbia (a distance of 911 km).

The scope of the Project includes developing on site and off site surface infrastructure to support open pit and underground mining activities required to extract mineral reserves from the ABM Deposit.



Project Proposal Organization – Main Report



Project Proposal Organization –Appendices

In preparation of this Project Proposal, BMC has engaged with the Kaska, local communities, government agencies and boards, and other interested parties. In support of BMC's social licence to operate, consultation and engagement with stakeholders and interested parties will continue throughout the permitting process and entire life of the Project, with issues and concerns being considered and addressed, as practicable.

In its complete and submitted form, this Project Proposal represents BMC's development proposal for the Project. The intent of the Project Proposal is to demonstrate that mining of this property will on balance be environmentally, socially and economically beneficial. The Project will promote economic prosperity in Yukon by providing employment and generate business opportunities as well as producing local, territorial and federal tax revenues. Importantly, at a local community level the Project will provide employment training, work skills and increased meaningful opportunities for local employment at supervisory and management levels through implementation of the BMC – Kaska Education Scholarship Program. BMC believes that the Project can be implemented without lasting adverse effects on the local or regional environment or economies, and without undermining family or community well-being or public health. BMC is committed to implementing and operating the Project in accordance with responsible mining practices.

Project History

BMC purchased the Project from Teck Resources Ltd. (Teck) in January 2015. Since that time, BMC has engaged in a program of assessing historical work completed on the Project, extensive resource drilling, baseline environmental studies, First Nations and community engagement, and economic assessment.

Prior to BMC's involvement with the Project, the original property owners, Cominco Ltd. (Cominco) (subsequently acquired by Teck), completed an exploration program in the mid-1990s which outlined an economic resource at KZK. Cominco completed environmental and socio-economic studies for the Project in 1994/1995 to support the Initial Environmental Evaluation (IEE) under *Canadian Environmental Assessment Act* (submitted for regulatory review in March 1996 and approved in December 1997). Throughout this process, Cominco undertook an extensive consultation and engagement program which informed Project design and helped develop the mitigation and management strategies for the Project.

In 1998, approval to commence development of a mining project at Kudz Ze Kayah was provided to Cominco through the issue of Type A Water Licence QZ97-026. Subsequent to that licence, Cominco, and then Teck, did not develop the Project but did comply with all licence conditions. Part of that compliance included the collection of and reporting on environmental baseline data on a biennial basis.

When the property was purchased by BMC from Teck, the Water Licence was transferred to BMC as Licence QZ97-026-01. BMC's Project design is largely within the same footprint as the Cominco design. BMC has used the development of this Project Proposal as a planning tool to ensure that Project decisions (and related physical activities and components) are considered in a careful and precautionary manner to avoid or minimize the potential for adverse environmental and socio-

economic effects. The current Project Proposal has incorporated the environmental data collected since the mid-1990s into the assessment, as well as considerations raised through the previous assessment and permitting process.

Land Tenure

The KZK property contains 923 quartz claims held by BMC. Other quartz mineral claims with Land Use Permits near the Project include Bolt, Boot, Fyre Lake, and Wolverine. Other land tenure adjacent to the Project includes an interim protected Category A Settlement Lands Rural Block (R-block) held by the RRDC (R-15A), and located adjacent to the southeast of BMC's KZK claims. The Project is located within outfitting concession #20 (held by Yukon Big Game Outfitters) and within Game Management Subzone (GMS) 10-07. The Project claim boundary overlaps with two trapping concessions; the Tote Road and the west portion of the claims overlap group trapline concession #405 (held by Ross River group) and the eastern portion of the claims overlap trapline concession #250.

FIRST NATIONS AND COMMUNITY CONSULTATION

BMC has engaged with government agencies, boards, First Nations, various stakeholder groups, and interested parties since 2014 with the initial aim of introducing the Company to these groups prior to purchase of the KZK property. Since that time, BMC and has continued to pursue further engagement and consulted with these parties regarding the proposed Project, the Project planning and design, Project Proposal content, and permitting strategies.

Consultation in relation to the Project began with Cominco (subsequently Teck) in the 1990s during the environmental assessment and water licencing processes. Throughout these two regulatory processes, Cominco undertook an extensive consultation and engagement program, responses to which informed final Project design and helped develop the mitigation and management strategies for the Project.

For this current Project the two principal Kaska First Nations consulted were RRDC and Liard First Nation (LFN), with RRDC acknowledged as the lead agency under the Kaska Collaboration Agreement. As Kaska Dena Council represents citizens of all Kaska citizens they have also been consulted, as have the local communities of Ross River, Watson Lake, Faro, and Whitehorse.

BMC has developed strong relationships with the Kaska and local communities by building on the relationship developed by the Project's previous owners. Consultation and engagement activities began prior to BMC purchasing the property, with the 2004 Socio-economic Participation Agreement (SEPA) held by Teck assigned to BMC at the time of Project acquisition. BMC met with RRDC prior to and after acquisition of the Project and this respectful approach to engagement and consultation continues to underpin the good relationship that BMC enjoys with the Kaska today.

The means of consultation have included:

- Meetings and communications with Chief and Councillors;
- Meetings and communications with Chief and Elders;

- Public community open houses;
- Quarterly newsletters; and
- Virtual Open House.

To complement the public community open houses, BMC developed a Virtual Open House which is hosted on the KZK Project website (www.kudzzekayah.com/kudz-ze-kayah-proposal-community-information), for those who were either unable to attend one of the community meetings, or who desired more detailed and contemplative review of the Project material.

BMC has committed to ongoing community and First Nation's engagement throughout the life of the Project; this approach forms a core component of BMC's corporate philosophy, is codified in BMC's policies and has been endorsed by the BMC Board of Directors.

PROJECT DESCRIPTION

The scope of the assessment for the purposes of the effects assessment (EA) and this Project Proposal are the activities during construction, operations, closure, and post-closure. Project construction will commence when the necessary permits and financing are in place. The various Project phases are defined sequentially as follows:

- **Construction Phase**: will last approximately two years and includes site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground mining and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to collectively as the closure phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all closure activities have finished onsite and will continue until active monitoring is no longer required; the phase is split into two periods: a transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to fill following the end of operations) and a 10-year post-closure monitoring period.

The scope of the Project includes developing on site and off site surface infrastructure to support open pit and underground mining activities required to extract mineral reserves from the ABM Deposit. The Project will have a nominal 5,500 tpd throughput over an approximate 10-year mine life.

On site surface infrastructure will include:

- Open-pit mine and underground mine (portal access from within the open pit);
- Processing facility and associated run of mine (ROM) and low grade stockpile facilities;
- Paste backfill plant;

- Three waste storage facilities for tailings and waste rock (Class A, Class B, and Class C); Waste rock will be placed in different storage facilities based on its assessed potential for generation of acidic drainage and metal leaching;
- Overburden and topsoil stockpiles that will used for progressive reclamation and for final closure;
- Water management infrastructure, including a Pit Rim Pond for mine dewatering, water collection ponds, Operations Water Management Ponds (Upper and Lower), water treatment plant, and surface water diversion ditches;
- Camp facilities;
- Core shack and core storage;
- Waste management facility that will include an incinerator, a small Land Treatment Facility, and a small landfill area; and
- General mine infrastructure including an explosives facility, workshops, and fuel facilities.

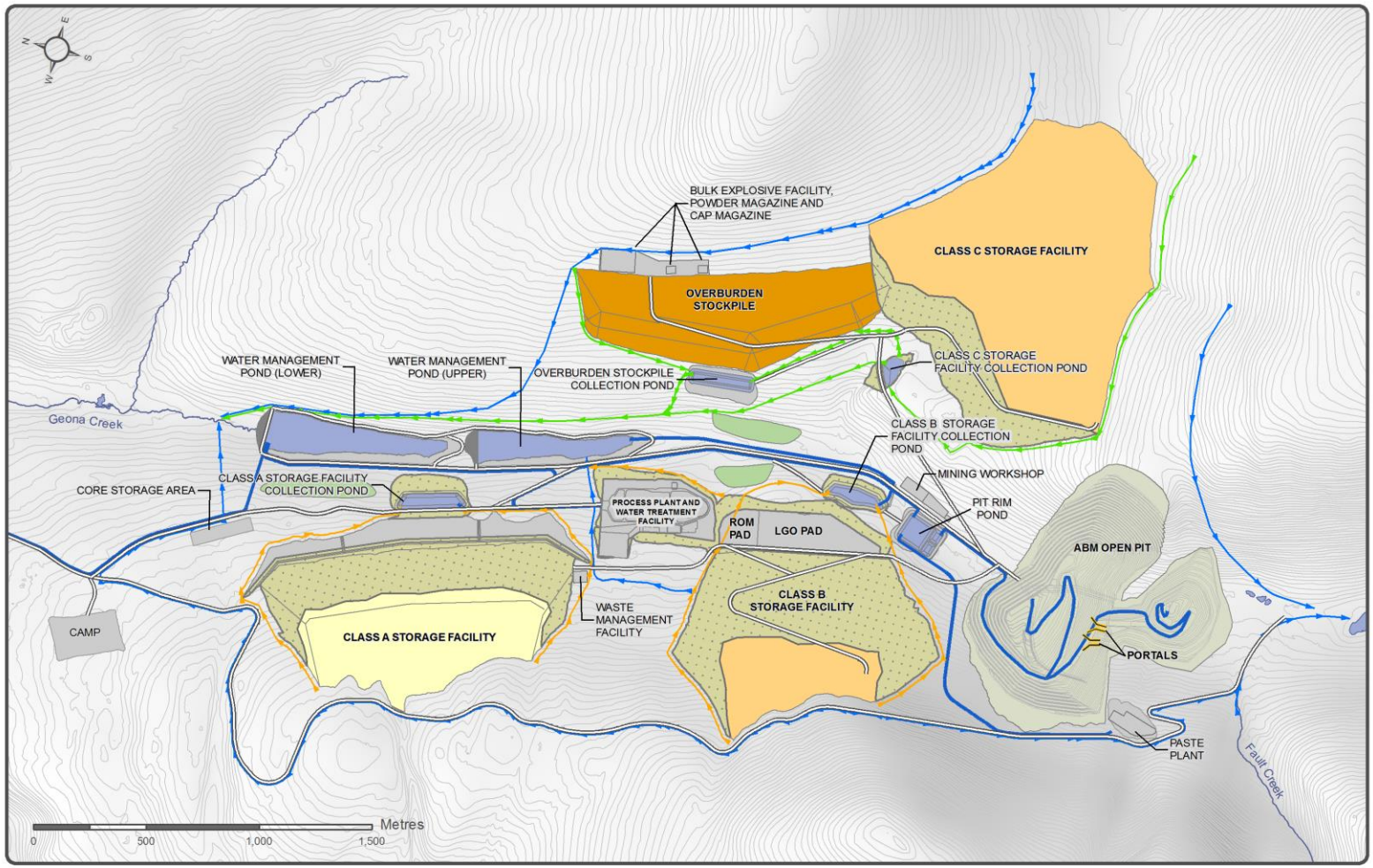
Off site infrastructure will include upgrades to the existing 24 km Tote Road that runs from the Robert Campbell Highway to the Project site, and upgrade of the Finlayson Lake airstrip located approximately 40 km from the site.

The on site and off site infrastructure is further summarized in Table 1 with general mine site layout shown in the figure below.

Table 1: Project Description Summary

Mine Facility	Key Parameters (estimated)	
ABM Open Pit: A single open pit will be mined that will access the ABM and Krakatoa Zones. Mining of the ABM Zone is staged into three separate phases and the Krakatoa Zone mined in a single phase.	Final surface area	340,000 square metres (m^2)
	Ore volume	3.7 million cubic metres (Mm^3)
	Life of mine	10.5 years
Underground Mine: Underground mining has only been considered for the Krakatoa Zone of the Deposit, due to the majority of the ABM Zone being mined by open pit methods.	Portal Elevation	1,340 masl (metres above sea level)
	Life of mine	7 years
Processing Plant and ROM Facilities: The plant will produce separate copper, lead and zinc concentrates and tailings. Concentrates will be thickened, filtered, and stockpiled on site prior to being loaded onto trucks for transport to third party smelters.	Processing rate	2.0 Mtpa
	Crushed ore capacity	3,000 t
Class A Storage Facility: A co-disposal facility to manage filtered tailings and strongly potentially acid generating waste rock. Located north of the Process Plant Facility on the western hillside of the Geona Creek valley.	Final surface area	741,900 m^2
	Tailings volume	7 Mm^3
	Tailings tonnage	15.1 million tonnes (Mt)
	Waste rock volume	6 Mm^3
	Waste rock tonnage	11.6 Mt
	Design Storage volume	15 Mm^3

Mine Facility	Key Parameters (estimated)	
Class B Storage Facility: A facility to manage weakly potentially acid generating waste rock. Located on the western hillside of Geona Creek adjacent to the ABM open pit.	Final surface area	700,500 m^2
	Waste rock volume	24 Mm^3
	Waste rock tonnage	47.3 Mt
	Design Storage volume	25 Mm^3
Class C Storage Facility: A facility to manage potentially non-acid generating waste rock. Located in a hanging valley on the east side of Geona Creek.	Final surface area	1,255,000 m^2
	Waste rock volume	32 Mm^3
	Waste rock tonnage	64.1 Mt
	Design Storage volume	34 Mm^3
Overburden and Topsoil Stockpiles: Overburden stripped from the ABM open pit excavation will be placed in a stockpile along the valley's east slope. Topsoil will also be stockpiled.	Overburden volume	16.1 Mt
	Topsoil volume	715,000 m^3
Water Management Structures: A water treatment plant (WTP) will be constructed at the processing facility to treat contact water from the collection ponds of the Class A and B Storage Facilities, and the runoff from the process plant area collected in the perimeter sumps.	Annual nominal capacity of WTP	2,035,000 m^3 per year.
	Nominal Capacity of Lower Water Management Pond	500,000 m^3
	Nominal Capacity of Upper Water Management Pond	250,000 m^3
	Nominal Capacity of Pit Rim Pond	60,000 m^3



Project Mine Site Layout (Year 10)

ASSESSMENT METHODS

The effects assessment approach for the Project followed standard effects assessment guidance and addresses the requirements set out under *YESAA* and is consistent with that outlined in the YESAB guidance document (YESAB, 2005). In general, the EA has followed seven steps:

1. **Identify Valued Components (VCs)**: The valued components were identified based on likely Project interactions as well as consultation with First Nations, regulators and other stakeholders and form the framework for the assessment of the potential effects of the Project on the environment and communities.
2. **Define Assessment Scope/Boundaries**: The spatial and temporal boundaries were selected to define the scope or limits of the assessment for each VC. The selected boundaries encompass the areas within and times during which Project effects may occur.
3. **Describe Existing Conditions**: The existing conditions were described in enough detail to provide the benchmark against which the Project effects were evaluated.
4. **Determine Interactions and Project Effects**: Project activities were first screened against each VC to identify potential Project-VC interactions and to focus the detailed effects assessment. The identified interactions were assessed further to identify potential effects.
5. **Describe Mitigations of Potential Project Effects**: For any identified potential effects, mitigation measures were proposed to eliminate, reduce or manage the effect on the VC.
6. **Characterize Residual Effects**: If the effect remained after application of the mitigation measures, the effect was considered residual and was characterized using effects criteria.
7. **Determine Significance of Residual Effects**: The significance of the identified residual effects was determined using VC-specific definitions.

Each identified residual effect was also assessed in the context of potential cumulative effects that encompassed the effects of other past, present, and reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects were defined as those projects or land use activities for which proposals have been submitted to YESAB. Potential cumulative effects were identified on the basis that the Project's residual effects overlapped with other projects' effects in space, time and the type of effect.

Valued components are defined by YESAB as "elements of the environmental and/or socio-economic systems valued for environmental, scientific, social, aesthetic, or cultural reasons" (YESAB, 2005). Valued components are aspects of biophysical and human environments that, if altered by the proposed Project, would be of concern to First Nations, regulators, stakeholders, and the general public. Fourteen Valued Components were selected and included in the EA and are shown in Table 2 (including the rationale for inclusion).

Assessment boundaries, being the space (spatial) and time (temporal) boundaries, for each VC have been characterized and assessed. Spatial boundaries may include as applicable; the Project footprint, being the area within which the Project infrastructure will be located and is the area of direct disturbance from the Project activities; the local study area which refers to the area within which most of the direct Project effects are expected to occur; and the regional study area which refers to the area within which indirect and cumulative effects may occur. Temporal boundaries are defined

to include all Project phases within which effects are expected to occur and may also include seasonal considerations (i.e., winter/summer, breeding periods), if applicable.

Table 2: Environmental and Socio-economic Valued Components

Valued Component	Rationale for Inclusion
Air Quality	Air Quality was selected as a VC due to its fundamental importance to the health and well-being of humans, wildlife, vegetation, and other biota. Assessment of air quality also considered Project greenhouse gas emissions. Project activities will result in air emissions.
Noise Levels	Noise was selected as a VC because of its fundamental importance to the quality of life for humans and wildlife in the vicinity of the Project. Elevated noise levels may lead to negative health effects in humans. For wildlife, noise may lead to habitat avoidance as well as unfavourable physiological and behavioral responses, with concerns for potential effects of noise on wildlife raised through consultation. Project activities will generate noise.
Surface Water	Surface water was selected as a VC because of its important role in maintaining functioning aquatic and biophysical environments. Furthermore, water quality is highly valued by Yukon residents, including First Nations, with concerns regarding changes to surface water quality and quantity (flow) raised through consultation. Project activities have a potential to affect surface water quality and quantity.
Groundwater	Groundwater was selected as a VC because of its fundamental importance in maintaining function of aquatic and biophysical environments. Furthermore, overall water quality and quantity has been identified as highly valued by Yukon residents, including First Nations, with concerns regarding changes to groundwater raised through consultation. Project activities have a potential to affect groundwater flow and quality.
Aquatic Ecosystems and Resources	Aquatic ecosystems and resources were selected as a VC because of their importance in maintaining function of aquatic and biophysical environments as well as the cultural and recreational importance of fish, with concerns regarding potential effects on fish and fish habitat raised through consultation. Aquatic ecosystems and resources may be affected by Project activities due to potential changes in water quality and flow.
Terrain and Soils	Terrain and soils are closely interrelated, and are considered as a single VC for the Project as they are vital to landscape and ecosystems that support the biophysical and human environments. Project facilities have potential to change local terrain and result in local soil loss. Project activities may also affect soil quality.
Vegetation Cover and Composition	Vegetation cover and composition were selected as a VC due to their fundamental importance to the health and well-being of the biophysical and human environment, as well as being raised through consultation having high cultural and First Nations value. Project activities have the potential to affect vegetation through clearing activities.
Wildlife and Wildlife Habitat	Wildlife and wildlife habitat were selected as a VC due to their fundamental importance to the health and function of the biophysical and human environment, as well as wildlife's high cultural and First Nations' value, with concerns about potential effects on wildlife raised through consultation. Project activities may have direct and indirect effect on the wildlife.
Heritage Resources	Heritage resources were selected as a VC due to existing legislation and the high value given them by the RRDC and LFN. Project activities may affect heritage resources present in the area.
Economy and Sustainable Livelihood	The affected communities and First Nations place a high value on a sustainable, diverse, and stable community economy that provides local employment and business opportunities, and helps to support local government. Promoting the self-sufficiency of community members and avoiding the excesses of a boom and bust economy are also valued. Project activities have potential to contribute to local economies through employment and business opportunities.
Human Health and Well-being	Human health and well-being are universally VCs. Project activities may affect the health of individuals and community health in the area.
Community Vitality	Community vitality includes a number of economic and social factors, such as population structure, health of local businesses, crime rates, and community events. Project activities may contribute to local community vitality through population changes, business opportunities, community events.
Infrastructure and Services	Infrastructure and related services make up the physical core of any community. Project activities may affect the availability of infrastructure and services (e.g., transportation infrastructure, municipal services).

Valued Component	Rationale for Inclusion
Culture, History and Heritage	Culture, history and heritage form an important part of community identity. This VC considers language preservation and restoration, traditional knowledge and practice preservation and restoration, and heritage and historic sites.

Traditional Knowledge Integration

Traditional Knowledge (TK) integration was both a part of the relationship building efforts with the RRDC and other Kaska groups, and to fulfill the territorial requirements for the Project assessment and planning. To date, BMC has been consulting primarily with the RRDC (along with LFN) whose Traditional Territory overlaps with the Project. The RRDC is part of the trans-boundary Kaska Dena Council. A Kaska TK study was undertaken over the Project area by RRDC in the 1990s for the Initiation Environmental Evaluation (Rutherford, 1995). A desk-based TK study was also completed for the Project in 2016 comprising a compilation of the TK information available in the Yukon Archives, EMR library, and academic institutions, such as Yukon College and the University of British Columbia. In addition, RRDC is currently undertaking a supplemental TK study over the Project area. In this context, further consideration and integration of Kaska TK information will occur in an ongoing manner as it becomes available through partnership and collaboration with RRDC.

Kaska TK has been integrated throughout the effects assessment. The principles that guided the process of incorporating Kaska TK were as follows:

- Kaska TK was considered on par with scientific knowledge (where available);
- Kaska citizens were recognized and referenced as key contributors to the effects assessment; and
- Iterative communications were maintained between BMC and RRDC throughout the TK integration process.

There are key integration destinations for Kaska TK within each chapter of the effects assessment, including:

- Identification of Valued Components;
- Determination of assessment boundaries;
- Description of existing conditions;
- Effects characterization;
- Development of mitigation measures; and
- Determination of residual effects and their significance.

AIR QUALITY

Assessment Approach

The air quality effects assessment relied on the results of air dispersion modelling conducted using CALPUFF, a Gaussian puff model that accounts for time-and-space varying meteorological conditions, different source configurations and contaminants, and chemical transformations.

Project related greenhouse gas emissions were also assessed because of their known association with climate change. For greenhouse gases, an inventory was carried out using published emission factors to estimate average annual emissions for each Project phase.

The following subcomponents were selected for assessment of air quality:

- Criteria Air Contaminants (CACs); and
- Greenhouse Gases (GHGs).

Assessment Boundaries

The study area boundaries included areas where measurable changes in ambient air quality might be caused by the Project, and included the proposed camp as a receptor. The proposed camp location was selected as a receptor because ambient air concentrations at the camp will be representative of exposure to off-duty workers.

Existing Conditions

Due to the Project's remote location and the fact that there are no industrial or residential activities in the area, baseline air quality data was not collected. Gaseous air contaminants are expected to be minimal and any existing baseline air contaminants likely originate from natural sources (e.g., fugitive dust) or long range transport, and likely consist mainly of fine particulate matter ($PM_{2.5}$) able to survive long range transport. Subsequently, baseline concentrations were assumed to be similar to other remote locations with no anthropogenic sources.

Greenhouse gas emissions from the mining sector (excluding smelting and refining) represent an average of 1% of the total Canadian greenhouse gas emissions. Yukon emissions represent less than 0.1% of total Canadian emissions.

Climatic and meteorological conditions for the Project were also characterized using regional data available through Environment and Climate Change Canada (EC) and Environment Yukon, as well as meteorological data collected on site in 1995, and at the meteorological station's new site commissioned in late August 2015. The mean annual temperature recorded at the Project for the period September 2015 to August 2016 was -0.47°C, with extremes ranging from -26°C to 20°C. When compared to both long-term regional averages and to regional data for the same period, the 2015-2016 record at the Project generally shows warmer average winter temperatures (October to April), and cooler average summer temperatures (May to September). Total precipitation recorded

on site was 343 mm (September 2015 to August 2016), with July and August being the wettest months. When compared to long-term regional annual means, the 2015-2016 data collected for the Project generally showed lower total precipitation than at most regional stations reviewed, except for Ross River and Faro, which have lower long-term annual averages.

Project-specific Effects

Modelled ambient concentrations for criteria air contaminants resulting from Project activities were added to baseline concentrations and compared against Yukon Government (YG) Ambient Air Quality Standards (YAAQS) for sulphur dioxide (SO_2), total suspended particulate (TSP), carbon monoxide (CO), fine particulate matter, aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$), nitrous oxide (NO_2), coarse particulate matter, aerodynamic diameter of less than 10 µm (PM_{10}). Short duration (24-hour) exceedances of the YAAQS were predicted at the camp location for TSP and PM_{10} during operations under the worst-case meteorological and operational conditions. However, mitigation measures such as road and surface watering can be adjusted in frequency and combined with additional measures described in the Conceptual Air Quality Management Plan to ensure that standards are not exceeded in camp. No other YAAQS exceedances were predicted to occur.

Greenhouse gases emissions were estimated for each Project phase based on equipment and vehicle use. Predicted Project greenhouse gas emissions would, in comparison to 2014 Canadian total and mining sector emissions, comprise a relatively small fraction. As a further comparison, they would represent 4% to 22% of the 2014 total territorial emissions depending on the Project phase.

The residual effects, key mitigation measures and assessed significance are summarized in Table 3.

Table 3: Air Quality Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Increase in ambient concentrations of particulate matter (TSP, PM_{10}, $PM_{2.5}$) at receptor	Dust suppression and prevention measures. Progressive reclamation of disturbed areas. Minimizing land clearing activities. Construction of the Access Road and site roads with suitable material. Low speed limits for all mobile equipment. Orientation of material stockpiles so that the length is parallel with prevailing winds, where practicable. Construction of wind breaks or stationary misters. Visual inspections to identify and address potential dust emissions.	Not significant
Increase in ambient concentrations of criteria air contaminants (TSP, PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2) at receptor	Use filters, scrubbers, and other pollution control devices at processing facilities. Avoid engine idling (where practicable). Ensure vehicles and equipment are maintained according to manufacturers' guidelines. Use catalytic control systems on diesel engines.	Not significant
Emission of GHG contributing to territorial and national inventories	Waste reduction at source and recycling. Waste segregation. Incinerator operation for optimum combustion. Regular inspection and maintenance of incinerator.	Not significant

Cumulative Effects

No overlap in space was identified with any other projects considered in the cumulative effects assessment, under the criteria air contaminants subcomponent of the air quality VC. However, for greenhouse gases, because they have effects on the regional scale and over the long-term, this subcomponent overlaps both in time and space with most of the other projects considered in the cumulative effects assessment. The expected greenhouse gas emissions from other projects were considered in combination with the Project greenhouse gas emissions. It is expected that the overall cumulative contribution to Canadian greenhouse gas inventory will remain less than 0.02% (Yukon greenhouse gas emissions are generally very low, representing less than 0.1% of total Canadian emissions). The overall cumulative effects from greenhouse gas emissions were assessed as not significant.

Effects Monitoring

No ongoing air quality monitoring is proposed. The Air Quality Management Plan will be in place and will aim to eliminate all exceedances identified through modelling as those are predicted during worst meteorological and operational conditions.

Meteorology monitoring was proposed to continue at the existing weather station to collect the following ongoing measurements:

- Air temperature (°C);
- Relative humidity (%);
- Wind speed (m/s) and direction (degrees);
- Barometric pressure (hPa);
- Solar radiation (W/m^2); and
- Total precipitation (mm).

NOISE LEVELS

Assessment Approach

Noise modelling was conducted using SoundPLAN Essential; a standard software for predicting noise from industrial sites, using International Organization for Standardization (ISO) 9613 standards.

The following subcomponents were selected for assessment of noise levels:

- Daytime noise level;
- Night-time noise level; and
- Blasting noise.

Assessment Boundaries

The study area boundaries were selected to include areas where measurable changes in sound levels might be caused by the Project, and included the camp as a receptor. The camp was selected as a receptor because the noise levels at camp will be representative of exposure to off-shift workers. The regional study area was selected to evaluate the potential effects of increased traffic on the Tote Road, and the extent of predicted changes in baseline noise levels associated with the Project activities.

Existing Conditions

The Project is located in a remote area in central Yukon, where noise levels are expected to be low and dominated by natural sounds (wind, wildlife, and creeks). As such, no baseline sound level data were collected at or in the vicinity of the Project. However, based on the remote location of the Project, the existing acoustic ambient conditions are expected to be similar to the average ambient sound level for rural areas as established by the Energy Resources Conservation Board (ERCB, 2007) and the BC Oil & Gas Commission (BC OGC, 2009).

Project-specific Effects

Under the loudest scenarios, daytime and night-time noise levels differed from baseline by less than 3 dBA over a maximum extent of approximately 4 km in the east-west direction and 8 km in the north-south direction centered on the Project Footprint. One to five dBA is the typical threshold for an increase in sound level that is considered to be "barely perceptible" by the human ear (Health Canada, 2011). A similar threshold is assumed for animals.

Noise at camp resulting from blasting was expected to reach a maximum of 106 dB to 109 dB, which falls below both the Ontario Ministry of the Environment (MOE) (Ontario MOE, 1978) Noise Pollution Control (NPC) NPC-119 Blasting and Environment Canada's *Environmental Code of Practice for Metal Mines* (2009) guidelines.

The residual effects, key mitigation measures and assessed significance are summarized in Table 4.

Table 4: Noise Levels Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Increase in daytime noise level at camp receptor	Noise dampening enclosures for boiler, generators and compressor. Crusher, grinding mills, conveyor shielding (enclosed building). Equipment maintenance and equipment specific noise mitigation. Maintaining natural cover (vegetation) between noise sources and receptor. Maintaining the Project roads regularly to minimize vehicle noise associated with vibration. Considering noise control factors when procuring equipment.	Not significant
Increase in night-time noise level at camp receptor		Not significant
Blasting noise perceptible at camp receptor	Adhering to BMC's blasting strategy that implements controlled blasting procedures, optimizes blasting operations, and minimizes non-productive noise.	Not significant

Cumulative Effects

No projects or activities were identified to overlap with Project residual effects for noise levels in type of effect, in time and in space. Therefore, no potential cumulative effects were identified for noise.

Effects Monitoring

No noise specific monitoring was proposed.

SURFACE WATER QUALITY AND QUANTITY

Assessment Approach

A water quality prediction model (Excel and PHREEQC) and water balance (Excel and Goldsim) were used to predict changes to water quality and quantity, based on the anticipated water sources associated with the Project during the construction, operations, and closure phases.

The following subcomponents were selected for assessment of surface water quality and quantity:

- Surface water quantity; and
- Surface water quality.

Assessment Boundaries

The local study area for surface water assessment was defined as the Geona Creek catchment, including the footprint of the proposed Mine infrastructure, and Geona Creek downstream to the confluence with Finlayson Creek.

The regional study area for surface water assessment was defined as the local study area (Geona Creek) and the Finlayson Creek catchment downstream of the local study area to the Robert Campbell Highway, and included South Creek to a monitoring location downstream (due to the planned diversion of Fault Creek into the South Creek catchment).

Existing Conditions

The Project is located in a small (approximately) 26 km^2 watershed called Geona Creek, which is a north flowing tributary of Finlayson Creek. Finlayson Creek meets the outflow of Finlayson Lake north of the Robert Campbell Highway and flows east to eventually join Frances River, and ultimately, the Mackenzie River.

Local hydrometric data collection occurred in 1995 as part of the Initial Environmental Evaluation and Water Use Licencing processes and was re-initiated in May 2015. Peak flows typically occur in May due to snow melt, or in summer months in years when snow melt generated peak flows are less significant and large summer rain storms occur. Low flows occur in late winter in March, April, or early May depending on the melt cycles and snowpack in any given year. None of the creeks were

observed to freeze completely and some flow was observed in all months during the monitoring programs.

Water quality surveys were completed in 1994-1995 as part of the Initial Environmental Evaluation and Water Use Licencing processes and subsequent water licence biennial sampling was conducted between 2002 and 2016. Monthly water quality sampling was initiated in 2015 at twelve surface water stations located on South Creek, Fault Creek, Geona Creek, Finlayson Creek, and East Creek with the aim of supplement the historic data set and evaluating the natural background chemistry of major watercourses located in the Project area. Measured water quality was compared against the most recently revised water quality guidelines for protection of aquatic life established by the Canadian Council of Ministers of the Environment (CCME) or British Columbia Ministry of the Environment (BCMoE), which indicated sporadic exceedances for fluoride, phosphorus, aluminum, arsenic, cadmium, chromium, copper, iron, lead, selenium, and zinc. In general, more water quality guideline exceedances were noted for total metal concentrations than their dissolved counterparts, suggesting that a significant portion of the metals were particulate-bound, especially during freshet and/or other periods characterized by elevated levels of total suspended solids. The much less frequent water quality guideline exceedances observed for dissolved metals is important information as it is the dissolved fraction that is the most bioavailable.

Higher total metal concentrations were measured during spring freshet due to the high run-off and associated stream flow which increased the particulate content of the streams. The exceptions to this were concentrations of fluoride, total selenium, uranium, and hardness, which were lowest during freshet. Selenium, uranium, and hardness concentrations rose throughout the year to be highest during the winter months, suggesting that groundwater is an important contributor to the surface water concentrations of these constituents.

A comparison of 1994-1995 data with 2015-2016 data showed that the majority of parameters had a similar concentration range, suggesting that site water quality has remained largely unchanged in the past two decades of monitoring. Only total chromium and selenium exhibited clear differences between the datasets. Total chromium concentrations were typically lower in the 2015-2016 dataset compared to the historic sampling, perhaps due to a preponderance of higher flow sampling events in the historic samples, which may have resulted in higher particulate chromium concentrations. Conversely, total selenium concentrations were generally higher in the recently collected samples compared to the 1994-1995 survey possibly because fewer samples were taken during low flows in the 1994-1995 when selenium concentrations are higher.

Project-specific Effects

The following effects were assessed for surface water quality and quantity:

- Changes in surface water quantity and quality as a result of water diversions and dewatering activities during construction;
- Changes in surface water quantity and quality as a result of water management and discharge during operations;

- Changes in surface water quantity and quality as a result of flooding of ABM open pit at closure and ABM lake formation; and
- Changes in surface water quantity and quality as a result of water management and discharge during closure.

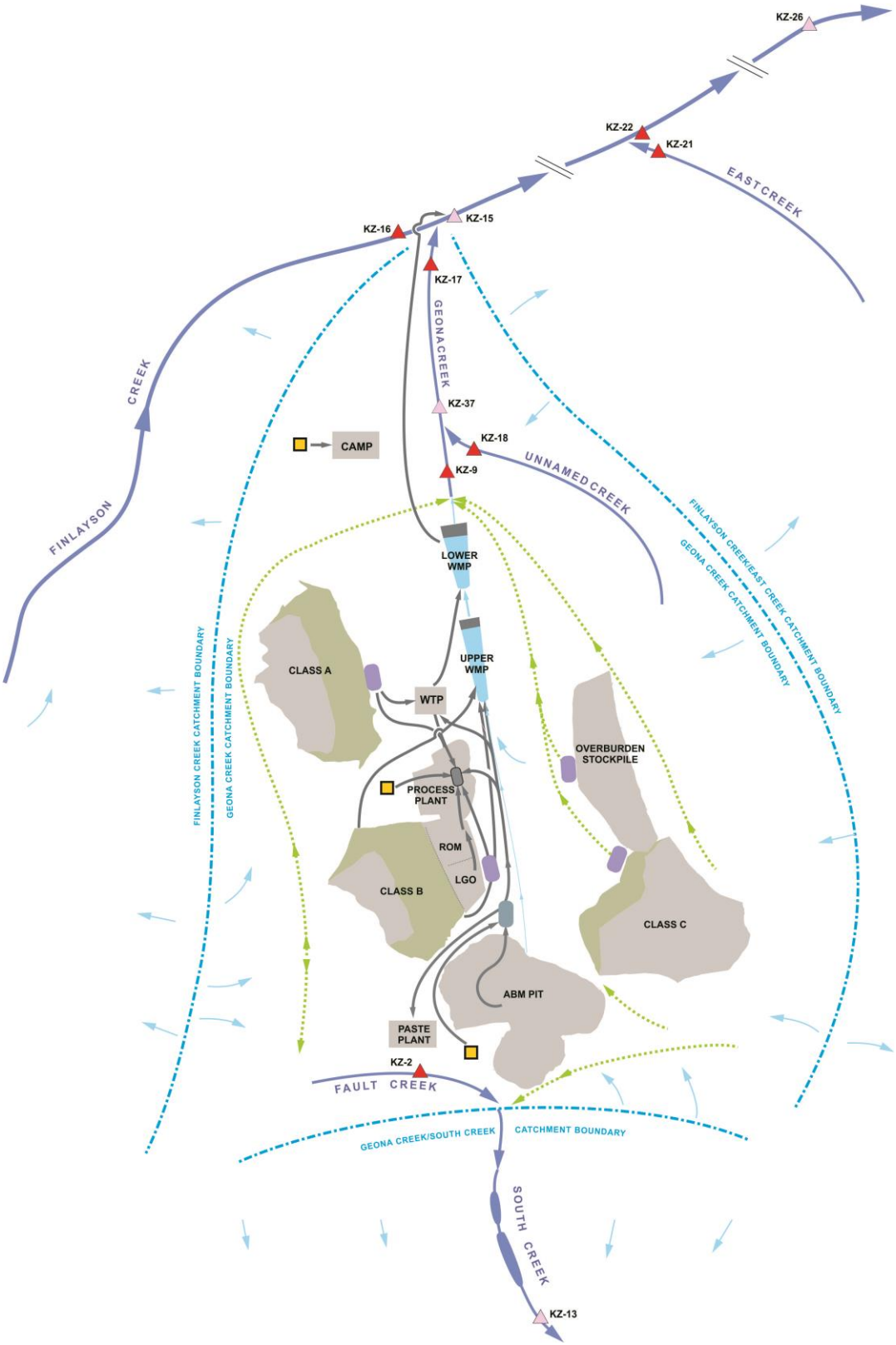
The effects of the Project on surface water quality and quantity identified above were assessed at four locations (see figure below):

- KZ-37: Geona Creek below the Project Footprint and the major eastern tributary (KZ-18);
- KZ-15: Finlayson Creek below the confluence with Geona Creek;
- KZ-26: Finlayson Creek at the Robert Campbell Highway; and
- KZ-13: South Creek at near confluence with North River.

During the construction phase, Fault Creek and other small portions of the upper Geona Creek catchment will be diverted into South Creek to facilitate dewatering of the overburden in the location of the proposed ABM open pit. This was predicted to result in a 33% increase during the construction period in South Creek. During the construction phase, water will also be diverted around the Mine site into Geona Creek (below the Lower Water Management Pond), the model for this diversion predicted that this will result in a 19% increase in flows at the location were the diverted water meets Geona Creek.

During operations, water from areas outside the ProjectFfootprint and runoff from the east side of Geona Creek will continue to be diverted to Geona Creek below the Lower Water Management Pond. Water managed inside the Project footprint will be stored in the Lower Water Management Pond and directed to both Geona Creek and Finlayson Creek at minimum dilution ratios (Creek:effluent) of 3:1 and 2:1, respectively. As the ABM pit is excavated the drawdown of local groundwater increases and runoff in South Creek is reduced to 24% above baseline annually. Runoff in Geona Creek downstream of the Project was predicted decrease by 46% while increasing by only 10% at KZ-15 and 5% at KZ-26. During operations, water quality concentrations were estimated to be higher than baseline, but lower than preliminary water quality objectives for the majority of constituents. The exception was fluoride, which was estimated to marginally exceed its water quality objectives in Geona Creek and Finlayson Creek for some months of the calendar year during operations. Uranium was also estimated to exhibit marginal water quality objectives exceedances under the 1/10 dry year scenario in Geona Creek in October only.

In closure, diversions will be removed and covers will be put in place. South Creek will be reduced to 9% below baseline during the transition closure period, following the removal of the south diversions. The discharge in Geona and Finlayson Creeks will all be below baseline with the re-establishment of Fault Creek into the ABM open pit, but the effects on Geona Creek will be reduced as more water is allowed to discharge directly from the former Project footprint. As the ABM open pit lake forms, marginal selenium water quality objective exceedances were estimated at KZ-37 in Geona Creek for one month of the calendar year, under both the mean precipitation and 1/10 dry year conditions. In the 1/10 dry year scenario, slight fluoride exceedances were also estimated in upper Finlayson Creek.



Operations Water Management

Once the post-closure phase begins, the ABM lake will begin discharging water to the receiving environment and covers will be well established. Runoff is expected to return to near baseline levels, but slightly elevated in Geona and Finlayson Creeks due to the addition of deep groundwater to the ABM lake. No water quality objectives exceedances were identified in Geona or Lower Finlayson Creeks under the mean precipitation scenario. Only fluoride was estimated to exceed its water quality objective in upper Finlayson Creek, but the exceedance was marginal and only occurred in April of each year. Under the 1/10 dry year scenario, fluoride was estimated to exceed its water quality objective at KZ-37, KZ-15, and KZ-37. The modelled fluoride exceedance was marginal for all three sites and occurred only in March or April.

The residual effects, key mitigation measures and assessed significance are summarized in Table 5.

Table 5: Surface Water Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Surface water quantity		
Changes in surface water quantity as a result of water diversions and dewatering activities during construction	Diversion of Fault Creek to South Creek. Diversion of Geona Catchment above Project footprint.	Not significant
Changes in surface water quantity as a result of water management and discharge during operations	Diversion of Fault Creek to South Creek. Diversion of Geona Catchment above Project footprint.	Not significant
Changes in surface water quantity as a result of flooding of ABM open pit at closure and ABM lake formation	Removal of diversions to return baseline catchment boundaries. Installation of low permeability covers with natural vegetation to approximate natural cover and runoff.	Not significant
Changes in surface water quantity as a result of water management and discharge during closure	Removal of diversions to return baseline catchment boundaries. Installation of low permeability covers with natural vegetation to approximate natural cover and runoff.	Not significant
Surface water quality		
Changes in surface water quality as a result of water diversions and dewatering activities during construction	Manage open pit development water in Pit Rim Pond to settle suspended solids and aerate water. Lined Fault Creek diversion ditch. Energy dissipation structure at diversion outlet to South Creek catchment.	Not significant

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Changes in surface water quality as a result of water management and discharge during operations	Water treatment plant. Discharge at minimum dilution ratio to Geona Creek (3:1) and Finlayson Creek (2:1). Class A and B Storage Facilities will be constructed with a compacted low-permeability till liner. Upper Water Management Pond, Lower Water Management Pond, Pit Rim Pond, Class A and B Storage Facilities Water Collection Ponds will be constructed with an impermeable HDPE liner. Progressive reclamation of Class A, B and C Storage Facilities.	Not significant
Changes in surface water quality as a result of flooding of ABM open pit at closure and ABM lake formation	ABM lake treatment with lime and carbon source as it fills.	Not significant
Changes in surface water quality as a result of water management and discharge during closure	ABM lake treatment with lime and carbon source as it fills. Constructed wetland treatment system Low permeability covers for Class A and B Storage Facilities. Water Treatment Plan will remain onsite and available until Storage Facilities and constructed wetland treatment system are meeting design objectives.	Not significant

Cumulative Effects

No projects or activities were identified to overlap with Project residual effects for surface water quantity and quality in type of effect, in time and in space. Therefore, no potential cumulative effects were identified for surface water quantity and quality.

Effects Monitoring

Surface water monitoring was proposed through construction, operations, and closure phases. In addition to monitoring of the receiving environment, contact water, treated effluent, water management ponds and discharge points to the receiving environment will be added to the monitoring program during construction and operations. Surface water monitoring will occur on a monthly basis with the exceptions of the discharge from the Class A Storage Facility collection pond, the water treatment plant, and the Lower Water Management Pond, which will all be monitored on a weekly basis.

The monitoring of these surface water sites will continue at that sampling frequency for the first five years following closure (i.e., years 11 to 15). For the remainder of the transition closure period (i.e., years 16 to 26), the frequency of water quality monitoring at the surface water stations will be stepped downed to quarterly. Upon entering the post-closure period when the pit starts to overflow, the frequency of surface water quality monitoring will return to monthly for three years (i.e., years

27 to 29) before transitioning to quarterly sampling from year 30 until the end of the post-closure period (year 36).

Water quality monitoring of the ABM lake will begin approximately one year after the pit has started to fill with water (i.e., year 12) to allow sufficient volume to conduct sampling by boat. Once fully flooded (i.e., year 26), ABM lake sampling will continue at the same schedule for three years (i.e., until year 29). If the data suggest the ABM lake chemistry has largely stabilized, sampling will transition to quarterly for the remainder of the post-closure period (i.e., year 30 to 36).

GROUNDWATER QUALITY AND FLOW

Assessment Approach

The groundwater effects assessment was based on the results of the numerical groundwater model (MODFLOW-NWT) (Niswonger et al., 2011) that was developed and used to evaluate and quantify potential effects on groundwater.

The following subcomponents were selected for assessment of groundwater:

- Groundwater quality; and
- Groundwater quantity.

Assessment Boundaries

The local study area for the groundwater assessment was defined as the footprint of the proposed Mine infrastructure and included areas immediately downgradient of where groundwater quantity and/or quality may be affected by the Project activities. The regional study area for the groundwater assessment was defined as the Geona Creek valley downstream of the proposed Mine and the upper portion of the watershed to the south of the ABM Deposit.

Existing Conditions

The local hydrogeological system within the study area consists of two principal aquifers, a bedrock aquifer overlain across valley floors by an overburden aquifer. Overburden in the study area is primarily composed of till and glacial deposits ranging in thickness from a thin veneer on valley flanks, to more than 20 m near the centreline of the valley. The primary bedrock aquifer in the vicinity of the mineralized zones mainly consists of schistose felsic volcanics intersected with thick felsic tuff and sill/flow complexes that host the ore deposit. Groundwater discharges to receiving water bodies along the valley floors, with Geona Creek being the primary discharge feature within the study area.

There are currently forty-four groundwater wells in the Project monitoring network, which are a combination of older wells installed by Cominco in 1995, nineteen wells installed in 2015 by EBA, and eight wells installed in 2016 by Knight Pieshold. Twelve of the wells are completed as nested installations with a shallow piezometer completed in the overburden aquifer and a deeper piezometer completed in bedrock. In addition to some sporadic groundwater quality data from 1995, all monitoring wells have been sampled quarterly starting in summer 2015 with monthly sampling

conducted from May through November 2016 to characterize baseline groundwater quality including seasonal changes. Groundwater quality varied considerably across the study area, which is considered to be due to the considerable extent of the study area (over 5 km north to south), the various groundwater flow systems and recharge sources (east and west of Geona Creek) and the potential for differing chemistry in the vicinity of the ABM Deposit.

Groundwater collected from every well in the Project area over the period of monitoring reported at least one parameter that naturally exceeded one or more guideline values. Guideline exceedances by one or more samples of the following parameters were observed: aluminium, ammonia, arsenic, cadmium, chromium, copper, fluoride, iron, pH, phosphorus, selenium, sulphate, uranium and zinc.

While there were multiple natural exceedances of the applicable regulatory water quality guidelines, there were no obvious overall spatial trends or differences between aquifers with respect to exceedances of water quality guidelines. The exceedances did not imply that the groundwater at the site is currently contaminated. Rather, the exceedances indicated that background concentrations of these parameters are naturally elevated, reflecting the local geological and hydrogeological conditions in the Project area.

Project-specific Effects

The following potential effects on groundwater quality were assessed:

- Effects on groundwater quality in Mine workings (explosive residues, contact with exposed rock);
- Effects on groundwater quality from ABM lake discharge;
- Effects on groundwater quality by from seepage from of the Class A and B Storage Facilities, Water Management Ponds, and Waste Management Facility; and
- Effects on groundwater quality from the sewage disposal system.

Effects on groundwater quality in Mine workings and effects on groundwater quality from ABM lake discharge were assessed as part of the potential surface water quality effects. With the application of mitigation measures no residual effects were identified for groundwater quality.

The following potential effects on groundwater quantity were identified:

- Lowering of groundwater table for dewatering of Mine workings;
- ABM lake formation and long-term effects on groundwater table;
- Residual drawdown from Mine dewatering and effects on flow in Geona Creek and South Creek; and
- Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant.

The simulated drawdown during the final year of mining indicated that the zone of influence extends about 4 km to the southwest and about 1.5 km in the northern, eastern, and southern directions. At

Mine closure, the entrance to the underground workings will be sealed to prevent flow from occurring between the pit and the abandoned underground workings. The diversion of Fault Creek will then be removed, allowing the creek to resume its natural flow path, north toward Geona Creek and to flow directly into the pit, accelerating the rate of filling of the pit void. Filling the open pit will create a pit lake referred to as ABM lake. Upon filling to capacity (elevation of 1,380 masl) ABM lake will spill directly into Geona Creek. The ABM lake is expected to take 16 years to fill.

The irreversible changes to the groundwater regime in the area of the ABM lake result in a predicted decrease of the flow in South Creek (at station KZ-13) of about 10% relative to baseline conditions. The flow in Geona Creek is predicted to initially decrease to about 80% of the baseline flow upon Mine closure while the ABM lake is filling. Once the ABM lake reaches its spill elevation, the flow in Geona Creek was predicted to increase to about 110% of the baseline flow.

The extraction of groundwater for potable water use in the camp and reagent mixing in the Process Plant was predicted to result in local drawdown of the groundwater table near the proposed water wells at the camp and Process Plant. However, the demand of 3.7 m^3/hr and 5.5 m^3/hr at the camp and Process Plant, respectively, is small relative to the estimated baseflow in Geona Creek and Finlayson Creek.

The residual effects, key mitigation measures and assessed significance are summarized in Table 6. As noted above, no residual effects were identified for groundwater quality.

Table 6: Groundwater Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Lowering of groundwater table for dewatering of Mine workings	Dewatering system will be designed to minimize the required groundwater extraction and associated drawdown of the groundwater table.	Not significant
ABM lake formation and long-term effects on groundwater table	Re-divert Fault Creek into Geona Creek watershed and the ABM lake for accelerate the filling of the open pit.	Not significant
Residual drawdown from Mine dewatering and effects on flow in Geona Creek and South Creek	Dewatering system will be designed to minimize the required groundwater extraction and associated drawdown of the groundwater table.	Not significant
Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant	Water wells for groundwater supply to camp and Process Plant will be designed and constructed to maximize well performance and minimize drawdown of the groundwater table and associated effects.	Not significant

Cumulative Effects

No projects or activities were identified to overlap with Project residual effects on groundwater in type of effect, in time and in space. Therefore, no potential cumulative effects were identified for the groundwater quality and flow.

Effects Monitoring

Groundwater monitoring was proposed through construction, operations, and closure phases. Groundwater will be monitored upgradient and downgradient to monitor for potential change in groundwater quality or level due to the Project.

Groundwater quality monitoring will occur on a quarterly basis during operations, throughout the active and transition closure periods, and the first three years of the post-closure period (i.e., years 26 to 29). After that, groundwater sampling will be reduced to a semi-annual frequency during the non-frozen months of the year until the end of the post-closure period (i.e., year 36).

AQUATIC ECOSYSTEMS AND RESOURCES

Assessment Approach

The assessment of potential effects on aquatic ecosystems and resources relied largely on the surface water quantity and quality predictions.

The following subcomponents were selected for assessment of aquatic ecosystems and resources:

- Fish (Arctic grayling);
- Aquatic habitat; and
- Benthic invertebrates, periphyton and aquatic plants.

Assessment Boundaries

The local study area for the aquatic ecosystems and resources assessment included:

- Geona Creek from its headwaters until its confluence with Finlayson Creek;
- Finlayson Creek upstream of the confluence of Geona Creek until the location where non-contact water will be discharged into the creek; and
- South Creek catchment and Fault Creek area.

The regional study area for aquatic ecosystems and resources assessment included the Finlayson Creek, and East Creek catchments.

Existing Conditions

Fish sampling to support Initial Environmental Evaluation was conducted in Geona Creek and its headwater ponds, Finlayson Creek, East Creek, South Creek and its headwater lakes and the North Lakes/River system. Surveys occurred in 1995 in early spring, late spring, summer and fall, and included the use of backpack electrofishing units, minnow (Gee) traps, weir/fence traps and angling gear, aerial surveys and dive surveys. Subsequent aquatic baseline studies have been conducted every two years to meet the compliance monitoring requirements of the Water Use Licence (starting in 2002). Three sites on Finlayson Creek have been consistently monitored through electrofishing

and min now trapping during late summer for fish distribution and abundance as well as for fish tissue analyses. Additional, fisheries surveys were carried out in support of this Project Proposal in June, August and October 2015, and in June, July and October, 2016 via electrofishing and baited minnow traps, in Geona Creek, Fault Creek, South Creek, North River and East Creek.

Aquatic ecosystems and resources are of particular importance to the Kaska for cultural, sustenance, and social purposes. The fish of particular importance include Arctic grayling, trout, jackfish, whitefish, and suckers. Kaska fishing efforts are mainly focused on Pelly Lakes, Hoole Canyon, and Frances Lake, with Kaska citizens fishing opportunistically while hunting for caribou, sheep, and moose in and around the proposed Project area. The results of the TK research indicate Kaska fish in Finlayson Creek and at a greater distance from the proposed Project in North Lakes, Money Creek, and Wolverine Lake.

Historical and recent fisheries studies have indicated the presence of Arctic grayling in the upper reaches of Geona Creek (Project footprint), as well as throughout the regional drainages (South Creek, North River, Finlayson Creek, and East Creek).

Community composition results (diversity and dominant taxa) for benthic invertebrates indicate that the populations in the study area are stable over time; densities have typically been lower at the Finlayson Creek sites than at the other sites.

Stream sediments were collected on Finlayson Creek, Geona Creek, East Creek and Fault Creek. The studies have shown that arsenic levels were high throughout the study area, except in South Creek. Cadmium levels were also elevated throughout the Project area, except in South Creek and East Creek. Chromium and copper levels were generally below the interim freshwater sediment quality guidelines, except at the mouth of Geona Creek for chromium and in upper Geona Creek for copper. Lead and mercury showed no exceedances of their respective interim freshwater sediment quality guidelines, while zinc was generally elevated with Fault Creek and upper Geona Creek exceeding the Probable Effects Level. Dominant class was towards larger particle sizes at all sites (i.e., either 2 mm or 850 µm). Historical data indicated dominance of smaller particle sizes at some sites, while others had similar dominant size class. Differences could be attributable to a slightly different sampling location, or to a temporary change in flow pattern that could have affected sediment transport (e.g., high precipitation event prior to sampling). Overall, fractional components of stream sediments appeared to vary somewhat from year to year.

Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. Periphyton samples were collected from Finlayson Creek, Geona Creek, East Creek and Fault Creek. Results showed that abundance and density were the highest in Geona Creek and the lowest in Fault Creek. These results were generally consistent with benthic invertebrate results.

Chlorophyll *a* is the primary photosynthetic pigment and is common to all algae. Chlorophyll *a* samples were collected on Finlayson Creek, Geona Creek, East Creek and Fault Creek. Results showed that chlorophyll *a* concentration in the Project site were generally low, which is an indication of low productivity systems. Canopy coverage, and therefore sunlight penetration, may explain in part the differences observed among the sites.

Project-specific Effects

Project development will have an effect on aquatic ecosystems and resources mainly through changes in surface water conditions (quantity and quality) but also through habitat loss.

Changes to Arctic grayling population catch per unit effort or condition factor resulting from the Project activities were assessed to be in a beneficial or adverse direction, since Project activities would likely affect Arctic grayling population in an adverse direction while offsetting measures detailed in the Fish Offsetting Plan could enhance fish use and rearing conditions of the system. Sub-lethal effects to fish from changes in water quality were assessed to not result in residual effect as most parameters of interest did not exceed water quality objectives and chronic effects were alleviated by a number of toxicity modifying factors. Catch per unit effort and potential sub-lethal effects were assessed as not significant.

The two main Project activities that were assessed for potential effects on fish habitat are:

- Riparian clearing during the Tote Road upgrade to Access Road; and
- Construction of the Project facilities, open pit and diversion of Fault Creek.

The potential effects on aquatic habitat were evaluated through considering potential effects as a result of changes in habitat availability, distribution connectivity, total suspended solids, surface water quantity and quality, water temperature, stream sediments chemistry and particle size distributions. With implementation of mitigation measures, changes in water temperature were assessed not to result in residual effect with the rest of these effects on aquatic habitats assessed as not significant.

The potential effects on benthic invertebrates, periphyton and aquatic plants were evaluated through considering potential effects as a result of changes in benthic invertebrate community, abundance and diversity of periphyton communities, and chlorophyll *a*, as well as potential sublethal effects to benthic invertebrates, aquatic plants or algae. With implementation of mitigation measures, potential sublethal effects were assessed not to result in residual effects, with the rest of these effects on benthic invertebrates, periphyton and aquatic plants were assessed as not significant.

The residual effects, key mitigation measures and assessed significance are summarized in Table 7.

Table 7: Aquatic Ecosystems and Resources Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Fish (Arctic grayling)		
Changes in Arctic grayling population catch per unit effort (CPUE) or condition factor	Implementation of Fisheries Offsetting Plan. Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Not significant
Sub-lethal effects to fish	Implementation of Surface Water Management Plan (including water treatment).	Not significant
Aquatic Habitat		
Changes in habitat availability, distribution connectivity	Implementation of Fisheries Offsetting Plan.	Not significant
Changes in total suspended solids (TSS)	Implementation of Sediment and Erosion Control Plan.	Not significant
Change in surface water quantity	Implementation of Surface Water Management Plan (including water treatment).	Not significant
Change in surface water quality	Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Not significant
Change in stream sediments chemistry and particle size distribution	Implementation of Surface Water Management Plan (including water treatment). Implementation of Sediment and Erosion Control Plan.	Not significant
Benthic invertebrates, periphyton and aquatic plants		
Change in benthic invertebrate community	Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Sediment and Erosion Control Plan. Implementation of surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Not significant

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Change in abundance and diversity of periphyton communities	Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Sediment and Erosion Control Plan. Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Not significant
Change in Chlorophyll *a*	Implementation of Surface Water Management Plan (including water treatment).	Not significant

Cumulative Effects

No projects or activities were identified to overlap with Project residual effects for aquatic ecosystems and resources in type of effect, in time and in space. Therefore, no potential cumulative effects were identified for aquatic ecosystems and resources.

Effects Monitoring

Aquatics resource monitoring was proposed through construction, operations, and closure phases. The following monitoring programs was proposed:

- Benthic invertebrate monitoring program: every two years (except in years when benthic invertebrate sampling under the MMER-EEM program is required) in July/August, during construction, operation and closure;
- Sediment monitoring program: every two years in July/August, during operation and closure;
- Fisheries monitoring program: on an annual basis to monitor fish use in Geona, Finlayson and South Creeks (systems that will be influenced by Project development), and in East Creek as a reference site; methods will include electrofishing, minnow trapping, beach seining, angling and visual observations;
- Fish tissue sampling: every two years during July/August, during operations and closure, at Finlayson Creek stations; and
- Metal Mining Effluent Regulations (Environmental Effects Monitoring): Once the Project becomes subject to the MMER (i.e., when the operation begins discharging effluent at more than 50 m^3/day), a sub-lethal toxicity testing program (initially at a quarterly frequency for at least the first two years, followed by semi-annual sampling thereafter) on two plant species, one invertebrate and fish embryo; aquatic resource monitoring every 3 years to monitor effects from mining operations on the fish and benthic invertebrate communities downstream of its effluent discharge point (the annual fisheries monitoring program described above will serve to support the requirements under EEM).

TERRAIN AND SOILS

Assessment Approach

The terrain and soils EA followed the general EA methods. The following subcomponents were selected for assessment of terrain and soils:

- Terrain stability;
- Soil quantity; and
- Soil quality.

Assessment Boundaries

The local study area for the terrain and soils assessment encompassed the entire Mine footprint, Tote Road and Finlayson Lake airstrip. The regional study area for the terrain and soils assessment encompassed the local study area and a 2 km buffer surrounding the local study area.

Existing Conditions

Elevation within the Project area ranges from 1,000 masl at the beginning of the Tote Road (at the Robert Campbell Highway) to 2,040 masl at the southwestern extent of the Geona Creek catchment. The steepest terrain is in the southwest part of the Project footprint where the slopes are predominantly moderately inclined and locally moderately steep. Moderately steep to steep slopes occur along two gullies upslope from the site of the ABM open pit, and a band of moderate slopes occurs at the toe of the east side of the Geona Creek Valley.

Glacial, periglacial (ice related), and fluvial processes are the main processes which have been involved in the creation of landforms and surficial deposits in the Project area. The mountains immediate to the Project are rounded; exposed bedrock shows striations caused by the wear of glacial movement.

The Project area is within the Extensive Discontinuous Permafrost Zone (Yukon Permafrost Network, 2016). Permafrost is commonly encountered under the organic layers that cover the Geona and upper Finlayson valleys. Permafrost is typically located under poorly drained areas, cool aspects and upper elevations. Permafrost related ground movement or solifluction is apparent on upper to middle elevation slopes.

The soil samples were analyzed using CCME soil guidelines for industrial sites. Soil samples occasionally exceeded CCME industrial guidelines for arsenic, copper, selenium, and zinc. Distribution of the higher metal concentrations did not appear to be related to the samples proximity from the ABM Deposit. Soils in the local study area are, in general, nutrient poor and acidic.

Project-specific Effects

Project related activities may cause slope instability which could lead to geohazards. Project related activities, such as site preparation and clearing (including vegetation); site grading (including soil and overburden removal and stockpiling); infrastructure construction activities (including road building); pit dewatering and blasting may change the existing slope stability in the Project area. Changes in slope geometry (e.g., caused by erosion) can also cause slope instability. Slope instability may lead to geohazards (i.e., landslides or debris flows). Through Mine design and planning, construction in unstable or erodible terrain has been minimized. However, construction of the infrastructure required for the Project may affect the stability of some of the terrain. Taking the mitigation and design features into account, the probability of geohazard risk was considered unlikely and the overall effect of Project development on terrain stability was assessed to be not significant.

The primary soil quantity effect is loss of ecologically functioning soil. During construction and ongoing development of infrastructure during operations, approximately 655.6 ha of land will be covered under the footprint of facilities. Of this amount, it is expected that majority will be reclaimed, and after a period of time returned to its baseline biological function. Following Mine closure, the ABM lake will remain in place, thus creating a residual loss of soil of 34 ha. This represents 0.3% of the entire local study area and 5% of the total Project footprint disturbed during construction and operations. Due to the small size of covered land, as well as nutrient poor soils within the existing area of land, the overall effect of permanent soil loss associated with the Project was assessed as not significant.

Degradation of soil quality may occur throughout all phases of the Project by compaction, contamination, erosion, and other physical, chemical, or biological changes. The effects will be restricted to the Project Footprint. Due to the relative small areas of soil affected and the generally low capacity of the soils, the overall effect of degradation of soil quality was assessed to be not significant.

The residual effects, key mitigation measures and assessed significance are summarized in Table 8.

Table 8: Terrain and Soils Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Increase in geohazards due to temporarily increased slope instability	Mine design to minimize risk (slope stabilization and foundation measures). Soil erosion and control measures. Geotechnical and soil erosion monitoring.	Not significant
Loss of soil under infrastructure footprint	Minimize land clearing to the areas necessary for Project footprint. Soil salvage, storage and stockpiling.	Not significant

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Degradation of soil quality	Dust suppression techniques. Soil stockpiling techniques that conserve soil quality. Minimizing the number of times the soil is moved, reducing vehicle traffic over the stockpile surface, and avoiding handling soils when they are too dry or too wet. Erosion monitoring and prevention program. Reclamation methods that reduce equipment traffic during soil redistribution and placement.	Not significant

Cumulative Effects

No projects or activities were identified to overall with Project residual effects on terrain and soil in type of effect, in time and in space. Therefore, no potential cumulative effects were identified for terrain and soils.

Effects Monitoring

Geotechnical inspections were proposed to be undertaken by an engineer licenced to practice in the Yukon on an annual basis during operations for all storage facilities and water management infrastructure. Physical inspections of all storage facilities and water management infrastructure will be conducted on a monthly basis during operations by site personnel. The frequency of inspections will be reduced during closure as identified by the engineer of record.

VEGETATION COVER AND COMPOSITION

Assessment Approach

The vegetation cover and composition environmental assessment largely relied on results from the terrestrial ecosystem mapping (TEM) and air dispersion modelling. The TEM formed the basis for assessment of the extent of change and composition to the vegetation communities resulting from the Project.

The following subcomponents were selected for assessment of vegetation cover and composition:

- Wetland and riparian ecosystems;
- Old growth forest;
- Rare plants;
- Invasive plants; and
- Metal concentrations in traditionally used plants or wildlife browse plants.

Assessment Boundaries

The local study area for vegetation and composition assessment included a 3 km buffer around the Project footprint and a 1.5 km buffer on either side of the Access Road alignment. The regional study

area for vegetation cover and composition assessment encompassed the Pelly Mountains ecoregion and the Yukon Plateau North ecoregion within game management subzone (GMS) 10-07.

Existing Conditions

The Project is located in the Boreal Cordillera Ecozone. The Project is situated in a transitional climatic zone bordering on three different ecoregions: Yukon Plateau-North to the north, Liard Basin to the east, and Pelly Mountains Ecoregion to the south. The Mine site and proposed infrastructure is primarily situated in the subalpine bioclimate zone, from an elevation of 1,300 masl to approximately 1,550 masl, with the open pit planned to extend into the lower range of the alpine zone. At higher elevations within the Mine site, dwarf shrubs, graminoids, and herbs dominate; boreal forests are more prevalent at lower elevations.

From the terrestrial ecosystem mapping, there were 27 core vegetation communities identified (7 alpine, 9 boreal subalpine, 11 boreal high) that were derived from 126 vegetation associations. The most common species found within the study area were scrub birch (*Betula glandulosa*), willow (*Salix spp.*), subalpine fir (*Abies lasiocarpa*), and open stands of white spruce (*Picea glauca*). Along either side of the first 17 km of the Tote Road, a mixed forest of white and black spruce (*Picea mariana*) exists.

The wetland and riparian systems within the local study area are of two basic types: slow flowing creek/fen complexes with associated wetlands in upper Geona Creek, and faster flowing creeks confined to deep valleys with definitive floodplains, such as Finlayson Creek. In the 1996 vegetation study, categories were reported near wetlands; however, no specific information was included on the number or type of wetlands within the Project site, nor was the percentage of land covered by wetlands calculated (Norecol, Dames & Moore Ltd., 1996).

In general, timber quality is poor with usually less than 200 stems per hectare in forested areas.

No rare plants were found in the Project area during the rare plant surveys conducted in 2015 and 2016.

Ten non-native plant species were detected during the 2015 and 2016 invasive species surveys. Most invasive plants were observed along the Tote Road, particularly near the gatehouse and associated laydown area. An Invasive Species Management Plan was developed and implemented during the 2016 field season to manage the invasive species.

Baseline metal concentrations were determined for vegetation species including willow, grass, grass roots, horsetail, lowbush cranberry, and bog blueberry.

Project-specific Effects

Vegetation communities will change with Project development. However, through progressive reclamation and final reclamation, vegetation communities will be re-established.

Most of the effects on wetland communities will occur during the construction phase. Prior to mitigation, it was estimated that 6.0 ha of wetlands will be affected. However, three ponds will be constructed to offset fish habitat loss, which will also offset wetland habitat loss by 1.8 ha. This will result in a temporary loss of 4.2 ha of wetlands during operation. Also, during the closure phase, engineered wetlands will be constructed that will further reclaim wetlands with a gain of 3.3 ha. Thus, with the mitigation measures proposed there will be an overall loss of 0.9 ha of wetland area in the local study area.

Approximately 1.7 ha of old growth black and white spruce forest will be lost from the proposed Access Road upgrades. This area represents 1% loss of old growth forest in the local study area.

A chance find procedure will be implemented for rare plants in case they are found during clearing. This mitigation combined with no finds during baseline studies results in no residual effect.

Invasive plants occur at the Project and are managed through the Invasive Plant Management Plan that will continue through the life of the Project.

There is the potential for the Project to be a source of dust containing metals that could adversely affect surrounding vegetation. However, given the low levels of dust that were predicted to occur at the site, the risk of increased metals concentrations increasing in vegetation was assessed to be low. Subsequently, risks to humans and wildlife from consuming the vegetation was considered negligible. Risks are further reduced as the wildlife browsing on vegetation surrounding the Project have large ranges and are unlikely to consume nearby vegetation in quantities that would cause detrimental effects to the wildlife or any humans consuming these animals or plants directly.

The residual effects, key mitigation measures and assessed significance are summarized in Table 9.

Table 9: Vegetation Cover and Composition Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Loss of wetland and riparian ecosystems	Reclamation; construct wetland and riparian areas during construction (part of fish habitat offsets) and at closure (part of water treatment).	Not significant
Loss of old growth forest	Limit initial Project disturbance of old growth forest through design.	Not significant
Increase in invasive plants	Implementation of invasive species management plan.	Not significant
Metal increase in traditional use plants or wildlife browse	Implementation of air quality management plan.	Not significant

Cumulative Effects

No other projects or activities were identified that overlap with Project residual effects on vegetation in type of effect, time, or space. Therefore, no potential cumulative effects were identified for vegetation cover and composition.

Effects Monitoring

The vegetation cover and composition monitoring was proposed as follows:

- No specific monitoring program is proposed for old growth forests, or rare plants. Vegetation cover and composition will be indirectly monitored through the reclamation plan that monitors the success of the revegetation program and the constructed wetlands;
- Invasive plants will be monitored and removed on a regular basis following the invasive plant management plan to prevent the spread of invasive plants; and
- Dust deposition on soil will be monitored periodically to determine the distribution and extent of change. If the extent of change is high magnitude, then additional monitoring would be conducted on traditionally used plants and wildlife browse.

WILDLIFE AND WILDLIFE HABITAT

Assessment Approach

The wildlife and wildlife habitat environmental assessment relied on results from the terrestrial ecosystem mapping, habitat suitability mapping, air dispersion modelling, noise modelling, and water quality modelling.

The following subcomponents were selected for assessment of wildlife and wildlife habitat:

- Finlayson Caribou Herd (FCH);
- Moose;
- Grizzly Bear;
- Grey Wolf;
- Wolverine;
- Collared Pika;
- Little Brown Bat;
- Cliff-Nesting Raptors;
- Passerine birds;
- Waterfowl; and
- Bumble bees.

Assessment Boundaries

The local study area for the wildlife and wildlife habitat effects assessment was centred on the Project footprint, and included a 3 km buffer around the Project footprint and a 1.5 km buffer on either side of the Access Road alignment. The regional study area was dependant on the wildlife subcomponent

under assessment. The Finlayson Caribou Herd regional study area included three different boundaries, (1) the rutting range around the Project components, (2) the post calving range around the Project components, and (3) the entire Finlayson Caribou Herd range. The regional study area for moose and grizzly bear was the game management subzone 10-07. However, the grizzly bear regional study area also included an area extended for a 10 km radius around the proposed ABM open pit, encompassing specific locations where there is higher potential denning habitat.

Existing Conditions

The description of the existing conditions for wildlife and wildlife habitat was prepared from the compilation and review of existing information that was collected during the Initial Environmental Evaluation in 1995, desk based research, and the results of the 2015 and 2016 field programs.

The caribou that occupy the Project local and regional study areas are part of the Finlayson Caribou Herd. This herd has a traditional home range of 23,000 km^2 distributed in east-central Yukon. The Finlayson Caribou Herd is the most valued wildlife feature in the Project local study area as it is of ecological, economic, and cultural importance to both the Kaska and resident and guided hunters in the region. The herd is part of the Northern Mountain caribou population (*Rangifer tarandus caribou*), which has been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a Species of Special Concern and listed as such under the *Species at Risk Act (SARA)* in 2005.

Caribou use the uplands around the local study area in the spring, summer, and fall, and move to the lowlands of the Pelly River in winter. The post calving and rut periods have the most potential interaction with the Project. In 1982, Yukon Government (YG) surveyed the Finlayson Caribou Herd and determined that the population was declining (WCMPRC, 2011). A recovery program was initiated in 1983 and from 1983 through 1989, the wolf population was reduced by 85%, and licensed and First Nation harvest of the herd was reduced. The recovery program resulted in the herd doubling its population to a maximum of 5,950 animals by 1990. By 1994, the wolf population had re-established itself and the Finlayson Caribou Herd population began to decrease again. In 2007, the last late winter population census conducted for the Finlayson Caribou Herd, determined that the population had decreased to approximately 3,077 animals. A late winter population census for the Finlayson Caribou Herd is being planned by YG in collaboration with BMC for 2017. The 2015 post calving survey found a total of 73 caribou (12 calves and 61 cows). The 2016 post calving survey found a total of 147 caribou (103 cows, 18 calves, 11 immature bulls, 11 mature bulls, and 4 unclassified). The 2015 rut survey observed a total of 712 caribou (449 cows, 123 calves, 78 mature bulls, and 62 immature bulls). In the October 2016 rut survey, a total of 660 caribou were found (398 cows, 107 calves, 82 mature bulls, and 73 immature bulls). Per current Tote Road Licence, the access along the Tote Road is gated and closed to the public, significantly limiting hunting activity in the Project area. All workers, contractors and visitors to the exploration site are made aware of the caribou and their movements through the Mine site induction process. These mitigation measures will continue through all Project phases.

Moose (*Alces alces*) are widely distributed within the local study area and regional study area, and prefer shrub-dominated ecosystems near forest cover such as treeline edges, riparian or wetland

complexes, and regenerating burn areas. The Initial Environmental Evaluation concluded that the number of moose using the local study area ranged between 10 and 20 at various times of the year. Late winter and post rut surveys were conducted to document population levels of moose within the regional study area in 2015 and 2016. In the late winter surveys, 31 moose were counted in 2015 and 152 moose were counted in 2016. Observations were north of the Project footprint on flat or gently sloped terrain close to streams and habitat that contained shrub understory. Moose also move to the lowlands around Finlayson Lake in the winter. During the post rut survey, a total of 113 moose (40 bulls, 45 cows, 15 calves, and 13 unknown) were observed in 2015 and 154 moose (31 bulls, 100 cows, and 23 calves) were observed in 2016. Differences in the 1990s estimate and those observed during the 2016 survey could be attributed to the local study area being much larger in the more recent studies.

Grizzly bears (*Ursus arctos*) have large home ranges, preferring open valleys and subalpine regions, and may occur in all habitat types as they move through their range. There is limited historical information on grizzly bear distribution or abundance in the local study area. However, grizzlies are known to occupy the subalpine valleys and alpine plateaus of the local and regional study areas, where they feed on vegetation, berries, small mammals, and ungulates. Two observations were recorded in the 1995 Project camp log (one adult grizzly digging for ground squirrels in a basin south of the camp and one grizzly in the uplands southeast of the camp). Incidental grizzly bear sightings recorded during the 1995 wildlife aerial surveys included a sow with two yearlings, a sow with a two-year old, and two individual sub-adults. No bear den sites were observed during the aerial surveys and none were reported during other Project related work in the area. Many incidental grizzly bear observations were made in the Project local study area during 2015 and 2016 (17 grizzly bear observations were recorded from May 10 to September 3 in 2016). Grizzly bear dens were also found south of the Project footprint during spring and early winter surveys.

Grey wolf (*Canis lupus*), wolverine (*Gulo gulo*), and other furbearers (coyote, red fox, lynx, marten, woodchuck, and beaver) were observed in the local study area. Collared pika (*Ochotona collaris*) were found south and west of the Project foorprint in alpine talus fields. Other small mammals observed in the local study area include porcupine, snowshoe hare, vole, woodchuck, and weasel. Bats were located along the Tote Road. Cliff-nesting raptors and their habitat were located around cliffs in the southern portion of the local study area. Passerine or perching bird habitat exists throughout the local study area ranging from shrublands to forests. Waterfowl were found using wetland habitat throughout the local study area.

Project-specific Effects

Overall, wildlife will be affected by direct and indirect habitat loss from the Project development and potentially direct mortality from collisions with vehicles. Wildlife habitat losses will be mitigated through progressive and final reclamation as presented in the Conceptual Reclamation and Closure Plan. Other effects will be minimized through implementation of the Wildlife Protection Plan which includes provisions such as nest clearance surveys to minimize disturbance of migratory birds and fall grizzly denning activity checks to prevent denning and the resulting disturbance from open pit activities. The Traffic and Access Management Plan will prevent hunter access (i.e., continued operation of the manned gate to prevent hunter access to the Project), and together with signage,

speed controls, and radio communications, as well as employee and contractor education through the Mine site induction process will create awareness of wildlife and help prevent direct mortality. Aircraft overflight disturbance will be minimized by route planning.

Of key importance is disturbance of habitat for caribou, including disturbance of caribou movement corridors. It was estimated that the Project will result in 7.8 km^2 direct and 47.7 km^2 indirect loss of highly suitable rut habitat and 1.2 km^2 direct and 27.8 km^2 indirect loss of highly suitable post calving habitat. However, this habitat loss/disturbance will equate to less than 1% of all suitable rut and post calving habitat in the Finlayson Caribou Herd range. This habitat will be reclaimed over the long-term except in the area of the ABM open pit, which will become ABM lake during the closure phase. Disturbance of caribou movement corridors will be prevented by signage at known caribou road crossing areas. With mitigation measures in place, effects on caribou were assessed as not significant.

For moose, Project development was estimated to result in a direct and indirect loss of 4.7% (7.8 km^2 direct and 47.7 km^2 indirect) of moderately high and high suitability moose post rut habitat and 3.8% (8.4 km^2 direct and 83.0 km^2 indirect) of moderately high and high suitability late winter habitat in Game Management Subzone 10-07. These losses were determined to be of a low magnitude (less than 10%) and localised and were subsequently assessed as not significant. Effects on grey wolf are linked to the Project effects on caribou and moose and were similarly assessed as not significant.

The percentage of highly suitable grizzly bear denning habitat estimated to be lost due to Project activities was 1% in the regional study area. Lost grizzly habitat suitable for growing/feeding impacted by the Project included 9.8 km^2 of direct habitat within the Project footprint, plus 57.3 km^2 of indirect disturbance. This equates to 3% of the regional study area.

Collared pika habitat will not be directly affected. The percentage of highly suitable collared pika habitat estimated to be indirectly affected due to Project activities was 0.6% (0.11 km^2) in the local study area. For bats, 1.5% (0.24 km^2) of highly suitable bat habitat in the local study area will be directly lost from the Tote Road upgrade.

For cliff-nesting raptors, the Project was estimated to result in a loss of 3.6% (0.08 km^2) of highly suitable nesting habitat in the local study area. For olive-sided flycatchers, 5.5% (0.60 km^2) of highly suitable habitat will be directly lost to Project activities in the local study area. For waterfowl, the Project was estimated to result in a loss of 10.5% (1.92 km^2) of highly suitable waterfowl habitat in the local study area. For bumble bees, there was an estimated 5% (651 ha) of habitat lost in the local study area.

The residual effects, key mitigation measures and assessed significance are summarized in Table 10.

Table 10: Wildlife and Wildlife Habitat Residual Effects, Key Mitigation and Assessed Significance

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Finlayson Caribou Herd		
Direct rut and post calving habitat loss	Reclamation. Minimize activities in alpine and subalpine during rut period (September 28 to October 31). Minimize Project footprint through design.	Not significant
Indirect rut, calving, and post calving habitat loss	Minimize activities in alpine during the calving period (May 1 to May 31). Minimize activities in alpine and subalpine during rut period (September 28 to October 31). No hunting policy. Regularly scheduled blasting.	Not significant
Movement barrier between rut and wintering habitat from infrastructure and road	Speed limits. Radio controlled Access Road. Convoys of two or three vehicles to reduce sensory disturbance but maintaining 15 second distance between vehicles for human health and safety.	Not significant
Direct mortality from collisions with vehicles	Speed limits. Clearing vegetation from right-of-way. Radio controlled Access Road. Implement protocol for vehicle-ungulate encounters. Signage along road in areas with high frequency of ungulate crossings and reduced speed limits in these areas. All other requirements currently included in the existing Tote Road Licence.	Not significant
Disturbance of late winter range from aircraft	Follow designated flight and landing route for flights to Finlayson Lake airstrip that minimizes herd disturbance.	Not significant
Moose		
Direct early winter and late winter habitat loss	Progressive reclamation. Minimized Project footprint through design. Final reclamation at closure.	Not significant
Indirect early winter and late winter habitat loss	Progressive reclamation. Minimized Project footprint. Final reclamation at closure.	Not significant
Movement barrier in wintering habitat from infrastructure and road	Speed limit. Radio controlled Access Road. Convoys of two or three vehicles to reduce sensory disturbance but maintaining 15 second distance between vehicles for human health and safety.	Not significant
Direct mortality from collisions with vehicles	Speed limit. Clearing vegetation from right-of-way. Radio controlled Access Road. Implement protocol for vehicle-ungulate encounters. Signage along road in areas with high frequency of ungulate crossings. All other requirements currently included in the existing Tote Road Licence.	Not significant
Disturbance of late winter range from aircraft	Follow designated flight and landing route for flights to Finlayson Lake airstrip that minimizes disturbance.	Not significant

Identified Residual Effects	Key Mitigation Measures	Assessed Significance
Grizzly bear		
Direct and indirect growing season habitat loss	Progressive reclamation and final reclamation at closure.	Not significant
Direct and indirect denning habitat loss	Pre-denning surveys and mitigations to prevent indirect effects.	Not significant
Grey wolf		
Reduced prey availability due to ungulate loss of habitat	Progressive and final reclamation.	Not significant
Direct mortality	Speed limits. Clearing vegetation from right-of-way. Radio controlled Access Road. Ploughed breaks in snowbanks along roads.	Not significant
Wolverine		
Habitat avoidance from road density	Decommission inactive roads. Site clearing will be kept to a minimum.	Not significant
Collared pika		
Habitat loss	Minimize site clearing. Reclamation. Noise Management Plan.	Not significant
Bats		
Habitat loss	Reclamation. Site clearing of Access Road will be kept to a minimum.	Not significant
Direct mortality	Reduce travel speeds.	Not significant
Cliff-nesting raptors		
Habitat loss	Reclamation. Site clearing of Access Road will be kept to a minimum.	Not significant
Passerines (olive-sided flycatcher)		
Habitat loss	Reclamation. Site clearing of Access Road will be kept to a minimum.	Not significant
Direct mortality	Reduce travel speeds.	Not significant
Waterfowl		
Habitat loss	Reclamation. Site clearing will be kept to a minimum. No-clearing buffer zones around wetlands, where applicable. Creation of new wetlands for fish habitat compensation.	Not significant
Bumble bees		
Habitat loss	Reclamation.	Not significant

Cumulative Effects

Potential cumulative effects were identified if the Project's residual effects overlapped with other projects' effects in space, time, and type of effect. For caribou, moose, grizzly bear and furbearers, the Project's residual effects were predicted to overlap spatially or temporarily with other similar

residual effects from other projects in the regional study area and were therefore carried forward to the cumulative effects assessment.

There were potential cumulative effects on these subcomponents for the KZK Project in combination with the closed Wolverine Mine, Fyre Lake Exploration Project, Selwyn Exploration Project, Pelly Exploration Project, Robert Campbell Highway, guided outfitting, recreational hunting, First Nation hunting, and traplines.

For caribou, all combined activities influenced approximately 12% (2,365 km^2) of the Finlayson Caribou Herd range (20,369 km^2) after adding the direct footprints of the Project claims and roads and a 2 km avoidance zone around each. The KZK Project and claims equated to 2% (375 km^2) of the 12% cumulative disturbance in the Finlayson Caribou Herd range. It should be noted that disturbance was conservatively based on claim boundaries since information was limited for specific footprints of disturbance. It should also be noted that the human development is just part of the complex set of factors affecting the Finlayson Caribou Herd population. Other major influencing factors include predation, annual weather variability (especially snow depth and distribution), and climate change. Predation is known to be one of the most significant factors affecting the herd population.

Moose are more resilient to habitat changes than caribou, and in some instances, clearing of land can increase moose populations because the new growth is a desired food source. Nonetheless, moose are sensitive to human activity, especially hunting, and avoid roads except during migrations (Neumann, 2009). Within Game Management Subzone 10-07, cumulative footprints of disturbance of projects were estimated at less than 10%. There are no circle routes created by any of the projects in the regional study area which will help minimize habitat fragmentation.

For Game Management Subzone 10-07, there is the risk that grizzly bear mortalities could have a higher occurrence from multiple projects and activities for this region due to the overall increase in frequency of human-bear encounters. A loss of one to two bears in the regional study area would be similar to historic harvest numbers that have not reduced the regional grizzly bear population.

For furbearers, habitat fragmentation and movement barriers at the regional scale are less important for some of the smaller furbearers than larger mammals simply because of the size of the ranges. The trapline harvest in combination with accidental mortalities and habitat losses from activity on the exploration projects and highways activities were not expected to have residual cumulative effects.

In summary, the following residual cumulative effects were identified for wildlife and wildlife habitat and all were assessed not to be significant:

- Finlayson Caribou Herd habitat loss and fragmentation;
- Moose habitat loss and fragmentation; and
- Grizzly bear habitat loss and fragmentation.

Effects Monitoring

The wildlife and wildlife habitat monitoring program was proposed as follows:

- Caribou - Regular surveys of the Finlayson caribou herd will continue to be conducted in concert with YG and RRDC. The purpose of the monitoring program will be to track habitat use and population trends to assess whether the predicted rut habitat avoidance occurs and whether the lost habitat or indirect effects on predation are affecting the overall population or recruitment.
- Moose - Actual effects from the Project on moose populations and distribution will be evaluated through periodic late winter ungulate surveys. Of particular interest will be the population numbers and distribution around late winter habitat east and west of the Access Road.
- Grizzly bear - The main purpose of the grizzly bear monitoring program is to prevent the disturbance of mining on hibernating bears. The area surrounding the open pit will be monitored during the pre-denning period to determine if there are any bears that may try to build a den near the open pit. This survey can be tied in with the annual caribou rut count survey when pre-denning bears are usually observed. If denning behaviour is observed, mitigation measures will then be developed with RRDC Land Stewards and YG conservation officers.
- Wolf, wolverine, and other furbearers – Furbearers such as wolf, wolverine, and small mammals will be monitored through a Winter Wildlife Monitoring Program to provide information on the presence of furbearers, as well as help determine winter travel routes and denning locations for a variety of species.
- Collared pika – Monitoring of collared pika will be through the Wildlife Records Program. The objective is to check if collared pika will be disturbed more than expected from Project activities.
- Raptors – The raptor nest located in the direct area of disturbance will be monitored annually to determine its status on a yearly basis. In addition to monitoring currently existing nest sites, BMC will conduct pre-nesting surveys to reduce the chance of disturbance from construction or operations.
- Passerines – The objective of bird monitoring is to track Project effects on bird use of the area and Project conformance with the purpose of the *Migratory Birds Convention Act*, to protect and conserve migratory birds. Point-count surveys will be conducted during the breeding bird season (June – July) to monitor long-term trends in nesting bird populations in the local study area. Surveys will be conducted after mine development and every three years through closure. Surveys will also occur outside the local study area to act as a control site to monitor natural fluctuations in breeding bird populations in the regional area. In addition to monitoring for the occurrence of nesting birds, routine monitoring to remove/prevent potential nesting locations will occur during the pre-nesting period.
- Waterfowl – The objective of bird monitoring is to track Project conformance with the purpose of the *Migratory Birds Convention Act*. Waterfowl use of the water management and water treatment ponds, as well as the fish habitat compensation ponds, will be monitored during operations as part of the regular Wildlife Records Program. Waterfowl deterrent actions will be implemented if water quality monitoring results of these ponds

exceed acceptable standards. Monitoring of the reference wetlands outside the local study area will continue to maintain a record of waterfowl abundance and diversity at wetlands.

HERITAGE RESOURCES

Assessment Approach

The Heritage Resources Impact Assessment (HRIA) approach was largely based on the methods outlined in the *Yukon Archaeological Sites Regulations* and corresponding Guidelines for Archaeological Permit Holders. The assessment approach also included integrating traditional knowledge with contemporary scientific knowledge as part of the provisions contained in the bilateral Socio-economic Participation Agreement between BMC and Kaska.

The following subcomponents were selected for assessment of heritage resources:

- Paleontological resources;
- Archaeological resources;
- Historic and built structural resources; and
- Human remains.

Assessment Boundaries

The local study area for the heritage resources assessment encompassed the development footprints of all Project infrastructure, including the Access Road. The regional study area for the heritage resources assessment included Southern Yukon and was selected to provide context of the archaeological and cultural history of the area.

Existing Conditions

The Project, including the Tote Road, and associated ancillary developments were the subject of Heritage Resources Impact Assessments in 1995 (Rutherford, 1995a, 1995b) and 1996 (Rutherford, 1996); as well as in 2015 and 2016 to support the current Project Proposal.

In 1995, a heritage study was conducted in collaboration with the RRDC as part of the Initial Environmental Evaluation. The study identified no cultural materials or features (Rutherford, 1995a); however, a review of the oral history provided by Kaska citizens indicates that the Project area was used for subsistence hunting, trapping and fishing, and as an access route to the North Lakes (Rutherford, 1995b). In 1996, an additional assessment study for cultural materials was undertaken at a proposed airstrip location near the Robert Campbell Highway (Rutherford, 1996). No cultural materials were identified in this follow-up study, although it should be noted that the proposed airstrip location in 1996 was not the same as the Finlayson Lake airstrip extension proposed as part of the current Project.

Heritage investigations conducted in 2015 and 2016 found five heritage resources across the study area. These consist of three high elevation wood fragments (high elevation areas assessment was

required by BMC's exploration permit but these are not within the potential ground disturbance for the Project) and two prehistoric archaeological sites. The two prehistoric archaeological sites were both identified and recorded in 2015. As these two sites were found in the field, they were assessed for their significance and the potential impacts by proposed developments, with management recommendations presented on a site-by-site basis. No additional site specific heritage resources were identified within the Project footprint through the traditional knowledge data acquired in relation to the Project.

Project-specific Effects

One heritage site was identified within the footprint of the Class B Storage Facility. Following a recommendation from the 2015 study, the negative effects on the site have been mitigated. However complete and thorough an impact effect field assessment is, not every heritage resource may be identified. Remaining undiscovered heritage resources may be affected by the Project if encountered during any of the Project's phases. A Heritage Resources Management Plan, including a Chance Find Procedure, will be in place for the Project and will be followed should any heritage resources be identified during Project implementation. With the management procedures in place to mitigate any potential effects on unidentified heritage resources, no residual effects were identified.

Cumulative Effects

As no residual effects have been identified for heritage resources, no cumulative effects were assessed.

Effects Monitoring

No specific monitoring has been recommended for the two known heritage resources within the Project. However, the Heritage Resources Management Plan and chance find procedures are required to be in-use for the entire life span of the Project, and if any previously unrecorded heritage resources are identified then a site or resource specific management plan will be prepared and implemented.

SOCIO-ECONOMIC CONDITIONS AND EFFECTS ASSESSMENT

Assessment Approach

The assessment of socio-economic effects followed YESAB's *Guide to Socio-economic Effects Assessments* (YESAB, 2006).

The following VCs and associated subcomponents were selected for assessment of socio-economic effects:

- Economy and Sustainable Livelihood:
  - Traditional economic activities — hunting, fishing, trapping, food gathering;
  - Economic growth;

- Diverse and stable economy — discouraging a fluctuating cycle between economic expansion and contraction;
- Employment;
- Employability — education, training and experience;
- Broad participation in economic development;
- Business opportunities; and
- Government revenues.

- Human Health and Well-Being:
  - Individual health;
  - Family stress;
  - Reducing alcohol and drug abuse;
  - Gathering traditional medicine;
  - Public health and safety — increased traffic, hazardous material transport; and
  - Workplace health and safety.
- Community Vitality:
  - Population — number of children;
  - Healthy local business sector — reducing the cost of living;
  - Reducing crime;
  - Reducing discrimination and racism;
  - Political structure;
  - Community events and volunteerism; and
  - Recreational facilities and opportunities.
- Infrastructure and Services:
  - Housing and land availability;
  - Transportation infrastructure — roads and airports;
  - Municipal services — water, sewer, solid waste;
  - Healthcare services;
  - Police services; and
  - Child care.
- Culture, History and Heritage:
  - Language preservation and restoration;
  - Traditional knowledge and practice preservation and restoration; and
  - Heritage and historic sites.

Assessment Boundaries

The local study area for the socio-economic value components was defined as communities of Ross River, Watson Lake, and Faro. The regional study area included Whitehorse and Yukon Territory.

Socio-economic Setting

The Project is located approximately 115 km southeast of Ross River (home community of RRDC) and approximately 260 km northwest of Watson Lake (home community of LFN).

The region has long been used by the Kaska (both LFN and RRDC) to hunt, trap, fish, gather plants, and seek shelter. There are also traditional trails in the area used by Kaska citizens to travel between key traditional use locations. There are two main traditional access routes to the proposed Project area, including from the west starting at Frances Lake along Money Creek as well as from the north at Pelly Banks through Finlayson Creek.

A summary of socio-economic context for the in the local study area communities and Yukon is provided in Table 11.

Table 11: Socio-economic Context

	Ross River	Watson Lake	Faro	Whitehorse	Yukon
Population, 2015	411	1,469	375	28,872	37,566
GDP, 2013 in 2007 C$	–	–	–	–	$2.3 billion
Community income, 2013 in 2002 C$	$6.8 million	$32.3 million	$10.2 million	$1.2 billion	–
Unemployment rate, 2011 NHS	30.2%	8.8%	17.9%	7.9%	9.8%
Age 15+ without high school diploma, 2011 NHS	42.1%	32.9%	25.1%	15.0%	18.3%

Note: The unemployment rate for Upper Liard in 2011 was 42.9% and the share of the population aged 15+ years without a high school diploma was 62.5%.

Project-specific Effects

The main effects on socio-economic valued components were related to employment and purchasing of goods and services associated with the Project. The Project will provide jobs and economic opportunities for the Kaska as well as residents of Yukon and Canada. Total capital costs are estimated at CAN$426 million. The impact of Mine construction is substantial, amounting to between 7.7% and 11.7% of the Yukon's annual GDP. The effect of Project operations on GDP will also be substantial. Estimates range from 3.9% during the final year of production to 18% at the height of production. GDP will decline after cessation of mining operations with a reduction in the Yukon's GDP of about 12% to 13%.

The planned personnel shift rotations are 2 weeks on and 1 week off, with certain staff on a 9 days on and 5 days off rotation. Contractors will work a similar schedule to the 2 weeks on and 1 week-off roster. The maximum number of site based employees is expected to be 345 during the third year of

production. In addition, concentrate haulage activities are expected to employ approximately 120 people.

The Project was assessed to result in a number of beneficial socio-economic effects, as summarised in Table 12. Potential adverse effects have also been identified; these are centred on disruption to traditional economic activities such as gathering traditional medicines; the potential for disruption to the local economy through introduction of mining activities and then after time reduction in mining activities; and the associated community stresses that come with economic growth and contraction cycles (such as family stress, alcohol and drug abuse, and crime subcomponents). No residual effects were identified for the culture, history and heritage valued component, with the potential effects further assessed under the heritage resources valued component.

The residual effects, key mitigation measures and assessed significance are summarized in Table 12.

Table 12: Socio-economic Residual Effects, Key Mitigation and Assessed Significance

Subcomponent	Residual Effect	Proposed Key Mitigation or Enhancement Measures	Significance of Residual Project Effect
Economy and Sustainable Livelihood			
Traditional economic activities — hunting, fishing, trapping, food gathering	Potentially reduced opportunity to pursue traditional economic activities.	Two two-week periods of annual vacation/time off plus regular time off on rotation.	Not significant
	Increased traffic and industrial activity in the region may act to drive wildlife away.	Recreational use of all-terrain vehicles (ATVs) and snowmobiles is prohibited at the Project site. No public use of Access Road. Implement traffic and access management plan.	Not significant
	Disruption and loss of access.	BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights.	Not significant
Economic growth	The Project will provide economic growth to Yukon.	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honor the SEPA provisions for providing business opportunities to local and Yukon companies.	Beneficial
	The Project will provide economic growth to the communities.	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honor the SEPA provisions for providing business opportunities to local and Yukon companies.	Beneficial
Diverse and stable economy — discouraging boom and bust	Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	BMC will continue to explore its property for further reserves and attempt to extend the operating life of the mine.	Not significant
Employment	The Project will provide Kaska citizens and other Yukon residents employment during the construction phase.	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	Beneficial

Subcomponent	Residual Effect	Proposed Key Mitigation or Enhancement Measures	Significance of Residual Project Effect
	The Project will provide Kaska citizens and other Yukon residents employment during the operations phase.	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	Beneficial
	The Project will provide Kaska citizens and other Yukon residents employment during the decommissioning and reclamation phase.	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	Beneficial
Employability — education, training and experience	The Project has the potential to improve education levels.	BMC will continue to offer its Kaska Education Scholarship Program.	Beneficial
	The Project has the potential to offer training to Kaska and Yukon employees.	BMC will continue its Mentor Program. BMC and its contractors will offer general workplace training for employees. Trades apprenticeships will be part of the Project.	Beneficial
	The Project has the potential to offer work experience to Kaska and Yukon residents.	BMC will offer summer employment for Kaska students when the Project requires summer help.	Beneficial
Broad participation in economic development	Potential to continue the direct beneficial effect through the Project providing jobs and business opportunities to the entire cross-section of Yukon society.	BMC will continue to apply its Kaska hiring preference and will continue to honour its SEPA commitments to Kaska business. Rigorous application of BMC's Employment and Anti-Discrimination Policy.	Beneficial
Business opportunities	Potential to continue the direct beneficial effect through the Project providing business opportunities to Kaska and Yukon businesses.	BMC and its contractors will continue to honor both the letter and the spirit of its SEPA with the RRDC.	Beneficial
Government revenues	Potential beneficial effect of increased government revenues at the municipal, territorial and federal level through various taxes, fees, royalties, and other payments.	None.	Beneficial
Human Health and Well-being			
Individual health	The Project has the potential to provide a small beneficial effect by offering steady and well-paid employment, and education and skills development.	BMC will be offering a dental and extended health plan to all BMC employees at the Project. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Beneficial

Subcomponent	Residual Effect	Proposed Key Mitigation or Enhancement Measures	Significance of Residual Project Effect
Family stress	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.	Steady employment and increased incomes are strongly correlated with a greater sense of self-worth and better family stability and health. Extensive screening of employees before hire to gauge their suitability for shift work and to help educate them on its potential effects. Point of hire being Yukon in reduces travel time of employees to get back to their families. Provide assistance and education to all employees and their families as required including: • Financial management training; • Drug and alcohol counselling (including time off for employees who need treatment); • Marriage counselling; and • Healthy living education (i.e., benefits of diet and exercise). BMC will host annual family days at the Mine site to show spouses and children of the employees the Mine and associated facilities (BMC's experience is that families are more comfortable with their spouses being away if they have seen the site and facilities first hand). Communications at the site will be via microwave (to maximize bandwidth) and individual connections in each room to ensure that employees can easily communicate via Skype/Facetime etc. with their spouses and children in the privacy of their room rather than in a communal area. BMC will provide recreational facilities at the site and all meal times will have healthy food options, to promote health and wellbeing of employees while on-shift (with the intent that this would also extend to off-shift healthy living). Training of employees (e.g., trades, apprenticeships, management) to promote progression in their careers (which may enhance job satisfaction). Bereavement leave will be available to all employees. The 2 week in and 1 week out shift rotations, when combined with the four weeks of annual holiday available after the first year of employment, will allow employees to take one month off twice per year.	Not significant
Reducing alcohol and drug abuse.	Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Not significant
Gathering traditional medicine	Possible reduction in traditional medicine gathering and use due to rotation shift work and loss of gathering areas.	As part of the progressive reclamation and final reclamation planning, BMC has committed to working with RRDC in identifying the species that will be used for the reclamation purposes and developing a seed collection program and seed bank in Ross River.	Not Significant

Subcomponent	Residual Effect	Proposed Key Mitigation or Enhancement Measures	Significance of Residual Project Effect
Community Vitality			
Population — number of children	The Project may attract new residents and their families to the Yukon. Increased population, and especially families with children is desired in Faro and Watson Lake.	BMC's decision to make the Yukon the point of hire for employees creates an incentive for employees from elsewhere to move to the territory.	Beneficial
Healthy local business sector — reducing the cost of living	The Project has the potential to improve the health of the local business sector.	Higher incomes locally may lead to greater demand for goods and services, encouraging the diversification and growth of existing businesses and the establishment of new ones.	Beneficial
Reducing crime	The Project can potentially reduce crime through employment opportunities. However, if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.	The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Not significant
Reducing discrimination and racism	The Project has the potential to reduce discrimination and racism.	BMC will strictly enforce its Employment and Anti-Discrimination Policy prohibiting any form of discrimination or racism in the workplace. Complaints will be treated seriously and dealt with immediately. BMC and its contractors will continue to honour the SEPA provisions of preferential Kaska and other First Nation hire. BMC will hire two Kaska community mentors.	Beneficial
Community events and volunteerism	The Project has the potential to beneficially affect community events through sponsorship.	BMC will continue to support community events and projects as the Project proceeds.	Beneficial
Recreational facilities and opportunities	The Project has the potential to beneficially affect recreation facilities and opportunities through donations and sponsorship.	BMC will consider supporting recreation projects as the Project proceeds.	Beneficial
Infrastructure and Services			
Housing and land availability	The Project has the potential to have a beneficial effect on the oversupply of housing in Faro and, to a lesser extent, Watson Lake through the relocation of employees to these communities.	No additional enhancement measures, beyond the point of hire policy, have been identified.	Beneficial

Subcomponent	Residual Effect	Proposed Key Mitigation or Enhancement Measures	Significance of Residual Project Effect
Transportation infrastructure — roads and airports	Potential beneficial effect on the Robert Campbell Highway through highway improvements making it easier for people to travel between the communities of Ross River and Watson Lake.	Project provides continued incentive for YG Highways to continue highway improvements.	Beneficial
	Potential beneficial effect on Finlayson airstrip through improved infrastructure.	BMC will improve the airstrip making it more accessible for long term use.	Beneficial

Cumulative Effects

Potential cumulative effects were assessed for adverse residual effects and identified for the economy and sustainable livelihood, human health and well-being, and community vitality VCs with other projects throughout the Kaska Traditional Territory and Yukon.

With the mitigation measures in place, one residual cumulative effect was identified; that of the potential for creation of economic boom and bust cycles. This cumulative effect may occur if several projects proceed near-simultaneously and quickly exceed the available labour force and business capacity to supply, thereby creating a "boom", or conversely the occurrence of several near-simultaneous shut-downs that create a "bust". The experience of other Yukon mines indicated that the creation of a local "boom and bust" cycle was a likely probability of occurrence; however, the community resilience in dealing with this effect is high due to the common occurrence of mining activities starting up and shutting down in these communities. It was, therefore, assessed to be not significant.

Effects Monitoring

The effects of the Project on the potentially affected First Nations and communities will be managed through Socio-economic Effects Management Plan. The Project also has a Socio-economic Participation Agreement (SEPA) with the Ross River Dena Council.

EFFECTS OF ENVIRONMENT ON THE PROJECT

The consideration of potential effects of the environment on the Project included identification of environmental factors deemed to have reasonably possible consequences for the Project, and the mitigation measures currently implemented or planned to reduce or eliminate potential environmental effects. Consideration was also given as to whether they could affect one or more components of the Project. To characterize the potential environmental effects on the Project, the likelihood of the event (ranging from very unlikely to very likely) and the consequence/severity of the effect (ranging from negligible to extreme) were assessed. The environmental events which were considered to have a potential to affect the Project components and activities included:

- Site-specific terrain hazards;
- Seismic activity;
- Extreme weather events;
- Forest fires; and
- Climate change.

Terrain hazards assessed in the assessment included permafrost degradation, landslides, and slope stability. The potential effect on the Project as a result of terrain instability may affect Storage Facilities, roads and the ABM open pit. The terrain analysis highlighted local geohazards at the site and signs of previous landslides in the area. Debris slides have occurred, locally, on moderate natural slopes either side of Geona Creek. Therefore, the likelihood of terrain instability occurring within the Project footprint is considered to be likely. However, these events will probably be small in scale and localized, as the engineering design of relevant Project components took into account local geotechnical conditions. Stability assessment and geotechnical characterization of sites were undertaken for Storage Facilities and the Process Plant, and included consideration of potential effects on these in regard to slope stability and permafrost degradation. The severity of any such event is considered to be low, as no stoppage in Project activities is expected, and any damage is expected to be minor and repairable. The potential effects on the Project as a result of a debris flood hazard in the southern part of the ABM open pit footprint may affect ABM open pit operations. Recent debris slides have been identified in this area, and the likelihood of debris slides in this area is therefore considered to be likely. The Project design has taken this hazard into account and has provided for deflection on the south part of the alluvial fan in order to protect the ABM open pit and the nearby road. With design mitigation in place, the severity of the potential effects is considered to be negligible as no Project infrastructure will be affected. Therefore, effects to the Project or Project timing as a result of terrain hazards were assessed as not significant.

Seismic activity can trigger a variety of natural hazards, including ground vibrations, large landslides, avalanches, liquefaction of saturated sediment and surface ruptures. Even though the Project is located in an area of low seismic activity all buildings on site and facility are designed with seismic events in mind. The severity of seismic activity on the Project is anticipated to be negligible and potential effects were assessed as not significant.

Extreme weather events considered in the assessment included severe rainstorms and flooding, extreme snow and ice accumulation, wind and extreme temperature. Extreme weather events have been incorporated into the design of the Project and the effects of an event on the Project were assessed as not significant.

Forest fires are unpredictable and potential effects will be minimized through clearing of vegetation around key infrastructure, installation of fire water distribution system around the processing plant site and camp area (including water storage), and training of an emergency response team. These mitigation measures for forest fires reduce the likelihood of an event impacting the Project. Therefore, no significant effects to the Project or Project timing are anticipated as a result of forest fires.

The occurrence of climate change occurring is rated overall as likely; however, this change will occur over a long period, and in this context the magnitude of change likely to occur over the Project life is small. The severity of potential effects is therefore assessed as negligible given the short Project life, and Project design aspects that have taken climate change into consideration. Therefore, no significant adverse effects to the Project or Project timing were anticipated due to climate change.

MALFUNCTIONS, ACCIDENTS AND UNPLANNED CLOSURE

The major Project components were assessed to identify potential failure events, hazard scenarios and their potential causes, so as to identify resultant accidents and malfunctions that require addressing in this assessment. For each of the identified scenarios, a risk level (ranging from low to unacceptable) was derived from the product of probability (i.e., likelihood of occurrence) and consequence (i.e., severity of occurrence). The likelihood rating (ranging from very unlikely to very likely) was based on the probability of occurrence. This was derived from the level of design information available for the Project, the review of historic or current events, and from professional judgement. The consequence rating (ranging from very low to high) was determined based on the severity of the scenario and is derived from spatial and temporal effects.

Malfunctions assessment included consideration of potential failure within the following Project components:

- Open pit mining (slope failure; dewatering system failure; and reclamation measures failure);
- Underground mining (underground stope failure; and underground dewatering system failure);
- Storage facilities (Class A, B, C, and Overburden and Topsoil Stockpiles) (slope failure; erosion control failure; and reclamation measures failure);
- Process Plant Facility (mechanical equipment failure; and pipes and pumps failure);
- Water Management (embankment or spillway failure of Operations Water Management Ponds; clean water diversion (including Fault Creek) failure; sediment and erosion control measures failure; storage facility water collection systems failure; and water treatment plant failure); and
- Power generation facility failure (power outage).

A risk rating of low was assigned for all of the above malfunction scenarios with the exception of slope failure for storage facilities and seepage collection system failure for the Class A Storage Facility. Both of these were assigned a moderate risk rating. For the other Project components, a risk rating of low was assigned as the likelihood of each malfunction scenario was assessed to be low (i.e., the event is not expected to occur during the life of the Project, and/or there are no known occurrences on similar projects) and/or because of very low consequences if the event were to occur (i.e., potential effects are localized and are readily reversible).

The two malfunction scenarios assessed as moderate risk (storage facility slope failure and seepage collection system failure for the Class A Storage Facility) both had the likelihood of occurrence

identified as unlikely. The malfunction event of slope failure for storage facilities was assessed as low consequence as while the potential slope failure may affect the water collection system and ponds (limited to the Project site), effects on surface water quality may be observed in the short term only. The risk rating of moderate for the malfunction event of storage facilities seepage collection system failure for the Class A Storage Facility was assessed as a medium consequence rating and was identified conservatively as, in the event of the complete failure of the water collection system some of the Class A Storage Facility water may enter the receiving environment.

Accident assessment considered the following accident scenarios:

- Explosives accident;
- Spill or leak during transport;
- Spill or leak on site;
- Transportation accident (on site and off site); and
- Project-related fire.

Of the above, explosives accident, spill or leak during transport and transportation accident at Finlayson airstrip were assigned a moderate risk rating as they have potentially low consequences. All other accident scenarios were assigned a low risk rating as they were assessed to have very low consequences.

The unplanned closure scenario was also considered for potential environmental and socio-economic effects. The assessment included two scenarios: temporary closure and early permanent closure. The environmental effects of an unplanned closure were assessed to be low and not significant. The potential socio-economic effects were assessed to have a medium risk rating as the local communities have high resilience to boom and bust cycles in the local economies and BMC has committed to several mitigation measures to facilitate employee's job readiness in the event of temporary closure or early permeant closure. Thus, socio-economic effects were assessed as not significant as likelihood was assessed as unlikely, resulting in overall risk rating of moderate.

Based on the likelihood and consequence ratings, none of the accidents, malfunctions, or unplanned closure scenarios were assessed to have high or unacceptable risk rating. Therefore, accidents, malfunctions, and unplanned closure were assessed as having no significant effects on any of the VCs.

MANAGEMENT PLANS

Management plans are the main mechanism for implementing environmental and socio-economic mitigation and management measures and ensuring construction and operations are carried out in a manner that minimizes potential adverse effects.

The conceptual management plans that have been developed for the Project are listed in Table 14.

Table 13: Conceptual Management Plans

Environmental Protection Plans	Operational Management Plans	Socio-economic Management Plans
Waste Management Plan	Conceptual Construction Plan	Consultation and Engagement Plan
Hazardous Materials Management Plan	Mine Development and Operations Plan	Noise Management Plan
Surface Water Management Plan	Process Plant Facility Development and Operations Plan	Air Quality Management Plan
Spill Contingency Plan	Tailings Management Plan	Traffic Management Plan
Sediment and Erosion Plan	Waste Rock and Overburden Management Plan	Heritage Resources Management Plan
Wildlife Protection Plan	Road Construction Plan	Socio-economic Effects Management Plan
Vegetation Management Plan	Reclamation and Closure Plan	Health, Safety and Emergency Response Plan
Fisheries and Aquatic Resources Protection Plan		
Adaptive Management Plan		
Environmental Monitoring, Surveillance and Reporting Plan (conceptual monitoring programs)		

CONCLUSIONS

Prior to BMC's involvement with the Project, the original property owners, Cominco (subsequently Teck), completed an exploration program in the mid-1990s and developed an economic resource at KZK. Cominco completed environmental and socio-economic studies for the Project during 1994/1995 to support the IEE under the *Canadian Environmental Assessment Act* (submitted in March 1996 and approved December 1997). Throughout this regulatory process, Cominco undertook an extensive consultation and engagement program which informed Project design and helped develop mitigation and management strategies for the Project.

In 1998, approval to commence development of a mining project at Kudz Ze Kayah was provided to Cominco through the issue of Type A Water Licence QZ97-026. Subsequent to the issuing of that licence, Cominco (and then Teck) did not develop the Project but did comply with all requisite licence conditions. Part of the compliance included the collection of and reporting on environmental baseline data on a biennial basis.

When the property was purchased by BMC from Teck, the Water Licence was assigned to BMC as Licence QZ97-026-01. BMC's Project design has substantially remained within the same Project footprint as the original Cominco design. BMC has used the development of this Application as a planning tool to ensure that Project decisions (and related physical activities and components) are considered in a careful and precautionary manner to avoid or minimize the potential for adverse environmental and socio-economic effects. This Project Proposal has incorporated environmental data collected since mid-1990s into the assessment, as well as other considerations raised through the previous assessment and permitting process.

This Project Proposal has been prepared to meet the requirements for a screening pursuant to the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) by the Yukon Environmental and Socio-economic Assessment Board (YESAB) Executive Committee in Whitehorse, Yukon.

No significant residual or cumulative environmental or socio-economic effects have been identified through the assessment of the Project. The Project will provide employment and economic opportunities for the Kaska as well as residents of Yukon and Canada. The benefits of the Project will be achieved in an environmentally and socially responsible manner while meeting BMC's corporate policies and objectives. BMC will undertake the Project in line with the commitments made in this document through the implementation of identified mitigation and enhancement measures, management plans and monitoring programs.

LIST OF ACRONYMS

ABA	Acid Base Accounting
ABM	A.B. Mawer
AC	Alternating Current
AEG	Alexco Environmental Group Inc.
ALP	Alpine Bioclimate Subzone
AMP	Adaptive Management Plan
ANFO	Ammonium nitrate/fuel oil
AP	Acid generating potential
AQMP	Air Quality Management Plan
AR5	IPCC Fifth Assessment Report
ARD	Acid rock drainage
ASCE	American Society of Civil Engineers
ATV	All terrain vehicle
BC	British Columbia
bcm	Bank cubic metre
BC MOE	British Columbia Ministry of Environment
BC OGC	British Columbia Oil and Gas Commission
BCP	Background concentration procedure
BFA	Bench Face Angle
BIF	Business Integrity Framework
BISY	Benthic Information System for the Yukon
BMC	BMC Minerals (No. 1) Ltd.
BOH	Boreal High Bioclimate Subzone
BOS	Boreal Subalpine Bioclimate Subzone
BP	Before present
ca.	Circa
CAC	Criteria air contaminants
CANUTEC	Canadian Transport Emergency Centre
CBR	California Bearing Ratio
CCME	Canadian Council of Ministers of the Environment
CEA	Cumulative Effects Assessment
CEAA	Canadian Environmental Assessment Agency
CEP	Consultation and Engagement Plan
cfm	Cubic feet per minute
CH_4	Methane
CKS	Cultural keystone species
Cl	Cordierite
CL	Chlorite
cm	Centimetre
CMIP5	Coupled Model Intercomparison Project Phase 5
cmm	Cubic metre per minute

CMP	Crisis Management Plan
CO	Carbon monoxide
CO_2	Carbon dioxide
Cominco	Cominco Ltd.
Contango	Contango Strategies Ltd.
COPI	Constituent of potential interest
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CP	Chalcopyrite
CPUE	Catch per unit effort
CRA	Canada Revenue Agency
CRCP	Conceptual Reclamation and Closure Plan
CRIOM	Canadian Regional Input Output Model
CSR	*Contaminated Sites Regulation*
CSR AW	*Contaminated Sites Regulation*, Water Quality Standards for the Protection of Aquatic Life
CWQG	Canadian Water Quality Guidelines
CWTS	Constructed wetland treatment system
dB	Decibel
dBA	A-weighted decibel
DC	Direct current
DD	Diamond Drilling
DDH	Diamond Drill Hole
DFO	Fisheries and Oceans Canada
DKI	Dena Kayeh Institute
Dmt	Dry metric tonne
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DSR	Dump stability rating
EA	Effects Assessment
EBA	Tetra Tech EBA Inc.
EC	Environment Canada
EC_{50}	Half maximal effective concentration
EEM	Environmental Effects Monitoring
EIN	Environmental Incident Notification
EM	Environmental Monitoring
EMR	Energy, Mines and Resources
EMSRP	Environmental Monitoring, Surveillance and Reporting Plan
EPA	U.S. Environmental Protection Agency
EPCM	Engineering Procurement Construction Management
EPT	Ephemeroptera, Plecoptera, Trichoptera
Equity	Equity Exploration Consultants Ltd.
EQS	Effluent Quality Standards
ERCB	Energy Resources Conservation Board (Alberta)

ERP	Emergency Response Plan
ERS	Emergency Response System
ET	Evapotranspiration
ETV	Emergency Transport Vehicle
FAA	Fisheries Act Authorization
FAHMP	Fish and Aquatic Habitat Management Plan
FCH	Finlayson Caribou Herd
FEL	Front End Loader
FHCP	Fish Habitat Compensation Plan
FIG	Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites
FLSA	Finlayson Lake Study Area
FMEA	Failure Modes and Effects Analysis
FOP	Fisheries Offsetting Plan
FOS	Factor of safety
FW	Footwall
FWD	Footwall Domain
g	Gram
g/cc	Gram per cubic centimetre
g/t	Grams per tonne (=ppm)
GCL	Geosynthetic clay liner
GDP	Gross domestic product
GED	General educational development
GHG	Greenhouse gas
GHGRP	Greenhouse Gas Emissions Reporting Program
GIS	Geographic Information System
GL	Galena
GMS	Game Management Subzone
GMZ	Game Management Zone
GNRI	Global Natural Resource Investments
gpm	Gallons per minute
GW	Gigawatt
H	Bench Height
H:V	Ratio of horizontal distance to vertical distance (slope)
ha	Hectares
HBC	Hudson's Bay Company
HDPE	High-density polyethylene
HMMP	Hazardous Materials Management Plan
Hp	Horsepower
HRIA	Heritage Resource Impact Assessment
HRMP	Heritage Resource Management Plan
HSERP	Health, Safety and Emergency Response Plan
HSI	Habitat Suitability Index
HSMS	Health and Safety Management System

HW	Hanging wall
HWD	Hanging wall domain
Hz	Hertz
ICP	Inductively coupled plasma
ICP-MS	Inductively coupled plasma mass spectrometry
IEE	Initial Environmental Evaluation
IIOM	Interprovincial Input Output Model
IPCC	Intergovernmental Panel on Climate Change
IPMP	Invasive Plant Management Plan
IRA	Inter ramp angle
ISO	International Organization for Standardization
ISQG	Interim Freshwater Sediment Quality Guidelines
JORC	Joint Ore Reserves Committee
Kaska	Kaska Nation
KCA	Kaska Collaboration Agreement
KDC	Kaska Dena Council
kg	Kilogram
kg/bcm	Kilogram per bank cubic metre
kgt	Kilogram per tonne
km	Kilometre
km^2	Square kilometre
kN	Kilo newton
kN/m3	Kilo newton per cubic metre
koz	Thousand troy ounce
KP	Knight Piésold Ltd.
KSM	Kerr-Sulphurets-Mitchell
KZK	Kudz Ze Kayah
L/s	Litres per second
LC_{50}	Median lethal concentration
Leq	Equivalent continuous noise level
LFN	Liard First Nation
LGO	Low grade ore
LiDAR	Light Detection and Ranging
LNG	Liquefied natural gas
LOM	Life of mine
LSA	Local Study Area
LTF	Land treatment facility
LUPR	Land Use Planning Region
LWD	Large woody debris
m	Metre
M	Million
m^2	Square Metres
m^3	Cubic metres

m^3/s	Cubic metres per second
MAP	Mean annual precipitation
MAR	Mean annual runoff
masl	Metres above sea level
mbgs	Metres below ground surface
mE	Metres East
MG	Magnetite
mg/L	Milligrams per litre
MIF	Mine infrastructure footprint
ml	Millilitres
MLU	Mining Land Use (Approval)
mm	Millimetre
MMER	Metal Mining Effluent Regulations
MMU	Moose Management Unit
mN	Metres North
MPa	Megapascal
MPERG	Mining and Petroleum Environmental Research Group
MSDS	Material Safety Data Sheets
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Megawatt
N_2O	Nitrous oxide
NAAQO	National Ambient Air Quality Objectives
NAG	Non-acid generating
NAPS	National Air Pollution Surveillance Network
NAWCC	North American Wetlands Conservation Council (Canada)
NAWMP	North American Waterfowl Management Plan
NG	Natural gas
NHS	National household survey
NMP	Northern Mountain Population
NO_2	Nitrogen dioxide
NP	Acid neutralizing potential
NPR	Neutralization Potential Ratio
NPRI	National Pollutant Resource Inventory
NRCan	Natural Resources Canada
NSR	Net Smelter Return
NT	Northwest Territories
NTS	National Topographic System
OD	Ore domains
OH&S	Occupational Health and Safety
OK	Ordinary Kriging
OSA	On Stream Analyzer
Oz	Troy ounce (31.1 grams)

P_{80}	80% passing (a given size)
Pa	Pascal
PAC	Potentially acid consuming
PAG	Potentially acid generating
PAL	Protection of aquatic life
PC	Personal computer
PCB	Polychlorinated biphenyl
PEL	Probable effects level
PFS	Pre-Feasibility Study
PGA	Peak ground acceleration
PHC	Petroleum hydrocarbons
PID	Piping and Instrumentation Diagram
PLC	Programmable Logic Controllers
$PM_{2.5}$	Fine particulate matter, aerodynamic diameter of less than 2.5 µm
PM_{10}	Coarse particulate matter, aerodynamic diameter of less than 10 µm
PMP	Probable maximum precipitation
PO	Pyrrhotite
ppbv	Parts per billion by volume
PPE	Personal protective equipment
ppm	Parts per million
PSAS	Particle size analyzer
psi	Pound per square inch
pWQO	Preliminary Water Quality Objectives
PY	Pyrite
QMA	*Quartz Mining Act*
QML	Quartz Mining License
QP	Qualified Professional
RCMP	Royal Canadian Mounted Police
RCP	Representative Concentration Pathways
RL	Reduced level
RMR	Rock Mass Rating (RMR_{76} and RMR_{89} applied)
ROM	Run of mine
RoW	Right of Way
RQD	Rock Quality Designation
RRDC	Ross River Dena Council
RSA	Regional Study Area
RTC	Registered trapline concession
SAB	Semi-autogenous ball
SAG	Semi-Autogenous Grinding
SARA	*Species at Risk Act*
SC	Statistics Canada
SCADA	Supervisory Control and Data Acquisition
SCC	Statistics Canada census

SCP	Spill Contingency Plan
SECP	Sediment and Erosion Control Plan
SEMP	Socio-economic Effects Management Plan
SEPA	Socio-economic Participation Agreement
SFE	Shake Flask Extraction
SMD	Stirred Media Detritor
SNAP	Scenarios Network for Alaska and Arctic Planning
SO_2	Sulphur dioxide
SP	Sphalerite
SPAG	Strongly Potentially Acid Generating
SPL	Sound pressure level
SPT	Standard Penetration Test
SSD	Species sensitivity distribution
SSWQO	Site Specific Water Quality Objectives
STL	Shovel test location
STN	Station
SWD	Small woody debris
SWE	Snow water equivalent
SWMP	Surface Water Management Plan
t	Tonne
TAMP	Traffic and Access Management Plan
TDS	Total dissolved solids
TEAP	Transportation Emergency Assistance Plan
Teck	Teck Resources Ltd.
TEM	Terrestrial Ecosystem Mapping
TK	Traditional Knowledge
TKN	Total Kjeldahl Nitrogen
TLU	Traditional Land Use
TMP	Traffic Management Plan
tpd	Tonnes per day
tph	Tonnes per hour
TSP	Total suspended particulate
TSS	Total suspended solids
UCS	Uniaxial Compressive Strength
UFA	Umbrella Final Agreement
U.S.	United States
USCS	Unified Soil Classification System
USg	US gallons
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
V	Volt
VC	Valued Component
VMS	Volcanogenic massive sulphide

VWP	Vibrating wire piezometer
W	Bench width
W/m^2	Watts per square meter
WAD	Weak acid dissociable
WERP	Water Effects Ratio Procedure
WHMIS	Workplace Hazardous Materials Information System
WKA	Wildlife Key Area
WMP	Waste Management Plan
WPAG	Weakly Potentially Acid Generating
WPP	Wildlife Protection Plan
WQC	Water Quality Criteria
WQO	Water Quality Objective
WRDA	Waste Rock Disposal Area
WRMP	Waste Rock Management Plan
WTP	Water treatment plant
WUL	Water Use Licence
XRF	X-Ray Fluorescence
YAAQS	Yukon Ambient Air Quality Standards
YBGO	Yukon Big Game Outfitters
YBS	Yukon Bureau of Statistics
YCDC	Yukon Conservation Data Centre
YEC	Yukon Energy Corporation
YESAA	*Yukon Environmental and Socio-Economic Assessment Act*
YESAB	Yukon Environmental and Socio-Economic Assessment Board
YG	Yukon Government
YHPW	Yukon Highways and Public Works
YHSS	Yukon Health and Social Services
YISC	Yukon Invasive Species Council
YWCHSB	Yukon Workers Compensation Health and Safety Board
ZOI	Zone of influence
σ1	Major Stress
σ2	Intermediate Stress
σ3	Minor Stress
µg/m^3	Micrograms per cubic metre
µm	Micron
µS/cm	Micro Siemens per centimetre

GLOSSARY

A-weighted Decibel: a measurement of noise level based on the sensitivity of human hearing at moderate levels.

Abiotic: non-living chemical and physical parts of the environment that affect living organisms and the functioning of ecosystems. Includes atmosphere, water and temperatures as inputs to an ecosystem.

Acid-base Accounting: a screening procedure whereby the acid-neutralizing potential and acid generating potential of rock samples are determined to estimate its potential to produce acid over time.

Acid-generating Potential: total acid a material is capable of generating which is used in acid-base accounting to estimate potential future acidic drainage.

Acid Rock Drainage: drainage with acidic pH from material having an insufficient capacity to neutralize acidic products of sulphide and elemental sulphur oxidation and dissolution products of acidic minerals.

Alluvial Deposits: sand, silt, clay, gravel, or other matter deposited by flowing water, as in a riverbed, floodplain, delta, or alluvial fan.

Alluvial Fan: fan-shaped mass of alluvium deposited while the flow of a river decreases in velocity.

Alpine (Bioclimate Zone): high elevation ecosystems occurring at greater than 1,550 masl and associated with mountain environments.

Ammonium Nitrate/Fuel Oil: a widely used bulk industrial explosive mixture.

Archaeological or Prehistoric Sites: Archaeological or Prehistoric Sites generally represent use before European contact and are found on or under the ground surface, and may consist of the remains of ancient camps, including hearths, animal bone and stone tools and debris. In this usage, an Archaeological Site equates to a Prehistoric Site (a site that dates to the period before written history).

Artesian: underground water that reaches the ground surface under the natural pressure of the aquifer.

Assessment Endpoint/Threshold Criteria: these are the endpoints or criteria against which the measurable parameters will be assessed to identify potential effects on the Valued Component or subcomponent (e.g., regulatory guidelines).

Atlatl: a device to throw a dart or small spear, with a handle at one end and a hook or notch at the other, by which the projectile is pushed through the throwing motion.

Atterberg Limits: the basic measurement of critical water contents of fine-grained soil.

Aufeis: a sheet-like mass of layered ice that forms from successive flows of groundwater during freezing temperatures.

Baseline: the existing condition of the biophysical system prior to any alteration from human impact.

Benthic Invertebrates: organisms that live in or on the bottom sediments of rivers, streams, and lakes.

Biophysical: the combination of biotic and abiotic factors that influence the surrounding environment.

Boreal High (Bioclimate Zone): middle to upper elevations (900 – 1,300 masl) of forested area found above the boreal low zone in large valleys. Characterized by white and black spruce forests with well-developed shrub and moss understories.

Boreal Subalpine (Bioclimate Zone): sparsely forested areas of moderate to high elevation (1,300 – 1,550 masl) situated above the Boreal High and below the Alpine zone. The subalpine is a transitional zone from the forested boreal and higher elevation non-forested.

Bunding: a constructed retaining wall around storage where potentially polluting substances are handled, processed or stored, for the purposes of containing any unintended escape of material from that area until such time as remedial action can be taken.

CALPUFF: advanced, integrated Lagrangian puff modelling system for the simulation of atmospheric pollution dispersion. The CALPUFF model is designed to simulate the dispersion of buoyant, puff or continuous point and area pollution sources as well as the dispersion of buoyant, continuous line sources.

Carrying Capacity: the maximum population size of the species that the environment can sustain indefinitely given the food, habitat, water, and other necessities available in the environment.

Catch per unit effort: catch of fish in numbers during a defined period of effort (indirect measure of the abundance).

Chlorophyll α: primary photosynthetic pigment common to all algae.

Circumneutral: a pH near neutral (i.e., between 6.5 and 7.5).

Climate Habitat: the last stage in ecological succession. An ecosystem in which populations of all organisms are in balance with each other and with existing abiotic factors.

Closure Phase: see Decommissioning, Reclamation and Closure Phase.

Colluvium: material that accumulates at the foot of a steep slope.

Committee on the Status of Endangered Wildlife in Canada: a committee of experts that assesses and designates which wildlife species are in some danger of disappearing from Canada.

Concentrate: product produced by metal ore mines.

Construction Phase: project phase that will last approximately 2 years and includes site preparation and clearing and establishment of Project infrastructure.

Coupled Model Intercomparison Project: standard experimental protocol for studying the output of coupled atmosphere-ocean general circulation models.

Criteria Air Contaminants: set of air pollutants that cause smog, acid rain, and other health hazards. Typically emitted from many sources in industry, mining, transportation, electricity generation and agriculture. Sulphur dioxide (SO_2), total suspended particulates (TSP), carbon monoxide (CO), fine particulate matter less than 2.5 microns ($PM_{2.5}$), coarse particulate matter less than 10 microns (PM_{10}), and nitrogen dioxide (NO_2) were identified as measurable parameters for the CACs valued subcomponent.

Cumulative Effect: the combined environmental or socio-economic effects that accumulate from a series of similar or related individual actions, contaminants, or projects. The cumulative effects are considered where there is an interaction between Project's residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/ known future projects.

Cyanobacteria: a phylum of bacteria that obtain their energy through photosynthesis.

Debris Slide: a mass of predominantly unconsolidated and incoherent soil and rock fragments that has slid or rolled rapidly down a steep slope.

Decibel: a noise level measured on a logarithmic scale.

Decommissioning, Reclamation and Closure Phase: project phase that will last at minimum 3 years and occurs following Operations Phase once all mining and ore processing activities stop.

Detritus: dead particulate organic material.

Diapause: when referencing animal dormancy, is the delay in development in response to regularly and recurring periods of adverse environmental conditions. It is considered to be a physiological state of dormancy with very specific initiating and inhibiting conditions. Diapause is a mechanism used as a means to survive predictable, unfavorable environmental conditions, such as temperature extremes, drought, or reduced food availability.

Digital Elevation Model: a digital model or 3D representation of a terrain's surface.

Diurnal: pattern that recurs daily.

Downscaling: procedure of taking information known at large scales to make predictions at local scales.

EC_{50}: the concentration of a toxicant at which 50% of its maximum response is observed.

Ecological Succession: ecological succession is the process of change in the species structure of an ecological community over time.

Ecoregion: ecoregions represent smaller areas of ecozones characterized by distinctive physiography and ecological responses to climate as expressed by the development of vegetation, soil, water, and fauna.

Ecozone: ecozones are large and generalized ecological units characterized by interactive abiotic factors. Five ecozones are recognized in Yukon: Southern Arctic, Pacific Maritime, Taiga Plain, Boreal, and Taiga Cordillera.

Electrofishing: common scientific survey method using direct current electricity flowing between a submerged cathode and anode to affect the movement of the fish so that they swim towards the anode where they can be caught.

Emission Factor: average emission rate of a given air contaminant or greenhouse gas for a given source, relative to units of activity.

Ensemble Modelling: process of running two or more related but different analytical models and then synthesizing the results into a single score or spread in order to improve the accuracy of predictive analytics and data mining applications.

Equivalent Continuous Level: a common method of describing sound levels that vary over time, resulting in a single decibel value which takes into account the total sound energy over the period of time of interest.

Eskers: a long ridge of gravel and other sediment, typically having a winding course, deposited by meltwater from a retreating glacier or ice sheet.

Eutrophic: water body rich in phosphates, nitrates, and organic nutrients that promote a proliferation of plant life, especially algae.

Eutrophication: depletion of oxygen in a water body, which kills aquatic animals, in response to the addition of excess nutrients, which induces explosive growth of plants and algae, the decaying of which consumes oxygen from the water.

Existing Conditions: existing conditions descriptions include considerations of “historic” environmental conditions (through previous studies conducted in the area), Traditional Knowledge, available regional or case studies, and information gathered as part of the project baseline field programs.

Extirpation: to destroy or remove completely, as a species from a particular area, region, or habitat.

Fen: a category of wetland that is fed by mineral-rich surface or groundwater. They are characterized by a neutral pH and are usually dominated by grasses and sedges.

Ferruginous: a substance containing iron.

Forb: herbaceous flowering plant that is found in boreal forest understory and alpine meadows.

Fork Length: length of a fish measured from the tip of the snout to the end of the middle caudal fin rays.

French Drain System: trench filled with material or perforated pipe that redirects groundwater and surface water away from an area.

Freshet: an increase in stream flow resulting from snow and ice melt due to spring thaw.

Fry: juvenile fish life stage reached when fish are capable of feeding themselves.

Game Management Subzone: a legal boundary delineated by creeks and rivers that defines an area within which big game management objectives can be met through the setting of area specific regulations, and together form the larger Game Management Zones.

Game Management Zone: a legal boundary delineated by highway centerlines that defines an area within which big game management objectives can be met through the setting of area specific regulations, and is comprised of many Game Management Subzones.

Gaussian Puff Model: model assuming that the air pollutant dispersion has a Gaussian distribution, meaning that the pollutant distribution has a normal probability distribution; can be used for predicting the dispersion of non-continuous air pollution plumes (puffs).

Geographic Information System: a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Glacial Till: unsorted glacial sediment which is derived from the erosion and entrainment of material by the moving ice of a glacier.

Glaciofluvial Deposits: material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces.

Global Warming Potential: relative measure of how much heat a greenhouse gas traps in the atmosphere; it compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide.

Graminoid: herbaceous plants with a grass-like morphology. Includes the families Poaceae (grasses), Cyperaceae (sedges), and Juncaceae (rushes). Graminoids are often dominant in open habitat comprising grasslands, marshes, and alpine meadows.

Greenhouse Gas: gas in the atmosphere that absorbs and emits radiation in the thermal infrared range. This process is the fundamental cause of the greenhouse effect.

Gross Domestic Product: broadest quantitative measure of total economic activity. The monetary value of all goods and services produced in an economy over a specified time.

Habitat Suitability Index: a tool for predicting the suitability of habitat for a given species based on known affinities with environmental parameters.

Hardness: the amount of dissolved calcium and magnesium in water (i.e., hard water has high dissolved calcium and magnesium).

Heterotrophic microbe: an organism that cannot fix carbon and uses organic carbon for growth.

Hibernacula: a shelter for a hibernating animal.

Historic Sites: historic sites contain heritage resources that are greater than 45 years in age and possess significant heritage value. By convention, historic sites date to the period for which written records are available; in this case, the historic period commences with the arrival of the Hudson's Bay Company in the early-mid 19th century. Historic sites may include cabins, caches, camps, brush camps, and any other man-made structures, features or objects that date between about 1960 and 1830.

Human Remains: human remains are referred to here as non-fossilized remains of human bodies that are found outside a recognized cemetery or burial site.

Humidity Cell: a kinetic test used to determine the rates of acid generation and neutralization of geological material.

Hummock: a small knoll or mound extruding from the grounds surface. Hummocks are typically made of graminoids and can be found on wet north facing aspects or alpine environments.

Initial Environmental Evaluation: a previous body of work completed at Kudz Ze Kayah in the 1990's by Cominco, which included wildlife baseline surveys.

Intergovernmental Panel on Climate Change: scientific and intergovernmental body under the auspices of the United Nations, set up at the request of member governments, dedicated to the task of providing the world with an objective, scientific view of climate change and its political and economic impacts.

JORC Code (2012): The Australasian code for reporting of exploration results, mineral resources and ore reserves - a professional code of practice that sets minimum standards for Public Reporting of minerals Exploration Results, Mineral Resources and Ore Reserves.

Kames: a geomorphological feature, an irregularly shaped hill or mound composed of sand, gravel and till that accumulates in a depression on a retreating glacier, and is then deposited on the land surface with further melting of the glacier.

Kaska (i.e., Kaska First Nation): a transboundary Nation involving Kaska people from the Ross River Dena Council and Liard First Nation in southeastern Yukon, and Daylu Dena Council, Dease River First Nation and Kwadacha Nation in northern British Columbia.

Kettle: a shallow, sediment-filled body of water formed by retreating glaciers or draining floodwaters.

Kinetic Test: a procedure used to analyze dynamic physical and chemical processes of materials over time, including reaction rates, mineral alteration and drainage chemistry and loading resulting from the interaction between water and mine material.

LC_{50}: the concentration of a toxicant at which 50% mortality from toxicity is observed.

Littoral Zone: the near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants (macrophytes) to grow.

Local Study Area: refers to the area within which most of the direct Project effects are expected to occur and is Valued Component/subcomponent specific.

Malfunction: failure of a piece of equipment, a device, or a system to function normally.

Measurable Parameters: measurable parameters are the metrics used to assess and quantify the effect on the Valued Component from the Project activities. These represent how the change to the Valued Component is identified and measured.

Metal Leaching: extraction of soluble metals by solvents. Leaching can be natural or induced in a laboratory procedure.

Microlithic Technologies: prehistoric chipped stone tool manufacturing using very small, micro-cores, from which very small, thin, microblades were removed.

Minnow Trap: cylindrical device with ¼“or ½“ mesh and a funnel opening on each end, for capturing small fish.

Moose Management Unit: a designated boundary used to help manage moose populations in Yukon. Can consist of as few as 1 or as many as 23 Game Management Subzones.

N Value: a measure of standard penetration resistance as part of Standard Penetration Test (STP).

National Instrument 43-101: the standards of disclosure for minerals projects in Canada which has a codified set of guidelines and rules for displaying and reporting information related to mineral properties explored by, owned by, companies which report these results on stock exchanges within Canada.

Neutralization Potential: the total acid a material is capable of neutralizing. Measurements of NP are used in acid base accounting calculations to estimate future drainage pH and the potential for acidic drainage pH.

Northern Mountain Population: a distinct ecotype of woodland caribou that have unique habitat preferences and behaviour.

Operations Phase: project phase that will last approximately 10 years and includes open pit and underground development and ore processing.

Overwintering Habitat: area used by fish when winter conditions (cold or sub-zero temperatures, ice, snow, limited food supplies) make normal activity or even survival difficult.

Palaeonotological Resources: Palaeonotological Resources include the fossilized, mummified, or skeletal remains of previous life forms. These resources may be found in sedimentary rock formations, or eroding streams and creeks and contain a great deal of information concerning past environments. The most common of these resources include the skeletal remains of ice age mammals which are often associated with dark humic deposits. These remains may date from approximately ten of thousands to many hundreds of thousands of years before present.

Passive Air Sampler: passive (or diffusive) sampler relies on the unassisted molecular diffusion of gaseous agents (analytes) through a diffusive surface onto an adsorbent.

Pathogen: a bacterium, virus, or other microorganism that can cause disease.

Peak Overpressure: the peak pressure caused by a shock wave over and above normal atmospheric pressure.

Periglacial: relating to or denoting an area adjacent to a glacier or ice sheet or otherwise subject to repeated freezing and thawing.

Periphyton: complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems. Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. As photosynthesizers, algae form the base of the aquatic food web.

Permafrost: soil, rock or sediment that is frozen for more than two consecutive years. In areas not overlain by ice, it exists beneath a layer of soil, rock or sediment, which freezes and thaws annually and is called the "active layer".

Permeability: the measure of the ability of a material to transmit water and air.

Phylum: a principal taxonomic category that ranks above class and below kingdom.

Piezometric Elevation: also referred to as hydraulic head or piezometric head. Elevation to which water will naturally rise in a well. Sea level is commonly used as the reference geodetic datum.

Post-closure Phase: project phase that is assumed to begin once all physical activities have finished onsite and will continue until active monitoring is no longer required.

Potential Effect: an effect identified through potential interaction between Project activity and Valued Component. Potential effects are identified prior to application of addition mitigation measures.

Potentially Acid Generating: acid rock drainage occurs naturally within some environments as part of the rock weathering process but may be accelerated by large-scale earth disturbances within rocks containing

an abundance of sulphide minerals. Rocks are assessed as to whether they may be potentially acid generating, if disturbed.

Primary Production: the rate at which energy is converted by photosynthetic (e.g., algae and plants) and chemosynthetic (e.g., bacteria) autotrophs to organic substances.

Process Plant Facility: facility where the ore gets processed to produce a concentrate, which is then loaded on trucks for transport.

Project Area: refers to the general Project location and surrounding area.

Project Footprint: refers to the area within which the Project infrastructure will be located and is the area of direct disturbance from the Project activities.

Radiative Forcing: measurement of the capacity of a gas or other forcing agents to affect the Earth's energy balance, thereby contributing to climate change.

Rearing habitat: area where fish take up residence during some stage of development and utilize the area for feeding, shelter, and growth.

Recruitment Rate: the ratio of calves relative to the number of adult females.

Regional Study Area: refers to the area within which indirect and cumulative effects may occur and is valued component/subcomponent specific.

Representative Concentration Pathways: four greenhouse gas concentration (not emissions) trajectories adopted by the Intergovernmental Panel on Climate Change for its fifth Assessment Report (AR5) and used for climate modelling and research.

Residual Effect: residual effects are those that remain after mitigation measures are applied. Adverse residual effects are assessed for their significance.

Riparian: the interface between terrestrial and river or stream ecosystems.

Secondary Production: the generation of biomass of heterotrophic (consumer) organisms in a system (i.e., animals that eat plants).

Shake Flask Extraction: a static test procedure designed to measure the mass of soluble constituents of a material.

Shotcrete: concrete conveyed through a hose and pneumatically projected at high velocity onto a surface and may be reinforced by conventional steel rods, steel mesh, and/or fibres.

Solifluction: the gradual movement of wet soil or other material down a slope, especially where frozen subsoil acts as a barrier to the percolation of water.

Sound Pressure Level: a measurement of sound level. A ratio of the absolute sound pressure and a reference level; usually the lowest intensity sound that can be heard by most people.

Spawning habitat: areas where eggs are deposited and fertilized.

Split Set: rock bolt compromising 2 parts, a tube and matching domed bearing plate.

Static Test: a procedure for determining the physical, chemical or biological characteristics of a sample at a point in time and includes the measurements of chemical composition and acid base accounting analyses.

Stereonet: a lower hemisphere graph on to which a variety of geological data can be plotted.

Stope: process of extracting the desired ore or other mineral from an underground mine, leaving behind an open space known as a stope.

Subcomponents: subcomponents are identified to facilitate and structure the assessment of a broadly defined Valued Components (e.g., individual species or species groups for Wildlife Valued Component), as applicable.

Substrate: material that rests at the bottom of a stream.

Taxonomic Richness: number of different species represented in an ecological community.

Total Kjeldahl Nitrogen (TKN): sum of ammonia-nitrogen plus organically bound nitrogen.

Traditional Knowledge: Traditional Knowledge is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. Traditional Knowledge is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.

Transmissivity: the rate of flow under a unit hydraulic gradient through a unit width of aquifer of given saturated thickness. The transmissivity of an aquifer is related to its hydraulic conductivity as follows: $T=K \cdot b$; where T is transmissivity (L^2/T) and b is the aquifer thickness (L).

Trickle Leach Column: a kinetic test often conducted in a laboratory that is designed to measure the drainage chemistry of water percolated through a column of geological material. Leach column tests attempt to simulate the weathering, leaching and mineral precipitation and dissolution that occur in field conditions and the results of these tests are often used in the development of predictive source terms.

Undercatch: lower than actual precipitation readings in the rain or snow gauge due to winds preventing all precipitation from falling in the gauge.

Valued Component: element of the environmental and/or socio-economic systems valued for environmental, scientific, social, aesthetic, or cultural reasons. For the purpose of this environmental assessment, Valued Components are defined to include both environmental and socio-economic aspects.

Voltinism: number of broods or generations of an organism within a year.

Wildlife Key Area: areas designated by Yukon Government as especially important for wildlife, specifically during certain seasonal life functions (e.g., rutting, lambing, breeding).

Yukon Environmental and Socio-economic Assessment Board: an independent arms-length body, responsible for implementation of the assessment responsibilities under the *Yukon Environmental and Socio-economic Assessment Act*.

Zone of Influence: the spatial area of influence affecting an animal's behaviour caused from development activities.

TABLE OF CONTENTS

DISTRIBUTION LIST I

ACKNOWLEDGEMENTS I

EXECUTIVE SUMMARY II

LIST OF ACRONYMS LIX

GLOSSARY LXVII

1 INTRODUCTION **1-1**

1.1 PROJECT OVERVIEW 1-1

1.2 PROJECT PURPOSE AND RATIONALE 1-6

1.3 PROPONENT INFORMATION 1-6

1.3.1 BMC Overview and Purpose *1-6*

1.3.2 Corporate Address and Website *1-7*

1.3.3 Directors and Management *1-7*

1.3.4 Principal Contact Person for Purposes of Project Proposal *1-8*

1.3.5 Corporate Policies *1-8*

1.4 PROJECT BACKGROUND 1-10

1.4.1 Project History *1-10*

1.4.2 Existing Authorizations and Approvals *1-12*

1.5 ENVIRONMENTAL CONTEXT 1-12

1.6 SOCIO-ECONOMIC CONTEXT 1-13

1.7 *YESAA* TRIGGERS AND REQUIRED AUTHORIZATIONS 1-14

1.7.1 YESAA Requirements *1-14*

1.7.2 Applicable Legislation, Regulations and Permits *1-15*

1.8 ORGANIZATION AND LAYOUT OF THE PROJECT PROPOSAL 1-19

2 FIRST NATION AND COMMUNITY CONSULTATION **2-1**

2.1 INTRODUCTION 2-1

2.2 CONSULTATION REQUIREMENTS 2-2

2.3 HISTORICAL CONSULTATION 2-3

2.4 CONSULTATION AND ENGAGEMENT PLAN 2-4

2.4.1 Overview *2-4*

2.4.2 Objectives *2-4*

2.4.3 Approach *2-5*

2.5 IDENTIFICATION OF PARTIES TO BE CONSULTED 2-5

2.5.1 Potentially Affected First Nations *2-6*

2.5.2 Residents of Potentially Affected Communities *2-9*

2.6 NEWSLETTERS, PUBLICATIONS, HANDOUTS AND OTHER INFORMATION PROVIDED 2-9

2.7 KASKA FIRST NATIONS CONSULTATION 2-10

2.7.1 Ross River Dena Council 2-10
2.7.2 Liard First Nation 2-31
2.7.3 Kaska Dena Council 2-38
2.8 COMMUNITY CONSULTATION 2-40
2.8.1 Ross River 2-40
2.8.2 Watson Lake 2-45
2.8.3 Faro 2-50
2.8.4 Whitehorse 2-56
2.9 FUTURE CONSULTATION (POST SUBMISSION) 2-60
3 PROJECT LOCATION 3-1
3.1 GEOGRAPHICAL LOCATION 3-1
3.2 LAND TENURE 3-1
3.3 TRADITIONAL TERRITORY 3-4
3.4 YUKON LAND USE PLANNING REGION 3-4
3.5 CONSISTENCY WITH OTHER PLANS 3-6
4 PROJECT DESCRIPTION 4-1
4.1 PROJECT IDENTIFICATION 4-1
4.2 SCOPE OF THE ASSESSMENT 4-3
4.2.1 Outside the Scope of the Assessment 4-7
4.3 PROJECT PHASES AND SCHEDULING 4-7
4.3.1 Project Schedule 4-7
4.3.2 Construction Phase 4-10
4.3.3 Operations Phase 4-11
4.3.4 Decommissioning, Reclamation and Closure Phase 4-15
4.4 GEOLOGY 4-17
4.4.1 Regional Geology 4-17
4.4.2 Project Geology 4-17
4.4.3 Exploration and Data Collection 4-22
4.5 MINERAL RESOURCE 4-22
4.5.1 Resource Classification 4-22
4.5.2 Mineral Resource Estimate 4-23
4.6 MINE PLAN (OPEN PIT) 4-24
4.6.1 Open Pit Development 4-24
4.6.2 Pit Geometry and Slope Stability 4-28
4.6.3 Blasting and Explosives Management 4-30
4.6.4 Loading 4-31
4.6.5 Hauling 4-31
4.7 MINE PLAN (UNDERGROUND) 4-34
4.7.1 Underground Development 4-34
4.7.2 Mining Methods 4-34

4.7.3 Underground Geotechnical Study 4-40
4.7.4 Ventilation and Air Quality 4-41
4.7.5 Compressed Air 4-43
4.7.6 Power 4-43
4.7.7 Blasting and Explosives Management 4-43
4.7.8 Communications 4-44
4.7.9 Mine Warning System 4-44
4.7.10 Refuge Chambers 4-45
4.7.11 Escapeways 4-45
4.7.12 Paste Backfill 4-45
4.8 ORE PROCESSING 4-46
4.8.1 Overview 4-46
4.8.2 Metallurgical Studies 4-46
4.8.3 Process Plant Description 4-48
4.8.4 Processing Plant Location and Layout 4-52
4.8.5 Reagents 4-55
4.9 WASTE ROCK MANAGEMENT 4-56
4.9.1 Waste Characterization 4-56
4.9.2 Waste Rock Identification and Management 4-59
4.9.3 Deposition of Tailings and Mine Rock 4-59
4.9.4 Class A Storage Facility 4-62
4.9.5 Class B Storage Facility 4-67
4.9.6 Class C Storage Facility 4-70
4.9.7 Overburden Stockpile 4-73
4.10 WATER MANAGEMENT 4-75
4.10.1 Construction 4-75
4.10.2 Operations 4-82
4.10.3 Water Use 4-85
4.10.4 Site Water Balance 4-87
4.10.5 Closure 4-91
4.10.6 Geona Creek 4-92
4.11 SUPPORT INFRASTRUCTURE 4-92
4.11.1 Paste Fill Plant 4-92
4.11.2 Warehouse and Administration Complex 4-93
4.11.3 Workshop 4-94
4.11.4 Assay and Metallurgical Laboratory 4-94
4.11.5 Emergency Facility 4-94
4.11.6 Fuel Storage and Distribution 4-95
4.11.7 Fire Protection 4-96
4.11.8 Sewage Collection and Treatment 4-97
4.11.9 Waste Management Plan 4-97
4.11.10 Communications 4-98
4.11.11 Site Roads 4-99
4.11.12 Borrow Sources 4-99

4.11.13 Explosives Use and Storage *4-100*
4.11.14 Site Accommodations *4-100*
4.11.15 Site Power Supply *4-101*
4.12 ACCESS AND TRANSPORTATION 4-102
4.12.1 Tote Road Upgrade to Access Road *4-102*
4.12.2 Finlayson Lake Airstrip *4-107*
4.12.3 Concentrate Transport to Port of Stewart *4-111*
4.12.4 Transportation Volumes *4-112*
4.13 DECOMMISSIONING AND RECLAMATION PLAN 4-113
4.13.1 Closure Phases *4-114*
4.13.2 Mine Site Decommissioning and Restoration *4-119*
4.13.3 Water Management and Water Quality Control Measures *4-123*
4.13.4 Waste Management *4-125*
4.13.5 Monitoring, Maintenance and Schedule *4-126*
4.13.6 Access Road Closure *4-126*
4.14 WORKFORCE, PROCUREMENT, HIRING AND TRAINING 4-127
4.14.1 Construction *4-127*
4.14.2 Operations *4-128*
4.14.3 Decommissioning *4-131*
4.14.4 Closure *4-131*
4.14.5 Post-Closure *4-131*
4.14.6 Employee Health and Well-being *4-132*
4.15 ALTERNATIVES AND CHOSEN APPROACH 4-132
4.15.1 Introduction *4-132*
4.15.2 Methods *4-133*
4.15.3 Alternatives to the Project *4-134*
4.15.4 Alternative Means of Carrying out the Project *4-135*
4.16 TECHNOLOGIES 4-147
4.16.1 Flotation Ore Processing *4-147*
4.16.2 Filtered Tailings *4-147*
4.16.3 Filtered Tailings Reclamation *4-148*
4.16.4 Paste Backfill *4-149*
4.16.5 Containerized Transportation of Lead Concentrates *4-149*
4.16.6 Treated Wetlands *4-149*
5 EFFECTS ASSESSMENT METHODS 5-1
5.1 GENERAL APPROACH 5-1
5.2 TRADITIONAL KNOWLEDGE INTEGRATION 5-1
5.3 IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC VALUED COMPONENTS 5-3
5.3.1 Traditional Knowledge Integration *5-3*
5.4 ASSESSMENT BOUNDARIES 5-6
5.4.1 Spatial Boundaries *5-6*
5.4.2 Temporal Boundaries *5-6*

5.4.3 Traditional Knowledge Integration 5-7
5.5 EXISTING CONDITIONS 5-7
5.5.1 Traditional Knowledge Integration 5-7
5.6 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS 5-8
5.6.1 Effects Characterization 5-8
5.6.2 Mitigation Measures 5-10
5.6.3 Residual Effects 5-11
5.6.4 Determination of Significance 5-13
5.7 CUMULATIVE EFFECTS ASSESSMENT 5-13
5.7.1 Cumulative Effects Assessment Scoping 5-13
5.7.2 Cumulative Effects Assessment Methods 5-29
5.8 EFFECTS MONITORING 5-29
6 AIR QUALITY 6-1
6.1 ASSESSMENT APPROACH 6-1
6.1.1 Regional Setting 6-1
6.1.2 Selection of Subcomponents and Measurable Parameters 6-1
6.1.3 Criteria for Assessing Significance 6-3
6.2 ASSESSMENT BOUNDARIES 6-5
6.3 EXISTING CONDITIONS 6-8
6.3.1 Air Quality 6-8
6.3.2 Meteorology 6-11
6.4 PROJECT-SPECIFIC EFFECTS 6-15
6.4.1 Effects Characterization 6-15
6.4.2 Mitigation Measures 6-28
6.4.3 Residual Effects and Significance Determination 6-30
6.5 CUMULATIVE EFFECTS 6-33
6.5.1 Cumulative Effects Characterization 6-33
6.5.2 Cumulative Effects Mitigation Measures 6-36
6.5.3 Cumulative Effects Significance Assessment 6-36
6.6 EFFECTS MONITORING 6-38
6.6.1 Air Quality Monitoring 6-38
6.6.2 Meteorology Monitoring 6-38
7 NOISE LEVELS 7-1
7.1 ASSESSMENT APPROACH 7-1
7.1.1 Regional Setting 7-1
7.1.2 Selection of Subcomponents and Measurable Parameters 7-1
7.1.3 Criteria for Assessing Significance 7-2
7.2 ASSESSMENT BOUNDARIES 7-4
7.3 EXISTING CONDITIONS 7-6
7.4 PROJECT-SPECIFIC EFFECTS 7-7

7.4.1 Effects Characterization 7-7
7.4.2 Mitigation Measures 7-16
7.4.3 Residual Effects and Significance Determination 7-18
7.5 CUMULATIVE EFFECTS 7-21
7.5.1 Cumulative Effects Characterization 7-21
7.6 EFFECTS MONITORING 7-22
8 SURFACE WATER QUALITY AND QUANTITY 8-1
8.1 ASSESSMENT APPROACH 8-1
8.1.1 Selection of Subcomponents and Measurable Parameters 8-2
8.1.2 Criteria for Assessing Significance 8-3
8.2 ASSESSMENT BOUNDARIES 8-5
8.3 EXISTING CONDITIONS 8-8
8.3.1 Surface Water Quantity 8-8
8.3.2 Surface Water Quality 8-12
8.4 PROJECT-SPECIFIC EFFECTS 8-20
8.4.1 Effects Characterization 8-21
8.4.2 Mitigation Measures 8-104
8.4.3 Residual Effects, Consequence and Significance Determination 8-108
8.5 CUMULATIVE EFFECTS 8-118
8.5.1 Cumulative Effects Characterization 8-118
8.6 EFFECTS MONITORING 8-120
8.6.1 Historic and Current Surface Water Monitoring Program 8-120
8.6.2 Surface Water Monitoring Program during Construction and Operations 8-121
8.6.3 Surface Water Monitoring at Closure 8-121
8.6.4 Geochemistry Field Barrels 8-122
8.6.5 Quality Assurance/Quality Control 8-122
8.6.6 Reporting 8-122
9 GROUNDWATER QUALITY AND FLOW 9-1
9.1 ASSESSMENT APPROACH 9-1
9.1.1 Selection of Subcomponents and Measurable Parameters 9-1
9.1.2 Criteria for Assessing Significance 9-3
9.2 ASSESSMENT BOUNDARIES 9-5
9.3 EXISTING CONDITIONS 9-8
9.3.1 Hydrogeological Monitoring Network and Data Collection 9-8
9.3.2 Hydrogeological Setting and Aquifer Properties 9-12
9.3.3 Groundwater Occurrence and Flow 9-13
9.3.4 Groundwater – Permafrost Interaction 9-14
9.3.5 Groundwater – Surface Water Interaction 9-14
9.3.6 Groundwater Quality 9-14
9.4 PROJECT-SPECIFIC EFFECTS 9-17

9.4.1 Effects Characterization 9-17
9.4.2 Mitigation Measures 9-38
9.4.3 Residual Effects and Significance Determination 9-42
9.5 CUMULATIVE EFFECTS 9-46
9.5.1 Cumulative Effects Characterization 9-46
9.6 EFFECTS MONITORING 9-47
10 AQUATIC ECOSYSTEMS AND RESOURCES 10-1
10.1 ASSESSMENT APPROACH 10-1
10.1.1 Regional Setting 10-1
10.1.2 Selection of Subcomponents and Measurable Parameters 10-2
10.1.3 Criteria for Assessing Significance 10-6
10.2 ASSESSMENT BOUNDARIES 10-9
10.2.1 Local Study Area 10-9
10.2.2 Regional Study Area 10-9
10.2.3 Temporal Boundaries 10-11
10.3 EXISTING CONDITIONS 10-11
10.3.1 Traditional Knowledge 10-12
10.3.2 Fish and Aquatic Habitat 10-12
10.3.3 Benthic Invertebrates, Periphyton, and Aquatic Plants 10-21
10.4 PROJECT-SPECIFIC EFFECTS 10-23
10.4.1 Effects Characterization 10-23
10.4.2 Mitigation Measures 10-50
10.4.3 Residual Effects and Significance Determination 10-54
10.5 CUMULATIVE EFFECTS 10-59
10.5.1 Cumulative Effects Characterization 10-59
10.6 EFFECTS MONITORING 10-60
10.6.1 Aquatic Environmental Program 10-61
10.6.2 Benthic Invertebrate Monitoring Program 10-61
10.6.3 Sediment Monitoring Program 10-62
10.6.4 Fisheries Monitoring Program 10-63
10.6.5 Fish Tissue Sampling 10-63
10.6.6 Metal Mining Effluent Regulations - Environmental Effects Monitoring 10-63
11 TERRAIN AND SOILS 11-1
11.1 ASSESSMENT APPROACH 11-1
11.1.1 Selection of Subcomponents and Measurable Parameters 11-1
11.1.2 Criteria for Assessing Significance 11-2
11.2 ASSESSMENT BOUNDARIES 11-5
11.3 EXISTING CONDITIONS 11-7
11.3.1 Regional Setting 11-7
11.3.2 Glacial History 11-8

11.3.3 Surficial Geology 11-8
11.3.4 Permafrost Conditions 11-12
11.3.5 Terrain Analysis 11-12
11.3.6 Ground Conditions at Sites of Proposed Facilities 11-15
11.3.7 Soil Development 11-21
11.3.8 Metals in Soil 11-22
11.3.9 Soil Nutrients 11-22
11.4 PROJECT-SPECIFIC EFFECTS 11-22
11.4.1 Effects Characterization 11-22
11.4.2 Mitigation Measures 11-26
11.4.3 Residual Effects and Significance Determination 11-30
11.5 CUMULATIVE EFFECTS 11-32
11.5.1 Cumulative Effects Characterization 11-32
11.6 EFFECTS MONITORING 11-33
12 VEGETATION COVER AND COMPOSITION 12-1
12.1 ASSESSMENT APPROACH 12-1
12.1.1 Regional Setting 12-1
12.1.2 Selection of Subcomponents and Measurable Parameters 12-2
12.1.3 Criteria for Assessing Significance 12-5
12.2 ASSESSMENT BOUNDARIES 12-6
12.3 EXISTING CONDITIONS 12-9
12.3.1 Regional Context and Terrestrial Ecosystem Mapping 12-9
12.3.2 Wetland and Riparian Ecosystems 12-10
12.3.3 Rare Plants 12-11
12.3.4 Invasive Plants 12-12
12.3.5 Metals in Soils and Vegetation 12-15
12.3.6 Forest Productivity and Timber Volumes 12-17
12.4 PROJECT-SPECIFIC EFFECTS 12-18
12.4.1 Effects Characterization 12-18
12.4.2 Mitigation Measures 12-37
12.4.3 Residual Effects, Consequence, and Significance Determination 12-41
12.5 CUMULATIVE EFFECTS 12-45
12.5.1 Cumulative Effects Characterization 12-45
12.6 EFFECTS MONITORING 12-46
12.6.1 Soil and Plant Tissue Monitoring Program 12-46
13 WILDLIFE AND WILDLIFE HABITAT 13-1
13.1 ASSESSMENT APPROACH 13-1
13.1.1 Regional Setting 13-1
13.1.2 Selection of Subcomponents and Measurable Parameters 13-2
13.1.3 Criteria for Assessing Significance 13-10
13.2 ASSESSMENT BOUNDARIES 13-12

13.3 EXISTING CONDITIONS 13-16
13.3.1 Caribou 13-16
13.3.2 Moose 13-19
13.3.3 Grizzly Bear 13-21
13.3.4 Grey Wolf 13-23
13.3.5 Wolverine 13-23
13.3.6 Collared Pika 13-23
13.3.7 Bats 13-26
13.3.8 Cliff-Nesting Raptors 13-26
13.3.9 Passerines (Olive-sided Flycatcher) 13-27
13.3.10 Waterfowl 13-29
13.3.11 Bumble Bees 13-29
13.4 PROJECT-SPECIFIC EFFECTS 13-30
13.4.1 Effects Characterization 13-30
13.4.2 Mitigation Measures 13-76
13.4.3 Residual Effects, Consequence, and Significance Determination 13-90
13.5 CUMULATIVE EFFECTS 13-113
13.5.1 Cumulative Effects Characterization 13-113
13.5.2 Cumulative Effects Mitigation Measures 13-120
13.5.3 Cumulative Effects Significance Assessment 13-121
13.6 EFFECTS MONITORING 13-123
14 HERITAGE RESOURCES 14-1
14.1 ASSESSMENT APPROACH 14-1
14.1.1 Regional Setting 14-2
14.1.2 Selection of Subcomponents and Measurable Parameters 14-6
14.1.3 Criteria for Assessing Significance 14-7
14.2 ASSESSMENT BOUNDARIES 14-10
14.3 EXISTING CONDITIONS 14-13
14.4 PROJECT-SPECIFIC EFFECTS 14-15
14.4.1 Effects Characterization 14-15
14.4.2 Mitigation Measures 14-18
14.4.3 Residual Effects and Significance Determination 14-20
14.5 CUMULATIVE EFFECTS ASSESSMENT 14-20
14.6 EFFECTS MONITORING 14-20
15 SOCIO-ECONOMIC EFFECTS ASSESSMENT 15-1
15.1 ASSESSMENT APPROACH 15-1
15.1.1 Identified Interests and Selection of Valued Components 15-2
15.1.2 Criteria for Assessing Significance 15-5
15.2 ASSESSMENT BOUNDARIES 15-7
15.3 SOCIO-ECONOMIC SETTING 15-10
15.3.1 Project Area, Land and Resource Use 15-10

15.3.2 Yukon *15-11*
15.3.3 Ross River *15-16*
15.3.4 Watson Lake *15-19*
15.3.5 Faro *15-21*
15.3.6 Whitehorse *15-24*
15.4 PROJECT EFFECTS: INTERACTION MATRIX 15-26
15.5 PROJECT EFFECTS: ECONOMY AND SUSTAINABLE LIVELIHOOD 15-29
15.5.1 Traditional Economic Activities — Hunting, Fishing, Trapping, Food Gathering *15-29*
15.5.2 Economic Growth *15-31*
15.5.3 Diverse and Stable Economy — Discouraging Boom and Bust *15-37*
15.5.4 Employment *15-38*
15.5.5 Employability — Education, Training and Experience *15-45*
15.5.6 Broad Participation in Economic Development *15-47*
15.5.7 Business Opportunities *15-47*
15.5.8 Government Revenues *15-48*
15.5.9 Summary of Residual Effects *15-50*
15.6 PROJECT EFFECTS: HUMAN HEALTH AND WELL-BEING 15-53
15.6.1 Individual Health *15-54*
15.6.2 Family Stress *15-55*
15.6.3 Reducing Alcohol and Drug Abuse *15-56*
15.6.4 Gathering Traditional Medicine *15-57*
15.6.5 Public Health and Safety — Increased Traffic, Hazardous Material Transport, Waste Disposal *15-58*
15.6.6 Workplace Health and Safety *15-59*
15.6.7 Summary of Residual Effects *15-60*
15.7 PROJECT EFFECTS: COMMUNITY VITALITY 15-64
15.7.1 Population — Number of Children *15-64*
15.7.2 Healthy Local Business Sector — Reducing the Cost of Living *15-65*
15.7.3 Reducing Crime *15-66*
15.7.4 Reducing Discrimination and Racism *15-66*
15.7.5 Political Structure *15-68*
15.7.6 Community Events and Volunteerism *15-68*
15.7.7 Recreational Facilities and Opportunities *15-69*
15.7.8 Summary or Residual Effects *15-69*
15.8 PROJECT EFFECTS: INFRASTRUCTURE AND SERVICES 15-71
15.8.1 Housing and Land Availability *15-72*
15.8.2 Transportation Infrastructure — Roads and Airports *15-73*
15.8.3 Power and Communication Infrastructure *15-73*
15.8.4 Municipal Services — Water, Sewer, Solid Waste *15-74*
15.8.5 Healthcare Services *15-74*
15.8.6 Police Services *15-75*
15.8.7 Child Care *15-75*
15.8.8 Summary of Residual Effects *15-75*
15.9 PROJECT EFFECTS: CULTURE, HISTORY AND HERITAGE 15-76

15.9.1 Language Preservation and Restoration *15-77*
15.9.2 Traditional Knowledge and Practice: Preservation and Restoration *15-77*
15.9.3 Heritage and Historic Sites *15-78*
15.9.4 Summary of Residual Effects *15-78*
15.10 RESIDUAL EFFECTS AND SIGNIFICANCE DETERMINATION 15-78
15.10.1 Economy and Sustainable Livelihood *15-79*
15.10.2 Human Health and Well-being *15-84*
15.10.3 Community Vitality *15-87*
15.10.4 Infrastructure and Services *15-90*
15.10.5 Culture, History and Heritage *15-90*
15.10.6 Summary *15-90*
15.11 CUMULATIVE EFFECTS 15-92
15.11.1 Cumulative Effects Characterization *15-93*
15.11.2 Cumulative Effects Mitigation Measures *15-97*
15.11.3 Cumulative Effects Significance Assessment *15-98*
15.12 SOCIO-ECONOMIC EFFECTS MONITORING 15-98
16 EFFECTS OF THE ENVIRONMENT ON THE PROJECT 16-1
16.1 ASSESSMENT APPROACH 16-1
16.2 TERRAIN HAZARDS 16-3
16.2.1 Assessment Context and Effects Characterization *16-3*
16.2.2 Mitigation Measures *16-5*
16.2.3 Effects Assessment *16-6*
16.3 SEISMIC ACTIVITY 16-6
16.3.1 Assessment Context and Effects Characterization *16-6*
16.3.2 Mitigations Measures *16-9*
16.3.3 Effects Assessment *16-9*
16.4 EXTREME WEATHER EVENTS 16-9
16.4.1 Assessment Context and Effects Characterization *16-9*
16.4.2 Mitigation Measures *16-12*
16.4.3 Effects Assessment *16-13*
16.5 FOREST FIRE 16-14
16.5.1 Assessment Context and Effects Characterization *16-14*
16.5.2 Mitigation Measures *16-16*
16.5.3 Effects Assessment *16-16*
16.6 CLIMATE CHANGE 16-16
16.6.1 Assessment Context and Effects Characterization *16-16*
16.6.2 Mitigation Measures *16-23*
16.6.3 Assessment Summary *16-24*
16.7 SUMMARY OF POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT 16-24
17 MALFUNCTIONS, ACCIDENTS, AND UNPLANNED CLOSURE 17-1
17.1 METHODS 17-1

17.1.1 Scenario Identification *17-2*
17.1.2 Effects Analysis and Risk Level Determination *17-3*
17.1.3 Mitigation Measures *17-5*
17.2 MALFUNCTIONS ASSESSMENT 17-5
17.2.1 ABM Open Pit *17-5*
17.2.2 Underground *17-8*
17.2.3 Storage Facilities *17-9*
17.2.4 Process Plant Facility *17-14*
17.2.5 Site Water Management *17-16*
17.2.6 Power Generation Facility Failure (Power Outage) *17-21*
17.3 ACCIDENTS ASSESSMENT 17-22
17.3.1 Explosives Accident *17-22*
17.3.2 Spill or Leak During Transport *17-23*
17.3.3 Spill or Leak on Site *17-24*
17.3.4 Transportation Accident (On site and Off site) *17-25*
17.3.5 Project-related Fire *17-28*
17.4 UNPLANNED CLOSURE 17-28
17.5 SUMMARY 17-29
18 CONCEPTUAL MANAGEMENT PLANS 18-1
18.1 MANAGEMENT AND MONITORING FRAMEWORK 18-1
18.2 WASTE MANAGEMENT PLAN 18-3
18.2.1 Waste Management Regulatory and Management Context *18-3*
18.2.2 BMC Waste Management Strategy *18-3*
18.2.3 Waste Storage Locations and Disposal Methods *18-4*
18.2.4 Waste Management Mitigation Measures *18-5*
18.3 HAZARDOUS MATERIALS MANAGEMENT PLAN 18-6
18.3.1 Hazardous Materials Regulatory and Management Context *18-6*
18.3.2 BMC Hazardous Waste Management Strategy *18-7*
18.3.3 Hazardous Waste Management Mitigation Measures *18-7*
18.4 SURFACE WATER MANAGEMENT PLAN 18-11
18.4.1 Surface Water Regulatory and Management Context *18-12*
18.4.2 BMC Surface Water Management Strategy *18-15*
18.4.3 Surface Water Management Mitigation Measures *18-20*
18.5 SPILL CONTINGENCY PLAN 18-24
18.5.1 Spill Contingency Regulatory and Management Context *18-25*
18.5.2 BMC Spill Management Strategies *18-26*
18.5.3 Spill Prevention and Response Mitigation Measures *18-30*
18.6 SEDIMENT AND EROSION CONTROL PLAN 18-33
18.6.1 Sediment and Erosion Control Regulatory and Management Context *18-34*
18.6.2 BMC Management Strategies for Sediment and Erosion Control *18-35*
18.6.3 Sediment and Erosion Control Mitigation Measures *18-37*
18.7 WILDLIFE PROTECTION PLAN 18-39

18.7.1 Wildlife Protection Regulatory and Management Context 18-39
18.7.2 BMC Wildlife Management Policies and Strategies 18-40
18.7.3 Wildlife Protection Mitigation Measures 18-40
18.8 VEGETATION MANAGEMENT PLAN 18-49
18.8.1 Invasive Plant Management Plan 18-49
18.8.2 Rare Plant Chance Find Procedure 18-54
18.9 FISH AND AQUATIC HABITAT MANAGEMENT PLAN 18-55
18.9.1 Fish and Aquatic Habitat Regulatory Context 18-55
18.9.2 BMC Management Strategies for Fish and Aquatic Habitat 18-56
18.9.3 Fish and Aquatic Habitat Mitigation Measures 18-57
18.10 NOISE MANAGEMENT PLAN 18-60
18.10.1 Noise Regulatory and Management Context 18-60
18.10.2 BMC Management Strategies for Noise Reduction 18-60
18.10.3 Noise Reduction Mitigation Measures 18-61
18.11 AIR QUALITY MANAGEMENT PLAN 18-61
18.11.1 Air Quality Regulatory and Management Context 18-61
18.11.2 Dust Abatement and Air Quality Mitigation Measures 18-62
18.11.3 Operating Practices 18-63
18.12 TRAFFIC AND ACCESS MANAGEMENT PLAN 18-65
18.12.1 Traffic Management Regulatory and Management Context 18-66
18.12.2 BMC Traffic Management Policies 18-66
18.12.3 Traffic Management Mitigation Measures 18-67
18.12.4 Access Management 18-69
18.13 HERITAGE RESOURCES MANAGEMENT PLAN 18-75
18.13.1 Heritage Resources Regulatory and Management Context 18-75
18.13.2 BMC Heritage Resources Management 18-76
18.13.3 Heritage Resources Mitigation Measures 18-76
18.14 SOCIO-ECONOMIC EFFECTS MANAGEMENT PLAN 18-78
18.14.1 Employment Plan 18-78
18.14.2 Local Procurement Plan 18-79
18.14.3 Social and Cultural Well-being 18-80
18.14.4 Traditional Economic Activities 18-81
18.15 HEALTH, SAFETY AND EMERGENCY RESPONSE PLAN 18-82
18.15.1 Health, Safety and Emergency Response Management and Regulatory Context 18-82
18.15.2 BMC Health and Safety Management System 18-83
18.15.3 Emergency Response Mitigation Measures 18-85
19 SUMMARY AND CONCLUSIONS 19-1
19.1 SUMMARY OF CONSULTATION 19-1
19.2 SUMMARY OF RESIDUAL PROJECT AND CUMULATIVE EFFECTS 19-2
19.3 EFFECTS OF ENVIRONMENT ON THE PROJECT 19-14
19.4 MALFUNCTIONS, ACCIDENTS AND UNPLANNED CLOSURE 19-14

19.5 ENVIRONMENTAL MANAGEMENT AND MONITORING 19-16
19.6 CONCLUSIONS 19-17
20 ACKNOWLEDGEMENT 20-1
21 REFERENCES 21-1

LIST OF TABLES

Table 1-1: Environmental Context 1-12
Table 1-2: Socio-economic Context 1-14
Table 1-3: Applicable Legislation, Regulations and Permits 1-16
Table 1-4: Preliminary Schedule of Permitting Related Activities 1-19
Table 1-5: Table of Concordance - Executive Committee Submission 1-21
Table 2-1: Identification of Parties to be Consulted in BMC's Consultation and Engagement Plan 2-5
Table 2-2: Summary of Consultation with RRDC 2-15
Table 2-3: Views Presented by RRDC and BMC's Full and Fair Consideration 2-18
Table 2-4: Summary of Consultation with LFN 2-34
Table 2-5: Views Presented by LFN and BMC's Full and Fair Consideration 2-36
Table 2-6: Summary of Consultation with KDC 2-39
Table 2-7: Summary of Consultation with the Community of Ross River 2-41
Table 2-8: Views Presented by Ross River and BMC's Full and Fair Consideration 2-42
Table 2-9: Summary of Consultation with the Community of Watson Lake 2-46
Table 2-10: Views Presented by Watson Lake and BMC's Full and Fair Consideration 2-47
Table 2-11: Summary of Consultation with the Community of Faro 2-51
Table 2-12: Views Presented by Faro and BMC's Full and Fair Consideration 2-52
Table 2-13: Summary of Consultation with City of Whitehorse 2-57
Table 2-14: Views Presented by Whitehorse and BMC's Full and Fair Consideration 2-58
Table 4-1: Activities within the Scope of Assessment 4-3
Table 4-2: Activities Outside the Scope of Assessment 4-7
Table 4-3: Kudz Ze Kayah Project Phases and Schedule 4-7
Table 4-4: Kudz Ze Kayah Life of Project Schedule 4-9
Table 4-5: Construction Schedule for Kudz Ze Kayah Project 4-13
Table 4-6: ABM Deposit Lithological Units 4-18
Table 4-7: Summary of Drilling at the Project 4-22
Table 4-8: Project Mineral Resource Estimate 4-23
Table 4-9: Open Pit Mining Schedule 4-26
Table 4-10: Rock Slope Configuration Based on Kinematic Analysis 4-30
Table 4-11: Underground Mine Schedule 4-35
Table 4-12: Average UCS values, Grades and Terms for Ore and Waste Domains 4-40
Table 4-13: Summary of Point Load Test Results 4-40
Table 4-14: Preliminary Ground Support Recommendations for 5 m Span and 5 m Height 4-41
Table 4-15: Process Plant Reagents, Storage and Estimated Consumption 4-55

Table 4-16: Geodomain Characteristics 4-57
Table 4-17: Combined ARD Mining Waste Schedule 4-61
Table 4-18: Class A Facility Design Basis 4-62
Table 4-19: Class B Facility Design Basis 4-67
Table 4-20: Modelled Stability of Class B Storage Facility 4-68
Table 4-21: Class C Facility Design Basis 4-70
Table 4-22: Modelled Stability of Class C Storage Facility 4-71
Table 4-23: Temporary Overburden Stockpile Design Basis 4-73
Table 4-24: Modelled Stability of Temporary Overburden Stockpile 4-74
Table 4-25: Pond Design Specifications 4-79
Table 4-26: Results from Average Climatic Conditions in Year 10 (m^3/month) 4-88
Table 4-27: Results from 1 in 10 Year Dry Climatic Conditions in Year 10 (m^3/month) 4-89
Table 4-28: Results from 1 in 50 Year Wet Climatic Conditions in Year 10 (m^3/month) 4-90
Table 4-29: Summary of Fuel Storage and Distribution 4-95
Table 4-30: Waste Storage Locations and Disposal Method 4-98
Table 4-31: Design Specifications 4-103
Table 4-32: Proposed Haul Route 4-111
Table 4-33: Estimated Operations Traffic Volume 4-112
Table 4-34: Closure Schedule and Execution Strategy Summary 4-118
Table 4-35: Potential Hazardous Materials at Closure and Disposal Requirements 4-125
Table 4-36: Estimated Site Labour Requirements 4-130
Table 4-37: Summary of Alternatives for Tailings Disposal Methods and Locations 4-139
Table 4-38: Summary of Alternatives for Waste Rock Storage Facility Locations 4-140
Table 4-39: Summary of Alternatives for Waste Rock Management 4-141
Table 4-40: Summary of Alternatives for Airstrip Access 4-142
Table 4-41: Summary of Alternatives for Power Generation 4-143
Table 4-42: Summary of Alternatives for Concentrate Transport Route 4-145
Table 4-43: Summary of Alternatives for Mining Methods 4-147
Table 4-44: Examples of Passive Treatment in Northern Environments 4-150
Table 5-1: Environmental and Socio-economic Valued Components 5-4
Table 5-2: Interaction Matrix Used for Determining Potential Interactions for VCs 5-9
Table 5-3: Projects to be Considered in the Cumulative Effects Assessment for Environmental Valued Components 5-15
Table 5-4: Projects and Activities to be Considered in the Cumulative Effects Assessment for Socio-economic Valued Components 5-26
Table 6-1: Air Quality Subcomponents and Measurable Parameters 6-2
Table 6-2: Yukon Ambient Air Quality Standards (YAAQS) [i] 6-3
Table 6-3: Air Quality Significance Criteria Definition 6-4
Table 6-4: Proposed Study Areas for Air Quality 6-5
Table 6-5: Air Pollutants Ambient Concentrations, Whitehorse NAPS station 2012-2015 6-9
Table 6-6: Hourly Particulate Matter Baseline Ambient Concentration, Casino Mine Project 6-9
Table 6-7: Assumed Air Contaminants Baseline Concentrations 6-10
Table 6-8: National and Territorial GHG Emissions (in kilotonnes of CO_2 equivalent/year) 6-10

Table 6-9: Monthly Meteorological Data Summary, KZK, September 2015 to August 2016 6-12
Table 6-10: Wind Rose Summary Statistics 6-15
Table 6-11: Interaction Matrix for Air Quality 6-15
Table 6-12: Predicted TSP Concentrations.....6-17
Table 6-13: Predicted PM_{10} Concentrations 6-19
Table 6-14: Predicted $PM_{2.5}$ Concentrations.....6-19
Table 6-15: Predicted CO Concentrations.....6-22
Table 6-16: Predicted NO_2 Concentrations.....6-22
Table 6-17: Predicted SO_2 Concentrations.....6-25
Table 6-18: Average Annual Project GHG Emissions (tonnes of CO_2 equivalent).....6-27
Table 6-19: Identified Potential Project Effects for Air Quality 6-28
Table 6-20: Proposed Mitigation Measures for Air Quality.....6-28
Table 6-21: Project Effects Significance Assessment for Air Quality 6-31
Table 6-22: Cumulative Effects Screening for Air Quality.....6-34
Table 6-23: Proposed Cumulative Effects Mitigation Measures for Air Quality.....6-36
Table 6-24: Cumulative Effects Significance Assessment for Air Quality.....6-37
Table 7-1: Noise Subcomponents and Measurable Parameters.....7-1
Table 7-2: Noise Standards and Guidelines (Leq) 7-2
Table 7-3: Noise Significance Criteria Definition.....7-3
Table 7-4: Proposed Study Areas for Noise 7-4
Table 7-5: Interaction Matrix for Noise 7-7
Table 7-6: Predicted Blasting Noise Levels 7-15
Table 7-7: Identified Potential Project Effects for Noise 7-16
Table 7-8: Proposed Mitigation Measures for Noise 7-16
Table 7-9: Summary of Predicted Cumulative Noise Levels at the Camp Receptor (dBA) 7-17
Table 7-10: Summary of Predicted Increase in Noise Levels at the Camp Receptor (dBA) 7-17
Table 7-11: Project Effects Significance Assessment for Noise 7-20
Table 7-12: Cumulative Effects Screening for Noise 7-21
Table 8-1: Surface Water Quality and Quantity Subcomponents, – Measurable Parameters and Threshold Criteria 8-2
Table 8-2: Surface Water Significance Criteria Definition 8-4
Table 8-3: Study Areas for Surface Water Quality and Quantity.....8-6
Table 8-4: Hydrological Statistics for Various Catchments within the Project Area.....8-10
Table 8-5: Surface Water Quality and Hydrology Monitoring Locations.....8-13
Table 8-6: Summary of Water Quality Guideline Exceedances at each Sampling Site.....8-18
Table 8-7: Summary of Water Quality at Select Sampling Stations (mg/L) 8-19
Table 8-8: Interaction Matrix for Surface Water 8-21
Table 8-9: KZK Preliminary Water Quality Objectives Based on CCME and BCMoE Guidelines.....8-25
Table 8-10: KZK Site Specific Water Quality Objectives.....8-26
Table 8-11: Dewatering Rates for ABM Open Pit Overburden during Construction 8-55
Table 8-12: Percent Change in Discharge during 18-Month Construction Period for Mean Scenario....8-55
Table 8-13: Percent Change in Discharge during 18-Month Construction Period for 1/50 Wet Scenario.....8-56

Table 8-14: Percent Change in Discharge during 18-Month Construction Period for 1/10 Dry Scenario....8-56
Table 8-15: Groundwater Wells and Average Dissolved Groundwater Quality Data used in Water Quality Model (mg/L) 8-60
Table 8-16: South Diversion and South Creek Flows 8-62
Table 8-17: Northwest and Northeast Diversion Flows....8-63
Table 8-18: South Diversion Monthly Median Concentrations of Select Parameters (mg/L) 8-65
Table 8-19: ABM Open Pit and Underground Working Pumping Rates during Operations (year 10)....8-68
Table 8-20: Percent Change in Discharge during Year 10 of Operations for Mean Scenario 8-69
Table 8-21: Percent Change in Discharge during Year 10 of Operations for 1/50 Wet Scenario 8-69
Table 8-22: Percent Change in Discharge during Year 10 of Operations for 1/10 Dry Scenario 8-69
Table 8-23: Anticipated Explosives Use and Estimated Waste Production by Year 8-70
Table 8-24: Annual Nitrogen Loading to Storage Facilities, Nitrogen Load Stored in Storage Facility at Year's end and Nitrogen Load Released 8-71
Table 8-25: Pond Design Specifications 8-73
Table 8-26: Estimated Median Class A Storage Facility Drainage Chemistry (mg/L)....8-74
Table 8-27: Estimated Median Class B Storage Facility Drainage Chemistry (mg/L)....8-74
Table 8-28: Estimated Median Class C Storage Facility Drainage Chemistry (mg/L)....8-78
Table 8-29: Overburden Stockpile Concentrations used in Model....8-78
Table 8-30: Lower Water Management Pond Discharge Volumes to Geona and Finlayson Creeks (year 10) (m^3) 8-79
Table 8-31: Average and Maximum Total Concentrations of Modelled Parameters in the Lower Water Management Pond throughout Operations in each of the Precipitation Scenarios 8-82
Table 8-32: Percent Change in Discharge from Baseline during Active and Transition Closure for Mean Scenario....8-88
Table 8-33: Percent Change in Discharge from Baseline during Active and Transition Closure for 1/50 Wet Scenario....8-88
Table 8-34: Percent Change in Discharge from Baseline during Active and Transition Closure* for 1/10 Dry Scenario 8-89
Table 8-35: ABM Lake Formation and Water Budget 8-91
Table 8-36: ABM Lake Water Quality Results 8-92
Table 8-37: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for Mean Scenario 8-95
Table 8-38: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for 1/50 Wet Scenario 8-95
Table 8-39: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for 1/10 Dry Scenario....8-99
Table 8-40: Reduction Factors used in Modelling for the North Constructed Wetland during Transition Phase....8-101
Table 8-41 Reduction Factors Used in Modelling for the South Constructed Wetland in Post-Closure Phase....8-102
Table 8-42 Reduction Factors Used in Modelling for the North Constructed Wetland in Post-Closure Phase....8-102

Table 8-43: Identified Potential Project Effects for Surface Water 8-104
Table 8-44: Proposed Mitigation Measures for Surface Water 8-105
Table 8-45: Project Effects Significance Assessment for Surface Water Quantity 8-112
Table 8-46: Project Effects Significance Assessment for Surface Water Quality 8-115
Table 8-47: Cumulative Effects Screening for Surface Water Quantity 8-119
Table 8-48: Cumulative Effects Screening for Surface Water Quality 8-119
Table 8-49: Kudz Ze Kayah Surface Water Quality Monitoring Program Summary 8-124
Table 9-1: Groundwater Subcomponents and Measurable Parameters 9-2
Table 9-2: Groundwater Significance Criteria Definition 9-4
Table 9-3: Proposed Study Areas for Groundwater 9-5
Table 9-4: Monitoring Well Network at KZK 9-9
Table 9-5: Interaction Matrix for Groundwater 9-17
Table 9-6: Comparison of Groundwater Demand with Geona Creek and Finlayson Creek Baseline Low Flow 9-37
Table 9-7: Identified Potential Project Effects for Groundwater 9-38
Table 9-8: Proposed Mitigation Measures for Groundwater 9-39
Table 9-9: Project Effects Significance Assessment for Groundwater 9-45
Table 9-10: Cumulative Effects Screening for Groundwater 9-46
Table 9-11: Kudz Ze Kayah Groundwater Quality Monitoring Program Summary 9-49
Table 10-1: Aquatic Ecosystems and Resources Subcomponents and Measurable Parameters 10-3
Table 10-2: Fish and Aquatic Habitat Significance Criteria Definition 10-6
Table 10-3: Benthic Invertebrates, and Periphyton and Aquatic Plants Significance Criteria Definition 10-8
Table 10-4: Local and Regional Study Areas for Aquatic Ecosystems and Resources 10-9
Table 10-5: Interaction Matrix for Aquatic Ecosystems and Resources 10-24
Table 10-6: Low Flow Water Quality Predictions in Geona (KZ-37), Year -1 through Year 13 10-40
Table 10-7: Low Flow Water Quality Predictions in Finlayson Creek (KZ-15), Year -1 through Year 13 10-40
Table 10-8: Total Phosphorus Trigger Ranges for Canadian Lakes and Rivers 10-42
Table 10-9: Mean Monthly Water Temperature (°C) 10-47
Table 10-10: Identified Potential Project Effects for Aquatic Ecosystems and Resources 10-49
Table 10-11: Proposed Key Mitigation Measures for Aquatic Ecosystems and Resources 10-52
Table 10-12: Project Effects Significance Assessment for Aquatic Ecosystems and Resources 10-58
Table 10-13: Cumulative Effects Screening for Aquatic Ecosystems and Resources 10-60
Table 11-1: Terrain and Soils VC Subcomponents and Measurable Parameters 11-2
Table 11-2: Terrain Significance Criteria Definition 11-3
Table 11-3: Soils Significance Criteria Definition 11-4
Table 11-4: Study Areas for Terrain and Soils 11-7
Table 11-5: Interaction Matrix for the Terrain and Soil VC 11-23
Table 11-6: Identified Potential Project Effects for the Terrain and Soil VC 11-25
Table 11-7: Proposed Mitigation Measures for Terrain and Soil VC 11-29
Table 11-8: Project Effects Significance Assessment for Terrain and Soil VC 11-31
Table 11-9: Cumulative Effects Screening for Terrain and Soils VC 11-32
Table 12-1: Preliminary Vegetation Subcomponents and Measurable Parameters 12-3
Table 12-2: Vegetation Cover and Composition Significance Criteria Definition 12-5

Table 12-3: Proposed Study Areas for Vegetation Cover and Composition 12-6
Table 12-4: Rare Plants Identified in Yukon's Southeast Region and May Exist in the LSA 12-11
Table 12-5: Soil Metal Concentrations Compared to CCME Guidelines 12-15
Table 12-6: Vegetation Metal Concentrations from 1997, 2015, and 2016 Samples Compared to Uncontaminated Worldwide Background Ranges 12-17
Table 12-7: Interaction Matrix for Vegetation Cover and Composition 12-19
Table 12-8: Potential Project Effects on Vegetation Cover and Composition 12-21
Table 12-9: Summary of Predicted Ecosystems on Post-Mining Landforms by Main Project Facility 12-25
Table 12-10: Change in Wetland and Riparian Ecosystems within the LSA 12-30
Table 12-11: Change in Old Growth Forest within the LSA 12-32
Table 12-12: Identified Potential Project Effects for Vegetation Cover and Composition 12-37
Table 12-13: Proposed Mitigation Measures for Vegetation Cover and Composition 12-40
Table 12-14: Thresholds for Project Effects on Wetland and Riparian Ecosystems 12-41
Table 12-15: Thresholds for Project Effects on Old Growth Forest Ecosystems 12-42
Table 12-16: Project Effects Significance Assessment for Vegetation Cover and Composition 12-44
Table 12-17: Cumulative Effects Screening for Vegetation Cover and Composition 12-45
Table 12-18: Soil and Plant Monitoring Programs 12-49
Table 13-1: Rationale for Selection of Wildlife Subcomponents 13-2
Table 13-2: Species Known or Likely to Occur in the LSA, but not Selected as Subcomponents 13-5
Table 13-3: Wildlife Subcomponents, Measurable Parameters, Threshold Criteria, and Threshold Rationale 13-7
Table 13-4: Wildlife and Wildlife Habitat Significance Criteria Definition 13-11
Table 13-5: Study Areas for Wildlife and Wildlife Habitat 13-13
Table 13-6: Interaction Matrix for the Wildlife and Wildlife Habitat Subcomponents 13-31
Table 13-7: Summary of Finlayson Caribou Herd Rut Habitat Changes 13-38
Table 13-8: Summary of Finlayson Caribou Herd Post Calving Habitat Changes 13-39
Table 13-9: Summary of Caribou Habitat Loss 13-40
Table 13-10: Moose Post Rut Habitat Suitability Effects 13-48
Table 13-11: Moose Late Winter Habitat Suitability Effects 13-48
Table 13-12: Summary of Moose Habitat Loss 13-49
Table 13-13: Change in Grizzly Bear Denning Habitat Due to Project Effects in the RSA 13-54
Table 13-14: Change in Collared Pika Habitat Quality Due to Project Effects in the LSA 13-59
Table 13-15: Change in Little Brown Bat Habitat Quality Due to Project Effects in the LSA 13-63
Table 13-16: Change in Cliff-Nesting Raptor Habitat Quality Due to Project Effects in the LSA 13-67
Table 13-17: Change in Olive-sided Flycatcher Nesting Habitat Quality Due to Project Effects in the LSA 13-70
Table 13-18: Change in Waterfowl Habitat Quality Due to Project Effects in the LSA 13-73
Table 13-19: Identified Potential Project Effects for the Wildlife and Wildlife Habitat 13-75
Table 13-20: Proposed Mitigation Measures for Finlayson Caribou Herd 13-80
Table 13-21: Proposed Mitigation Measures for Moose 13-81
Table 13-22: Proposed Mitigation Measures for Grizzly Bear 13-84
Table 13-23: Proposed Mitigation Measures for Grey Wolf 13-85
Table 13-24: Proposed Mitigation Measures for Wolverine 13-85

Table 13-25: Proposed Mitigation Measures for Collared Pika 13-86
Table 13-26: Proposed Mitigation Measures for Bats 13-87
Table 13-27: Proposed Mitigation Measures for Cliff-Nesting Raptors 13-87
Table 13-28: Proposed Mitigation Measures for Olive-sided Flycatcher 13-89
Table 13-29: Proposed Mitigation Measures for Waterfowl 13-90
Table 13-30: Thresholds for Project Effects to Caribou Abundance 13-91
Table 13-31: Significance of Residual Effects – Finlayson Caribou Herd 13-92
Table 13-32: Thresholds for Project Effects to Moose Abundance 13-93
Table 13-33: Significance of Residual Effects – Moose 13-94
Table 13-34: Thresholds for Project Effects to Suitable Grizzly Bear Denning Habitat 13-95
Table 13-35: Significance of Residual Effects – Grizzly Bear 13-96
Table 13-36: Thresholds for Project Effects to Wolf Abundance 13-97
Table 13-37: Significance of Residual Effects – Wolf 13-98
Table 13-38: Thresholds for Project Effects to Wolverine Abundance 13-99
Table 13-39: Significance of Residual Effects – Wolverine 13-100
Table 13-40: Thresholds for Project Effects to Suitable Collared Pika Habitat 13-101
Table 13-41: Significance of Residual Effects – Collared Pika 13-102
Table 13-42: Thresholds for Project Effects to Suitable Bat Habitat 13-103
Table 13-43: Significance of Residual Effects – Bats 13-104
Table 13-44: Thresholds for Project Effects to Suitable Cliff-Nesting Raptor Habitat 13-105
Table 13-45: Significance of Residual Effects – Cliff-Nesting Raptors 13-106
Table 13-46: Thresholds for Project Effects to Suitable Olive-sided Flycatcher Nesting Habitat 13-107
Table 13-47: Significance of Residual Effects – Passerines (Olive-sided Flycatcher) 13-108
Table 13-48: Thresholds for Project Effects to Suitable Waterfowl Habitat 13-109
Table 13-49: Significance of Residual Effects – Waterfowl 13-110
Table 13-50: Significance of Residual Effects – Bumble Bee 13-112
Table 13-51: Residual Effects on Wildlife and Wildlife Habitat 13-113
Table 13-52: Cumulative Effects Screening for Wildlife and Wildlife Habitat 13-114
Table 13-53: Proposed Cumulative Effects Mitigation Measures for Wildlife and Wildlife Habitat 13-120
Table 13-54: Cumulative Effects Significance Assessment for Wildlife and Wildlife Habitat 13-122
Table 13-55: Wildlife Monitoring Programs 13-124
Table 14-1: Heritage Resources Subcomponents and Measurable Parameters 14-7
Table 14-2: Heritage Resources Significance of Impacts Criteria Definition 14-8
Table 14-3: Study Areas for Heritage Resources 14-10
Table 14-4: Interaction Matrix for Heritage Resources 14-16
Table 14-5: Identified Potential Project Effects for Heritage Resources 14-17
Table 14-6: Proposed Mitigation Measures for Heritage Resources 14-19
Table 15-1: Valued Components, Identified Interests and Indicators 15-3
Table 15-2: Socio-economic Significance Criteria Definition 15-6
Table 15-3: Proposed Study Areas for Socio-economic VCs 15-8
Table 15-4: Yukon Industries as Percentage of GDP, 2014 15-14
Table 15-5: Interaction Matrix for the Socio-economic Valued Components 15-27
Table 15-6: Project Construction Impact on Yukon GDP 15-32

Table 15-7: Estimated Project Gross Revenue, CAN $ millions 15-33
Table 15-8: Economic Effect on Yukon GDP: Project Operations 15-33
Table 15-9: Community Employment Assumption Ranges: Operations Phase, Full-Time-Equivalents 15-34
Table 15-10: Per Cent Growth in Community Aggregate Personal Incomes: Operations Phase 15-35
Table 15-11: Project Closure Costs 15-36
Table 15-12: Project Closure Costs: Effect on GDP 15-36
Table 15-13: Summary of Employment: Number of Personnel in the Operations Phase 15-40
Table 15-14: Summary of Open Pit Labour Requirements, Number of Personnel by Year 15-40
Table 15-15: Summary Underground Labour and Equipment Requirements by Year 15-42
Table 15-16: Processing Plant Labour Requirements 15-43
Table 15-17: Administration Labour Requirements 15-44
Table 15-18: Estimated Project Employee Income Taxes and Other Taxes 15-50
Table 15-19: Residual Effects on Economy and Sustainable Livelihood 15-51
Table 15-20: Expected Truck Traffic: Operations Phase 15-58
Table 15-21: Residual Effects on Human Health and Well-Being 15-61
Table 15-22: Residual Effects on Community Vitality 15-70
Table 15-23: Residual Effects on Infrastructure and Services 15-75
Table 15-24: Residual Effects on Culture, History and Heritage 15-78
Table 15-25: Project Effects Significance Assessment for Economy and Sustainable Livelihood 15-81
Table 15-26: Project Effects Significance Assessment for Human Health and Well-being 15-85
Table 15-27: Project Effects Significance Assessment for Community Vitality 15-88
Table 15-28: Project Effects Significance Assessment for Infrastructure and Services 15-91
Table 15-29: Residual Effects Considered in the Cumulative Effects Assessment 15-92
Table 15-30: Screening Table for Socio-economic Cumulative Effects 15-95
Table 15-31: Cumulative Effects Potential Interactions 15-96
Table 15-32: Socio-economic Cumulative Effects Mitigation Measures 15-97
Table 15-33: Cumulative Effects Significance Assessment 15-99
Table 16-1: Categories of Likelihood for Environmental Events 16-2
Table 16-2: Categories of Severity of Potential Effects of the Environment on the Project 16-2
Table 16-3: Seismic Annual Exceedance Probability, Return Period, and Peak Ground Acceleration 16-7
Table 16-4: Maximum 24-hour precipitation events at seven regional stations (period of record) 16-10
Table 16-5: Design 24-hour Precipitation Events 16-10
Table 16-6: Likelihood of Flooding from Infrastructure 16-13
Table 16-7: Global-scale assessment of recent observed changes, human contribution to the changes, and projected further changes for the early (2016–2035) and late (2081–2100) 21st century 16-17
Table 16-8: Projected Change in Global Mean Surface Air Temperature for 2046-2065 Relative to the Reference Period of 1986-2005 (°C) 16-18
Table 16-9: Examples of Key Findings of Yukon Climate Change 16-23
Table 17-1: Likelihood and Consequence Classifications 17-3
Table 17-2 Risk Level Classifications 17-4
Table 17-3 Valued Components with Potential Interaction from Accidents and Malfunctions 17-4
Table 17-4: Estimated Operations Traffic and Load Volumes 17-24
Table 17-5: Accidents, Malfunctions and Unplanned Closure Assessment Summary 17-30

Table 18-1: Environmental Management Plan Framework....18-2
Table 18-2: Waste Storage Location and Disposal Method....18-4
Table 18-3: Summary of Reagents....18-9
Table 18-4: Estimated Annual Precipitation and Evaporation Distribution for Kudz Ze Kayah....18-13
Table 18-5: Annual Operations Water Volumes (year 10)....18-18
Table 18-6: Pond Design Specifications....18-23
Table 18-7: Reportable Spill Thresholds....18-27
Table 18-8: Sensitive Seasonal Periods for Focal Wildlife and Mitigations....18-43
Table 18-9: Decision Matrix for Managing Problem Wildlife....18-48
Table 18-10: Yukon Invasive Plant Species....18-50
Table 19-1: Project and Cumulative Effects Summary....19-3
Table 19-2: Conceptual Management Plans....19-16

LIST OF FIGURES

Figure 1-1: Location of Kudz Ze Kayah Project....1-2
Figure 1-2: Project Overview....1-3
Figure 1-3: Project Mine Site Layout....1-5
Figure 1-4: Project Proposal Organization....1-20
Figure 2-1: Project Location, Communities and Kaska First Nations Traditional Territory....2-7
Figure 3-1: Proximity to Mining Projects in Southeast Yukon....3-2
Figure 3-2: Land Tenure Map....3-3
Figure 3-3: Yukon Land Use Planning Regions....3-5
Figure 4-1: Project Location....4-2
Figure 4-2: Project Mine Site Layout (Year 1)....4-12
Figure 4-3: Project Mine Site Layout (Year 10)....4-14
Figure 4-4: Project Layout in Post-Closure Period (Year 27+)....4-16
Figure 4-5: Plan View of ABM Deposit, Selected Drill Intercepts, and Cross Section....4-21
Figure 4-6: Final ABM Open Pit....4-27
Figure 4-7: Haul Road Design....4-33
Figure 4-8: Isometric Views of Main Access and Ventilation Ramps (Looking East)....4-36
Figure 4-9: Cut and Fill Extraction Sequence....4-37
Figure 4-10: General Long Hole Stoping with Fill Sequence....4-38
Figure 4-11: Isometric View of Underground Stope Distribution (Looking West)....4-39
Figure 4-12: Ventilation Network Schematic (Looking Southwest)....4-42
Figure 4-13: Process Flowsheet....4-47
Figure 4-14: Process Plant Facility Layout....4-54
Figure 4-15: Cross Section of Class A Storage Facility....4-63
Figure 4-16: Cross Section of Class A Storage Facility Progressively Reclaimed....4-66
Figure 4-17: Geona Creek Subcatchments....4-77
Figure 4-18: Operational Water Management Schematic....4-84
Figure 4-19: Access Road Alignment and Potential Borrow Sources....4-104

Figure 4-20: Finlayson Airstrip Extension....4-108
Figure 4-21: Proposed Finlayson Airstrip Extension....4-109
Figure 4-22: General Arrangement in the Active Closure Period (Year 13)....4-116
Figure 4-23: Project Layout in Transitional Closure Period (Year 20)....4-117
Figure 4-24: Tailings Storage Facility Alternatives....4-137
Figure 5-1: Projects to be Considered in the Environmental Cumulative Effects Assessment....5-25
Figure 5-2: Projects to be Considered in the Socio-economic Cumulative Effects Assessment....5-28
Figure 6-1: Mine Site Layout, Assessment Boundaries and Receptor....6-7
Figure 6-2: Wind Rose, KZK, September 2015 to August 2016....6-14
Figure 6-3: Predicted Maximum 24-hr TSP Concentrations....6-18
Figure 6-4: Predicted Maximum 24-hr PM_{10} Concentrations....6-20
Figure 6-5: Predicted Maximum 24-hr $PM_{2.5}$ Concentrations....6-21
Figure 6-6: Predicted Maximum 1-hr CO Concentrations....6-23
Figure 6-7: Predicted Maximum 1-hr NO_2 Concentrations....6-24
Figure 6-8: Predicted Maximum 1-hr SO_2 Concentrations....6-26
Figure 7-1: Noise Local and Regional Study Areas....7-5
Figure 7-2: Construction Phase Predicted Noise Levels (with Design Mitigations)....7-10
Figure 7-3: Operation Phase Predicted Noise Levels (with Design Mitigations)....7-12
Figure 7-4: Operation Phase Predicted Daytime Noise Levels (with Design Mitigations) – Extended Domain....7-13
Figure 7-5: Closure Phase Predicted Daytime Noise Levels (with Design Mitigations)....7-14
Figure 8-1: Local and Regional Study Area for Surface Water....8-7
Figure 8-2: Surface Water Quality and Hydrometric Monitoring Catchments....8-9
Figure 8-3: Surface Water Quality and Hydrology Monitoring Locations....8-11
Figure 8-4: Mean Monthly Runoff Distribution Measured at Kudz Ze Kayah Versus the Regional Distribution Versus the Combined Distribution....8-12
Figure 8-5: Monitoring Locations at Geona Creek (KZ-9) and South Creek (KZ-13)....8-14
Figure 8-6: Monitoring Locations at Upper Finlayson Creek (KZ-15) and Lower Finlayson Creek (KZ-26)....8-15
Figure 8-7: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-37 in Geona Creek in the Mean Precipitation Scenario....8-30
Figure 8-8: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-37 in Geona Creek in the Mean Precipitation Scenario....8-31
Figure 8-9: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-37 in Geona Creek in the Mean Precipitation Scenario....8-32
Figure 8-10: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario....8-33
Figure 8-11: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario....8-34
Figure 8-12: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario....8-35
Figure 8-13: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario....8-36

Figure 8-14: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario 8-37
Figure 8-15: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario 8-38
Figure 8-16: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario 8-39
Figure 8-17: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario 8-40
Figure 8-18: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario 8-41
Figure 8-19: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario 8-42
Figure 8-20: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario 8-43
Figure 8-21: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario 8-44
Figure 8-22: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario 8-45
Figure 8-23: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario 8-46
Figure 8-24: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario 8-47
Figure 8-25: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-13 in South Creek in the Mean Precipitation Scenario 8-48
Figure 8-26: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-13 in South Creek in the Mean Precipitation Scenario 8-49
Figure 8-27: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-13 in South Creek in the Mean Precipitation Scenario 8-50
Figure 8-28: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-13 in South Creek in the 1/10 Dry Year Scenario 8-51
Figure 8-29: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-13 in South Creek in the 1/10 Dry Year Scenario 8-52
Figure 8-30: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-13 in South Creek in the 1/10 Dry Year Scenario 8-53
Figure 8-31: Modelled Baseline and Construction Phase Discharge Rates in Geona Creek (KZ-37) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-57
Figure 8-32: Modelled Baseline and Construction Phase Discharge Rates in Upper Finlayson Creek (KZ-15) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-58
Figure 8-33: Modelled Baseline and Construction Phase Discharge Rates in Lower Finlayson Creek (KZ-26) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-58
Figure 8-34: Modelled Baseline and Construction Phase Discharge Rates in South Creek (KZ-13) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-59
Figure 8-35: Groundwater Monitoring Wells in ABM Open Pit Vicinity 8-61

Figure 8-36: Construction Water Management Schematic 8-66
Figure 8-37: Operations Water Management Schematic 8-77
Figure 8-38: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the Mean Precipitation Scenario 8-83
Figure 8-39: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the 1/10 Dry Year Precipitation Scenario 8-84
Figure 8-40: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the 1/10 Wet Year Precipitation Scenario 8-85
Figure 8-41: ABM Lake Mass Transfer Flowpaths during Closure Phases 8-86
Figure 8-42: ABM lake Storage-Elevation and Area-Elevation Curves 8-87
Figure 8-43: Active Closure Water Management Schematic 8-96
Figure 8-44: Transition Closure Water Management Schematic 8-97
Figure 8-45: Post-Closure Water Management Schematic 8-98
Figure 8-46: Modelled Post Closure and Baseline Discharge Rates in Geona Creek (at KZ-37) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-99
Figure 8-47: Modelled Post Closure and Baseline Discharge Rates in Upper Finlayson Creek (KZ-15) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-100
Figure 8-48: Modelled Post Closure and Baseline Discharge Rates in Lower Finlayson Creek (KZ-26) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-100
Figure 8-49: Modelled Post Closure and Baseline Discharge Rates in South Creek (KZ-13) Under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-101
Figure 8-50: Existing and Proposed Surface Water Quality Monitoring Locations 8-125
Figure 8-51: Existing and Proposed Surface Water Quality Monitoring Locations within Mine Site 8-126
Figure 9-1: Groundwater Local and Regional Study Areas 9-7
Figure 9-2: Current Groundwater Monitoring Well Locations 9-11
Figure 9-3: Estimated Total Flux Rates for Dewatering of the Mine Workings 9-21
Figure 9-4: Estimated Flux Rates for Dewatering of the Mine Workings by Source of Water 9-22
Figure 9-5: Drawdown Contours for the Bedrock Aquifer during Year 9 of Mining 9-24
Figure 9-6: Drawdown Contours for Shallow Bedrock 5 Years Post Mining 9-25
Figure 9-7: Drawdown Contours for Shallow Bedrock 30 Years Post Mining 9-26
Figure 9-8: ABM Lake Formation and Water Budget (positive flow rates indicate inflow, negative flow rates indicate outflow from the ABM lake) 9-27
Figure 9-9: Predicted Flow in Geona Creek, South Creek, and Finlayson Creek during Operations, Closure, and Post Closure Relative to Baseline Conditions 9-29
Figure 9-10: Post-closure Waste Rock Particle Tracking 9-33
Figure 9-11: Estimated Drawdown of Camp and Process Plant Supply Wells 9-36
Figure 9-12: Proposed Groundwater Monitoring Sampling Locations 9-50
Figure 10-1: Local and Regional Study Areas for Aquatic Ecosystems and Resources 10-10
Figure 10-2: Historical Aquatic Resource Monitoring Stations 10-13
Figure 10-3: 2015/2016 Fisheries Monitoring Locations 10-14

Figure 10-4: 2015/2016 Aquatic Resource Sampling Locations 10-15
Figure 10-5: Proposed Project Site Layout (Year 10) 10-29
Figure 10-6: Regional Catchments and Water Quality and Hydrometric Monitoring Stations 10-30
Figure 10-7: Regional Catchments and Water Quality and Hydrometric Stations 10-33
Figure 10-8: Predicted percent change in runoff relative to baseline in Geona Creek (KZ-37) 10-35
Figure 10-9: Predicted percent change in runoff relative to baseline in South Creek (KZ-13) 10-37
Figure 10-10: Predicted percent change in runoff relative to baseline in Finlayson Creek (KZ-15) throughout Project phases under three precipitation scenarios 10-38
Figure 10-11: Predicted percent change in runoff relative to baseline in Finlayson Creek (KZ-26) 10-39
Figure 11-1: Terrain and Soil Study Area 11-6
Figure 11-2: Surficial Geology Project Area 11-10
Figure 11-3: Surficial Geology along Tote Road/Proposed Access Road and Finlayson Lake Airstrip 11-11
Figure 11-4: Slope Angle Map 11-13
Figure 11-5: Terrain Analysis 11-14
Figure 11-6: Site Investigations and Approximate Permafrost Boundary Sheet 1 of 2 11-17
Figure 11-7: Site Investigations and Approximate Permafrost Boundary Sheet 2 of 2 11-18
Figure 12-1: Regional and Local Study Areas for Vegetation Cover and Composition 12-8
Figure 12-2: Rare Plant Survey Transects and Plots 12-13
Figure 12-3: Locations of Observed Invasive Plant Species 12-14
Figure 12-4: Predicted Ecosystems on Post-Mining 12-28
Figure 12-5: Riparian and Wetland Interaction with Project Footprint 12-31
Figure 12-6: Old Growth Forest Interaction with the Project Footprint 12-33
Figure 12-7: Extent of Dust Deposition During Operations 12-36
Figure 12-8: Soil Monitoring Sites 12-48
Figure 13-1: Regional and Local Study Areas for Caribou 13-14
Figure 13-2: Regional and Local Study Areas for Wildlife 13-15
Figure 13-3: Finlayson Caribou Herd Seasonal Distribution and Habitat Ranges 13-18
Figure 13-4: Moose Observations and Wildlife Key Areas 13-20
Figure 13-5: Grizzly Bear Observations 13-22
Figure 13-6: Small Mammal Survey Sites and Bat Detectors 13-25
Figure 13-7: Bird Site Survey Locations 2015-2016 13-28
Figure 13-8: Finlayson Caribou Herd Rut Habitat Suitability: Home Range and Regional Study Area 13-41
Figure 13-9: Finlayson Caribou Herd Rut Habitat Suitability: Local Study Area and Project Mine Footprint 13-42
Figure 13-10: Finlayson Caribou Herd Post Calving Habitat Suitability Home Range and Study Area 13-43
Figure 13-11: Finlayson Caribou Herd Post Calving Habitat Suitability Local Study Area and Proposed Mine Footprint 13-44
Figure 13-12: Moose Post Rut Habitat Suitability 13-50
Figure 13-13: Moose Late Winter Habitat Suitability 13-51
Figure 13-14: Grizzly Denning Habitat Suitability 13-55
Figure 13-15: Collared Pika Habitat Suitability within the Local Study Area 13-61
Figure 13-16: Little Brown Bat Habitat Suitability within the Local Study Area 13-65
Figure 13-17: Cliff-Nesting Raptor Nesting Habitat Suitability within the Local Study Area 13-68

Figure 13-18: Olive-sided Flycatcher Habitat Suitability within the Local Study Area....13-71
Figure 13-19: Waterfowl Habitat Suitability within the Local Study Area....13-74
Figure 13-20: Wildlife Cumulative Effects Assessment Areas and Project Activities....13-119
Figure 14-1: Heritage Resources Local Study Area....14-12
Figure 15-1: Socio-economic Study Area and Local Communities....15-9
Figure 15-2: Project and Activities to be Considered in the Socio-economic Cumulative Effects Assessment....15-94
Figure 16-1: Terrain Hazards....16-4
Figure 16-2: Regional Tectonic and Historic Seismicity....16-8
Figure 16-3: Fire History in Proximity of Kudz Ze Kayah Project Area....16-15
Figure 16-4: Observed Historical and Model Projected Mean Annual Temperature, RCP4.5 Scenario 16-19
Figure 16-5: Observed Historical and Model Projected Mean Annual Temperature, RCP8.5 Scenario 16-20
Figure 16-6: Observed Historical and Model Projected Mean Annual Precipitation, RCP4.5 Scenario 16-21
Figure 16-7: Observed Historical and Model Projected Mean Annual Precipitation, RCP8.5 Scenario 16-22
Figure 18-1: Water Management Catchments....18-14
Figure 18-2: Operations Water Management Schematic....18-17
Figure 18-3: Example of General Spill Response Procedure....18-29
Figure 18-4: Example of Emergency Spill Response Procedure....18-30
Figure 18-5: Location of Invasive Plant Species in KZK LSA....18-52
Figure 18-6: Access Road Potential Wildlife Crossings....18-70
Figure 18-7: Wildlife and Road Operation Decision Matrix....18-71
Figure 18-8: Key Wildlife Areas....18-74
Figure 18-9: Key Areas of the BMC Health and Safety System....18-83
Figure 18-10: Medical Evacuation Flowchart....18-88

LIST OF PHOTOGRAPHS

Photo 12-1: Ecosite 01-FEsWiFm (Subalpine fir-scrub birch-willow-feather moss)....12-22
Photo 12-2: Ecosite 11-EsLi (Scrub birch-lichen)....12-22
Photo 12-3: Ecosite 23-EsWiEmni (Scrub birch-willow-crowberry)....12-23
Photo 12-4: Ecosite 35-WiEqFbGr (Willow-horsetail-forbs-grass)....12-23
Photo 12-5: Ecosite 42-CaaqSp (Water sedge)....12-24
Photo 12-6: Wetland Ecosystem (Wetland B south of ABM open pit)....12-24

LIST OF APPENDICES

APPENDIX A CORPORATE POLICIES

APPENDIX A-1 COMPANY MANAGEMENT & OPERATING POLICIES AND PROCEDURES

APPENDIX A-2 COMMUNITY RELATIONS POLICY

APPENDIX A-3 EMPLOYMENT AND ANTI-DISCRIMINATION POLICY

APPENDIX A-4 ENVIRONMENT POLICY
APPENDIX A-5 FITNESS FOR WORK POLICY
APPENDIX A-6 OCCUPATIONAL HEALTH AND SAFETY POLICY
APPENDIX A-7 PERSONNEL MANAGEMENT POLICY
APPENDIX A-8 NO FIREARMS POLICY
APPENDIX A-9 NO FEEDING OF ANIMALS POLICY
APPENDIX A-10 HERITAGE POLICY
APPENDIX A-11 NO RECREATIONAL USE OF ALL-TERRAIN VEHICLES AND SNOWMOBILES POLICY

APPENDIX B CONSULTATION AND ENGAGEMENT

APPENDIX B-1 SUMMARY OF CONSULTATION DURING INITIAL ENVIRONMENTAL EVALUATION AND TYPE A WATER LICENCE APPLICATION
APPENDIX B-2 BMC CONSULTATION AND ENGAGEMENT PLAN
APPENDIX B-3 CONSULTATION RECORD RRDC
APPENDIX B-4 CONSULTATION RECORD LFN
APPENDIX B-5 CONSULTATION RECORD KDC
APPENDIX B-6 CONSULTATION RECORD RESIDENTS OF COMMUNITIES (JANUARY 2016 MEETINGS)
APPENDIX B-7 CONSULTATION RECORD RESIDENTS OF COMMUNITIES (DECEMBER 2016 MEETINGS)
APPENDIX B-8 CONSULTATION MATERIALS SENT TO ALL STAKEHOLDERS AND INTERESTED PARTIES

APPENDIX C PROJECT DESCRIPTION

APPENDIX C-1 CONCEPTUAL CONSTRUCTION PLAN
APPENDIX C-2 MILL SITE AREA GEOTECHNICAL CHARACTERIZATION
APPENDIX C-3 KUDZ ZE KAYAH PREFEASIBILITY STUDY – GEOTECHNICAL SITE CHARACTERIZATION SUMMARY
APPENDIX C-4 KUDZ ZE KAYAH PREFEASIBILITY STUDY – CLASS A STORAGE FACILITY STABILITY ASSESSMENT
APPENDIX C-5 SITE MANAGEMENT DRAWINGS AND FEATURES
APPENDIX C-6 KUDZ ZE KAYAH PREFEASIBILITY STUDY – UPDATED DESIGN OF CLASS B AND CLASS C STORAGE FACILITIES AND OVERBURDEN STOCKPILE
APPENDIX C-7 WATER BALANCE MODEL REPORT
APPENDIX C-8 PROPOSED RIGHT OF WAY FOR ACCESS ROAD AND TYPICAL CROSS SECTION FOR ROAD UPGRADE

APPENDIX D SURFACE WATER AND GROUNDWATER, MODELLING AND MANAGEMENT

APPENDIX D-1 KUDZ ZE KAYAH SURFACE WATER QUALITY BASELINE REPORT
APPENDIX D-2 HYDROMETEOROLOGY BASELINE REPORT
APPENDIX D-3 HYDROGEOLOGY BASELINE REPORT
APPENDIX D-4 HYDROGEOLOGICAL MODEL REPORT
APPENDIX D-5 ACID ROCK DRAINAGE AND METAL LEACHING CHARACTERISTICS KUDZ ZE KAYAH PROJECT
APPENDIX D-6 RECEIVING ENVIRONMENT WATER BALANCE REPORT
APPENDIX D-7 WATER QUALITY MODEL KUDZ ZE KAYAH PROJECT
APPENDIX D-8 PRELIMINARY WATER QUALITY OBJECTIVES REPORT

APPENDIX E ENVIRONMENTAL REPORTS

APPENDIX E-1 AIR DISPERSION MODEL REPORT

APPENDIX E-2 NOISE PREDICTION MODELLING REPORT

APPENDIX E-3 AQUATIC ECOSYSTEMS AND RESOURCES BASELINE REPORT

APPENDIX E-4 KUDZ ZE KAYAH PROJECT: PRELIMINARY FISHERIES OFFSETTING PLAN

APPENDIX E-5 KUDZ ZE KAYAH PROJECT – FINDINGS OF TERRAIN ANALYSIS

APPENDIX E-6 VEGETATION BASELINE REPORT

APPENDIX E-7 SITE ASSESSMENT FOR TREATMENT WETLANDS AT KUDZ ZE KAYAH SITE

APPENDIX E-8 WILDLIFE BASELINE REPORT

APPENDIX F HERITAGE AND TRADITIONAL KNOWLEDGE

APPENDIX F-1 HERITAGE RESOURCES IMPACT ASSESSMENT REPORT

APPENDIX F-2 HERITAGE RESOURCES MANAGEMENT PLAN FOR THE KUDZ ZE KAYAH MINE PROJECT

APPENDIX F-3 KASKA ETHNOGRAPHIC OVERVIEW OF THE KUDZ ZE KAYAH PROJECT

APPENDIX G SOCIO-ECONOMIC BASELINE

APPENDIX G-1 SOCIO-ECONOMIC BASELINE REPORT

APPENDIX H RECLAMATION AND CLOSURE

APPENDIX H-1 CONCEPTUAL RECLAMATION AND CLOSURE PLAN

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

1 INTRODUCTION 1-1

1.1 PROJECT OVERVIEW 1-1
1.2 PROJECT PURPOSE AND RATIONALE 1-6
1.3 PROPONENT INFORMATION 1-6
1.3.1 BMC Overview and Purpose 1-6
1.3.2 Corporate Address and Website 1-7
1.3.3 Directors and Management 1-7
1.3.4 Principal Contact Person for Purposes of Project Proposal 1-8
1.3.5 Corporate Policies 1-8
1.4 PROJECT BACKGROUND 1-10
1.4.1 Project History 1-10
1.4.2 Existing Authorizations and Approvals 1-12
1.5 ENVIRONMENTAL CONTEXT 1-12
1.6 SOCIO-ECONOMIC CONTEXT 1-13
1.7 *YESAA* TRIGGERS AND REQUIRED AUTHORIZATIONS 1-14
1.7.1 YESAA Requirements 1-14
1.7.2 Applicable Legislation, Regulations and Permits 1-15
1.8 ORGANIZATION AND LAYOUT OF THE PROJECT PROPOSAL 1-19

LIST OF TABLES

Table 1-1: Environmental Context 1-12
Table 1-2: Socio-economic Context 1-14
Table 1-3: Applicable Legislation, Regulations and Permits 1-16
Table 1-4: Preliminary Schedule of Permitting Related Activities 1-19
Table 1-5: Table of Concordance - Executive Committee Submission 1-21

LIST OF FIGURES

Figure 1-1: Location of Kudz Ze Kayah Project 1-2
Figure 1-2: Project Overview 1-3
Figure 1-3: Project Mine Site Layout 1-5
Figure 1-4: Project Proposal Organization 1-20

1 INTRODUCTION

BMC Minerals (No.1) Ltd. (BMC) proposes the development of the Kudz Ze Kayah (KZK) Project (the Project) in southeast Yukon and within the Kaska traditional territory. The Project is a proposed open pit/underground copper, lead, and zinc mine located approximately 115 km southeast of Ross River, Yukon. The Project location is shown on Figure 1-1 and Figure 1-2.

BMC purchased the Project from Teck Resources Ltd. (Teck) in January 2015. Since that time, BMC has actively engaged in a program of assessing historical work completed on the Project, resource drilling, economic assessment, baseline environmental studies, and First Nations and community engagement.

This submission and its appendices (the Project Proposal) have been developed to meet the requirements for a screening pursuant to the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) by the Yukon Environmental and Socio-economic Assessment Board (YESAB) Executive Committee in Whitehorse, Yukon. Section 1.8 provides the organization and layout of the Project Proposal.

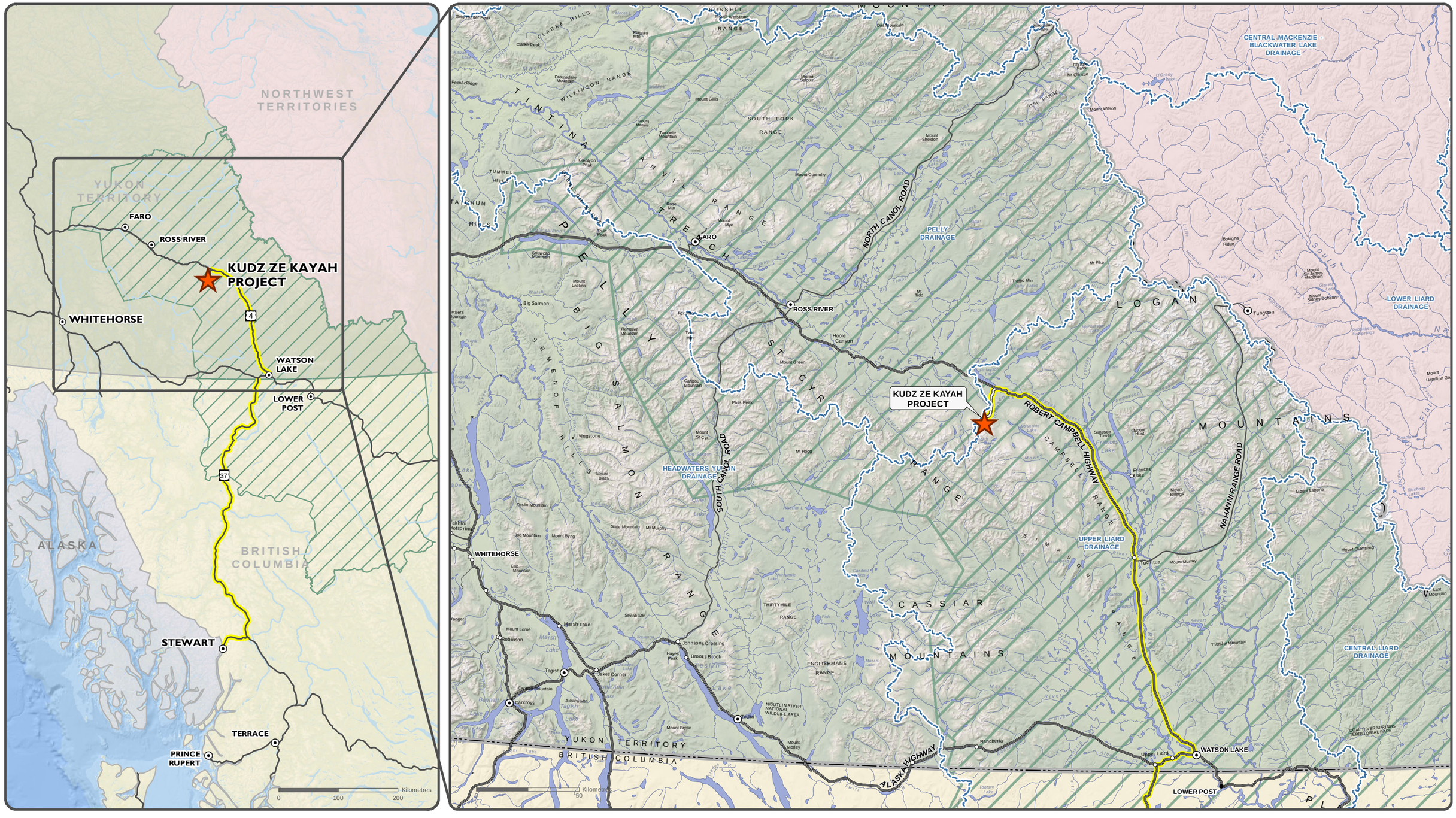
The information in this submission supersedes all information presented in the report entitled "Kudz Ze Kayah Project Overview", which was previously submitted by BMC to YESAB, government agencies, boards, Kaska Nation and other interested parties.

1.1 PROJECT OVERVIEW

The Project encompasses the A.B. Mawer (ABM) Deposit (named in recognition of geologist A.B. Mawer), of which there are two zones; the ABM Zone and the Krakatoa Zone. The ABM Deposit is a polymetallic volcanogenic massive sulphide (VMS) deposit containing economic concentrations of copper, lead, zinc, gold, and silver. Mining is planned to be conducted via both open pit and underground mining methods, with ore processed into separate copper, lead, and zinc concentrates via sequential flotation through a nominal 2 million tonnes per year (Mtpa) processing plant. Dry stack tailings will be deposited in the Class A Storage Facility on the western slope of the Geona Creek Valley while waste rock will be stored according to acid generation and metal leaching potential. Strongly acid generating material will be co-disposed within tailings or alternatively stored in mined out areas of the open pit and underground workings. Other waste rock material will be placed on the surface in managed facilities.

The mine is planned to operate for ten years, producing up to 180,000 tonne (t) zinc, 60,000 t copper, and 35,000 t lead concentrates annually. Concentrate will be transported to the port of Stewart for sale to market via Highway 4 south (Robert Campbell Highway) to Watson Lake and Highway 37 south to Stewart, British Columbia (a distance of 911 km), as shown in Figure 1-1.

The scope of the Project includes developing on site and off site surface infrastructure to support open pit and underground mining activities required to extract mineral reserves from the ABM Deposit. The Project will have a nominal 5,500 tonne per day (tpd) throughput over an approximate 10-year mine life. The general Project overview is shown in Figure 1-2.



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AEG

Kudz Ze Kayah Project

Proposed Concentrate Transport Route

Kaska Dena First Nation (Ross River Dena Council and Liard) Traditional Territory

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 1-1
LOCATION OF KUDZ ZE KAYAH PROJECT

MARCH 2017

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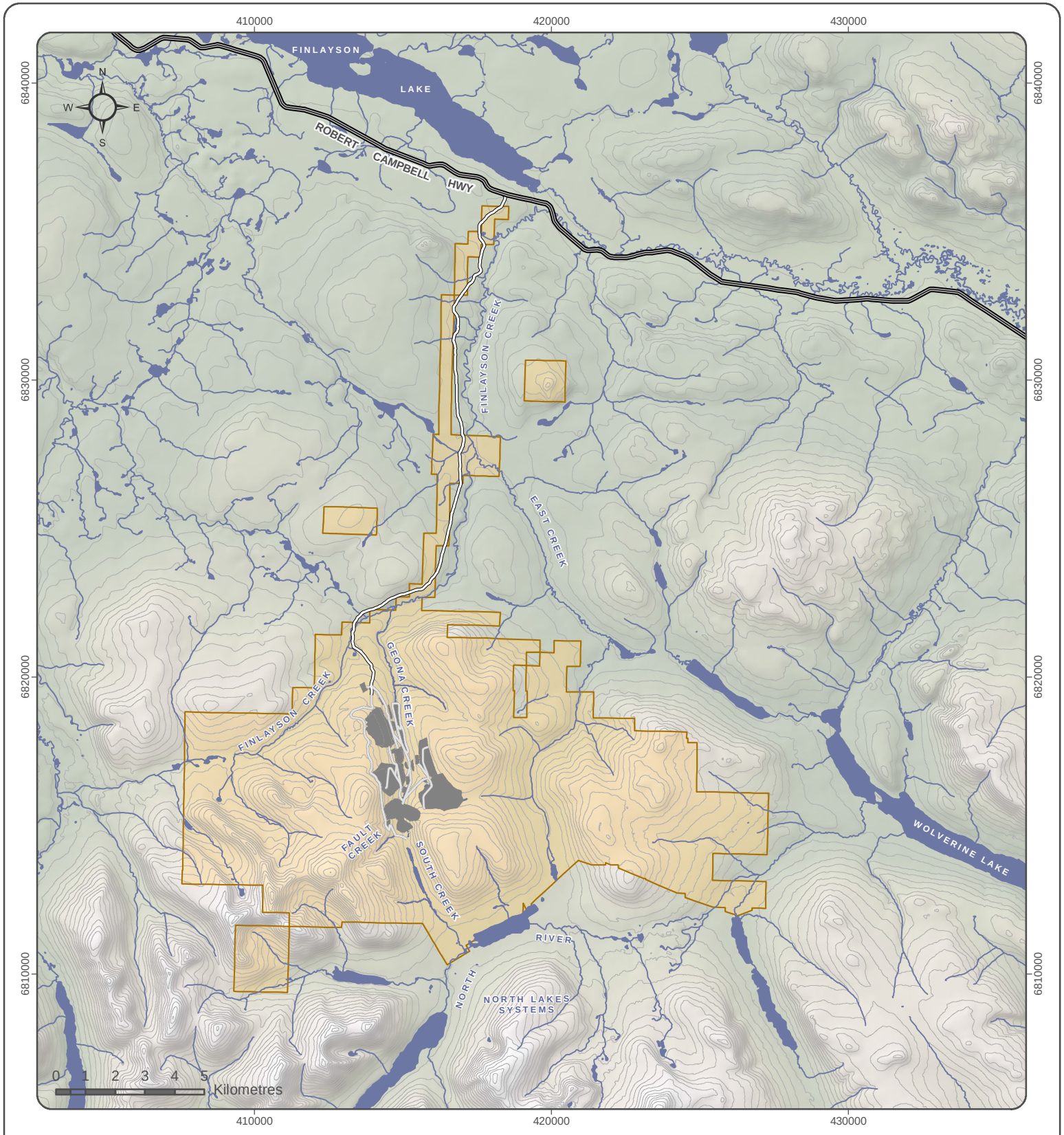

Location of Proposed Mine Infrastructure

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Waterbody

Tote Road/Proposed Access Road

Proposed Mine Road

Contour (40 m interval)

Watercourse

KUDZ ZE KAYAH PROJECT

FIGURE 1-2

PROJECT OVERVIEW

MARCH 2017

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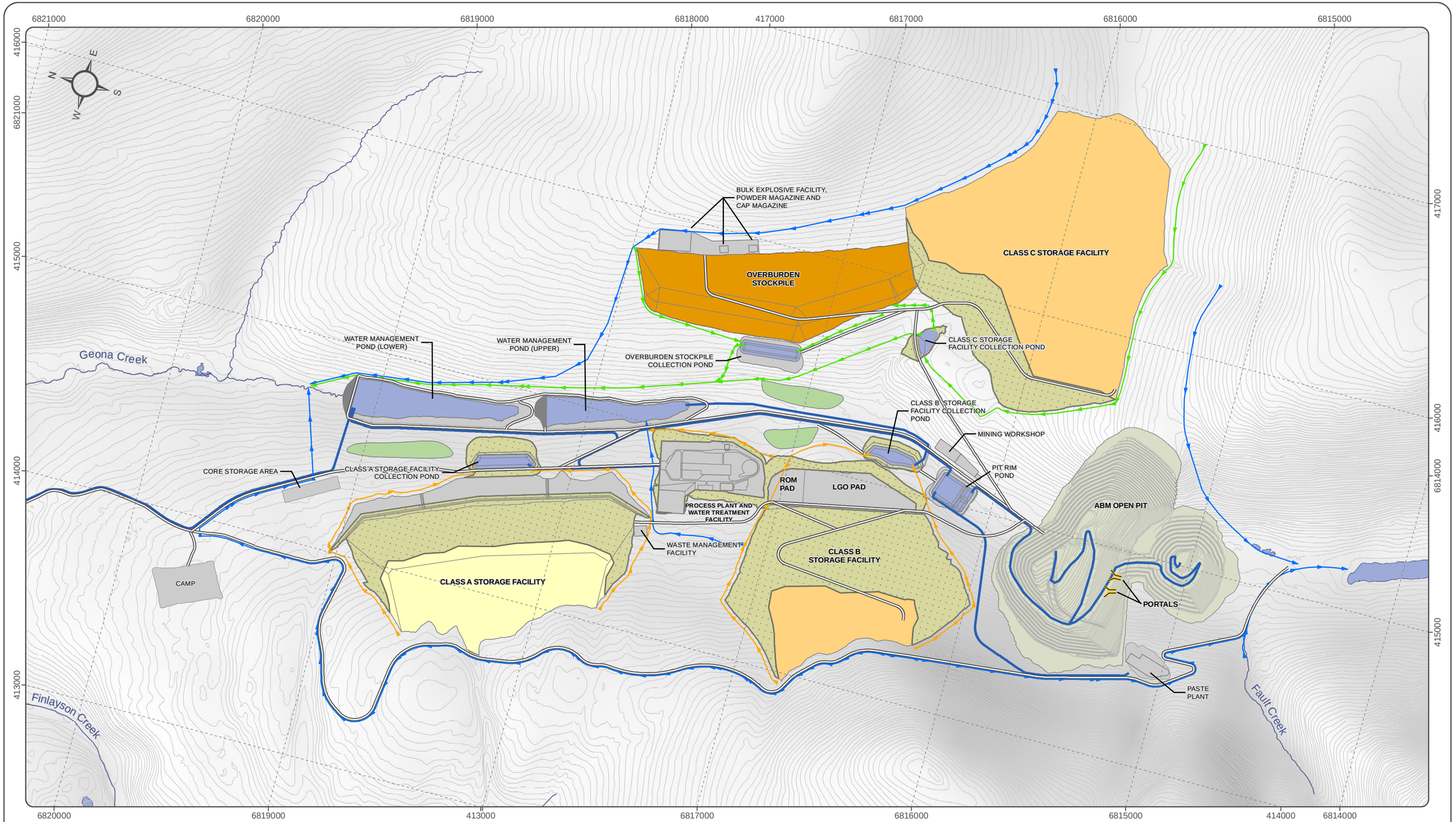
On site surface infrastructure will include (Figure 1-3, shown at year 10):

- Open-pit mine (and underground mine not shown in figure, access is within the open pit);
- Processing facility and associated run of mine (ROM) and low grade stockpile facilities;
- Paste backfill plant;
- Three waste storage facilities for tailings and waste rock (Class A, Class B, and Class C); waste rock will be placed in different storage facilities based on the assessed potential for generation of acidic drainage and metal leaching;
- Overburden and topsoil stockpiles that will be used for progressive reclamation and on final closure;
- Water management infrastructure, including a Pit Rim Pond for mine dewatering, water collection ponds, Operations Water Management Ponds (Upper and Lower), and surface water diversion ditches;
- Camp facilities;
- Core shack and core storage;
- Waste management facility that will include an incinerator, a small Land Treatment Facility, and a small landfill area; and
- General mine infrastructure including explosives facilities, workshops, and fuel facilities.

Offsite infrastructure will include upgrades to the existing 24 km Tote Road from the Robert Campbell Highway to the Project site and upgrades to the Finlayson Lake airstrip located approximately 40 km from the site.

The Project will provide jobs and economic opportunities for the Kaska as well as residents of Yukon and Canada. The benefits of the Project will be achieved in an environmentally and socially responsible manner while meeting BMC's corporate policies (Section 1.3.5 and Appendix A) and objectives.



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Metres
0 250 500 750

- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Pipeline
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 1-3
PROJECT MINE SITE LAYOUT (YEAR 10)

JANUARY 2017

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1.2 PROJECT PURPOSE AND RATIONALE

The purpose of the Kudz Ze Kayah Project is to mine approximately 19.2 million tonnes of ore identified in the ABM Deposit in an economically efficient and environmentally responsible manner. The Prefeasibility Study undertaken to evaluate the engineering and economic characteristics of the mine that BMC has designed to develop the resource, indicates that it will provide robust economic performance under current and expected market conditions.

The rationale for the projected economic and environmental success of the Project is founded on a combination of the following characteristics:

- The large tonnage, near-surface ABM Deposit is amenable to open pit and underground mining methods. The initial years of relatively less costly open pit mining will give the overall Project good financial performance including expedient payback of the capital required for initial mine construction. The characteristics of the Deposit, coupled with the efficient mine engineering design, will ensure waste rock production is minimised.
- The Deposit contains high grades of multiple-metal ore. BMC and its financial partners (Global Natural Resource Investments) has conducted market analysis and research that supports the long-term expectation for strong commodity demand which translates into high metal prices of the primary metals (e.g zinc) contained in the Deposit.
- Yukon hosts a stable and predictable political and regulatory regime. The Yukon's newly developed permitting regime enjoys good political and public support, and it is founded on the principles of procedural fairness and natural justice.
- Yukon has good existing infrastructure including paved roads, air and ground shipping systems, and relative proximity to a year-round seaport which presents access to Asian markets. Having developed successful projects in jurisdictions with greater infrastructure challenges, the BMC management team is reassured by the situation in Yukon.
- Kudz Ze Kayah presents a relatively small project footprint with easily mitigatable short term and no long term environmental impacts. With all Project infrastructure located within the relatively small Geona Creek watershed, environmental impacts can be well managed and effectively mitigated.

1.3 PROPONENT INFORMATION

1.3.1 BMC Overview and Purpose

BMC is a private company, incorporated in Canada (BC Registration number BC 1014247), its parent company BMC (UK) Limited was established in 2014 to take advantage of emerging opportunities in mining and exploration projects with major shareholder Global Natural Resource Investments (GNRI). BMC is engaged in the assessment, acquisition, and development of base metals projects which the Directors believe to be of a quality that is capable of maintaining a mining project that is economically robust and likely to have a positive legacy outcome for both the company and the local community.

1.3.2 Corporate Address and Website

BMC's Canadian Corporate Office is located at: Suite 530, 1130 West Pender Street, Vancouver, British Columbia. The Project website is: http://kudzzekayah.com/

1.3.3 Directors and Management

The BMC (UK) Limited Board is a team with a track record in delivering successful mining operations outside of the framework of industry majors. The BMC (UK) Limited Board has a clear objective to identify and acquire metals assets with real economic viability and efficiently progress projects through defined stages such as Joint Ore Reserves Committee, National Instrument 43-101, prefeasibility, bankable feasibility, development, and into production.

The BMC (UK) Limited Board comprise:

Gary Comb – Chairman

Mr. Comb has 35 years of experience in the international mining industry. As Managing Director of Jabiru Metals Ltd (Jabiru) he oversaw the acquisition, feasibility study and construction of the Jaguar copper/zinc/silver mine in Western Australia and the emergence of Jabiru to be a respected mid-tier mining company in Australia before it was taken over by Independence Group NL. He is currently a Non-Executive Director of a number of other resource based public companies and Chairman of ASX listed Finders Resources Ltd.

Scott Donaldson – CEO & Executive Director

A qualified mining engineer with a graduate diploma in business, Mr. Donaldson brings 30 years of experience in the mining industry in Australia and New Zealand. An experienced company director, he has also successfully managed and developed from prefeasibility to construction, commissioning and production, a number of Australian mining and mineral processing projects over the last 15 years including the Jaguar copper/zinc/silver project with Jabiru Metals, Western Metals' Pillara lead-zinc project, Tectonic Resources' Rav8 nickel project, and the Coobina chromite project with Consolidated Minerals.

Neil Martin – Executive Director, Exploration and Development

Mr. Martin is a geologist with nearly 30 years of experience in mineral exploration and mining across a range of commodities including gold and base metals. His experience has included project generation, through to near mine exploration and mining. The holder of a PhD in geology from the University of Tasmania (CODES), he has a successful career in the mining and exploration industry. An experienced company director, he has also held senior executive roles as Exploration Manager of Jabiru Metals Ltd, Chief Geologist of Independence Group NL, and previous Senior Geologist and District Geologist roles with Acacia Resources Ltd, MIM Exploration, and Dominion Mining Limited.

Other Directors

In addition to the above, GNRI are also entitled to appoint representatives to the Board and they currently have three non-executive directors on the Board, including David Ellis, Managing Director of GNRI.

Management:

Julian Tambyrajah – Chief Financial Officer

Mr. Tambyrajah is a global mining executive, a qualified Accountant and Chartered Company Secretary with 24 years professional experience in the resources (mining, oil & gas) and manufacturing industries, working in different environments such as operator, service contractor, explorer, construction, joint ventures and alliances. Mr. Tambyrajah has covered diverse roles in the areas of treasury, financing, accounting, supply & logistics, acquisitions, project evaluation, feasibility, life of mine modelling, and operations. An experienced CFO, Julian has held roles with DRDGold Ltd, Central Petroleum Ltd, Hills Industries, Brown & Root, Woodside, Normandy Mining, Crescent Gold Ltd, Rusina Gold Ltd.

George Smith – Group Mining Engineer

An experienced mining engineer Mr. Smith is an Executive Director of BMC Minerals (No.1) Ltd. Mr. Smith has been involved in the international mining community for approximately 25 years in Australia and Canada. Most recently he was the Chief Mining Engineer with Barrick Gold in Toronto with previous roles as, Chief Mining Engineer with Tectonic Resources (Australia) and Senior Engineer with McMahan Contractors (Australia).

1.3.4 Principal Contact Person for Purposes of Project Proposal

The principal contact person for the purposes of the Effects Assessment (EA) is Ms. Kelli Bergh.

Ms. Bergh's contact information is as follows:

Kelli Bergh, BSc, MET, RP Bio
Environmental Manager
Email: kellib@bmcminerals.com
Telephone: 778-233-7058

1.3.5 Corporate Policies

BMC operates under a Business Integrity Framework (BIF) which all subsequent policies comply with. The purpose of the Framework is to ensure that BMC meets several important objectives:

- Complies with Relevant Legislation.

- Conducts its business with the level of integrity and ethics that would be expected by business partners, employees, investors, finance providers, regulators, lawmakers and the people and communities impacted by BMC's activities.
- Defines responsibilities of BMC's personnel.
- Defines a control and reporting framework to ensure compliance is properly monitored and associated risks are managed.

To achieve these objectives, BMC is committed to uphold the Framework at all times, both in internal matters and decision-making, and in BMC's interaction with external parties. BMC is also committed to developing a culture among its personnel and external counterparties in which the importance of business integrity is actively promoted. When dealing with external parties, including business partners, government bodies and officials, and the people and communities impacted by the BMC's activities, it is critical that BMC's personnel ensure that the relevant external parties understand the vital role of business integrity for the Company.

BMC has a number of Corporate Policies that have been adopted for the Project. These policies include:

- Company Management and Operating Policies;
- Occupational Health and Safety;
- Fitness for Work;
- Environment;
- Community Relations;
- Employment and Anti-Discrimination; and
- Personnel Management.

Additional policies that are specific to the Project include:

- No Recreational Use of All-Terrain Vehicles and Snowmobiles Policy;
- No Hunting/No Fishing Policy;
- No Firearms Policy;
- No Feeding of Animals Policy; and
- Heritage Policy.

Behind each of these policies is a set of other policies and procedures designed to allow the management team to be able to implement each policy and ensure that all employees, contractors, site visitors and, where necessary, suppliers comply with each policy statement.

These procedures emphasize the strong commitment that BMC has to local community groups, including traditional owners, landowners, and local residents. Copies of the corporate policies are provided in Appendix A.

As the Project moves towards a construction decision, these policies will be enhanced through the development of appropriate standards, procedures, and programs to fulfill BMC's commitments under the policies.

1.4 PROJECT BACKGROUND

1.4.1 Project History

1.4.1.1 Ownership

The first mineral claims were staked by Cominco Ltd. (Cominco) in the immediate vicinity of the ABM Deposit in 1993. Additional mineral claims were staked in 1994 subsequent to drilling of the ABM discovery hole, and further claims were staked by Cominco across the district until 1997 after which staking by Cominco effectively ceased.

In March 2000, Expatriate Resources Ltd. (Expatriate) signed a purchase arrangement with Cominco for acquisition of the Project. During 2001, Cominco merged with Teck Corporation to form Teck Cominco Metals Limited (Teck Cominco). In September 2001, Expatriate informed Teck Cominco that they were unable to meet a scheduled purchase payment, after which the Project was returned to Teck Cominco. In 2008, Teck Cominco was renamed as Teck Resources Limited (Teck).

BMC purchased the Project from the wholly owned Teck subsidiary, Teck Worldwide Holdings Limited, in January 2015.

1.4.1.2 Previous Exploration Activity

The significant mineral potential of the Project area was first recognized in 1992 when a program of grass roots (reconnaissance) silt and soil sampling by Cominco confirmed and expanded upon an anomalous silt sample identified by a Geological Survey of Canada regional geochemistry program. Follow-up prospecting and geological mapping by Cominco in 1993 resulted in the discovery of well-mineralized rock in the anomalous creek drainage. The suspected host rocks were recognized to disappear beneath valley fill, consequently electromagnetic (EM) geophysical surveys were deployed to image possible massive sulphide bodies. Results were prospective, consequently claims were staked and more detailed geochemical and geophysical surveys defined a target worthy of drill testing late in the 1993 field season.

Early in the 1994 field season, Cominco tested the target with the first diamond drill hole – a true discovery hole that returned 22.5 m of massive sulphide (i.e., metal-bearing) rock which analyses showed contained 10.0% zinc and 2.8% lead as well as significant silver, gold, and copper. Cominco's geologists named this massive sulphide body the ABM Deposit in recognition of geologist A.B. Mawer (ABM) who discovered the mineralized rock the year before.

Cominco completed significant geological, geophysical, metallurgical, environmental, and archaeological work on the KZK property over the ensuing four years (1995 to 1998) including drilling nearly 200 diamond drill holes to define the extents of the massive sulphide body.

No further exploration work of significance was completed on the Project until BMC acquired the KZK property from Teck in January 2015 and commenced exploration activities in July 2015.

Following its purchase of the Project, BMC embarked on an aggressive exploration program that included upgrading and building new exploration infrastructure, compiling historical data, re-logging historical drill core, LiDAR surveying, differential global positioning system surveying of the Tote Road and historical drill collars, geophysical surveying (airborne, ground-based, downhole), resource and exploration drilling, metallurgical drilling and sampling, petrographic studies, geotechnical drilling and engineering, hydrogeological drilling and environmental studies.

1.4.1.3 Previous Development Studies

Cominco completed a prefeasibility study for the ABM Deposit in June 1995 which envisioned open pit mining 11.3 Million tonnes (Mt) of ore at a rate of 1.08 Mtpa over a period of 10.5 years (Norecol, Dames & Moore Ltd., 1996). Waste mined totalled 106 Mt, for a life of mine strip ratio of 9.37:1. Ore would be processed in a conventional flotation plant, producing separate copper, lead, and zinc concentrates by sequential flotation. Tailings would be stored in a valley fill style dam in Geona Creek, permanently covered by water during both operations and after closure.

The Cominco study assessed approximately 5% of waste rock to be mined as having strong potential for acid generation and would be stored subaqueously within the tailings storage facility with another 35% of waste rock assessed to have weak acid generation potential. Of this material, two thirds was to be placed in a surface storage facility and rehandled back into the mined pit on closure with the remaining one third backfilled in the pit as it was mined, removing any requirements for rehandling. The remaining 60% of the waste rock mined was assessed as acid consuming and was planned to be stored in a surface storage facility.

Baseline environmental data collection commenced prior to the prefeasibility study and continued following study completion. The Project was considered economic and Cominco completed an Initial Environmental Evaluation (IEE) under the *Canadian Environmental Assessment Act* in 1996 and subsequently secured a Type A Water Licence (in 1998).

Further studies continued with a feasibility level geotechnical assessment completed in 1996 (Golder Associates, 1996); however, a final feasibility study report was not completed and the Project did not ultimately proceed to development, due to a significant reduction in commodity prices.

In 2000, Expatriate completed a new prefeasibility study assessing the combination of the Project with the Wolverine Deposit (Hatch, 2000). This study considered open pit mining at the ABM Deposit of 11.1 Mt of ore at a rate of 1.1 Mtpa in a little over ten years. Ore would be processed through a 1.55 Mtpa flotation plant constructed in the Geona Creek valley, with the balance of ore requirements produced by the Wolverine mine. A new haul road was proposed to link the Wolverine Project to the

processing plant. Strategies for the management of tailings and waste rock remained unchanged from that proposed in the Cominco prefeasibility study.

In 2001, Expatriate terminated the acquisition agreement with Cominco and more detailed development studies did not progress.

1.4.2 Existing Authorizations and Approvals

Environmental and socio-economic studies for the Project were completed in 1994/1995 to support the IEE under *Canadian Environmental Assessment Act* (submitted for regulatory review in March 1996 and approved in December 1997). These studies included climate and hydrology; surface water and groundwater quality; stream sediment quality, aquatic resources (fish, benthic invertebrate, and zooplankton characterization); vegetation and terrain mapping; wildlife; and archaeological investigations.

In 1998, Water Licence QZ97-026 was issued to Cominco. When the property was purchased by BMC from Teck, the Water Licence was transferred to BMC as Licence QZ97-026-1.

In 2015, BMC underwent a *YESAA* (YESAB project #2015-028) screening for exploration activities and subsequently received a class 3 Mining Land Use Approval (LQ00424). Additionally, in 2015 the Yukon Land Lease for the KZK Tote Road (Deposition No: 105G07-001) was renewed until 2020.

1.5 ENVIRONMENTAL CONTEXT

The Project is within the Pelly River and Pelly Mountain ecoregions. The major part of the Pelly River ecoregion is underlain by metamorphic rock; however, large bodies of volcanic and intrusive rocks and small bodies of sedimentary rocks occur throughout. An overview of the environmental setting of the Project is provided in Table 1-1.

Table 1-1: Environmental Context

Context	Description
Drainage Region	Major Drainage Area: Arctic Drainage Area, Yukon River Drainage Sub Drainage Area: Upper Liard, Pelly Sub-sub Drainage Area: Headwaters Liard, Upper Pelly, Frances
Significant Watersheds	Finlayson Creek
Ecoregion	Yukon Plateau-North Ecoregion of the Boreal Cordillera Ecozone Pelly Mountains Ecoregion of the Boreal Cordillera Ecozone
Study Area Elevation	800-1,800 metres above sea level (masl)
Vegetation Communities	Subalpine and alpine vegetation zones
Traditional Territory	Kaska, primarily Ross River Dena Council and Liard First Nation

The ABM Deposit lies approximately 24 km south of Finlayson Lake (see Figure 1-2) on the northern edge of the Pelly Mountains, a range that bisects the Yukon in a northwest-southeast direction. The area drainage includes Finlayson Creek and its tributaries, and the Finlayson River which flows into

the Frances River, which in turn empties into the Liard River. Geona Creek (Kaska for "wolf") is a tributary of Finlayson Creek and flows across the sub-crop of the ABM Deposit.

The Project area has a typical northern interior climate. Summers are cool and short, whereas winters are long and cold. Mean annual temperature recorded at KZK site (September 2015 to August 2016) was -0.47°C with extremes ranging from -26°C to 20°C. When compared to both long-term regional averages and to regional data for the same period, the 2015-2016 record at the Project generally shows warmer winter temperatures (October to April), cooler summer temperatures (May to September). Total precipitation recorded onsite was 343 mm (September 2015 to August 2016 by AEG), with July and August being the wettest months. When compared to long-term regional annual means, the 2015-2016 data collected at the Project generally showed lower total amounts than at most regional stations reviewed, except for Ross River and Faro, which have lower long-term averages.

The region has discontinuous permafrost with moist depression areas containing peat plateaus, patterned fen and bog complexes. Scree covered slopes are most prominent in sedimentary rock. Deep colluvium occurs on steeper mid to lower slopes. The Project area is mostly a forest region, except for topographic peaks, which are in the alpine tundra region. White and black spruce are the most common tree types. Black spruce is usually dominant in wetter areas, while white spruce dominates in drier areas. Trembling aspen, balsam poplar, and lodgepole pine also occur. Subalpine fir occurs at the treeline (1,350 to 1,500 masl). In dense coniferous stands, feathermoss dominates the understorey, but in more open areas willows and heath-like shrubs become prevalent. Sedge or sphagnum tussocks are common in wetlands and under black spruce. Shrub birch and willow occur in the subalpine and extend well above the treeline.

Regionally significant wildlife resources occur in the Project area, notably the Finlayson Caribou Herd. The herd uses the uplands around the ABM Deposit from the spring to the fall, and the lowlands of the Pelly River in the winter. These caribou provide a valuable food source for the Kaska and are also of economic significance to sport hunters and the guiding industry. Moose are also a significant wildlife resource. Furbearer populations are also utilized by Kaska citizens. Fish in the larger lakes (including Finlayson Lake) and streams include Arctic grayling, burbot, slimy sculpin, whitefish, lake trout, and possibly Dolly Varden char.

1.6 SOCIO-ECONOMIC CONTEXT

The Project is located in the traditional territory of the "Kaska" or "Kaska Nation" as meaning collectively, Ross River Dena Council (RRDC), Liard First Nation (LFN), Daylu Dena Council, Dease River First Nation, and Kwadacha First Nation people. Under the Kaska Collaboration Agreement (KCA) of October 2011, for each negotiation on a project carried out pursuant to the KCA, a Lead Community will be identified by the Kaska Nation from the jurisdiction (Yukon or British Columbia) in which the project is located. For the KZK Project the two primary Kaska communities are LFN and RRDC, with RRDC acknowledged as the lead agency under the KCA.

The Project is located approximately 115 km southeast of Ross River (home community of RRDC) and approximately 260 km northwest of Watson Lake (home community of the LFN). The Project is

approximately 24 km south of the Robert Campbell Highway and is accessed by an all-weather Tote Road that leaves the Highway near the south end of Finlayson Lake. The Tote Road is gated and licensed for use by the Project owners only and so does not provide access for any other resource users.

The area has long been used by the Kaska to hunt and trap. There are also traditional trails in the area, indicating the area's use as a travel route. The Project is located in the far southeast corner of the Ross River group trapline 405 but the mineral claim blocks extend into registered trapline 250 held by an individual.

The wider area around the project is used by non-First Nation hunters who usually gain access by flying into different lakes. The Project is within outfitting concession #20, held by Yukon Big Game Outfitters.

The Project is located in what is known as the Finlayson Lake VMS District that was largely discovered and defined in a rush of staking and exploration activity in the 1990s. The entire district is blanketed with quartz mining claims and there are at least six known significant VMS deposits, including those at the Project. The now-closed Wolverine Mine (with its separate access road) is located approximately 25 km to the east of the Project. The area has no known history of placer mining or forestry.

The socio-economic context for the communities and Yukon is provided in Table 1-2.

Table 1-2: Socio-economic Context

	Ross River	Watson Lake	Faro	Whitehorse	Yukon
Population, 2015	411	1,469	375	28,872	37,566
GDP, 2013 in 2007 C$	–	–	–	–	$2.3 billion
Community income, 2013 in 2002 C$	$6.8 million	$32.3 million	$10.2 million	$1.2 billion	–
Unemployment rate, 2011 NHS	30.2%	8.8%	17.9%	7.9%	9.8%
Age 15+ without high school diploma, 2011 NHS	42.1%	32.9%	25.1%	15.0%	18.3%

Note: The unemployment rate for Upper Liard in 2011 was 42.9% and the share of the population aged 15+ years without a high school diploma was 62.5%.

1.7 *YESAA* TRIGGERS AND REQUIRED AUTHORIZATIONS

1.7.1 *YESAA* Requirements

The Project is subject to assessment in accordance with Section 47(2)(c) of the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) as follows:

> *47 (2) An activity listed under paragraph (1)(a) – and not excepted under paragraph (1)(b)—is subject to assessment if proposed to be undertaken in Yukon and if (c) an authorization or the grant of an interest in land by a government*

agency, an independent regulatory agency, municipal government or first nation is required for the activity to be undertaken;

The Project is assessable under Schedule 3 Item 3(b) of the Project Regulations, which requires an Executive Committee Screening for:

a metal mine, other than a gold mine, with an ore production capacity of 1500 tpd or more.

1.7.2 Applicable Legislation, Regulations and Permits

1.7.2.1 Quartz Mining Act and Mining Land Use Regulations (Territorial)

The Project requires a Quartz Mine License (QML) under section 135 of the Yukon's *Quartz Mining Act* (QMA), as it will meet the definitions of development and production under Section 129(1) of the Act which states:

"development" means the construction of a facility or work for the production of minerals, but excludes the construction of a facility or work for the sole or principal purpose of assessing land for its suitability for the production of minerals.

"production" means taking a mineral from the land, or treating a mineral that has been taken from the land, if done for commercial purposes, but excludes an exploration program.

The QML will be issued in a phased approach, first authorizing site preparation/construction activities under a Phase I Construction Management Plan. This will allow for at least one and possibly two seasons of site preparation activities while the Type A Water Licence process is underway. The Phase II QML (for operations) will set out requirements for routine monitoring and reporting, and will include a number of adaptive management plans for different aspects of the mine and its potential impacts (such as waste, hazardous materials, and air quality).

1.7.2.2 Waters Act

The existing Type A Water Use Licence (QZ97-026-1) will expire in September 2018 (likely during the environmental process. Therefore, under sections 6(1) and 7(1) of the *Waters Act* (Yukon) with respect to the mine operations for the use of water and deposit of waste, respectively, and for undertakings related to Project design (water course diversion and watercourse training and crossings) a new licence will be applied for. This licence is issued by the Yukon Water Board, which follows a quasi-judicial review process including a formal public hearing.

Section 12(1) of the *Waters Act* together with Section 7 and Schedule 7 (Column 4) of the Waters Regulation (Yukon) specifically requires a Type A Licence in relation to quartz mining undertakings with respect to:

direct water use for …production and milling at a rate of 100 tonnes of ore per day or for production leaching.

A new Type B Water Use Licence will be secured for two purposes: i) this licence will prevent an unlicensed gap that would otherwise occur between expiry of the existing Type A and issuance of the new Type A; and ii) this licence can be easily amended to coincide with Phase I of the QML, issued to authorize site preparation and mine construction (post YESAB) as outlined above.

1.7.2.3 Fisheries Act and Metal Mine Effluent Regulations (Federal)

A Fisheries Offsetting Plan (see Chapter 18 and Appendix E-4) will be developed in collaboration with Fisheries and Oceans Canada (DFO), to offset the temporary disruption of upper Geona Creek during operations. The plan falls under the *Fisheries Act*, and Metal Mine Effluent Regulations (Federal).

Any proposed construction measures (associated with the Fisheries Offsetting Plan) must be incorporated in the Project Proposal for review by YESAB, and DFO may not issue the final authorization for the plan until the Decision Document is issued under that process. Community consultation about the proposed plan is a required component of DFO's regulatory process.

Also, the Metal Mine Effluent Regulations will prescribe monitoring and reporting requirements during operations through the adoption of an Environmental Effects Monitoring program. There is a requirement to continue this program post-closure, until the mine is designated closed by DFO upon application by BMC.

1.7.2.4 Minor Permits

The Project will require a number of other permits and authorization as detailed in Table 1-3.

Table 1-3: Applicable Legislation, Regulations and Permits

Authorization	Activity	Enacting Legislation	Regulatory Agency
Land Tenure/Land Use			
Mining Land Use Approval	Surface use of quartz mining claims.	*Quartz Mining Act*, Mining Land Use Regulations	Energy, Mines & Resources, Lands Branch
Application for Land	Tenure for land lease.	*Territorial Lands Act*, *Lands Act*, Land Use Regulation	Energy, Mines & Resources, Lands Branch
Quarry Permit, Quarry Lease Air Emissions Permit (if excavation is greater than 4 ha)	Obtaining gravel/sand from a quarry.	*Territorial Lands Act, Lands Act*, Land Use Regulation *Environment Act*, Air Emissions Regulation	Energy, Mines & Resources, Lands Branch Environment Yukon, Environmental Programs
Access Permit	Constructing road access on highway right-of-way.	*Highways Act*, Highways Regulation	Highways & Public Works, Transportation Maintenance Branch

Authorization	Activity	Enacting Legislation	Regulatory Agency
Land Use Permit Permit under Highways Act Section 7(2)	Construction of new road access.	*Territorial Lands Act, Lands Act*, Land Use Regulation *Highways Act*, Highways Regulation	Energy, Mines & Resources, Lands Branch Highways & Public Works, Transportation Maintenance Branch
Licence of Occupation	Use of land within highway right-of-way.	*Highways Act*	Highways & Public Works, Transportation Maintenance Branch
Work in Right-of-Way Permit	Perform work within highway right-of-way.	*Highways Act*, Highways Regulation	Highways & Public Works, Transportation Maintenance Branch
Sign Permit	Erect sign within highway right-of-way.	*Highways Act*, Highways Regulation	Highways & Public Works, Transportation Maintenance Branch
Burning Permit	Burning refuse wood.	*Territorial Lands Act, Lands Act*, Land Use Regulation	Energy, Mines & Resources, Lands Branch
Forest Resources Permit	Clearing of forest resources incidental to other activity (including land use, road construction, working within a Right-of-Way, etc.).	*Forest Resources Act*	Energy, Mines & Resources, Forest Management Branch
Conformance to Regulation	Inadvertent destruction of nests and eggs due to forest clearing. is called “incidental take”.	*Migratory Birds Convention Act*, Migratory Birds Regulations	Environment Canada
Construction/Building-Related			
Building Permit	Construction of buildings outside a municipality. Installation of fuel storage tanks.	*Building Standards Act*	Community Services, Building Safety
Plumbing Permit	Plumbing outside of Whitehorse.	*Building Standards Act*	Community Services, Building Safety
Permit to Install a Sewage Disposal System	Onsite sewage disposal system.	*Public Health and Safety Act*, Sewage Disposal Systems Regulation	Health & Social Services, Environmental Health Services
Electric Permit	Electrical work.	*Electrical Protection Act*, Canadian Electrical Code	Community Services, Building Safety
Gas Installation Permit	Gas installation or modification.	*Gas Burning Devices Act*	Community Services, Building Safety
Registration	Installation of power boilers over 10 kW, heating boilers over 20 kW, pressure vessels and piping systems.	*Yukon Boiler and Pressure Vessel Act*	Community Services, Building Safety
Air Emissions Permit	Operation of fuel burning equipment greater than 5Mbtu/hr.	*Environment Act*, Air Emissions Regulation	Environment Yukon, Environmental Programs

Authorization	Activity	Enacting Legislation	Regulatory Agency
Water Licence	Bridge crossing (if bridge crosses >5 m width stream).	*Territorial Lands Act, Lands Act*, Land Use Regulation Waters Act	Energy, Mines & Resources, Lands Branch Water Board
Contaminants and Waste			
Solid Waste or Waste Management Permit for camp Land Lease	Solid waste disposal facility or commercial dump.	*Yukon Environment Act*, Solid Waste Regulations	Environment Yukon, Environmental Programs
Storage Tank Systems Permit Land Use Permit	Storage and handling of petroleum products.	*Yukon Environment Act*, Storage Tank Regulation *Territorial Lands Act, Lands Act*, Land Use Regulation	Environment Yukon, Environmental Programs
Application for Operation, Closure, Abandonment, or Renovations to Storage Tanks	Use of storage tanks.	*Environment Act*, Storage Tank Regulation	YG Community Services, Protective Services Branch, Fire Marshall's Office
Special Waste Permit	Handling, disposal, generation or storage of special (hazardous) wastes.	*Environment Act*, Special Waste Regulation	Environment Yukon, Environmental Programs
Air Emissions Permit	Release of air pollutants (i.e. incinerator, diesel generators).	*Environment Act*, Air Emissions Regulation	Environment Yukon, Environmental Programs
Air Emissions Permit/ Waste Management Permit	Operation of solid waste incinerator.	*Environment Act*, Air Emissions Regulation	Environment Yukon, Environmental Programs
Land Treatment Facility Permit	Operation of Land Treatment Facility	*Environment Act*, Contaminated Sites Regulation	Environment Yukon, Environmental Programs
Explosives			
Land Use Permit	Use of more than 50 kg of explosives on Commissioner's land in any 30-day period.	*Territorial Lands Act, Lands Act*, Land Use Regulation	Energy, Mines & Resources, Lands Branch
Permit for Use of Explosives	Overnight storage of explosives at any site other than a mine or quarry.	*Explosives Act*	Natural Resources Canada, Minerals & Metals Sector
Explosives Magazine Permit	Explosives storage.	*Explosives Act*	Yukon Worker's Compensation Health and Safety Board, Occupational Health & Safety
Underground and Surface Authorization to Conduct Blasting in Yukon	Blasting.	Occupational Health and Safety Regulations, Part 14: Blasting Regulations	Yukon Worker's Compensation Health and Safety Board, Occupational Health & Safety
Temporary Blaster's Permit	Temporary blasting.	Occupational Health and Safety Regulations, Part 14: Blasting Regulations	Yukon Worker's Compensation Health and Safety Board, Occupational Health & Safety

Authorization	Activity	Enacting Legislation	Regulatory Agency
Transportation			
Over-dimensional or Over-weight Vehicle Permits	Oversize trucking.	*Highways Act*	YG Highways & Public Works, Transportation Services Branch
Certificate and/or Permit for Transport of Dangerous Goods Special Waste Permit and Waste Manifest	Transport of dangerous goods/waste.	*Transportation of Dangerous Goods Act* *Environment Act*, Special Waste Regulation	YG Highways & Public Works, Transportation Services Branch Environment Yukon, Environmental Programs

1.7.2.5 Permitting Timeline

A preliminary breakdown of anticipated permitting related activities is provided in Table 1-4. Consultation activities associated with permitting timeline are discussed in Chapter 2.

Table 1-4: Preliminary Schedule of Permitting Related Activities

Milestone	Date
Complete Prefeasibilty Study (PFS)	October 2016
Complete Project Description	October 2016
Submit Project Proposal to Executive Committee	March 2017
Prepare and Present Quartz Mining License Application: Operations	November 2017
Prepare and Present Type A Water Licence Application	February 2018
YESAB Decision Document Issued	November 2018
Water Board Issue of Type A Licence	May 2020
Energy Mines and Resources Issue of Final QML Licence: Operations	May 2020

1.8 ORGANIZATION AND LAYOUT OF THE PROJECT PROPOSAL

The Project Proposal generally follows Appendix A of YESAB's Rules for Screenings Conducted by the Executive Committee (YESAB, 2005b), and the draft Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions (YESAB, 2005a). The layout of the main report portion of the Project Proposal is shown in Figure 1-4. Each of the Valued Component (VC) assessment chapters (Chapter 6 through 15) includes a description of existing conditions, effects assessment (including determination of significance), and cumulative effects assessment as it pertains to that VC. The main report is supported by a number of technical appendices. A table of concordance to demonstrate that the Project Proposal meets YESAB's identified requirements in the draft Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions (YESAB, 2005a) is provided in Table 1-5.

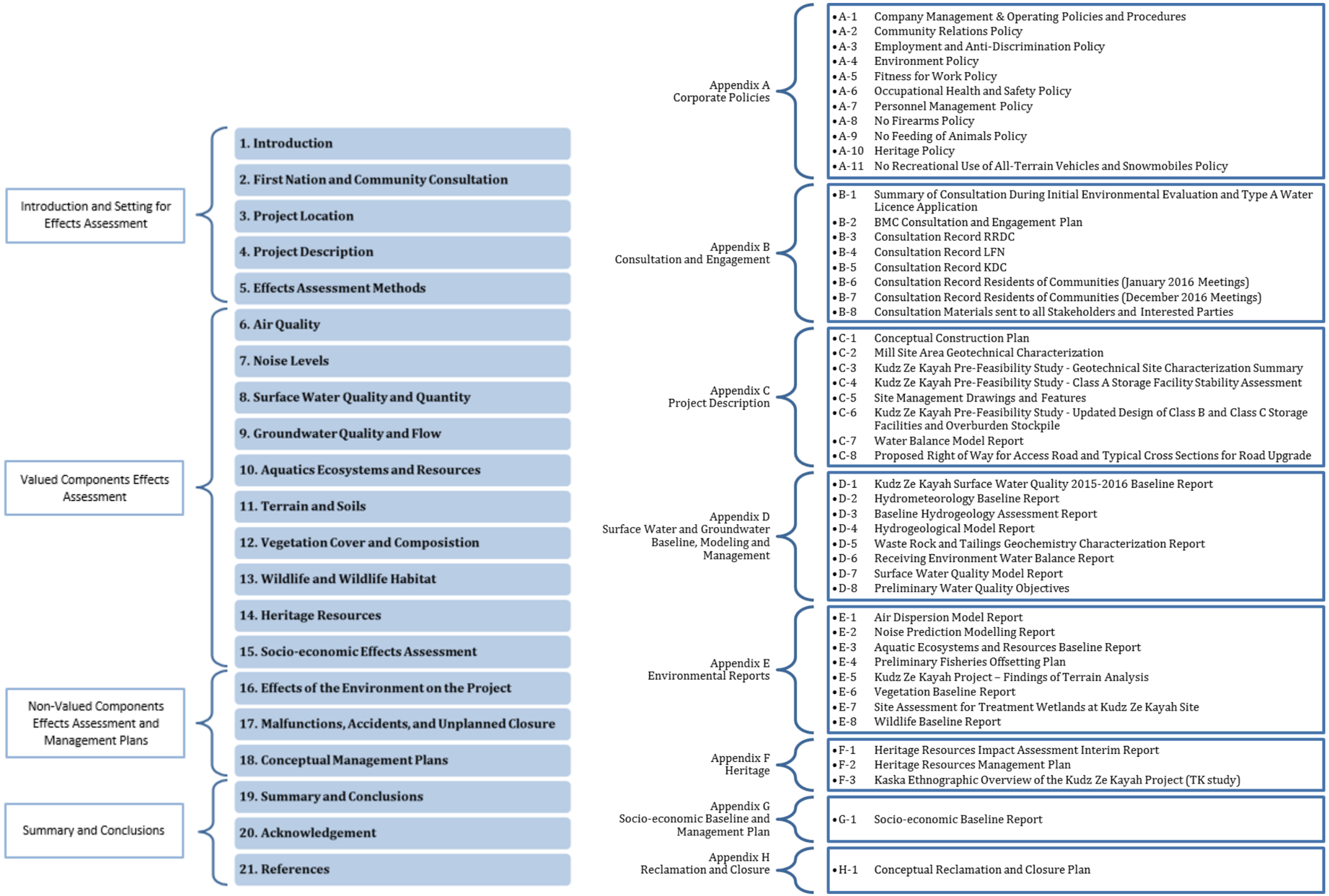


Figure 1-4: Project Proposal Organization

Table 1-5: Table of Concordance - Executive Committee Submission

YESAB Guidance Section	Project Proposal Section Information Provided In
Part 1 Generic Information Requirements For All Executive Committee Screenings	
1.0 Project Introduction and Overview	
1.1 Executive Summary	Executive Summary
1.2 Proponent Information	Section 1.3
1.3 Project Background	Section 1.4
1.4 Project Purpose	Section 1.2
1.5 Required Authorizations and Regulatory Approvals	Section 1.7
2.0 First Nations/Community Consultation	Chapter 2
3.0 Project Location	
3.1 Geographical Location	Section 3.1
3.2 Land Tenure	Section 3.2
3.3 Traditional Territory	Section 3.3
3.4 Yukon Land Use Planning Region	Section 3.4
3.5 Consistency with Other Plans	Section 3.5
4.0 Description of Existing Environmental and Socio-economic Conditions	
4.1 Environmental Conditions	Scope of Project/Study Areas: general study areas described in Section 5.5. VC specific study areas are described in corresponding VC chapters. Described for each Valued Component (VC), as follows: • Air quality (including climate) – Section 6.3; • Noise levels – Section 7.3; • Surface water quality and quantity – Section 8.3; • Groundwater quality and flow – Section 9.3; • Aquatic ecosystems and resources – Section 10.3; • Terrain and soil (including general physiography and surficial geology) – Section 11.3; • Vegetation cover and composition – Section 12.3; and • Wildlife and wildlife habitat – Section 13.3.
4.2 Socio-economic Conditions	Heritage – Section 14.3; and Socio-economic conditions (including community information, and land and resource use) – Section 15.3.
5.0 Project Description	
5.1 Project Identification	Section 4.1
5.2 Alternatives and Chosen Approach	Section 4.15
5.3 Technologies	Section 4.16
5.4 Project Phases and Scheduling	Section 4.3, as well as detail in Sections 4.6 to 4.14

YESAB Guidance Section	Project Proposal Section Information Provided In
6.0 Environmental and Socio-economic Effects Assessment	
6.1 Values Information	Study area maps provided for each VC, as follows: • Air quality – Section 6.2; • Noise levels – Section 7.2; • Surface water quality and quantity – Section 8.2 • Groundwater quality and flow – Section 9.2 • Aquatic ecosystems and resources – Section 10.2; • Terrain and soil (including surficial geology) – Section 11.2; • Vegetation cover and composition – Section 12.2; • Wildlife and wildlife habitat – Section 13.2; • Heritage resources – Section 14.2; and • Socio-economic – Section 15.2.
6.2 Valued Environmental and Socio-economic Components	Section 5.3
6.3 Potential Environmental and Socio-economic Effects	See subsections below
6.3.1 Assessment Boundaries	General assessment boundaries described in Section 5.4. Assessment provided for each VC, as follows: • Air quality – Section 6.2; • Noise levels – Section 7.2; • Surface water quality and quantity – Section 8.2 • Groundwater quality and flow – Section 9.2 • Aquatic ecosystems and resources – Section 10.2; • Terrain and soil (including surficial geology) – Section 11.2; • Vegetation cover and composition – Section 12.2; • Wildlife and wildlife habitat – Section 13.2; • Heritage resources – Section 14.2; and • Socio-economic resources – Section 15.2.
6.3.2 VC Baseline Information	VC existing conditions provided for each VC as follows, as well as supporting appendices as shown in Figure 1-4: • Air quality – Section 6.3; • Noise levels – Section 7.3; • Surface water quality and quantity – Section 8.3; • Groundwater quality and flow – Section 9.3; • Aquatic ecosystems and resources – Section 10.3; • Terrain and soil (including surficial geology) – Section 11.3; • Vegetation cover and composition – Section 12.3; • Wildlife and wildlife habitat – Section 13.3; • Heritage resources – Section 14.3; and • Socio-economic resources – Section 15.3.

YESAB Guidance Section	Project Proposal Section Information Provided In
6.3.3 Characterizing Effects	Assessment methods described in Section 5.6.1. Effects assessment discussed for each VC, as follows: • Air quality – Section 6.4.1, supported by air quality model report provided in Appendix E-1; • Noise levels – Section 7.4.1, supported by noise model report provided in Appendix E-2; • Surface water quality and quantity – Section 8.4.1, supported by surface water quality model report provided in Appendix D-7; • Groundwater quality and flow – Section 9.4.1, supported by hydrogeology model report provided in Appendix D-4; • Aquatic ecosystems and resources – Section 10.4.1; • Terrain and soil (including surficial geology) – Section 11.4.1; • Vegetation cover and composition – Section 12.4.1; • Wildlife and wildlife habitat – Section 13.4.1; • Heritage resources – Section 14.4.1; and • Socio-economic resources – Section 15.4.1.
6.3.4 Effects of the Environment on the Project	Chapter 16
6.3.5 Effects of Accidents and Malfunctions	Chapter 17
6.4 Mitigation Measures	Mitigations measures methods described in Section 5.6.2. Conceptual Management Plans outlining mitigation measures described in Chapter 18. Fisheries Offsetting Plan is provided in Appendix E-4. Mitigation measures discussed for each VC, as follows: • Air quality – Section 6.4.2; • Noise levels – Section 7.4.2; • Surface water quality and quantity – Section 8.4.2; • Groundwater quality and flow – Section 9.4.2; • Aquatic ecosystems and resources – Section 10.4.2; • Terrain and soil (including surficial geology) – Section 11.4.2; • Vegetation cover and composition – Section 12.4.2; • Wildlife and wildlife habitat – Section 13.4.2; • Heritage resources – Section 14.4.2; and • Socio-economic resources – Section 15.4.2.
6.5 Determination of Significance	Determination of significance methods described in Section 5.6.3. Determination of significance discussed for each VC, as follows: • Air quality – Section 6.4.3; • Noise levels – Section 7.4.3; • Surface water quality and quantity – Section 8.4.3; • Groundwater quality and flow – Section 9.4.3; • Aquatic ecosystems and resources – Section 10.4.3; • Terrain and soil (including surficial geology) – Section 11.4.3; • Vegetation cover and composition – Section 12.4.3; • Wildlife and wildlife habitat – Section 13.4.3; • Heritage resources – Section 14.4.3; and • Socio-economic resources – Section 15.4.3.

YESAB Guidance Section	Project Proposal Section Information Provided In
6.6 Effects Monitoring and Adaptive Management	Effects monitoring and adaptive management general approach described in Section 5.8. Effects monitoring summarized for each VC as follows: • Air quality – Section 6.6; • Noise levels – Section 7.6; • Surface water quality and quantity – Section 8.6; • Groundwater quality and flow – Section 9.6; • Aquatic ecosystems and resources – Section 10.6; • Terrain and soil (including surficial geology) – Section 11.6; • Vegetation cover and composition – Section 12.6; • Wildlife and wildlife habitat – Section 13.6; • Heritage resources – Section 14.6; and • Socio-economic resources – Section 15.6. Conceptual management plans – Chapter 18
7.0 Cumulative Effects Assessment	
7.1 Valued Environmental and Socio-economic Components	Projects considered through cumulative effects assessment identified in Section 5.7. Cumulative effects discussed for each VC, as follows: • Air quality – Section 6.5; • Noise levels – Section 7.5; • Surface water quality and quantity – Section 8.5; • Groundwater quality and flow – Section 9.5; • Aquatic ecosystems and resources – Section 10.5; • Terrain and soil (including surficial geology) – Section 11.5; • Vegetation cover and composition – Section 12.5; • Wildlife and wildlife habitat – Section 13.5; • Heritage resources – Section 14.5; and • Socio-economic resources – Section 15.5.
7.2 Other Projects and Activities	
7.3 Potential Cumulative Effects	
7.4 Mitigation Measures	
7.5 Residual Cumulative Effects	
7.6 Significance	
8.0 Acknowledgement and Certification	Chapter 20
Part 2 Additional Information Requirements for Sector Specific Executive Committee Projects – Hardrock (Quartz) Mining Projects	
H.1 Proponent Information	Information on corporate policy on environmental responsibility provided in Section 1.2.5.
H.2 Surficial Geology/Soils	Section 4.4 Section 11.3
H.3 Hydrology	Section 8.3
H.4 Hydrogeology	Section 9.3
H.5 Water Quality	Section 8.3
H.6 Benthic Invertebrates/Periphyton	Section 10.3
H.7 Stream Sediments	Section 10.3
H.8 Land Tenure	Figure 1-2, Section 3.2
H.9 Alternatives Means of Carrying out the Project	Section 4.15.4
H.10 Major Project Components	Sections 4.6 to 4.11
H.11 Access and Transportation	Section 4.12

YESAB Guidance Section	Project Proposal Section Information Provided In
H.12 Fuel, Hazardous Materials, and Explosives Storage Sites	Section 4.11
H.13 Construction phase	Section 4.3.2
H.14 Operation/Modification Phase	Section 4.2.2
H.15 Ore Processing	Section 4.8
H.16 Waste Rock Disposal	Section 4.9
H.17 Tailings Disposal	Section 4.9
H.18 Decommissioning/Abandonment/Reclamation Phase	Section 4.13 and Appendix H-1
H.19 Managing Accidents and Malfunctions	Chapter 17

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

2 FIRST NATION AND COMMUNITY CONSULTATION 2-1

2.1 INTRODUCTION 2-1
2.2 CONSULTATION REQUIREMENTS 2-2
2.3 HISTORICAL CONSULTATION 2-3
2.4 CONSULTATION AND ENGAGEMENT PLAN 2-4
2.4.1 Overview 2-4
2.4.2 Objectives 2-4
2.4.3 Approach 2-5
2.5 IDENTIFICATION OF PARTIES TO BE CONSULTED 2-5
2.5.1 Potentially Affected First Nations 2-6
2.5.2 Residents of Potentially Affected Communities 2-9
2.6 NEWSLETTERS, PUBLICATIONS, HANDOUTS AND OTHER INFORMATION PROVIDED 2-9
2.7 KASKA FIRST NATIONS CONSULTATION 2-10
2.7.1 Ross River Dena Council 2-10
2.7.2 Liard First Nation 2-31
2.7.3 Kaska Dena Council 2-38
2.8 COMMUNITY CONSULTATION 2-40
2.8.1 Ross River 2-40
2.8.2 Watson Lake 2-45
2.8.3 Faro 2-50
2.8.4 Whitehorse 2-56
2.9 FUTURE CONSULTATION (POST SUBMISSION) 2-60

LIST OF TABLES

Table 2-1: Identification of Parties to be Consulted in BMC's Consultation and Engagement Plan 2-5
Table 2-2: Summary of Consultation with RRDC 2-15
Table 2-3: Views Presented by RRDC and BMC's Full and Fair Consideration 2-18
Table 2-4: Summary of Consultation with LFN 2-34
Table 2-5: Views Presented by LFN and BMC's Full and Fair Consideration 2-36
Table 2-6: Summary of Consultation with KDC 2-39
Table 2-7: Summary of Consultation with the Community of Ross River 2-41
Table 2-8: Views Presented by Ross River and BMC's Full and Fair Consideration 2-42
Table 2-9: Summary of Consultation with the Community of Watson Lake 2-46
Table 2-10: Views Presented by Watson Lake and BMC's Full and Fair Consideration 2-47
Table 2-11: Summary of Consultation with the Community of Faro 2-51
Table 2-12: Views Presented by Faro and BMC's Full and Fair Consideration 2-52
Table 2-13: Summary of Consultation with City of Whitehorse 2-57

Table 2-14: Views Presented by Whitehorse and BMC's Full and Fair Consideration.....2-58

LIST OF FIGURES

Figure 2-1: Project Location, Communities and Kaska First Nations Traditional Territory.....2-7

2 FIRST NATION AND COMMUNITY CONSULTATION

2.1 INTRODUCTION

BMC Minerals (No.1) Ltd. (BMC) considers community engagement and consultation to be fundamental for the success of the Project and is committed to consultation involving two-way communication with First Nations, governments, stakeholders and other interested parties. BMC's Community Relations Policy (Appendix A-2) outlines this commitment: *The Company shall constantly strive to act in accordance with "Good Neighbor" principles in our dealings with local communities within which our projects operate.*

BMC has built on the strong relationship with local communities and the Kaska First Nations (Kaska) that was initially developed between Kudz Ze Kayah's (KZK) previous owners Cominco Ltd. subsequently taken over by Teck Resources Inc. (Teck). Consultation and engagement initiatives were commenced prior to purchasing the property to firstly introduce BMC to the Kaska and secondly confirm that their support for the Project as expressed in the 2004 Socio-economic Participation Agreement (SEPA) would be extended to BMC once that agreement was assigned by Teck. This respectful approach continues to underpin the good relationship that BMC enjoys with the Kaska today.

Since purchasing the property BMC has continued consultation with Kaska as well as with other interested parties. Ongoing engagement has included discussions regarding Project planning and design, Project Proposal content, and permitting strategies. This has consisted of numerous planned, regular and ongoing meetings with appropriate boards, agencies, Ross River Dena Council (RRDC), Liard First Nation (LFN), Kaska Dena Council (KDC), and other interested parties.

BMC has provided opportunities for these groups to visit the Project site to gain a firsthand view of the Project area and BMC's Director and President has made himself available at numerous community events and meetings offering his direct mobile number and email for further communications should they be required. Key community engagement events such as open house and community consultation meetings held by BMC and recorded in the Community Consultation Record, include six meetings in Ross River and two community meetings in each of the towns of Faro, Whitehorse, and Watson Lake.

In tandem with this direct, face to face engagement, BMC has developed a Project website (www.kudzzekayah.com) to provide online access to Project information and a means for contact for any questions and concerns regarding the Project. BMC also produces a quarterly newsletter, emailed to a database of interested recipients, as a forum to disseminate updated Project information and seek feedback.

To complement the community open houses, BMC developed a Virtual Open House which is hosted on the Project website (www.kudzzekayah.com/kudz-ze-kayah-proposal-community-information), for those who were either unable to attend one of the community meetings, or who desired more detailed and contemplative review of the Project material.

These direct and indirect means of communication have been designed and established to ensure a measure of continuous communications and consultation.

Consultation materials included on the KZK Virtual Open House are as follows:

- Digital copy of the detailed Project Overview;
- Digital copy of the complete Microsoft® PowerPoint presentation made for the November/December 2016 Community Meetings;
- Digital copies of the themed informational posters that were displayed for the Open Houses;
- Newsletters; and
- A dedicated web-based comment submission form where interested parties can directly communicate with BMC.

The Virtual Open House remains "open for business" and any comment forms received will be given a response which according to the nature of the comment, question or concerns, may include a commitment to follow up with the person who sent the email. However, it is noted that for inclusion in the Project Proposal, the date cut off for comments, questions or concerns was December 15, 2016.

This chapter provides BMC's approach to First Nation's and community consultation and engagement for the Project, as well as a detailed record of the materials presented, the time provided for recipients to review the material, and BMC's full consideration of the questions asked and any concerns raised and subsequent outcomes, along with BMC's plans to continue consultation throughout the remainder of the permitting process.

When undertaking the alternatives assessment of various Project components as presented in Section 4.15, BMC considered and incorporated views of parties consulted when developing the comparative ranking of alternatives.

BMC has also committed to ongoing community and First Nation's engagement throughout the life of the mine, which is a core element of BMC's corporate philosophy. There are also prescribed consultation measures and procedures detailed in the BMC-Kaska Socio-economic Participation Agreement that are not detailed in the Project Proposal.

2.2 CONSULTATION REQUIREMENTS

Consultation requirements for resource projects in Yukon are set out in Section 50(3) of the *Yukon Environmental and Socio-Economic Assessment Act* (*YESAA*):

> *Before submitting a proposal to the executive committee, the proponent of a project shall consult any First Nation in whose territory, or the residents of any community in which the project will be located or might have significant environmental or socio-economic effects.*
>
> *This duty to consult shall be exercised by providing notice to the party to be consulted:*

a. *Notice of the matter in sufficient form and detail to allow the party to prepare its views on the matter;*

b. *A reasonable period for the party to prepare its views,*

c. *An opportunity to present its view to the party having the duty to consult; and*

d. *By considering fully and fairly any views so presented.*

Further guidance, including Yukon Socio-economic Assessment Board's (YESAB) expectations for the documentation of consultation is provided in the Draft Proponent's Guide – Consultation Documentation – (April 11, 2016 v.2) (YESAB, 2016).

BMC has prepared and presented this consultation summary document to support YESAB's Executive Committee determination of the sufficiency of our consultative effort, as described above. BMC asserts that:

- That each of the four criteria in Section 50(3) have been met for each affected First Nation and community;
- Prior to meeting, each party has been provided with detailed information about the Project, and then allowed adequate time to consider;
- That BMC listened and responded to the issues raised during the consultation (i.e., has given full and fair consideration to each of the views presented); and
- That BMC made adjustments to the planning process or the Project Proposal (where appropriate), as a result of the consultation.

2.3 HISTORICAL CONSULTATION

The original property owners, Cominco Ltd., subsequently Teck, completed an exploration program in the mid-1990s which outlined an economic resource at KZK. Teck prepared a mine design to develop the resource; this design was put forward to Yukon regulatory agencies to support their mining applications, which were granted in 1997 and 1998, as described below.

An Initial Environmental Evaluation (IEE) for the Project was submitted for regulatory review in March 1996 and was approved in December 1997. A Water Licence Application for the Project was submitted for regulatory approval in 1997. The Type A Water Licence (QZ97-026) was issued in December 1998 and remains in effect until September 2018. Throughout these two regulatory processes, Teck undertook an extensive consultation and engagement program which informed Project design and helped develop the mitigation and management strategies for the Project. BMC's Project design is largely within the same footprint as the Teck design.

Appendix B-1 provides a summary of the consultation undertaken during the IEE and Water Licence Application review processes.

2.4 CONSULTATION AND ENGAGEMENT PLAN

2.4.1 Overview

In accordance with BMC's Community Relations Policy, a Consultation and Engagement Plan (CEP) was developed for the Project (Appendix B-2).

The CEP sets out the tools, techniques and context for consulting with the entire suite of governments, agencies, boards, organizations, stakeholder groups and First Nations with whom BMC will continue to engage in order to support assessment and eventual licensing and operating of the Project. Techniques described in the CEP will ensure that assessment, licensing and operations, and closure of the proposed mine is underpinned by thorough, formal consultation.

The CEP was presented to YESAB for review on August 12, 2015. The purpose of early submission of the CEP was to solicit feedback regarding the communities and First Nations that were proposed to be engaged with, as well as the level of engagement that YESAB would like during Project planning and prior to submission of the Project Proposal. YESAB preferred to review the Project Description prior to providing recommendations for the selection of communities that should be consulted or the level of detail required. On May 27, 2016, YESAB technical staff provided BMC with a detailed guidance document (Proponent's Guide for Consultation) (YESAB, 2016), which has been used as the basis for the documentation of the consultation efforts as set out in this chapter.

BMC continued with the consultation and engagement as per the CEP and the Proponent's Guide for Consultation, once it was available.

2.4.2 Objectives

The CEP set out the following objectives:

- Conduct meaningful and socially responsible consultation with those who are potentially affected;
- Identify values and interests, to discuss potential effects of the Project, to consider views and to take into account these views in the development of the Project;
- Ensure that all stakeholders and interested parties have sufficient opportunity to consider all aspects of the Project and participate in a fully informed dialogue with BMC; and
- Submit this Project Proposal with the support of RRDC, LFN and KDC and affected communities.

2.4.3 Approach

The consultation approach was developed to satisfy YESAB requirements, to support permitting, and to reflect BMC's principles and objectives, outcomes from past consultation efforts, and also to consider the environmental and socio-economic conditions potentially impacted by the Project.

The consultation and engagement approach used for the Project consisted of the following key steps:

- Identification of parties to be consulted;
- Provision of information to all interested stakeholders/interested parties in a format designed to be easily understood and allowing adequate time for interested parties to develop meaningful questions ahead of the consultation;
- Receipt of comments and input through a number of forums and techniques;
- Response to questions and concerns presented by stakeholders; and
- Demonstration of how the interaction between BMC, the Kaska First Nations, the affected communities, and the other interested parties and the public has modified the planning process or the Project Proposal.

Over the past two years BMC has applied and been granted two Exploration Licences following the consultation process established by BMC and RRDC. This consultation process that is now "custom & practise" demonstrates BMC's commitment to continuous and inclusive consultation. The Exploration Licence applications were modified as a consequence of RRDC feedback and as a result BMC's exploration programs have enjoyed solid Kaska support. The consultation under the CEP and included in this Project Proposal has followed a similar process.

2.5 IDENTIFICATION OF PARTIES TO BE CONSULTED

Table 2-1 presents the parties that were identified in the CEP for consultation and engagement.

Table 2-1: Identification of Parties to be Consulted in BMC's Consultation and Engagement Plan

Category	Party
Consultation Required Prior to Project Proposal Submission to YESAB, and Reported in This Chapter	
First Nations	RRDC, LFN, KDC
Community	Ross River, Watson Lake, Faro, Whitehorse
Consultation with Other Parties	
Government Agencies and Boards	YESAB Executive Committee, Yukon Government (YG) Development Assessment Branch, YG Energy, Mines and Resources, YG Environment, YG Water Resources, YG Highways and Public Works, Environment Canada, Canadian Wildlife Service, Fisheries and Oceans Canada, Natural Resources Canada, Transport Canada, YG Community Services, YG Health and Social Services, YG Tourism and Culture, Northern Projects Management Office
Other Interested Parties	Trapline concession holders, Yukon Big Game Outfitters Ltd. (YBGO) (holder of Outfitting Concession #20), Yukon Chamber of Mines, Yukon Chamber of Commerce, Yukon Conservation Society, Wilderness Tourism Association, Watson Lake Chamber of Commerce, Association of Yukon Communities, Yukon Mine Training Association, Yukon College

Table 2-1 is a comprehensive list of all the parties BMC has engaged with to varying degrees. BMC's comprehensive Communications and Consultation Record documents all consultation and engagement that has occurred to date to support the Project design and assessment. However, the *YESAA* requirement for consultation prior to submission of a Project Proposal is limited to affected First Nations and residents of affected communities. Therefore, the consultation and engagement reported herein is a subset of BMC's overall consultation and engagement program, which is not only broader in scope of recipients, but longer in duration as it continues through assessment, licencing, and into operations. This chapter sets out the methods and results of the consultation that were undertaken to inform and be informed by potentially affected First Nations and residents of communities.

The following sub-sections identify the sub-set of parties that BMC has consulted with, and who have been identified as being relevant for YESAB's review.

2.5.1 Potentially Affected First Nations

For the purposes of this Project Proposal "Kaska" and "Kaska Nation" means collectively: RRDC, LFN, Daylu Dena Council, Dease River First Nation, and Kwadacha First Nation people. The Project lies entirely within the traditional territory of the Kaska Nation. Under the Kaska Collaboration Agreement (KCA) of October 2011, for each negotiation on a project carried out pursuant to the KCA, a Lead Community will be identified by the Kaska Nation from the jurisdiction (Yukon or BC) in which the project is located. For this Project the two primary Kaska Nations are RRDC and LFN, with RRDC acknowledged as the lead agency under the KCA. KDC represents citizens of all Kaska First Nations. Figure 2-1 present the Project Location within the Yukon Kaska Traditional Territory.

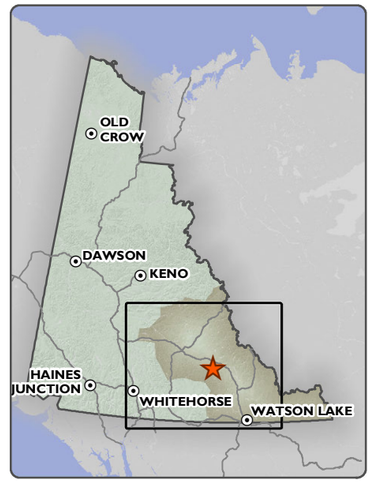
BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 2-1

PROJECT LOCATION, COMMUNITIES AND KASKA FIRST NATION TRADITIONAL TERRITORY

MARCH 2017



Kudz Ze Kayah Project

Communities Consulted

Kaska Dena First Nation (Ross River Dena Council and Liard) Traditional Territory

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.
Drainage areas obtained from National Hydrology Network 2011

Datum: NAD 83; Projection UTM Zone 9N

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As per the KCA, the negotiating of bilateral agreements between BMC and Kaska, such as the Socio-economic Participation Agreement (SEPA), Kaska has designated RRDC to be the negotiating entity and by agreement RRDC has full rights and obligations to consult with BMC on behalf of the entire Kaska Nation. For this reason, the majority of BMC's engagement efforts has been focussed on RRDC. However, BMC has also included LFN and KDC as parties to be consulted as per *YESAA* requirements and, as such, have included them in consultation meetings, site tours and discussions. Consultation events with LFN and KDC were less frequent than what BMC considers ideal due to factors beyond BMC's control. BMC has followed, and will continue to follow, a Business Integrity Framework (BIF) which guides the way BMC conducts business and encapsulates BMC's values and beliefs. The BIF falls under BMC's Company Management and Operating Policies and Procedures (Appendix A) with key objectives that include compliance with relevant legislation; as well as conducting business that meets the level of integrity and ethics that would be expected of business partners, employees, finance providers, regulators and the people and communities within which BMC operates.

BMC's Community Relations Policy (Appendix A-2) sits within BMC's Company Management and Operating Policies and Procedures and outlines BMC's aims to have a positive impact on the region and local communities within the Project area and BMC's commitment to the promotion of enhanced business opportunities, work skills and increased awareness of local community and cross cultural issues. BMC's consultation and engagement objectives with Kaska focus on the following key areas and describes the steps taken as BMC strives to be recognised as a "Good Neighbour":

- Focus on youth:
    - Voluntary implementation of a three year BMC Kaska Education Scholarship Program pre-SEPA (i.e., pre-mining) to support students that want to commence, continue or complete secondary or post-secondary studies and who would benefit from additional financial support.
    - Sponsorship of a RRDC housing rehabilitation management program through Yukon College, engaging local students in carpentry, plumbing, electrical and heating system home maintenance;
- Focus on economic benefits and capacity enhancement:
    - 'second effort' to retain local employees and contractors, including pre-qualification standards leading to the successful award to Kaska contractors of major drilling contract in 2016 season. Nearly 100% of total major suppliers for the 2016 field program were from Yukon or have strong Yukon background, and of that number 70% were from businesses or corporations associated with Kaska corporations or members.
- Focus on employees:
    - Besides BMC's planned Scholarship program which will help prepare Kaska for future mining and associated industries employment, BMC have hired a Kaska mentor and liaison officer to foster and ensure employee stability and retention.

- Focus on culture:
  - Multiple cross-cultural awareness through contracting local elders with expertise in providing Traditional Knowledge and Cultural Awareness programs. First Nation elders have facilitated workshops in Vancouver and at KZK site for exploration contractors and BMC management.
- Focus on elders:
  - Presentations prepared exclusively for elders (not just First Nation government); also hiring for key roles (i.e., liaison, mentoring and internal guidance roles);
- Focus on community:
  - Encouraged community led interaction of exploration contractors, including Open House meetings, and community BBQ's.
- Focus on communication:
  - Site tours for Kaska leadership and elders; continual neighbor-like communications, with an emphasis on listening. Regular newsletters with Project updates distributed and adoption of an open door policy whereby BMC management are available to answer community questions and queries at any time.

2.5.2 Residents of Potentially Affected Communities

The legislative requirement for consultation and engagement with potentially significantly affected communities is set out in *YESAA* legislation. While the definition of "significantly affected" is not explicit, it is implicit that reasonable consultation and consideration must be given to communities close to the Project location. As such, BMC considers potentially affected communities in the following two tiers:

1. Tier 1 Communities (Ross River and Watson Lake): These communities are likely to experience the most benefits and effects from the Project; and
2. Tier 2 Communities (Faro and Whitehorse): These will likely be interested in and may be affected by the Project (for example some KZK employees may choose to become residents of these communities, and some locally based businesses may provide goods and services), but will likely be effected to a lesser degree than the Tier 1 communities.

Figure 2-1 illustrates the Project location and potentially affected communities that were identified for consultation and engagement.

2.6 NEWSLETTERS, PUBLICATIONS, HANDOUTS AND OTHER INFORMATION PROVIDED

BMC developed and published a series of quarterly newsletters, publications, and other informational handouts provided at meetings such as open houses to ensure that the Kaska Nation and residents of potentially affected communities had written material that would help them gain a better understanding of the Project. BMC also developed and implemented a Virtual Open House on

its Project website, where people who could not attend meetings in person could review information and respond to BMC with comments. The Virtual Open House contains the Project Overview document, Microsoft® PowerPoint community presentation, newsletters and posters (www.kudzzekayah.com/kudz-ze-kayah-proposal-community-information).

Newsletters, publications, handouts and other information provided is included as appendices to this chapter and is cross referenced in the applicable summaries of consultation in the following sections.

2.7 KASKA FIRST NATIONS CONSULTATION

This section is divided into three separate components to allow for a full and separate record for RRDC, LFN and KDC.

2.7.1 Ross River Dena Council

Prior to BMC's purchase of the Project, BMC met with RRDC twice and continues to meet with RRDC on a regular basis. BMC has met with RRDC over 20 times since the purchase of the Project. BMC keeps a communication tracking log where all meetings and discussions are recorded. Because the nature of the meetings is more than just consultation (i.e., negotiations of bilateral agreements), BMC has selected only a subset of the relevant meetings for the purposes of the summary of BMC's consultation with RRDC.

Topics discussed at some of the key meetings that have been held to date are summarized below. The most relevant meetings are also summarized in Table 2-2 which includes the cross references for the appendices where the notice for the meetings are provided, as well as the consultation materials presented at the meetings (where applicable).

On October 29, 2014, BMC representatives and a representative from Teck met with RRDC Chief Brian Ladue and Council Members at Council's chambers in Ross River. The primary purpose of the meeting was for Teck to provide introductions to RRDC of the potential purchaser (BMC) of the Project. The topics discussed included the following:

- An overview of the RRDC experiences with government and exploration companies in the past and the concerns they have based on those experiences;
- RRDC's capacity to participate in the Project activities (i.e., labour, trades and contracting capacity);
- Cultural and etiquette training for Project employees working with the RRDC; and
- Invitation for BMC to return at a later date to provide a presentation about BMC and the plans for the Project to the greater community.

On November 26, 2014, BMC representatives and representatives from Equity Exploration Consultants Ltd. ("Equity") met with RRDC Chief Brian Ladue and several Council members at Council's chambers in Ross River to further discuss the proposed KZK Exploration Project. The topics discussed included the following:

- The 2004 Socio-economic Participation Agreement (between Teck Resources Inc. and RRDC);
- Hiring community members for the Project;
- Repairs required on the existing Tote Road;
- RRDC capacity concerns;
- RRDC concerns based on experience with other exploration and mining companies in the Traditional Territory (primarily socio-economic);
- RRDC companies and Kaska contractor companies;
- The draft Land Use Management Plan prepared by RRDC;
- Existing traditional knowledge for the Project area and the potential for undertaking additional studies;
- Existing caribou data for the Project area and the potential for undertaking winter aerial surveys; and
- BMC's intent to submit a draft exploration permit for their review and comment prior to submission to the regulatory agency.

On April 8, 2015, BMC and Equity representatives met with the RRDC Chief and Councillors at the RRDC Band Office. The topics discussed at the meeting were BMC's explorations plans for the 2015 field season, status of the exploration permit application and an overview of the plans for the environmental studies that would be undertaken in 2015.

On April 8, 2015, BMC representatives and representatives from Equity held a community dinner and presentation in Ross River for RRDC citizens. The content of the presentation included: an overview of BMC, the plans for the exploration Project, the status of the exploration permit application, and an overview of the environmental study and exploration programs. A copy of the presentation is included in Appendix B-3 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-3. At the dinner, BMC obtained email addresses from community members who were interested in receiving the KZK quarterly newsletter. All newsletters that have been sent to those who signed up to receive a copy are included in Appendix B-8.

In June 2015 BMC, RRDC Chief and Councillors and their negotiators participated in several teleconference calls regarding the Project. These discussions included: Project "kick off" meeting for the exploration field season; reporting on local contractors that were awarded work on the Project; Project updates regarding the scoping study; and items related to the Exploration Memorandum of Understanding. These meetings are underpinned by the consultation process established by BMC and RRDC, which is based on regular and open communications between both Parties.

In November 2015 BMC met with RRDC Chief and Councillors to discuss the Exploration Memorandum of Understanding, as well as a discussion on how the 2015 exploration field season went. This meeting provided the opportunity for both Parties to identify areas where Project improvements could be made in 2016. One of the key outcomes of this meeting was the

recommendation by Chief Ladue that BMC hire an RRDC citizen as a mentor in order to help employee retention and job readiness for the Exploration Project.

On January 11, 2016, BMC and RRDC Chief and Council met in Whitehorse to discuss the following topics: 2016 exploration program; ongoing prefeasibility study; cultural awareness training; consultation and engagement plan; and traditional knowledge agreement. It was agreed that any action items from the meeting would be discussed in Vancouver, BC, during the Mineral Exploration Roundup Conference (January 23 to 26, 2016).

On January 12, 2016, BMC hosted a community dinner and presentation in Ross River, which was attended by RRDC citizens. Questions at the meeting focussed on the exploration plans, land use and access, wildlife, jobs, fish barrier at the YG culverts where Finlayson Creek flows under the Robert Campbell Highway, and fish habitat compensation. It is noted that most of the questions at the meeting were related to development plans for KZK rather than the exploration activities. For concerns that were not addressed, BMC committed to returning and addressing them once the prefeasibility study was complete. Once the technical studies to support the PFS were complete, BMC provided detailed responses. Notice for this meeting is included in Appendix B-6 Section 1 – Notice. A copy of the presentation is included in Appendix B-6 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-3.

On January 25, 2016 BMC participated in Kaska meeting in Vancouver with RRDC and LFN Chief and Councillors, other Kaska Chiefs and Councillors and several Kaska Elders. At the meeting BMC provided the group with a Project update including: summary of the 2015 exploration program; BMC's successes and areas for improvement with respect to hiring Kaska citizens and local contractors; status of exploration memorandum of understanding; and cultural awareness training prior to commencement of the 2016 field season.

Throughout the 2015 and 2016 field seasons, the Exploration Camp Managers visited Ross River on a bi-weekly basis to have in-person discussions with the RRDC contractors, suppliers, employees and Chief and Council (as available) to ensure the Exploration Project ran smoothly and to establish long term relationships with RRDC citizens.

In 2016, BMC hired a Kaska liaison/mentor who is a RRDC citizen. The position (in part) included communicating to BMC environmental and socio-economic concerns that might arise from Ross River citizens (i.e., concerns regarding traditional land use disruption). Through ongoing communication, unforeseen residual effects were mitigated in a timely manner. The Kaska liaison/mentor spent part of the time in the community working with exploration employees on job readiness, and spends the other part of the time in camp working with exploration employees on job retention.

In the summer of 2016, in addition to several site tours for Government Regulatory Agencies, BMC hosted three site tours at KZK for RRDC Elders and Chief and Council representatives. The tours were intended to provide participants with an appreciation of the Project area (it is recognized that to Kaska, the Project site has been part of their environment for centuries) and to give them an opportunity to learn what BMC proposes to build, and to listen to their concerns. The tours included:

- A presentation summary of BMC's exploration activities in 2015 and 2016 and proposed mine;
- Vehicle tour and helicopter fly over of the exploration and proposed mine site; and
- Tour of the KZK core processing area.
- Notice for these tours is included in Appendix B-3 Section 1 – Notice. A list of the questions/concerns that were raised during the tours and BMC responses were compiled in the consultation log and are summarized in Table 2-3.

BMC was invited to three RRDC Elders meetings in 2016 (June 1, July 13 and September 27). The meetings were well attended with good questions and discussions regarding BMC's plans for KZK. Each of the meetings was organized by the RRDC Traditional Knowledge Lead. A copy of the presentations given at the Elders meetings (where applicable) are included in Appendix B-3 Section 2 - Consultation Materials and Appendix B-6 – Section 2 Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-3.

BMC invited RRDC Elders D. Smith and M. Maje to join D. Dick and K. Suza in presenting a cross-cultural workshop with BMC parent Company Directors (who traveled internationally to attend), BMC Directors and senior management on September 10 and 11, 2016. The workshops were conducted at the KZK site. The cross-cultural awareness workshops covered important topics in depth including: historical cultural practices, tribal codes, sacred traditions, life stages past and present, languages, community-based justice, historic Wolf and Crow governance practices, residential school history, traditional medicines (plants), and foods from the land.

On December 6, 2016 BMC hosted a community dinner and presentation in Ross River (Table 2-2). The content of the presentation included:

- BMC's company overview;
- ABM Deposit and BMC's regional exploration;
- KZK proposed mine plan;
- Environmental management;
- Maximizing socio-economic benefits; and
- Permitting and proposed timeline.

Notice for this meeting is included in Appendix B-7 Section 1 – Notice. A copy of the Project Overview, presentation, and posters are included in Appendix B-7 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-3. Questions at the meeting focussed on socio-economics and reclamation.

The Project Overview and access to the above-mentioned posters and presentation are located on the Virtual Open House site (kudzzekakyah.com/kudz-ze-kayah-proposal-community-information/).

On December 7, 2016 BMC met with RRDC Chief and Council in Ross River to discuss a number of items including, but not limited to, the following:

- Update on Project status: Project will see limited activity at the site in 2017, beyond environmental baseline studies and geotechnical;
- Next steps: Project on 'final approach' to entering YESAB review; prefeasibility study nearly complete;
- Technical review of YESAB Project Proposal: selection of consultant should happen immediately as BMC can provide funding for this and the review will be able to commence in a matter of a couple of weeks;
- Interim Traditional Knowledge study; a desktop Traditional Knowledge study has been completed and is proposed to complement RRDC's Traditional Knowledge report for KZK property. Copies of the ethnographic study were provided to Council.

Notice for this meeting is provided in Appendix B-3 Section 1 – Notice and Appendix B-7 Section 1 - Notice. Questions and responses specific to the content of the Project Proposal are included in Table 2-3.

Table 2-2: Summary of Consultation with RRDC

Event		Introductory Meeting with Chief and Council	Introductory Meeting with Chief and Council	Project Update for Chief & Council	BMC Introductory Meeting for RRDC Citizens	BMC Project Update at RRDC Annual General Meeting	Community Meeting #1	RRDC Elders Meeting #1	KZK Site Tour for Elders #1	RRDC Elders Meeting #2	KZK Site Tour for Elders #2	KZK Site Tour for Chief and Council	RRDC Elders Meeting #3	Community Meeting #2
Date of Event		October 29, 2014	November 26, 2014	April 8, 2015	April 8, 2015	August 1, 2015	January 12, 2016	June 1, 2016	June 22, 2016	July 13, 2016	August 1, 2016	September 8, 2016	September 27, 2016	December 5, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	BMC invited to meeting arranged between Teck and RRDC	BMC invited to meeting arranged between Teck and RRDC	Possibility for meeting discussed in Vancouver in January 2015, final meeting date invitation extended by RRDC to BMC approximately 2 weeks before meeting	Chief Brian Ladue invited BMC to present approximately 2 weeks prior to date.	Chief Brian Ladue invited BMC to present approximately 2 weeks prior to date.	Every day in Whitehorse Star from January 4th to the 12th, 2016 January 6th and 8th in Yukon News Everyday three times per day on radio (CKRW) from January 4th to 13th Posters were put up around town in early January	May 30, 2015 RRDC TK Lead invited BMC to give presentation to elders	Posters were posted around Ross River the first week in June.	RRDC TK Lead invited BMC to give presentation to elders two days before meeting.	July 20, 2016 Posters were posted around Ross River	BMC Community Liaison organized tour and confirmed with chief and council tour approximately 2 weeks before tour.	RRDC TK Lead invited BMC to give presentation to elders	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15 CHON-FM: 9 spots Dec. 2, 5, and 6 Posters up Lands office, RRDC office, Dena General store, Post office, Margaret Thompson Centre, Yukon College and Nursing Station Notice and Virtual Open House post on BMC's website: kudzzekayah.com
	Recipient	RRDC Chief & Council	RRDC Chief & Council	RRDC Chief & Council	RRDC Chief & Council, RRDC Citizens	RRDC Chief & Council, RRDC Citizens	RRDC Chief & Council, RRDC Citizens	RRDC Elders	RRDC Elders	RRDC Elders	RRDC Elders	RRDC Chief & Council	RRDC Elders	RRDC Chief &Council, RRDC Citizens
	Subject matter for Consultation	Introduction of BMC by previous owner Teck, scope of Project - History with Government & mining company's, capacity to participate in Project, cultural and etiquette training	BMC and Equity Exploration Consultants meeting with RRDC - 2004 socio-economic agreement between Teck and RRDC, hiring RRDC members, RRDC capacity, past concerns with other exploration and mining companies, RRDC and Kaska contractors, RRDC draft Land Use Management Plan, TK, caribou, Draft exploration permit submission	BMC and Equity meeting - Similar to meeting held same day with RRDC citizens	Project Update from BMC as part of RRDC Annual General Meeting	Project Update from BMC as part of RRDC Annual General Meeting	Community Meeting - Power Point Presentation: • BMC Corporate Overview • Summary of 2015 Project Activities (Exploration, Environmental, Community) • Anticipated Project Timelines • Anticipated 2016 Project Activities • Overview of BMC's Engagement Plan	Project Overview (same presentation that was given at Community Meeting #1)	KZK Site Tour: • Overview of BMC • Overview of the KZK mine development plans (based on the current site plan) • Tour via vehicle and helicopter of the ABM Deposit and proposed mine infrastructure	Project update on KZK mine design	KZK Site Tour: • Overview of BMC • Overview of the KZK mine development plans (based on the current site plan) • Tour via vehicle and helicopter of the ABM Deposit and proposed mine infrastructure	KZK Site Tour: • Overview of BMC • Overview of the KZK mine development plans (based on the current site plan) • Tour via vehicle and helicopter of the ABM Deposit and proposed mine infrastructure	Power Point Presentation: BMC Minerals (No.1) Company Overview; ABM Deposit and BMC's Regional Exploration; KZK Proposed Mine Plan; Environmental Management; Maximizing Socio-economic Benefits; and Permitting and Proposed Timeline	Original date for this meeting was set for November 14/16. Meeting was postponed due to funeral in the community. Agenda for meeting: update on KZK status, next steps (including permitting, PFS study), technical review of YESAB Project Proposal, exploration MOU, SEPA and TK protocol, Type B water licence application, interim TK study, update on EMR/RRDC negotiations on the RRDC Draft Land Use Management Plan
	Method of notice	email to BMC from Teck	email to BMC from Teck	email: Chief Brian Ladue invited BMC to present - RRDC Chief and Council provided notice to RRDC Citizens via word of mouth and posters around Ross River	email: Chief Brian Ladue invited BMC to present - RRDC Chief and Council provided notice to RRDC Citizens via word of mouth and posters around Ross River	email: Chief Brian Ladue invited BMC to present - RRDC Chief and Council provided notice to RRDC Citizens via word of mouth and posters around Ross River	newspapers/radio stations/posters around town	RRDC Traditional Knowledge Lead organized meeting and provided notice	Posters were posted around Ross River	RRDC Traditional Knowledge Lead organized meeting and provided notice	Posters were posted around Ross River	In person at RRDC Band Office	RRDC Traditional Knowledge Lead organized meeting and provided notice	Phone, email, posters

Event		Introductory Meeting with Chief and Council	Introductory Meeting with Chief and Council	Project Update for Chief & Council	BMC Introductory Meeting for RRDC Citizens	BMC Project Update at RRDC Annual General Meeting	Community Meeting #1	RRDC Elders Meeting #1	KZK Site Tour for Elders #1	RRDC Elders Meeting #2	KZK Site Tour for Elders #2	KZK Site Tour for Chief and Council	RRDC Elders Meeting #3	Community Meeting #2
	Documentation in Consultation Record	Appendix B-3, Section 1. Notice	Appendix B-3, Section 1. Notice	Appendix B-3, Section 1. Notice	Appendix B-3, Section 1. Notice Appendix B-3, Section 2. Consultation Materials	Appendix B-3, Section 2. Consultation Materials	Appendix B-6, Section 1. Notice Appendix B-6, Section 2. Consultation Materials	Appendix B-6, Section 2. Consultation Materials (same presentation that was given at Community Meeting #1)	Appendix B-3, Section 1. Notice	Notice and agenda for meeting were not provided with sufficient time for BMC to prepare materials. Presentation was a verbal update	Appendix B-3, Section 1. Notice	N/A	Appendix B-3, Section 2. Consultation Materials	Appendix B-3, Section 1. Notice Appendix B-7, - Section 1 Notice Appendix B-7, Section 2 Consultation Materials
2. A reasonable period of time to prepare views	**Recipient**	RRDC Chief & Council	RRDC Chief & Council	RRDC Chief & Council	RRDC Chief & Council, RRDC Citizens	RRDC Chief & Council, RRDC Citizens	RRDC Chief & Council, RRDC Citizens	RRDC Elders	RRDC Elders	RRDC Elders	RRDC Elders	RRDC Councillor & Deputy Chief	RRDC Elders	RRDC Chief & Council/RRDC Citizens
	Period of Time to Prepare Views	Questions and answers were provided at the meeting.	Questions and answers were provided at the meeting.	Questions and answers were provided at the meeting.	RRDC Citizens At the April 2015 meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to RRDC Citizens up until the Project Proposal data cutoff date of December 15th, 2016.	RRDC Citizens At the August meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to RRDC Citizens up until the Project Proposal data cutoff date of December 15th, 2016.	RRDC Citizens At the January 12 meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to RRDC Citizens up until the Project Proposal data cutoff date of December 15th, 2016.	Those who participated asked questions during the tour and BMC responded. BMC's contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to Elders up until the Project Proposal data cutoff date of December 15th, 2016.	RRDC elders had over 1 week to decide if they wanted to participate. Those who participated asked questions during the tour and BMC responded. BMC's contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to Elders up until the Project Proposal data cutoff date of December 15th, 2016.	Those who participated asked questions during the tour and BMC responded. BMC's contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to Elders up until the Project Proposal data cutoff date of December 15th, 2016.	RRDC elders had over 2 weeks to decide if they wanted to participate. No questions were asked during this tour. Opportunities to present views were available to Elders up until the Project Proposal data cutoff date of December 15th, 2016.	No questions were asked during this tour. Opportunities to present views were available to RRDC Citizens up until the Project Proposal data cutoff date of December 15th, 2016.	Those who participated asked questions during the tour and BMC responded. BMC's contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to Elders up until the Project Proposal data cutoff date of December 15th, 2016.	RRDC confirmed acceptance for the rescheduled meeting for December 6, 2016 on November 28, 2016. 8 days notice. Initially RRDC also had notice of initial meeting and were provided with detailed Project information (copy of Project Overview) more than a month prior to this rescheduled meeting. D. Reddies called Dec. 5 to change meeting to December 7, 8:30 a.m. in Ross River Opportunities to present views were available to Chief and Council up until the Project Proposal data cutoff date of December 15th, 2016.
3. Opportunity to Present Views	**Recipient**	RRDC Chief & Council	RRDC Chief & Council	RRDC Chief & Council	RRDC Chief & Council, RRDC Citizens	RRDC Chief & Council, RRDC Citizens	RRDC Chief & Council, RRDC Citizens	RRDC Elders: 20 elders and several youths attended.	RRDC Elders: 8 attendees	RRDC Elders: 35-40 Elders attendees (plus some younger attendees)	RRDC Elders: 7 attendees	RRDC Councillor and Deputy Chief	RRDC Elder's: 25 (plus 7 younger attendees & 7)	RRDC Chief & Council, RRDC Citizens
	Description of recipient's response	Documentation from this meeting is confidential as per the bilateral agreement between BMC and RRDC.	Documentation from this meeting is confidential as per the bilateral agreement between BMC and RRDC.	Documentation from this meeting is confidential as per the bilateral agreement between BMC and RRDC.	Categories of questions included but were not limited to: Project Description, Socio-economic, Heritage, Wildlife.	Only two questions were asked and were limited to exploration findings and the frequency of water quality sampling.	Categories of questions included but were not limited to: Aquatic Eco-System and Resources, Exploration, Groundwater/Surface Water, Mine Design, Traditional Knowledge Mitigation and Management, Wildlife.	Categories of questions included but were not limited to: Exploration, Mine Design/Environmental Management, Socio-economic, Surface Water, Traditional Knowledge.	Categories of questions included but were not limited to: Aquatic ecosystems and resources, Exploration, Groundwater, Surface water, Mine design, Traditional Knowledge, Wildlife.	Categories of questions included but were not limited to: Aquatics Eco-systems and Resources, Consultation, General, Groundwater, Heritage, Project Description, Socio-economic, Surface Water, Vegetation, and Wildlife.	N/A	N/A	Categories of questions included but were not limited to: Consultation, Exploration, Environment, and Project Description.	Categories of questions included but were not limited to: General, Mine Design, Groundwater, Socio-economic, and Reclamation.

Event		Introductory Meeting with Chief and Council	Introductory Meeting with Chief and Council	Project Update for Chief & Council	BMC Introductory Meeting for RRDC Citizens	BMC Project Update at RRDC Annual General Meeting	Community Meeting #1	RRDC Elders Meeting #1	KZK Site Tour for Elders #1	RRDC Elders Meeting #2	KZK Site Tour for Elders #2	KZK Site Tour for Chief and Council	RRDC Elders Meeting #3	Community Meeting #2
	Method	In person at meeting	In person at meeting	In person at meeting	In person at meeting, email, phone	In person at meeting, email, phone	In person at meeting, email, phone, KZK website	At meeting	In person at meeting/phone/email/ KZK website	In person at meeting/phone/email/ KZK website	N/A	N/A	In person at meeting/phone/email/ KZK website	In person at meeting/phone/email /KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	Documentation from this meeting is confidential as per the bilateral agreement between BMC and RRDC	Documentation from this meeting is confidential as per the bilateral agreement between BMC and RRDC	Documentation from this meeting is confidential as per the bilateral agreement between BMC and RRDC	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration	The response to the two questions were: 1. the results of the exploration program thus far have confirmed Teck's original findings. 2. surface water samples at all sites are collected monthly	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration	N/A	N/A	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration	Table 2-3: RRDC Views Presented and BMC's Full and Fair Consideration

Table 2-3: Views Presented by RRDC and BMC's Full and Fair Consideration

RRDD Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised									
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment /Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	RRDC Introductory Community Meeting April 8, 2015 Attendees: 20 RRDC members	Ross River Community Meeting #1 January 12, 2016 Attendance: 30	RRDC Elders Meeting in Ross River #1. June 1, 2016 Attendance: 20 elders and several youths	KZK RRDC Elders Tour June 22, 2016 Attendance: 8	RRDC Elders Meeting in Ross River #2 July 13, 2016 Attendance: 35-40 elders (plus some younger attendees)	RRDC Elders Tour August 1, 2016 Attendance: 7	RRDC Chief and Council Tour Sept. 8, 2016 Attendance: 2	Elders Meeting #3. Sept 27, 2016 Attendees 25 elders (approximately 7 other participants)	Ross River Community Meeting #2 December 6, 2016 Attendees: 15	RRDC Chief & Council Meeting December 7, 2016 Attendees: 3
What is fish habitat compensation?	The federal department of Fisheries and Oceans requires the replacement of any fish habitat that will lost due to the Project.	N/A	Aquatic Eco-systems and Resources	Fish Habitat Compensation Plan - Appendix D-4		√								
YTG Highways has a culvert on the Robert Campbell Highway at Finlayson Creek that is blocking fish passage and is even killing small fish.	BMC cannot be responsible for YTG's culvert. BMC does have a monitoring station at the location.	Following the meeting BMC assessed the reported fish barrier art the culverts and determined that eliminating the barrier would open up Finlayson Creek fish habitat for arctic grayling. BMC discussed this option with YG biologists and concluded that this may be a viable option. At the second community meeting BMC responded: BMC will propose to remove the barrier as part of the Fish Habitat Compensation Plan.	Aquatic Eco-systems and Resources	Fish Habitat Compensation Plan - Appendix D-4		√								
We don't want impacts to fish in Campbell River.	There will be no impact on the fish in Campbell River.	N/A	Aquatic Eco-systems and Resources	Aquatic Ecosystems and Resources - Chapter 10					√					
Concerned about the tailings and impacts on fish and wildlife (we all saw what happened at Mt Polly).	Mt.Polly was a collapsed tailings dam; KZK will not have a tailings dam. KZK will use modern, environmentally responsible dry-stack method, where the tailings are pressed dry, and placed on the hillside above the creek in a progressively reclaimed facility that conforms to the existing hillside slope. We are using this much safer and more expensive method because we think it's the right thing to do.	N/A	Aquatic Eco-systems and Resources/Wildlife	Project Description - Chapter 4 Aquatic Ecosystems and Resources - Chapter 10 Wildlife and Wildlife Habitat - Chapter 13					√					
Micro climate there – the region is warmer.	BMC has installed a climate station there to record climate data which will be incorporated into the design of mining infrastructure.	A micro-climate has not been identified from the 2015/2016 climate data for the site.	Climate and Meteorology	Hydrometeorology Baseline Report - Appendix D-2					√					
It was mentioned that RRDC citizens would like to be partners rather than just provide input when requested.	BMC has been in regular discussions with RRDC chief and council since prior to purchase of the Project and throughout 2015 and 2016. Our key principles and commitments are to include RRDC throughout the Project from planning, permitting, construction and operations (if there is a financial decision to move forward with the Project) and closure. BMC and RRDC's Exploration Memorandum of Understanding and updated SEPA will outline the cooperative engagement process which will further ensure that RRDC and BMC work together rather than merely soliciting feedback.	N/A	Consultation	N/A					√					
The area is important to us and we want involvement.	BMC has been in regular discussions with RRDC chief and council since prior to purchase of the Project and throughout 2015 and 2016. Our key principles and commitments are to include RRDC throughout the Project from planning, permitting, construction and operations (if there is a financial decision to move forward with the Project) and closure. BMC and RRDC's exploration memorandum of understanding and updated SEPA will outline the cooperative engagement process which will further ensure that RRDC and BMC work together rather than merely soliciting feedback.	N/A	Consultation	N/A					√					
Would like to hire an independent reviewer of the environmental studies.	Absolutely, please let us know who you would like to use and we can begin to provide the individual with the materials we have prepared to date.	BMC retained RRDC's Environmental Company (Dena Cho) to review the draft Project Proposal. The comments on the review have been addressed throughout the Project Proposal.	Consultation	N/A								√		
The elders would like to be fully and meaningfully consulted.	BMC is committed to full and meaningful consultation. BMC has strong policies in this regard.	BMC had two additional meetings following the request and will continue to consult with the Elders as the Project progresses.	Consultation	N/A					√					

RRDD Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised									
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An attendee recommended that BMC needs to use technology to show the area, 3D mapping – so Elders can see the area and understand the big picture – hard to see based on what you have so far.	BMC is currently preparing a 3D rendering of the Project area that will be presented at the Elder's Meeting fall 2016.	A video presenting the Project though all Project phases was presented at the September 27th Elders meeting.	Consultation	N/A					√					
Would like ecological and traditional values mitigated.	Any potential impacts to ecological and traditional values will be mitigated.	N/A	Environmental Management and Mitigation	Effects Assessment Chapters - Chapters 6 to 17 Conceptual Environmental Management Plans - Chapter 18					√					
Faro is a mess and we are left to deal with it, will KZK be the same?	Faro is a mess from another era, when mining was largely unregulated and without the advantages of modern techniques and technologies that are effective today in preventing long term environmental impacts. BMC has designed the mine for closure which includes progressive reclamation. Also, BMC will be required by the Territorial and Federal agencies to adhere to strict environmental permits to ensure that a mess is not generated as well as provide security bonds up front and that funds are available to reclaim the site by government, if needed.	N/A	Environmental Protection	N/A					√					
The land is important to us, we want our children and grandchildren to be able to use the land.	We understand and respect that completely.	N/A	Environmental Protection	Project Description - Chapter 4 Effects Assessment Chapters - Chapters 6 through 17 Conceptual Environmental Management Plans - Chapter 18					√					
What about cumulative effects? Both social and environmental. Non-Yukoners moving into the areas and hunting and fishing in the traditional territory.	We obviously can only control our own activities which we are committed to conducting them with the least possible impact to the environment and the people of Ross River.	N/A	Environmental Protection/Socio-economic	Project Description - Chapter 4Effects Assessment Chapters - Chapters 6 though 17Conceptual Environmental Management Plans - Chapter 18								√		
Elders want to see BMC's long term plans (i.e., with Wolf, Pelly and KZK)	BMC does have other claims in the area. Maps will be provided at the Elders Presentation in the fall of 2016. Our current plan is to focus on the Project.	At the September 27th Elders meeting BMC responded: BMC's current plan is to develop the Project. However, we do have Pelly (approximately 23 km east of the Project) and Wolf (approximately 50 km west of the Project) claims which we may conduct exploration activities on. No resource estimate is currently available for these claims.	Exploration	N/A					√					
Do you have a Pelly Project? Where is it?	Yes, we have claims called the Pelly claims they are on the eastern side of Wolverine Lake and the border some of the wolverine claims. The claims are between KZK and the wolverine mine.	N/A	Exploration	N/A						√				
What are the plans for Pelly?	BMC has recently obtained a class 3 exploration permit for the Pelly claims. However, we currently have not developed a plan to drill there.	N/A	Exploration	N/A						√				
Where is the Wolf project?	The wolf claims are approximately 50 km west of KZK.	N/A	Exploration	N/A			√			√				
What date will work start on site this year?	BMC does not yet have a fixed date but is hoping to start in April, weather and snow conditions permitting. Job and contracting opportunities will be circulated in March.	N/A	Exploration	N/A		√								
Do you ever come across any craters?	No we've not seen craters in the Project area.	N/A	Exploration	N/A									√	

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Have the exploration activities to date been successful?	Our drilling last year confirmed the results from the Comino exploration and last fall we discovered the Krakatoa lens of the ABM deposit. We are currently working on the prefeasibility study which will present the economic viability of the Project.	N/A	Exploration	N/A					√					
Is there a plan for the R block by KZK?	We have discussed the R block with RRDC and we are interested in continuing these discussions.	N/A	Exploration	N/A					√					
How many meters of drilling is planned this field season (2016)?	Approximately 20,000 meters are planned for 2016.	At the Elders meeting on September 27th and at the second community meeting the meter drilled in 2016 were provided.	Exploration	N/A			√							
Are you going to use the camp next year?	Yes, but will have a limited drill program as we focus on the Project Proposal submission.	N/A	Exploration	N/A								√		
Questions were raised at the last meeting that included BMCs long term plans in the territory given the number of claim areas that we have purchased. BMC would like to re-iterate the response.	BMC plans to continue to explore, develop and produce mining projects in Yukon. At this point there are no plans to advance anything other than KZK to production stage. For example, Wolf, GP4F remain exploration targets which will see some diamond drilling over the next few years.	N/A	Exploration	N/A								√		
The Elders on this tour did not have any questions, but were very appreciative of the opportunity to see the exploration site.	No response required.	N/A	General	N/A				√						
What is your track record? What is the last mine your company developed? Is it successful?	BMC management are highly regarded as having run a number of mines which were technical, financial, environmental and social successes.	N/A	General	N/A					√					
How far is Fyre Lake?	Fire lake is approximately 30 km to the south of KZK.	N/A	General	Effects Assessment Methods - Chapter 5 (has a map showing the location of Fyre Lake)						√				
What if you sell the Project? How will your commitments to us hold up?	Our commitments to RRDC are laid out in the SEPA, which is a legal document binding any future mine owners. However, it is BMC's intention to develop and operate the mine ourselves. That is our track record, that is our plan.	N/A	General	N/A								√		
Is there still a plan to tour the high school students through the mine site?	BMC plans to invite students that might be interested in learning about the environmental and geotechnical studies that will be underway next spring.	N/A	General	N/A									√	
Will BMC be available at the time of graduation next year?	Yes - we fully intend to participate in the graduation ceremonies of the 11 graduating students.	N/A	General	N/A									√	
Is there financing for more than this year?	Yes, BMC has $150 million in financing to find and develop base metal mining projects. KZK is the prime focus at this time. Approximately $8 million spent in 2015 and about the same budgeted in 2016.	N/A	General	N/A		√								

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There are a lot of artesian seeps on site. Is ground water going to be a problem? Water levels will rise as mining happens, how are you going to deal with it?	Yes, the site is artesian. In 2015 BMC capped a number of drill holes left by Cominco. How the ground water will be dealt with is something that will be part of the mining and water management plans.	At the second community meeting BMC described the water management plan for the Project in detail.	Groundwater/Surface water	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Baseline Report - Appendix D-1 Receiving Environment Water Balance Report - Appendix D-6 Surface Water Quality Model Report - Appendix D-7		√								
Is the dry stack going to have a culvert?	No, it won't have a culvert. Water will be drained via a rock-filled "french drain".	N/A	Mine Design	Project Description - Chapter 4									√	
Rather than constructing a liner for dry stack can you line it with moss?	Moss is not feasible as it would not provide a sufficiently low permeably barrier to protect groundwater.	N/A	Mine Design	N/A									√	
Will you use the existing road?	We will upgrade the Tote Road to an Access Road.	N/A	Mine Design	Project Description - Chapter 4									√	
What metallurgical challenges do you have?	Nothing out of the ordinary for this type of deposit. BMC is working on the metallurgy now and expects to improve on Cominco's metallurgical results through the use of modern technology and reagents.	N/A	Mine Design	Project Description - Chapter 4		√								
Will BMC use dry stack tailings?	BMC is currently looking at a number of tailings options including dry stack. This will be part of the mine plan.	Follow-up response at the second community meeting: BMC has conducted an alternatives assessment of the tailing options and BMC will construct a dry stack tailing facility on the west side of the valley as shown in the figure in the presentation.	Mine Design	Project Description - Chapter 4		√								
Are there creeks by the tailings facility?	There are no creeks near the dry stack (and there is no tailings pond).	N/A	Mine Design	N/A					√					
How many open pits will there be?	There will be one open pit with two lobes.	N/A	Mine Design	Project Description - Chapter 4					√					
How big of an area is planned for development?	The property is approximately 3 km by 2 km.	N/A	Mine Design	Project Description - Chapter 4					√					
Where is the tailings pond on the map?	There is no tailings pond - it's a dry stack facility.	N/A	Mine Design	Project Description - Chapter 4					√					
Would like a map of where all service roads will be.	Maps are being finalized and will be made available as soon as possible.	Maps were provided at the September 27th Elders meeting.	Mine Design	Project Description - Chapter 4					√					
Where is the location of the mill?	The mill is located between the Class A and B Facilities on the western side of the valley.	N/A	Mine Design	Project Description - Chapter 4						√				
Will KZK have the same problem as Wolverine with having a full tailings pond?	No - BMC is not planning to have tailings stored underwater, we are proposing to have dry stack tailings.	N/A	Mine Design	Project Description - Chapter 4						√				
Will KZK be the first dry stack tailings mine in Yukon?	No, Keno and Minto both have dry stack tailings in Yukon and in Alaska - Greens Creek, pogo and Kensington.	N/A	Mine Design	Project Description - Chapter 4						√				
What type of cover will be used on the dry stack? Seeded?	The plan is to progressively reclaim it with an engineered low permeability cover, 1 m layer of compacted natural till cover, and approximately three meters of Class C material for frost protection. The facility will be revegetated up to a pre-determined elevation to mimic the current site conditions.	N/A	Mine Design	Project Description - Chapter 4						√				

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What is the life of the mine?	It is currently projected to be a 10-year mine life (not including construction and closure).	N/A	Mine Design	Project Description - Chapter 4						√				
Is the dam in the valley for power generation?	No, it is for water storage during operations.	N/A	Mine Design	Project Description - Chapter 4								√		
What power source will you use?	We are looking at dual generators powered by LNG or Diesel.	N/A	Mine Design	Project Description - Chapter 4								√		
What is the depth of the pit?	Approximately 250 m.	N/A	Mine Design	Project Description - Chapter 4								√		
Environmental protection was brought up as a key concern.	BMC is committed to designing the Project to minimize environmental impacts and will be conducting a thorough impact assessment in collaboration with RRDC (as per the cooperative engagement process that will be developed as part of the SEPA amendments).	Environmental protection will continue to be addressed as part of ongoing consultation as the Project progresses.	Mine Design/Environmental Management	Project Description - Chapter 4 Conceptual Environmental Management Plans - Chapter 18			√							
Will the permitting take 4 years? How much can Kaska influence this timing - how has Kaska held it back, or how could Kaska speed it up?	We would expect Kaska's support of the Project and will encourage a timely review of the Project Proposal by Kaska.	N/A	Permitting	Introduction - Chapter 1									√	
Access is open to guide outfitters but not Kaska members (Kaska respect the road licence rules but would like access).	The licence is specific to limiting the use of the Tote Road to BMC, it does not limit the Kaska from entering the area via other routes.	This response has been provided at all subsequent meetings with RRDC.	Project Description	Project Description - Chapter 4	√									
What kind of minerals are you mining?	Copper, Zinc, Lead, Silver, Gold.	N/A	Project Description	Project Description - Chapter 4										
What type of ore is it?	Copper, Zinc, Lead, Silver, Gold.	N/A	Project Description	Project Description - Chapter 4						√				
What are you going to do with the waste rock and water - will it be like Faro?	BMC explained modern permitting and design would not permit environmental impacts like Faro to occur and then later in the presentation described the waste rock storage and management strategies (i.e., dry stack methods and design to keep clean water clean).	N/A	Project Description	Project Description - Chapter 4								√		
Will the ABM lake at closure need treatment?	The final water quality predictions are being worked on, but the thoughts are that with design strategies such as adding limestone to the pit that the potential for treatment is unlikely. However, there will be a treatment plant on site through operations and closure and would be used post closure (it is not known at this time if it will be required).	Modelling has been completed since the meeting and the results are presented in the Project Proposal.	Project Description	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Reclamation and Closure Plan - Chapter - Appendix H-1								√		
Why not use the Wolverine mill and tailings impoundment (this would reduce the impact at KZK)?	The Wolverine Mill is not suitable for the Project.	Follow-up response at the September 27th Elders meeting. BMC has not received favourable responses from Yukon Zinc. BMC has made enquiries about Yukon Zinc and has learned that the Wolverine Mine facilities are not appropriate for KZK because: it is not available for sale, facility is not sufficient capacity to process the KZK ore, the mill process at Wolverine is designed for a different ore type from the KZK, there is not enough room identified at the Wolverine site to place KZK tailings if they were to be milled there.	Project Description	Project Description - Chapter 4					√					

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We don't agree with building a new facility when you can use the wolverine facility.	We're not able to use the Wolverine facility.	Follow-up response at the September 27th Elders meeting. BMC has not received favourable responses from Yukon Zinc. BMC has made enquiries about Yukon Zinc and has learned that the Wolverine Mine facilities are not appropriate for KZK because: it is not available for sale, facility is not sufficient capacity to process the KZK ore, the mill process at Wolverine is designed for a different ore type from the KZK, there is not enough room identified at the Wolverine site to place KZK tailings if they were to be milled there.	Project Description	Project Description - Chapter 4					√					
The Elders would like to be part of designing the mine as infrastructure may need to be changed to meet the Elders needs.	RRDC (including Elders, have been involved since purchase of the Project) and will continue to be involved in accordance with the cooperative engagement plan under the renewed SEPA.	Will continue to be addressed as part of ongoing consultation as the Project progresses.	Project Description	N/A					√					
How far is it from the camp to the pit?	Approximately 5 km.	N/A	Project Description	Project Description - Chapter 4						√				
Will the Project operate all winter?	Yes.	N/A	Project Description	Project Description - Chapter 4						√				
One Elder requested a detailed presentation on the progressive reclamation of the tailings storage area.	BMC will provide this at our next Elders meeting.	A detailed description of the progressive reclamation was presented at the September 27th Elders meeting.	Project Description	Project Description - Chapter 4						√				
Where is the concentrate going to be trucked?	The concentrate will be hauled south through Watson Lake to the Port in Stewart BC.	N/A	Project Description	Project Description - Chapter 4						√				
How many truck loads per day?	There will be approximately 19 trucks per day (one way).	N/A	Project Description	Project Description - Chapter 4								√		
Hauling - why not use the Canol Road rather than the Robert Campbell Highway?	The Robert Campbell Highway is designed to haul heavy loads at highway speeds, and the Canol Road would require substantial reconstruction, which would make it not economically feasible for this Project.	N/A	Project Description	N/A									√	
How far from the road is the mine?	Approximately 25 km.	N/A	Project Description	Chapter 3 - Project Location					√					
Where are the Lakes?	The lakes were shown on the map.	N/A	Project Description	Surface Water Quality and Quantity - Chapter 8					√					
The ponds past the end of the Tote Road are called South Lakes.	Yes, they are called South Lakes.	N/A	Project Description	Surface Water Quality and Quantity - Chapter 8					√					
How far is it to South Lakes?	Approximately 500 m.	N/A	Project Description	Surface Water Quality and Quantity - Chapter 8						√				
Will the tailings impact the creek?	The tailings will be placed in a lined facility and dry stacked on the side of the valley, with a small slope. The tailings will be progressively reclaimed with an engineered low permeable barrier to minimize water infiltration. Additional designs include water management ponds, water treatment, water collection ponds and treated wetlands. Therefore, no impacts to the water quality in the creek are predicted.	N/A	Project Description/Water Quality	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Conceptual Environmental Management Plans - Chapter 18								√		
The pit looks like it will be about 1000 m wide - this could be a danger to wildlife.	BMC will put a fence or some sort of wildlife barrier up around the slopes of the pit to prevent wildlife incidents.	N/A	Project Description/Wildlife	Project Description - Chapter 4 Wildlife and Wildlife Habitat - Chapter 14								√		

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After completion of mining, there is concern that the government will have to clean up.	In recognition of this concern, long before mining starts, BMC will have a closure plan - which is part of the Type A water licence. The closure plan is costed and funds are set aside. Operations will be conducted using progressive reclamation techniques - costing will be revaluated every two years and the funds required for closure will be updated and added to the closure fund as required.	N/A	Reclamation and Closure	Reclamation and Closure Plan - Appendix H-1.										√
During the environmental assessment for Cominco a deposit of $23 million was required up front - is that what BMC will have to do?	Government's current practice is to require payment for closure plan to be made in tranches, in accordance with liability that exists at the site at the time.	N/A	Reclamation and Closure	Reclamation and Closure Plan - Appendix H-1.										√
Will you abandon the Project when metal prices decrease?	We will never 'abandon' the Project; we believe it will always be our responsibility, before, during and after mining operation ceases for whatever reason. Modern legislation governing mine closure ensures that government makes companies accountable versus in the past where mining companies left projects without reclaiming them.	N/A	Reclamation and Closure	Reclamation and Closure Plan - Appendix H-1					√					
On closure, will willows, moss and lichen grow?	Yes, BMC has prepared, as part of baseline studies, a vegetation map. This will be used in revegetation planning to ensure accurate revegetation occurs.	N/A	Reclamation/Vegetation	Reclamation and Closure Plan - Appendix H-1									√	
It's been a problem in the past - using seeds that are not native to this area that would not grow. Ross River wants to suggest using local seeds.	In recognition of this concern BMC has committed to developing a seed collection program in the community of Ross River to support reclamation activities during progressive reclamation and at closure. BMC is proposing to initiate the seed collection program in 2017.	N/A	Reclamation/Vegetation	Reclamation and Closure Plan - Appendix H-1									√	
Are you going to move the cranberry patch?	The vegetation and organic soils in the areas of disturbance (including the cranberry locations where the Class A Storage Facility is proposed) will be removed and set aside - to be replaced during progressive reclamation. BMC is proposing to work with RRDC on a seed collection program which would start in 2017.	N/A	Reclamation/Vegetation	Reclamation and Closure Plan - Appendix H-1									√	
We want access to the land – to visit grave sites.	BMC understands that continued access is important. We do, however, have safety standards which will restrict the use of all active mine roads by anyone for any purpose other than BMC personnel for mine purposes.	N/A	Socio-economic	Project Description - Chapter 4					√					
Socio-economic Participation Agreement (SEPA) is dated. Will it be reviewed and amended?	Yes, BMC and RRDC will be reviewing the SEPA and amending it.	N/A	Socio-economic	N/A	√									
The land use disruption payment was identified by Chief Caesar as not sufficient and that he would like to see RRDC members permitting to use the tote road occasionally for hunting.	It was agreed that BMC would look in to arranging a joint meeting with RRDC Chief and Council, BMC and YG to discuss the tote road licence.	Will be addressed as part of ongoing consultation as the Project progresses.	Socio-economic	N/A			√							
One of the elders would like to see a management committee formed.	There is a management committee already set out in the SEPA, which will be activated once the Project moves from exploration to development and production.	N/A	Socio-economic	N/A					√					
Elders reclaiming our place as responsible managers of the land.	BMC values the input of RRDC elders in ensuring the Project provides a positive legacy.	N/A	Socio-economic	N/A					√					
Would like environmental monitors – guardianship.	BMC currently has Kaska environmental monitors employed for the exploration season and will continue in accordance with internal policies and within the SEPA.	N/A	Socio-economic	N/A					√					
How are you intending to seek consent from RRDC?	Consent is in place with the existing SEPA. Our goal is to receive renewed Kaska consent with the signing of the renewed SEPA.	N/A	Socio-economic	N/A								√		

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Is there preferential hiring of RRDC citizens? Is there training and job retention programs?	These provisions are contained within the Exploration MOU and the SEPA, currently under negotiation.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15									√	
What about courses to help people learn while they are in their community? (trades, apprentices)	BMC is committed to ensuring the provision of training programs as part of its employment and training program.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15									√	
Need to see residents (citizens) benefiting from mining.	BMC agrees fully and these commitments will be captured within our Socio-economic Participation Agreement and Exploration MOU.	N/A	Socio-Economic	Socio-economic Effects Assessment - Chapter 15										√
We have concern about whether there will be employment opportunities.	As part of the SEPA, BMC is obligated to provide Ross River Citizens employment opportunities. Hiring locally is a priority for BMC.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√									
We have a concern about impacts to Trapline Holders 405 and 250.	Impacts to traplines are addressed (in part) as part of the SEPA.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√									
How will BMC address addiction, literacy, and training?	Addiction – we will have strong and clear policies in place regarding "Fitness to Work" and will have a similarly strong training package around this topic. The site support will include a Mentor who will educate employees about the subject and help them to not fall Education/Literacy – BMC will develop Scholarship & Bursary program in place and this will include small financial assistance packages to help kids stay in school longer. We will also work with the Ross River school to show kids why finishing school is important. Training – we will have in house training programs for every area of the operation. We are also currently (and will expand on) providing financial assistance to people attending Yukon College to do apprenticeships and will have our own apprentice program at site.	BMC has implemented all of these through the 2015 and 2016 exploration programs and BMC presented a more detailed description of each at the September 27th Elders meeting.	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√									
Would like use the area for hunting and fishing and traditional uses.	BMC is not opposed to RRDC using the regional area for such purposes; however, BMCs primary concern is safety of the public and safety of the workers. The use of the tote road by RRDC citizens has been raised at several meetings and it's not a straight forward problem to solve. This is likely a discussion that has to be had with RRDC, YG, BMC and other land users and we are completely open to participating in developing a solution with all parties.	Will be addressed as part of ongoing consultation as the Project progresses.	Socio-economic	Socio-economic Effects Assessment - Chapter 15								√		
SEPA with Cominco provides for access – we want to hunt, fish and trap in that area.	The SEPA does not provide access to the Tote Road. BMC understands that access is important. We do, however, have safety standards which will restrict the use of all active mine roads by anyone for any purpose other than BMC personnel for mine purposes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15					√					
Is there a real potential for a mine at KZK?	We have not yet completed our prefeasibility study; however, at this point indications are positive; we do believe there is real potential for a mine at KZK.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15								√		

RRDD Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised									
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment /Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	RRDC Introductory Community Meeting April 8, 2015 Attendees: 20 RRDC members	Ross River Community Meeting #1 January 12, 2016 Attendance: 30	RRDC Elders Meeting in Ross River #1. June 1, 2016 Attendance: 20 elders and several youths	KZK RRDC Elders Tour June 22, 2016 Attendance: 8	RRDC Elders Meeting in Ross River #2 July 13, 2016 Attendance: 35-40 elders (plus some younger attendees)	RRDC Elders Tour August 1, 2016 Attendance: 7	RRDC Chief and Council Tour Sept. 8, 2016 Attendance: 2	Elders Meeting #3. Sept 27, 2016 Attendees 25 elders (approximately 7 other participants)	Ross River Community Meeting #2 December 6, 2016 Attendees: 15	RRDC Chief & Council Meeting December 7, 2016 Attendees: 3
Concerns about RRDC citizens not being able to use the Tote Road for hunting was the main discussion at the meeting. It was recommended that BMC arrange a meeting with RRDC and YG to allow RRDC citizens seasonal use of the tote road for hunting. One of the elders reminded the group that RRDC agreed to the permit requirements when Cominco and YG were consulting them on the licence requirements before the licence was issued.	The access restrictions on the tote road are part of our licence requirements (for safety and to minimize the impacts to wildlife from increased access for hunting purposes). A land use disruption payment is included in the existing SEPA and BMC has been providing the payment to RRDC). In addition, the licence is only for Tote Road use, the area may be accessed the way it was traditionally accessed before the road was constructed in the 1990s.	Will be addressed as part of ongoing consultation as the Project progresses.	Socio-economic	Socio-economic Effects Assessment - Chapter 15			√							
There was a discussion about compensation for impacts from exploration activities and the Project.	There is an existing SEPA for the Project and RRDC chief and council and BMC will be making some changes to the SEPA. However, the existing SEPA does provide for benefits to RRDC and other Kaska citizens, which BMC has been providing.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15			√							
Would like benefits such as jobs.	Through the field season this year 20 of the 49 exploration staff on site at any given time were RRDC citizens, Kaska or other First Nations. If the Project progresses to construction and operations this number will increase as more opportunities become available.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15					√					
What benefits will we see from this Project?	Aside from the financial benefits included as part as the SEPA, BMC intends to use this Project as a means of increasing the capacity of the contractors and workforce of the Kaska citizens.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15					√					
Are you still working on modernizing the SEPA?	Yes, sent a revised SEPA to RRDC chief and council approximately 2 weeks ago for their review and comment.	N/A	Socio-economic	N/A								√		
The elders would like to be consulted on the SEPA and Exploration MOU and have requested that RRDC Chief and Council and their negotiators consult with them on the agreements.	BMC acknowledged that the elders have requested consultation by RRDC chief and council and their negotiators on the agreements. - BMC noted that the main difference between the 2004 SEPA and the modernized one is that the existing one had a number of objectives but didn't specify how those objectives would be met. The amended SEPA will layout how both parties will achieve the objectives.	N/A	Socio-economic	N/A								√		
Is the exploration MOU also pre-existing and being amended?	No, the exploration MOU is a new agreement between BMC and Kaska. The exploration MOU is for BMCs claims' outside of the Project (as the Project is covered by the SEPA).	N/A	Socio-economic	N/A								√		
The Elders would like to see more RRDC citizens employed at the exploration project (i.e., up to 25%).	BMC is honoring the SEPA and as outlined in the SEPA has a requirement for all contractors to try to use RRDC and other Kaska Citizens if qualified and they meet the fitness for work policies. All contractors are required to report monthly on use of RRDC Citizens, Kaska, other First Nations and Yukoners. As per the SEPA, BMC reported the employment numbers and expenditures for the 2015 field season to RRDC Chief and Council and have made a significant effort to improve those numbers in 2016. Through the field season this year 20 of the 49 exploration staff on site at any given time were RRDC Citizens, Kaska or other First Nations. This meets the recommended 25% (which does not include our other contractors that supply goods to the site).	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15								√		

RRDD Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised									
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment /Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	RRDC Introductory Community Meeting April 8, 2015 Attendees: 20 RRDC members	Ross River Community Meeting #1 January 12, 2016 Attendance: 30	RRDC Elders Meeting in Ross River #1. June 1, 2016 Attendance: 20 elders and several youths	KZK RRDC Elders Tour June 22, 2016 Attendance: 8	RRDC Elders Meeting in Ross River #2 July 13, 2016 Attendance: 35-40 elders (plus some younger attendees)	RRDC Elders Tour August 1, 2016 Attendance: 7	RRDC Chief and Council Tour Sept. 8, 2016 Attendance: 2	Elders Meeting #3. Sept 27, 2016 Attendees 25 elders (approximately 7 other participants)	Ross River Community Meeting #2 December 6, 2016 Attendees: 15	RRDC Chief & Council Meeting December 7, 2016 Attendees: 3
There was concern that some of the RRDC based companies don't hire enough RRDC citizens.	BMC reiterated the contractual agreements with the local contractors and suggested that if they are concerned then they could consider talking to the contractors directly.	N/A	Socio-economic	N/A								√		
In follow-up here was a discussion that the workforce in Ross River may be limited due to BMC's drug and alcohol policy and that the local contractors have to look outside of the community for staff that can meet the fitness for work policies.	BMC explained that the policy is strictly for health and safety as this is the number one priority on site. BMC also explained that through discussions with Chief and Council that it is not a one time pass or fail. If a person fails, they are able to spend time improving their lifestyle and re-apply and get re-tested. BMC indicated that they have hired an RRDC mentor/liaison to assist in employee retention and to help with job readiness and this has improved the turn over that was experienced last year.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15								√		
One of the elders suggested that if BMC is interested in increasing local employment that the Elders committee could be contacted.	BMC responded that the elders would be a really good source of information regarding the local workforce as there have been some challenges in the past.	N/A	Socio-economic	N/A								√		
There was a concern that some people without tickets have not been hired, but they have 30 years work experience?	People who can prove capabilities competency but don't have tickets can be hired, but this year there were over 120 people who applied for a limited amount of positions. Hopefully the mentor/liaison will be able to help us improve on this.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15								√		
Youth are very important to us; we need help from you to ensure the younger generation has a future.	Opportunities for youth is a special focus of BMC and we look forward to continue working with RRDC to provide opportunities to enhance the capacity of youth	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15								√		
Water is really important and would like to see it protected.	The Project has been designed to re-use water where ever practical and to keep clean water clean.	N/A	Surface Water	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Conceptual Environmental Management Plans - Chapter 18								√		
Wolverine Lake is black; will your Project do the same to the lakes there?	No - this is not a possibility for our Project.	N/A	Surface Water	N/A					√					
Is there an evidence of natural current contamination from minerals at surface or near surface? Is there background selenium in the water? Will selenium in the water increase as mining occurs?	KZK appears to be typical of the types of sites with surface and near-surface mineralization. There are very low levels of selenium in the water now. The levels occurring in the water now will be part of the baseline and as mining proceeds the allowable level of selenium and other metals will be set in the relevant licences.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Baseline Report - Appendix D-1 Receiving Environment Water Balance Report - Appendix D-6		√								
Concerns about impacts to water quality was brought up.	BMC is designing the Project to reduce and minimize the potential for water quality impacts. The water quality modelling is currently underway. Once the design and modelling is complete, we will present the results to the community to show all of the steps we will take to reduce the potential for water quality impacts.	N/A	Surface water	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Conceptual Environmental Management Plans - Chapter 18			√							
Will the impacts to water impact Campbell River? We use Campbell River as a drinking water source.	There will be no impacts to water quality in Campbell River.	N/A	Surface water	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Conceptual Environmental Management Plans - Chapter 18					√					

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Concern is the continental divide with the water going in both directions.	In consideration of this concern, BMC will ensure that any temporary impacts during mining operations will be reversed upon mine closure.	N/A	Surface water	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Conceptual Environmental Management Plans - Chapter 18 Reclamation and Closure Plan - Chapter - Appendix H-1										√
Is the Project by Mink Creek? This creek is important to us.	No, the Project is not close to Mink Creek.	N/A	Surface Water	N/A					√					
Is selenium an issue?	KZK has about one tenth the level of selenium as Wolverine. Selenium may end up in the concentrate or in the tails. If in the concentrate selenium may have a smelter credit or penalty. Will have to wait on more testing and markets during operations to know for sure.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Model Report - Appendix D-7		√								
Will the mine impact water quality?	BMC is designing the Project to reduce and minimize the potential for water quality impacts. The water quality modelling is currently underway. Once the design and modelling is complete, we will present the results to the community to show all of the steps we will take to reduce the potential for water quality impacts.	At the second community meeting BMC described the water management plan for the Project in detail. Including the strategies to minimize impacts to water quality.	Surface Water	Surface Water Quality and Quantity - Chapter 8 Conceptual Environmental Management Plans - Chapter 18						√				
Will the Pit Lake water after the mine is closed be contaminated?	We are currently modelling the ABM lake water at the closure scenario. If metals are predicted to be elevated, we will treat the water until it meets the water quality guidelines. We are also planning to construct a wetland treatment system to treat the spill water long term. But the final design will be presented in the Project Proposal once more studies are completed.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8						√				
Culturally important sites and buffers around these sites were also brought up at the meeting. Are there any cultural values there? (i.e., grave sites, cabin sites, mineral licks, trails) if so they will need buffer zones to ensure protection. The RRDC Traditional Knowledge lead indicated that ongoing Traditional Knowledge work has identified grave sites near Pelly Project and NE end of Wolverine Lake and would like to see them protected. TK has been done in that area since 2003 – huge database, we have it in GIS files as well as audio and video. For sacred areas – my Elders said there is an area of coloured clay – not sure exactly where it is but needs to be protected. The area contains culturally important sites.	A Traditional Knowledge study was conducted for the Project in the 1990s, the study has shown no sites that overlap with the proposed infrastructure. BMC has been working with the RRDC TK team on a TK Protocol. Once the TK protocol has been finalized the RRDC TK team will initiate a supplemental TK study for the Project. As part of those negotiations, BMC was invited here today to provide the Elders with an introduction to BMC, the exploration activities and an overview of the environmental studies that we've been working on. It is understood that after lunch the elders will be using maps generated (by the RRDC TK team) to preliminarily identify culturally important sites (which may be incorporated into the future TK study). In addition, prior to exploration activities starting in 2015 and 2016, BMC provided the RRDC TK team with the proposed drill hole locations, so that they could overlay the proposed drill holes with the existing RRDC TK database and identify if there were any no work zones. No avoidance zones were provided to BMC.	BMC responded as follows at the December 6, 2016 meeting with Chief and Council: A desk-based ethnographic study was conducted for the Project to assist in identifying important cultural sites. The study from the 1990s is incorporated into this report. Ongoing future traditional knowledge data collection efforts by RRDC, as well as consultation and engagement activities with RRDC, may result in additional information and understanding on this issue. Once additional traditional knowledge information is provided to BMC we will consider it. A chance find procedure has been developed and will be included as part of the on site orientation for all BMC employees and contractors.	Traditional Knowledge	Kaska Ethnographic Overview of the Kudz Ze Kayah Project - Appendix F-3Heritage Management Plan - Appendix F-2			√		√					

RRDD Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised									
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There is a caribou fence by the Project.	We look forward to receiving the RRDC TK study that will allow us to identify and ensure protection of all sacred and/or culturally important sites.	BMC responded as follows at the December 6, 2016 meeting with Chief and Council: A desk-based ethnographic study was conducted for the Project to assist in identifying important cultural sites. The study from the 1990s is incorporated into this report. Ongoing future traditional knowledge data collection efforts by RRDC, as well as consultation and engagement activities with RRDC, may result in additional information and understanding on this issue. Once additional traditional knowledge information is provided to BMC we will consider it.	Traditional Knowledge	Kaska Ethnographic Overview of the Kudz Ze Kayah Project - Appendix F-3					√					
The RRDC and elders have completed a land use plan for the traditional territory that is not yet public. There will be specific prescriptions for different parts of the KZK site, e.g., mineral lick and traditional trails that will be stronger than current YG rules.	No response at meeting.	BMC looks forward to seeing the plan as soon as RRDC is ready to make it available. BMC will incorporate the prescriptions where practicable.	Traditional Knowledge. Mitigation and Management	The plan had not yet been provided at the time of Project Proposal preparation.		√								
Grave sites have not been addressed.	An archaeological impact assessment and a traditional use study was conducted as part of the initial environmental evaluation in the 1990s. No grave sites were identified. A new archaeological study and a Traditional Knowledge study will be conducted in 2015. The TK study will be conducted by RRDC. The results of these studies will be included in the Project Proposal.	BMC responded as follows at the Third Elders Meeting: The results of the 2015 archaeology study were presented to RRDC citizens in the fall of 2015. The results of the 2016 archaeology study were sent to RRDC chief and council in the fall of 2016. To date no grave sites were identified as part of the studies that have been completed. BMC responded as follows at the December 6, 2016 meeting with Chief and Council: A desk-based ethnographic study was conducted for the Project to assist in identifying important cultural sites. Ongoing future traditional knowledge data collection efforts by RRDC, as well as consultation and engagement activities with the RRDC, may result in additional information and understanding on this issue. Once additional traditional knowledge information is provided to BMC we will consider it. To date no grave sites have been identified as part of the studies that have been completed. A chance find procedure has been developed and will be included as part of the on site orientation for all BMC employees and contractors.	Traditional Knowledge/Heritage	Heritage Resources Baseline Report - Appendix F-1 Heritage Management Plan - Appendix F-2 Kaska Ethnographic Overview of the Kudz Ze Kayah Project - Appendix F-3	√									
Did you see the invasive plants growing along the road?	In 2015 BMC conducted a survey for invasive species and found invasive along the Tote road in a few places and several at the gatehouse. BMC subsequently developed an Invasive Species Management Plan and in 2016 removed the species including the roots and incinerated them. Ongoing monitoring will be conducted through the growing season of 2017 to ensure they don't grow back. This Management Plan will continue to be implemented through our construction and operations.	N/A	Vegetation	Conceptual Environmental Management Plans - Chapter 18									√	
Would like to know what plants and animals are there.	Vegetation consists of alpine and subalpine species. Most wildlife species identified in Yukon are present in the Project area including but not limited to: moose, caribou, hare, arctic ground squirrel, black bear, grizzly, many species of birds, furbearers such as wolves, fox, wolverine, marmot.	N/A	Vegetation/Wildlife	Vegetation Baseline Report - Appendix E-6 Wildlife Baseline Report - Appendix E-7					√					

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BMC needs to keep hunters out, especially fly-in hunters (not the outfitter).	No hunters are allowed to use the access road (this is a condition of the licence) but BMC cannot control air access to lakes in the region.	N/A	Wildlife	Project Description - Chapter 4 No Fire Arms Policy - Appendix A-9 No recreational Use of All-Terrain Vehicles and Snowmobile Policy - Appendix B-11		√								
Impacts to furbearers from noise due to exploration activities.	BMC will conduct baseline studies for furbearers and will conduct an impact assessment for how noise will impact furbearers as part of the Project Proposal.	N/A	Wildlife	Wildlife and Wildlife Habitat - Chapter 13	√									
Lack of wildlife management by YG.	BMC is not responsible for wildlife management by YG.	N/A	Wildlife	N/A	√									
Caribou and moose populations are decreasing.	We note your concern.	N/A	Wildlife	Wildlife and Wildlife Habitat - Chapter 13 Wildlife Baseline Report - Appendix E-6 Conceptual Environmental Management Plans - Chapter 18					√					
There is sheep south of the Project.	That's correct, they are approximately 7 km south of the Project.	N/A	Wildlife	Wildlife and Wildlife Habitat - Chapter 13 Wildlife Baseline Report - Appendix E-6					√					
Has BMC had a discussion with RRDC Chief and Council about fly-in hunting?	BMC has discussed hunting in relation to the SEPA, but not about fly-in or other hunting issues.	N/A	Wildlife	N/A		√								

The most common concerns that have been raised during the meetings with RRDC citizens to date have been regarding:

- Long term effects on water quality;
- Questions about potential impacts to wildlife, e.g., caribou (potential increased access resulting in over-hunting);
- Questions about potential impacts to traditional land uses;
- Questions about potential impacts to heritage sites; and
- Access to the Tote Road for traditional use purposes.

BMC has described the preliminary water management designs and strategies for minimizing the potential impacts to water quality and have committed to ongoing discussions with RRDC regarding the final designs, mitigation measures, and modelling results.

BMC will maintain a "no hunting" policy at camp, and continuous road access monitoring and control at the gatehouse through the permanent gate-keeper.

Mitigation of potential impacts to traditional land uses are addressed in the SEPA agreement through payment of a land use interruption fee which acknowledges a temporary disruption of traditional pursuits during active mining phases.

BMC has undertaken a comprehensive Traditional Knowledge desktop study and has conducted heritage baseline studies on site to provide complete information about Heritage Sites. This has informed the preparation of BMC's Heritage Resources Management plan, submitted to YESAB as part of the Project Proposal.

With respect to provisions to use the Tote Road for traditional use purposes, BMC has described the conditions of the Tote Road Licence of "no unauthorised use". BMC's primary concern is safety (workers, general public). BMC has acknowledged that the use of the Tote Road by RRDC citizens has been raised at several meetings and explained that it is not a straight forward problem to resolve, and that a discussion needs to occur between RRDC, YG, BMC and other landusers, and BMC is open to participating in developing a solution with all parties. BMC has also pointed out that the use of the Tote Road by Kaska is not a necessary precursor to Kaska participating in traditional land use in the KZK claim area as other access methods and routes exist. BMC also notes that not all Kaska support the use by Kaska of the Tote Road and have advised BMC that they would prefer to see BMC not agree to Kaska using the road for hunting access.

2.7.2 Liard First Nation

On April 13, 2015, BMC representatives met with LFN Chief and Council and LFN's Traditional Knowledge lead (Table 2-4). The meeting was introductory in scope with BMC providing a high-level overview of the Project and BMC's current plans for exploration and the prefeasibility study. LFN advised BMC that RRDC were the lead community as per the Kaska Collaboration Agreement and

would take the lead on the Exploration Memorandum of Understanding negotiations. The discussion then focussed on the type of mine, haul routes, job opportunities, and other issues. Concerns regarding impacts to wildlife and water quality were also raised. Several additional attempts to have in-person meetings with LFN Chief and Council have been unsuccessful. These additional attempts have been documented in Table 2-4 and Appendix B-4 Section 1 – Notice (where available). During the April 13, 2015 meeting BMC committed to sending LFN copies of the draft environmental baseline study work plan for 2015 as well as BMC's KZK Exploration Project Environmental Management Plan for the 2015 field season, such that LFN could review the documents and provide feedback and or recommend changes. This information is provided in Appendix B-4 Section 2 – Consultation Materials. As of March 2017, no response has been received regarding the documentation provided to LFN.

On September 8, 2016, BMC conducted a site tour that was intended exclusively for both LFN and RRDC Chief and Councils. Following confirmation via email and phone to LFN, BMC chartered an airplane large enough to accommodate all members of both Councils plus BMC executive. Upon arrival of the plane in Watson Lake to pick up LFN Chief and Council, no one was present for the tour. Repeated calls to Chief Morris were unsuccessful. After waiting approximately 20 minutes, the charter continued on to Ross River. The Deputy Chief and one Councillor were picked up and flew to the Finlayson airstrip where BMC conducted an informative site tour. The attempts to engage LFN have been documented in Table 2-4 and Appendix B-4 Section 1 – Notice (where available).

On January 14, 2016, BMC hosted a community dinner and presentation in Watson Lake, in which LFN citizens attended (Table 2-4). The meeting focussed on: an introduction and overview of BMC, the 2015 exploration program, status of the prefeasibility study, and the ongoing environmental and socio-economic programs. It is noted that some of the questions at the meeting were related to development plans for KZK rather than the exploration activities. For concerns that were not addressed, BMC committed to returning and addressing them once the prefeasibility study was complete. Notice for this meeting is included in Appendix B-4 Section 1 Notice and Appendix B-6 Section 1 – Notice. A copy of the presentation is included in Appendix B-6 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-5. During the meeting attendees had the opportunity to sign up for the BMC quarterly newsletter. Copies of the newsletters are included in Appendix B-8.

On March 16, 2016 Equity Exploration (on behalf of BMC) hosted an informal job fair in Watson Lake that involved meetings with LFN citizens who were interested in working on the KZK Exploration Project for the 2016 field season. Meetings were held in three separate community offices:

- Watson Lake Community Outreach – A meeting was held with three personnel who subsequently posted the jobs on their notice board and added to their online job postings. Following the job postings BMC received numerous job applications from LFN citizens.
- LFN Office – A meeting was held with the administrative assistant who took copies of the job advertisements and posted them on their notice board.
- Kaska Nation Office – A meeting was held with Deputy Chief Cindy Porter. The discussion included a description of the types of jobs that would be available and a general overview of

the status of the Project. Ms. Porter introduced Equity Exploration to five LFN citizens and subsequently met with them as a group and discussed Project plans for 2016.

Although the meetings held on March 2016 were informal, it was a great opportunity to provide LFN citizens with BMC's Project Plans and provide opportunities for employment at the same time.

On November 17, 2016 BMC hosted a community dinner and presentation in Watson Lake, in which LFN citizens attended (Table 2-4). This was accomplished through the assistance of helpful LFN citizens who mounted a phone campaign to citizens to advise them of the meetings, as they may not have been previously advised, despite the advertising throughout the community. It was clear that LFN citizens at the meeting felt uninformed in general; BMC will discuss the approach with LFN leadership increasing the frequency of such Town Hall meetings as the Project progresses through assessment and licensing.

The content of the presentation included:

- BMC Company Overview;
- ABM Deposit and BMC's Regional Exploration;
- KZK Proposed Mine Plan;
- Environmental Management;
- Maximizing Socio-economic Benefits; and
- Permitting and Proposed Timeline.

Notice for this meeting is included in Appendix B-4 Section 1 Notice and Appendix B-7 Section 1 – Notice. A copy of the Project Overview, presentation, and posters are included in Appendix B-7 Section 2 - Consultation Materials. The consultation materials are also posted on the Project website. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-5. Questions at the meeting were generally related to: environment, mine design, socio-economics, water quality, and wildlife.

During the Community Consultation that was conducted in November, 2016, BMC was unable to meet with LFN leadership following many attempts by BMC to reach LFN by phone, email, and in person (Table 2-4, Appendix B-4 Section 1 Notice). BMC was successful in holding conversations with very helpful office administrative staff who cooperated by advertising the proposed meetings and sending advisories to the Chief and Council. BMC representatives met with administrative staff when in Watson Lake.

Table 2-4: Summary of Consultation with LFN

Event		Introductory Meeting with Chief and Council	Project Update for Chief & Council	Community Meeting #1	Proposed KZK Site Tour	Proposed KZK Site Tour	Proposed KZK Site Tour	Chief and Council Meeting	Community Meeting #2
Date of Event		April 13, 2015	N/A - this was not an event, it was information distribution	January 14, 2016	July 28, 2016	July 28, 2016	September 8, 2016	November 17, 2016	November 17, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	After two weeks of attempts to contact LFN, the meeting was confirmed on April 10, 2015	August 12, 2015	Provided to Chief and Council: December 1 to 17, 2015, January 7, 2016, January 8, 2016, January 14, 2016 Provided to LFN Citizens: Every day in Whitehorse Star from January 4th to the 12th, 2016 January 6th and 8th in Yukon News Everyday three times per day on radio (CKRW) from January 4th to 13th Posters were put up around town in early January	July 10, 11 and 12, 2016	July 20, 2016	August 11 (twice), August 24, August 25 (twice), September 7 (three times)	Email October 20, 2016	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15 Posters up: LFN office, Post Office, Big way grocery Store, Community Centre Notice and Virtual Open House post on BMC's website: kudzzekayah.com
	Recipient	Chief Daniel Morris, Deputy Chief Cindy Porter, Traditional Knowledge Coordinator Roy Dick	Chief Daniel Morris and Deputy Chief Cindy Porter	LFN Chief and Council / LFN Citizens	Chief Daniel Morris, and Deputy Chief Cindy Porter	Chief Daniel Morris	Chief Daniel Morris and Deputy Chief Cindy Porter, Liard First Nation Office	Chief Daniel Morris and Deputy Chief Cindy Porter, Liard First Nation Office	LFN Chief and Council / LFN Citizens
	Subject matter for Consultation	Introductory Meeting - BMC described the plans for the 2015 exploration season, type of Project, history of Project, environmental programs.	2015 Exploration Environmental Management Plan.	Phoned LFN numerous times. No response. Attempts to advise LFN of community meeting/presentation by BMC - no response. On January 8, 2016 was able to talk to Deputy Chief and conveyed message & she said she'd call back - no call back. On January 14 was able to talk to Deputy Chief and she thought the Chief would attend - no one from LFN attended. Community Meeting - Power Point Presentation: • BMC Corporate Overview • Summary of 2015 Project Activities (Exploration, Environmental, Community) • Anticipated Project Timelines • Anticipated 2016 Project Activities • Overview of our Engagement Plan	Phoned Chief Morris to invite Chief & Council to KZK tour Chief Morris confirmed to attend. Second call with the Chief to discuss KZK tour, Chief Morris confirmed to attend. July 11 email to discuss details of tour - no response.	Talked to Chief Morris - BMC postponed C&C tour by RRDC due to 3 recent deaths in a Kaska community. Chief Morris was OK with BMC's decision.	Many attempts by phone and email to Chief, Deputy Chief and LFN office to discuss the rescheduling of the Chief & Council tour to the Project. Following discussion with the Chief's wife once, and leaving many messages the date of September 8, 2016 was established for the tour that was to replace the previously postponed tour. This tour was offered by BMC executive to RRDC Chief and Council, and LFN Chief and Council jointly.	Agenda for meeting: update on KZK status, next steps (including permitting, PFS study), technical review of YESAB Project Proposal, exploration MOU, SEPA and TK protocol, Type B water licence application, interim TK study, update on EMR/RRDC negotiations on the RRDC Draft Land Use Management Plan.	Community Open House - Power Point Presentation: BMC Minerals (No.1) Company Overview; ABM Deposit and BMC's Regional Exploration; KZK Proposed Mine Plan; Environmental Management; Maximizing Socio-economic Benefits; and Permitting and Proposed Timeline.
	Method of Notice	Phone, with assistance from Allan Carlick (First Nation Liaison Officer with YG), email	email	Phone/newspapers/radio stations/posters around town	Phone	Phone 867-536-2782	phone, email	Emailed invitation Oct. 20, left several phone messages, dropped in at LFN office to deliver documentation and advise of meeting - no response	newspapers/radio stations/posters around town
	Documentation in Consultation Record	Appendix B-4, Section 1. Notice	Appendix B-4, Section 1. Notice	Appendix B-4, Section 1. Notice Appendix B-6, Section 1. Notice Appendix B-6, Section 2. Consultation Materials	N/A	N/A	N/A	Appendix B-4, Section 1. Notice	Appendix B-4, Section 1. Notice Appendix B-7, Section 1. Notice Appendix B-7 Section 2. Consultation Materials

Event		Introductory Meeting with Chief and Council	Project Update for Chief & Council	Community Meeting #1	Proposed KZK Site Tour	Proposed KZK Site Tour	Proposed KZK Site Tour	Chief and Council Meeting	Community Meeting #2
2. A reasonable period of time to prepare views	**Recipient**	Chief Daniel Morris, Deputy Chief Cindy Porter, Traditional Knowledge Coordinator Roy Dick	Chief Daniel Morris, Deputy Chief Cindy Porter	LFN Citizens	Chief Daniel Morris, and Deputy Chief Cindy Porter	N/A	Chief Daniel Morris and Deputy Chief Cindy Porter, Liard First Nation Office	Chief Daniel Morris and Deputy Chief Cindy Porter, Liard First Nation Office	LFN Citizens
	Period of Time to Prepare Views	N/A - introductory meeting.	No constraints were provided on feedback, BMC has left it open for LFN to review and respond.	Over one month's notice was provided to Chief and Council. For LFN Citizens notice was up to 10 days before meeting.	Up to 18 days notice was provided.	N/A	Up to 28 days notice was provided from initial attempts to communicate.	28 days notice was provided from initial email letter of invitation.	28 days notice was provided from initial email letter of invitation.
3. Opportunity to Present Views	**Recipient**	Chief Daniel Morris, Deputy Chief Cindy Porter, Traditional Knowledge Coordinator Roy Dick	Chief Daniel Morris and Deputy Chief Cindy Porter	LFN Citizens Although the Chief and Council did not attend the community meeting, many LFN Citizens were in attendance and provided questions. Opportunities to present views were available to LFN citizens and Chief and Council up until the Project Proposal data cut off date of December 15th.	Chief Daniel Morris, and Deputy Chief Cindy Porter	Chief Daniel Morris	Chief Daniel Morris and Deputy Chief Cindy Porter, Liard First Nation Office	Chief Daniel Morris and Deputy Chief Cindy Porter, Liard First Nation Office	LFN Citizens Although the Chief and Council did not attend the community meeting, many LFN Citizens were in attendance and provided questions. Opportunities to present views were available to LFN citizens and Chief and Council up until the Project Proposal data cut off date of December 15th.
	Description of Recipient's Response	The main response at the meeting was that LFN was interested in being informed of BMC's plans for the Project but that RRDC would be the lead Kaska First Nation for the Project based on the Kaska Collaboration Agreement.	LFN did not provide a response.	Categories of questions included but were not limited to: exploration, mine design, socio-economics, water quality.	Event did not happen.	Please see above.	Event did not happen.	Event did not happen - no response.	Categories of questions included but were not limited to: environment, exploration, mine design, socio-economics, water quality and wildlife.
	Method	N/A - introductory meeting	N/A	In person at meeting/phone/email/KZK website	Phone	Phone	Phone/email	Phone/email	In person at meeting/phone/email/KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	BMC agreed to continue to provide LFN regular Project updates as the Project progressed from exploration through to permitting.	N/A	Table 2-5: LFN Views Presented and BMC's Full and Fair Consideration.	N/A	N/A	N/A	Phone/email	Table 2-5: LFN Views Presented and BMC's Full and Fair Consideration.

Table 2-5: Views Presented by LFN and BMC's Full and Fair Consideration

LFN Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised	
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Addressed	Watson Lake Community Meeting #1. January 14, 2016 Attendance: 60	Watson Lake Community Meeting #2. Nov. 17, 2016 Attendees: 30
Can you explain the spill contingency plan?	The spill contingency plan will encompass safe storage and handling procedures to minimize the risk of any spill - also it will detail procedures to be taken in the unlikely event of a spill. Signage and labelling of procedures will be posted and will be a key component to a successful plan. All employees will be provided with the policies and the procedures will be followed.	N/A	Environment	Accidents and Malfunctions - Chapter 17 Environmental Management Plans - Chapter 18		√
What goods and/or services are you looking for from Watson Lake?	BMC wants to work with the Watson Lake Chamber of Commerce to find what is available in Watson Lake. (listed a number of examples of goods and services that BMC will need in 2016).	Will be addressed as part of ongoing consultation as the Project progresses.	Exploration/Socio-economic	Socio-economic Effects Assessment - Chapter 15	√	
Why are only a few people getting a job there? How do you choose and how do you be fair?	Jobs are advertised and applications are reviewed according to the criteria set out for each particular job. BMC is currently only hiring seasonally for the exploration programs and so there is a limited amount of jobs available, many more would be available during construction and operations.	N/A	Exploration/Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
What is the total number of Kaska working on the Project?	When the mine is in operation, there will be significant opportunities for employment. BMC's protocol is contained within the SEPA.	N/A	Exploration/Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Is there anything else being shipped out of Stewart?	Stewart is an independent port facility - newly developed and privately owned.	N/A	General	N/A		√
How much time will it take to sample 30 wells?	It will likely take two people 7-10 days to complete the work. They need to purge them and download data, not just get a sample. Some of the wells are accessible only by helicopter.	N/A	Groundwater	N/A	√	
What kind of minerals are you mining?	Copper, lead, zinc, silver, and gold.	N/A	Mine Design	Project Description - Chapter 4		√
From the flotation mill - where would all the wastewater go?	The design is based on recycling water from the process ponds back to the mill - so it's being recycled.	N/A	Mine Design	Project Description - Chapter 4		√
Will it be an open pit mine? How many pits will be constructed?	The mine will have one pit with two lobes and an underground component to reach the deepest part of the deposit for the last few years of mining.	N/A	Mine Design	Project Description - Chapter 4		√
Will you be covering the tailings piles as you mine? Want to make sure that the Faro mine problems don't happen at KZK.	There will be one tailings storage facility which will be constructed with progressive reclamation techniques, which means that it will be continually covered. This operation will be a dry stack facility, which is completely different system than Faro.	N/A	Mine Design	Project Description - Chapter 4		√
You've covered a lot of detail about your baseline data. But what are you going to do to the environment? Will you dam the creek?	BMC is now in the process of looking at the various alternatives for how to mine the deposit. Next time BMC comes to the community it will have a mine plan that will answer these kinds of questions and ask for further input from residents of Faro and LFN citizens.	Follow-up response at the second community meeting: BMC has completed the alternatives assessment and there will be no submerged tailings placed in the valley with a dam in perpetuity, which was the original plan by Cominco. BMC will have a dry stack tailing facility on the west side of the valley as shown in the figure in the presentation. However, due to the positive water balance of the site, two small temporary dams will be placed in the valley to manage water during construction and operations, but they will be removed at closure.	Mine Design	Project Description - Chapter 4	√	

LFN Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised	
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Addressed	Watson Lake Community Meeting #1. January 14, 2016 Attendance: 60	Watson Lake Community Meeting #2. Nov. 17, 2016 Attendees: 30
How safe is the containment of the tailings piles - worried about dust in the air and water quality?	Dust will be minimized via dust suppression techniques during construction and operations and will be reduced further through progressive reclamation activities of the Class A Storage Facility.	N/A	Mine Design / Air Quality	Project Description - Chapter 4Air Quality - Chapter 6 Air Quality Model Report - Appendix E-1		√
On closure, when will the road be closed down? Worried about moose.	Closure measures will be determined through a consultative process. The ultimate fate of this road will be determined as part of this process.	Although BMC intends to consult on the closure plan during the environmental and socio-economic assessment process, the closure plan for the road contained in this Project Proposal is per the approved closure plan for the existing Tote Road permit.	Reclamation and Closure	Reclamation and Closure Plan - Appendix H-1		√
Will the Kaska benefit from the mine?	Yes, there is a Socio-economic Participation Agreement in place, which is currently being updated - that allows full participation and will ensure benefits are maximized.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Is it going to be a dry camp?	Yes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15 Fitness for Work Policy - Appendix A-5		√
What about apprenticeship? Training?	Apprenticeship, education and training are a cornerstone of BMC's corporate policy.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Where was the scholarship information posted?	This information was posted at the band office, at the schools in Ross River and Watson Lake and online. Teachers, Principals, and Yukon College staff got the information out also. We expect there to be more awareness of the scholarship availability, and public knowledge will increase in the coming years as the program gains more public awareness.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Do you have a program for high school students to work in the summer?	Once the mine has been approved and is in operation, it is expected, the range of employment will dramatically increase. There will likely be a number of job opportunities for high school students.	N/A	Socio-economic	Project Description - Chapter 4 Socio-economic Effects Assessment - Chapter 15		√
Would Kaska members that live outside of the area be eligible to work at the mine?	Yes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Qualified people don't seem to be getting jobs - only hearing about jobs that require training. Look outside of Ross River and consider the LFN for workers.	BMC is currently only hiring seasonally for the exploration programs and so there is a limited amount of jobs available, many more would be available during construction and operations. BMC's protocol is contained within the SEPA.	N/A	Socio-economic	Project Description - Chapter 4 Socio-economic Effects Assessment - Chapter 15		√
Will LFN benefit from the mine or just RRDC? When? How?	LFN would see benefits as the SEPA is relevant to all Kaska citizens, although RRDC is the lead community as per the Kaska Collaboration Agreement.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Will there be opportunities for expediters?	Yes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√	
How safe is the water that reaches the spawning ground?	Completely safe.	N/A	Surface Water	Surface Water Quality Baseline Report - Appendix D-1		√
Will the wildlife habitat be protected?	Yes, BMC's closure and reclamation plan is focussed on returning the land to pre-Project conditions which includes caribou habitat.	N/A	Wildlife	Reclamation and Closure Plan - Appendix H-1		√

2.7.3 Kaska Dena Council

On January 27, 2016, BMC representatives met with KDC Chiefs and Elders. There was a general update of BMC's activities at KZK as well as an update by the RRDC negotiators regarding the progress on the negotiations of the Exploration Memorandum of Understanding and the modernizing of KZK SEPA (Table 2-6).

BMC had numerous discussions with KDC Chair George Miller during the development and roll out of the BMC-Kaska Scholarship Program (fall 2016). Based on the uptake of the Scholarship Program from non-RRDC Kaska students, it is apparent that these discussions were fruitful.

During the Community Consultation that was conducted in November, 2016 (Table 2-6), BMC was unsuccessful in arranging a meeting with KDC leadership (Appendix B-5 Section 1 Notice, Appendix B-7 Section 1 Notice). A copy of the Project Overview document was provided to KDC in October 2016 (Appendix B-7 Section 2 Consultation Materials). Additionally, access to the Project Overview and presentation are located on the Virtual Open House site (kudzzekakyah.com/kudz-ze-kayah-proposal-community-information/).

Table 2-6: Summary of Consultation with KDC

Event		Introductory Meeting	Community Meeting #2
Event Date		January 27, 2016	November 17, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	BMC was invited by RRDC approximately one week prior to meeting taking place.	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15 Posters up: LFN office, Post Office, Bigway grocery Store, Community Centre
	Recipient	Kaska Dena Council	Kaska Dena Council
	Subject Matter for Consultation	General update of BMC's activities at KZK as well as an update by the RRDC negotiators regarding the progress on the negotiations of the Exploration Memorandum of understanding and the modernizing of Kudz Ze Kayah SEPA	Agenda for meeting: update on KZK status, next steps (including permitting, PFS study), technical review of YESAB Project Proposal, exploration MOU, SEPA and TK protocol, Type B water licence application, interim TK study, update on EMR/RRDC negotiations on the RRDC Draft Land Use Management Plan.
	Method of notice	N/A	Emailed invitation Oct. 20, left several phone messages, dropped in at LFN office to deliver documentation and advise of meeting - no response.
	Documentation in Consultation Record	Appendix B-6, Section 1. Notice	Appendix B-5, Section 1. Notice Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials
2. A reasonable period of time to prepare views	**Recipient**	Kaska Dena Council	Kaska Dena Council
	Period of Time to Prepare Views	N/A	28 days notice was provided from initial email letter of invitation.
3. Opportunity to Present Views	**Recipient**	N/A	Kaska Dena Council
	Description of Recipient's Response	N/A	No members of KDC attended the community meeting and a KDC/BMC specific meeting did not come to fruition.
	Method	In person at meeting, phone, KZK website	phone, KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	N/A	N/A

2.8 COMMUNITY CONSULTATION

2.8.1 Ross River

Community presentations were held in Ross River on January 12, 2016 and December 6, 2016.

On January 12, 2016, BMC hosted a community dinner and presentation in Ross River (Table 2-7) Questions at the meeting focussed on: the exploration plans, land use and access, wildlife, jobs, fish barrier at the YG culverts where Finlayson Creek flows under the Robert Campbell Highway, and fish habitat compensation. It is noted that most of the questions at the meeting were related to development plans for KZK rather than the exploration activities. For concerns that were not addressed, BMC committed to returning and addressing them once the prefeasibility study was complete. Once the technical studies to support the prefeasibility study were complete, BMC provided detailed responses. Notice for this meeting is included in Appendix B-3 Section 1 – Notice, and Appendix B-6 Section 1 – Notice. A copy of the presentation is included in Appendix B-6 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-8.

On December 6, 2016 BMC hosted a second community dinner and presentation in Ross River (Table 2-7). The content of the presentation included:

- BMC Company Overview;
- ABM Deposit and BMC's Regional Exploration;
- KZK Proposed Mine Plan;
- Environmental Management;
- Maximizing Socio-economic Benefits; and
- Permitting and Proposed Timeline.

Notice for this meeting is included in Appendix B-3 Section 1 – Notice, and Appendix B-7 Section 1 – Notice. A copy of the Project Overview, presentation, and posters are included in Appendix B-7 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-8. Questions at the meeting focussed on socio-economics and reclamation.

Additionally, the Project Overview and access to the above-mentioned posters and presentation are located on the Virtual Open House site (kudzzekakyah.com/kudz-ze-kayah-proposal-community-information/).

Table 2-7: Summary of Consultation with the Community of Ross River

Event		Community Meeting #1	Community Meeting #2
Event Date		January 12, 2016	December 6, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	Every day in Whitehorse Star from January 4th to the 12th, 2016 January 6th and 8th in Yukon News Ever day three times per day on radio (CKRW) from January 4th to 13th Posters were put up around town on January	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15 CHON-FM: 9 spots Dec. 2, 5, and 6 Posters up Lands office, RRDC office, Dena General store, Post office, Margaret Thompson Centre, Yukon College and Nursing Station
	Recipient	Residents of Ross River	Residents of Ross River
	Subject matter for Consultation	Community Meeting - Power Point Presentation: • BMC Corporate Overview • Summary of 2015 Project Activities (Exploration, Environmental, Community) • Anticipated Project Timelines • Anticipated 2016 Project Activities • Overview of our Engagement Plan	Community Open House - Power Point Presentation: BMC Minerals (No.1) Company Overview; KZK deposit and BMC's Regional Exploration; KZK Proposed Mine Plan; Environmental Management; Maximizing Socio-economic Benefits; and Permitting and Proposed Timeline. Community Open House was originally scheduled, advertised and confirmed for Nov. 14/16 but was postponed due to a funeral in Ross River on Nov. 14.
	Method of Notice	newspapers/radio stations/posters around town	Newspapers/radio stations/What's Up/Posters/Facebook
	Documentation in Consultation Record	Appendix B-6, Section 1. Notice Appendix B-6, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials
2. A reasonable period of time to prepare views	**Recipient**	Residents of Ross River	Residents of Ross River
	Period of Time to Prepare Views	Notice was provided up to 8 days before meeting.	Notice of up to 12 days was provided to community prior to first scheduled Open House, and then once the final meeting date was established notice of 7 days was provided.
3. Opportunity to Present Views	**Recipient**	Residents of Ross River: Attendees 30 At the January 12 meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to the residents of Ross River up until the Project Proposal data cut off date of December 15th.	Residents of Ross River: Attendees 15 Most attendees were present for the PowerPoint Presentation presented by the BMC team, followed by a question and answer period. Technical posters were set up and the team members were available for one-on-one questions - most questions were answered at that time. Opportunities to present views were available to the residents of Ross River up until the Project Proposal data cut off date of December 15th.
	Description of Recipient's Response	Categories of questions included but are not limited to: Aquatics, General, Exploration, Geology, Mine Design, Permitting, Socio-economic, Wildlife and Vegetation. Refer to Table 2-8 for record of questions presented to BMC.	Categories of questions included but are not limited to: General, Geology, Mine Design, Permitting, Socio-economic, Reclamation and Vegetation. Refer to Table 2-8 for record of questions presented to BMC.
	Method	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	Table 2-8: Ross River Views Presented and BMC's Full and Fair Consideration	Table 2-8: Ross River Views Presented and BMC's Full and Fair Consideration

Table 2-8: Views Presented by Ross River and BMC's Full and Fair Consideration

Ross River Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised	
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	Ross River Community Meeting #1. January 12, 2016 Attendance: 30	Ross River Community Meeting #2. December 6, 2016 Attendees: 15
What is fish habitat compensation?	The federal department of Fisheries and Oceans requires the replacement of any fish habitat that will lost due to the Project.	N/A	Aquatic Eco-systems and Resources	Fish Habitat Compensation Plan - Appendix D-4	√	
YG Highways has a culvert on the Robert Campbell Highway at Finlayson Creek that is blocking fish passage and is even killing small fish.	BMC cannot be responsible for YG's culvert. BMC does have a monitoring station at the location.	Following the meeting BMC assessed the reported fish barrier at the culverts and determined that eliminating the barrier would open up Finlayson Creek fish habitat for arctic grayling. BMC discussed this option with YG biologists and have concluded that this may be a viable option. At the second community meeting BMC responded: BMC will propose to remove the barrier as part of the Fish Habitat Compensation Plan.	Aquatic Eco-systems and Resources	Fish Habitat Compensation Plan - Appendix D-4	√	
What date will work start on site this year?	BMC does not yet have a fixed date but is hoping to start in April, weather and snow conditions permitting. Job and contracting opportunities will be circulated in March.	N/A	Exploration	N/A	√	
Do you ever come across any craters?	No we've not seen craters in the Project area.	N/A	Exploration	N/A		√
Is there still a plan to tour the high school students through the mine site?	BMC plans to invite students that might be interested in learning about the environmental and geotechnical studies that will be underway next spring.	N/A	General	N/A		√
Will BMC be available at the time of graduation next year?	Yes - we fully intend to participate in the graduation ceremonies of the 11 graduating students.	N/A	General	N/A		√
Is there financing for more than this year?	Yes, BMC has $150 million in financing to find and develop base metal mining projects. KZK is the prime focus at this time. Approximately $8 million was spent in 2015 and about the same is budgeted in 2016.	N/A	General	N/A	√	
Has BMC had a discussion with RRDC Chief and Council about fly-in hunting?	BMC has discussed hunting in relation to the SEPA, but not about fly-in or other hunting issues.	N/A	General	N/A	√	
There are a lot of artesian seeps on site. Is groundwater going to be a problem? Water levels will rise as mining happens, how are you going to deal with it?	Yes, the site is artesian. In 2015 BMC capped a number of drill holes left by Cominco. How the groundwater will be dealt with is something that will be part of the mining and water management plans.	At the second community meeting BMC described the water management plan for the Project in detail.	Groundwater/Surface water	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Baseline Report - Appendix D-1 Receiving Environment Water Balance Report - Appendix D-6 Surface Water Quality Model Report - Appendix D-7	√	
Is the dry stack going to have a culvert?	No, it won't have a culvert. Water will be drained via a rock-filled "french drain".	N/A	Mine Design	Project Description - Chapter 4		√
Rather than constructing a liner for dry stack can you line it with moss?	Moss is not feasible as it would not provide a sufficiently low permeably barrier to protect groundwater.	N/A	Mine Design	N/A		√
Will you use the existing road?	We will upgrade the Tote Road to an Access Road.	N/A	Mine Design	Project Description - Chapter 4		√

Ross River Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised	
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	Ross River Community Meeting #1. January 12, 2016 Attendance: 30	Ross River Community Meeting #2. December 6, 2016 Attendees: 15
What metallurgical challenges do you have?	Nothing out of the ordinary for this type of deposit. BMC is working on the metallurgy now and expects to improve on Cominco's metallurgical results through the use of modern technology and reagents.	N/A	Mine Design	Project Description - Chapter 4	√	
Will BMC use dry stack tailings?	BMC is currently looking at a number of tailings options including dry stack. This will be part of the mine plan.	Follow-up response at the second community meeting: BMC has conducted an alternatives assessment of the tailing options and BMC will construct a dry stack tailing facility on the west side of the valley as shown in the figure in the presentation.	Mine Design	Project Description - Chapter 4	√	
Will the permitting take 4 years? How much can Kaska influence this timing - how has Kaska held it back, or how could Kaska speed it up?	We would expect Kaska's support of the Project and will encourage a timely review of the Project Proposal by Kaska.	N/A	Permitting	Introduction - Chapter 1		√
Hauling - why not use the Canol Road rather than the Robert Campbell Highway?	The Robert Campbell Highway is designed to haul heavy loads at highway speeds, and the Canol Road would require substantial reconstruction, which would make it not economically feasible for this Project.	N/A	Project Description	N/A		√
On closure, will willows, moss and lichen grow?	Yes, BMC has prepared, as part of baseline studies, a vegetation map. This will be used in revegetation planning to ensure accurate revegetation occurs.	N/A	Reclamation/Vegetation	Reclamation and Closure Plan - Appendix H-1		√
It's been a problem in the past - using seeds that are not native to this area that would not grow. Ross River wants to suggest using local seeds.	In recognition of this concern BMC has committed to developing a seed collection program in the community of Ross River to support reclamation activities during progressive reclamation and at closure. BMC is proposing to initiate the seed collection program in 2017.	N/A	Reclamation/Vegetation	Reclamation and Closure Plan - Appendix H-1		√
Are you going to move the cranberry patch?	The vegetation and organic soils in the areas of disturbance (including the cranberry locations where the Class A Facility is proposed) will be removed and set aside - to be replaced during progressive reclamation. BMC is proposing to work with RRDC on a seed collection program which would start in 2017.	N/A	Reclamation/Vegetation	Reclamation and Closure Plan - Appendix H-1		√
Is there preferential hiring of RRDC citizens? Is there training and job retention programs?	These provisions are contained within the exploration Memorandum of Understanding and the SEPA.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
What about courses to help people learn while they are in their community (trades, apprentices)?	BMC is committed to ensuring the provision of training programs as part of its employment and training program.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√
Is there an evidence of natural current contamination from minerals at surface or near surface? Is there background selenium in the water? Will selenium in the water increase as mining occurs?	KZK appears to be typical of the types of sites with surface and near-surface mineralization. There are very low levels of selenium in the water now. The levels occurring in the water now will be part of the baseline and as mining proceeds the allowable level of selenium and other metals will be set in the relevant licences.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Baseline Report - Appendix D-1 Receiving Environment Water Balance Report - Appendix D-6	√	
Is selenium an issue?	KZK has about one tenth the level of selenium as Wolverine. Selenium may end up in the concentrate or in the tails. If in the concentrate selenium may have a smelter credit or penalty. Will have to wait on more testing and markets during operations to know for sure.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Model Report - Appendix D-7	√	
RRDC and Elders have completed a land use plan for the traditional territory that is not yet public. There will be specific prescriptions for different parts of the KZK site, e.g., mineral lick and traditional trails that will be stronger than current YG rules.	No response at meeting.	BMC looks forward to seeing the plan as soon as RRDC is ready to make it available. BMC will incorporate the prescriptions where practicable.	Traditional Knowledge. Mitigation and Management	The plan had not yet been provided at the time of Project Proposal preparation.	√	

Ross River Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised	
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	Ross River Community Meeting #1. January 12, 2016 Attendance: 30	Ross River Community Meeting #2. December 6, 2016 Attendees: 15
Did you see the invasive plants growing along the road?	In 2015 BMC conducted a survey for invasive species and found invasive along the Tote road in a few places and several at the gatehouse. BMC subsequently developed an Invasive Species Management Plan and in 2016 removed the species including the roots and incinerated them. Ongoing monitoring will be conducted through the growing season of 2017 to ensure they don't grow back. This Management Plan will continue to be implemented through our construction and operations.	N/A	Vegetation	Conceptual Environmental Management Plans - Chapter 18		√
BMC needs to keep hunters out, especially fly-in hunters (not the outfitter).	No hunters are allowed to use the Tote Road (this is a condition of the licence) but BMC cannot control air access to lakes in the region.	N/A	Wildlife	Project Description - Chapter 4 No Fire Arms Policy – Appendix A-9 No recreational Use of All-Terrain Vehicles and Snowmobile Policy - Appendix B-11	√	

2.8.2 Watson Lake

Community presentations were held in Watson Lake on January 14, 2016 and November 17, 2016.

On January 14, 2016, BMC hosted a community dinner and presentation in Watson Lake (Table 2-9). The meeting focussed on: an introduction and overview of BMC, the 2015 exploration program, status of the prefeasibility study and the ongoing environmental and socio-economic programs. It is noted that some of the questions at the meeting were related to development plans for KZK rather than the exploration activities. For concerns that were not addressed, BMC committed to returning and addressing them once the prefeasibility study was complete. Notice for this meeting is included in Appendix B-6 Section 1 – Notice. A copy of the presentation is included in Appendix B-6 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-9. During the meeting attendees had the opportunity to sign up for the BMC quarterly newsletter. Copies of the newsletters are included in Appendix B-8.

On November 17, 2016 BMC hosted a community presentation in Watson Lake, in which LFN citizens attended (Table 2-7).

The content of the presentation included:

- BMC Company Overview;
- ABM Deposit and BMC's Regional Exploration;
- KZK Proposed Mine Plan;
- Environmental Management;
- Maximizing Socio-economic Benefits; and
- Permitting and Proposed Timeline.

Notice for this meeting is included in Appendix B-7 Section 1 – Notice. A copy of the Project Overview, presentation and posters are included in Appendix B-7 Section 2 - Consultation Materials. The consultation materials are also posted on the Project website. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-9. Questions at the meeting were generally related to: environment, mine design, socio-economics, water quality and wildlife.

BMC also met with the Watson Lake town council on January 14, 2016 and November 17, 2016. Table 2-9 summarizes the notice and materials provided at the meetings while Table 2-10 summarizes the questions and views presented and BMC's full and fair consideration of those questions/views.

Table 2-9: Summary of Consultation with the Community of Watson Lake

Event		Town of Watson Meeting #1	Community Meeting #1	Town of Watson Meeting #2	Community Meeting #2
Event Date		January 14, 2016	January 14, 2016	November 17, 2016	November 17, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	28-Dec-15	Every day in Whitehorse Star from January 4th to the 12th, 2016 January 6th and 8th in Yukon News Everyday three times per day on radio (CKRW) from January 4th to 13th Posters were put up around town on January	emailed letter - Meeting Request - October 21, 2016 Confirmation of meeting by phone and email	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15 Posters up: LFN office, Post Office, Bigway grocery Store, Community Centre
	Recipient	Watson Lake Town Council Meeting - Attendees: 3	Residents of Watson Lake	Watson Lake Town Council Meeting	Residents of Watson Lake
	Subject matter for Consultation	• BMC Corporate Overview • Summary of 2015 Project Activities (Exploration, Environmental, Community) • Anticipated Project Timelines • Anticipated 2016 Project Activities • Overview of our Engagement Plan	Community Meeting - Power Point Presentation: • BMC Corporate Overview • Summary of 2015 Project Activities (Exploration, Environmental, Community) • Anticipated Project Timelines • Anticipated 2016 Project Activities • Overview of our Engagement Plan	Project Details, including mine plan. Provided copy of Presentation given at Open House, plus September, 2016 Newsletter. Project Overview was mailed to Town Council prior to meeting.	Community Open House - Power Point Presentation: BMC Minerals (No.1) Company Overview; KZK deposit and BMC's Regional Exploration; KZK Proposed Mine Plan; Environmental Management; Maximizing Socioeconomic Benefits; and Permitting and Proposed Timeline.
	Method of Notice	via email	newspapers/radio stations/posters around town	Phone, email	Newspapers/radio stations/What's Up/Posters/Facebook
	Documentation in Consultation Record	Appendix B-6, Section 1. Notice	Appendix B-6, Section 1. Notice Appendix B-6, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials
2. A reasonable period of time to prepare views	**Recipient**	Watson Lake Town Council	Residents of Watson Lake	Watson Lake Town Council	Residents of Watson Lake
	Period of Time to Prepare Views	Notice was provided up to 17 days before meeting	Notice was provided up to 10 days before meeting	Notice was provided 27 days prior to meeting, also Project Overview was delivered to Mayor and Council October 29, 2016	Notice was provided up to 15 days prior to Open House
3. Opportunity to Present Views	**Recipient**	Watson Lake Town Council	Watson Lake Community - Attendees 50 At the January 14 meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to the residents of Watson Lake up until the Project Proposal data cut off date of December 15th.	Watson Lake Town Council - Attendees 3 Opportunities to present views were available to the residents of Watson Lake up until the Project Proposal data cut off date of December 15th.	Residents of Watson Lake - Attendees 30 November 17, 2016 Open House - most attendees were present for the PowerPoint Presentation presented by the BMC team, followed by a question and answer period. Technical posters were set up and the team members were available for one-on-one questions - most questions were answered at that time. Most attendees signed in with their email addresses so that BMC could put them on the Newsletter email list. Opportunities to present views were available to the residents of Watson Lake up until the Project Proposal data cut off date of December 15th.
	Description of Recipient's Response	Categories of questions included but are not limited to: General, Project Description. Refer to Table 2-10 for record of questions presented to BMC.	Categories of questions included but are not limited to: Groundwater, Project Description, Socio-economic. Refer to Table 2-10 for record of questions presented to BMC.	Categories of questions included but are not limited to: General, Project Description, Socio-economic, Surface Water. Refer to Table 2-10 for record of questions presented to BMC.	Categories of questions included but are not limited to: General, Geology, Mine Design, Project Description, Socio-economic, Surface Water, Wildlife. Refer to Table 2-10 for record of questions presented to BMC.
	Method	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	Table 2-10: Watson Lake Views Presented and BMC's Full and Fair Consideration	Table 2-10: Watson Lake Views Presented and BMC's Full and Fair Consideration	Table 2-10: Watson Lake Views Presented and BMC's Full and Fair Consideration	Table 2-10: Watson Lake Views Presented and BMC's Full and Fair Consideration

Table 2-10: Views Presented by Watson Lake and BMC's Full and Fair Consideration

Watson Lake Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised			
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/Section/ Appendix where Question/Comment/ Concern is Further Addressed	Watson Lake Town Council Meeting #1. January 14, 2016 Attendance: 3	Watson Lake Community Meeting #1. January 14, 2016 Attendance: 60	Watson Lake Town Council Meeting #2. Nov. 17, 2016 Attendees: 3	Watson Lake Community Meeting #2. Nov. 17, 2016 Attendees: 30
Can you explain the spill contingency plan?	The spill contingency plan will encompass safe storage and handling procedures to minimize the risk of any spill - also it will detail procedures to be taken in the unlikely event of a spill. Signage and labelling of procedures will be posted and will be a key component to successful plan. All employees will be aware of these policies and procedures will be followed.	N/A	Environment	Accidents and Malfunctions - Chapter 17 Environmental Management Plans - Chapter 18				√
Which way will you be accessing the site during 2016? From Carmacks or Watson Lake?	Mostly accessed from Carmacks through Ross River in 2015 and will likely be largely the same in 2016.	N/A	Exploration	N/A	√			
What goods and/or services are you looking for from Watson Lake?	BMC wants to work with the Watson Lake Chamber of Commerce to find what is available in Watson Lake. (Listed a number of examples of goods and services that BMC will need in 2016).	Will be addressed as part of ongoing consultation as the Project progresses.	Exploration/ Socio-economic	Socio-economic Effects Assessment - Chapter 15		√		
How many do you have employed right now?	Currently there are 10 employees - but it's our winter season and we've employed many more in the summer months.	N/A	Exploration/ Socio-economic	Socio-economic Effects Assessment - Chapter 15			√	
Why are only a few people getting a job there? How do you choose and how do you be fair?	Jobs are advertised and applications are reviewed according to the criteria set out for each particular job. BMC is currently only hiring seasonally for the exploration programs and so there is a limited amount of jobs available, many more would be available during construction and operations.	N/A	Exploration/ Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
What is the total number of Kaska working on the Project?	When the mine is in operation, there will be significant opportunities for employment. BMC's protocol is contained within the SEPA.	N/A	Exploration/ Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
The Watson Lake Chamber of Commerce is an active organization and they have a current list of members along with their goods and services on their website (linked to Town website).	BMC will contact the Chamber and review what goods and services are available in Watson Lake.	Will be addressed as part of ongoing consultation as the Project progresses.	General	N/A	√			
Where else does BMC work?	KZK is currently BMC's only active project. However, the management team has built other mines and the company may be looking at other projects going forward.	N/A	General	N/A	√			
Are any or all of you working on this Project full time?	Jim and Robin work for BMC full time. Kelli spends 90% of her work time on the Project. Rob and Malcolm are Yukon-based team members who are on contract, not full time.	At the second community meeting BMC presented the roles and titles of each team member.	General	N/A	√			
So it's a private company.	Yes.	N/A	General	N/A			√	
Is there anything else being shipped out of Stewart?	Stewart is an independent port facility - newly developed and privately owned.	N/A	General	N/A				√
Town of Watson Lake is working on getting scheduled air service (hopefully jet service) back to Watson Lake. Will be a plus for BMC if and when it happens.	No response at meeting.	N/A	General	N/A	√			
The Robert Campbell Highway will be chip sealed as far up as Frances Lake in the next couple of years.	No response at meeting.	N/A	General	N/A	√			
How long are you able to operate before having to go for financing?	We are a privately held company - the funds are in place for this Project.	N/A	General	N/A			√	
Is that fund financing other mining projects around the world?	Yes, there are other projects that are very similar in style to the Project that are funded by our ethical funds company.	N/A	General	N/A			√	

Watson Lake Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised			
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/Section/ Appendix where Question/Comment/ Concern is Further Addressed	Watson Lake Town Council Meeting #1. January 14, 2016 Attendance: 3	Watson Lake Community Meeting #1. January 14, 2016 Attendance: 60	Watson Lake Town Council Meeting #2. Nov. 17, 2016 Attendees: 3	Watson Lake Community Meeting #2. Nov. 17, 2016 Attendees: 30
How much time will it take to sample 30 wells?	It will likely take two people 7-10 days to complete the work. They need to purge them and download data, not just get a sample. Some are accessible only by helicopter.	N/A	Groundwater	N/A		√		
Are any other mines doing "dry stack" (thickened tailings)?	Yes - Alexco, Minto and other mines in Alaska.	N/A	Mine Design	Project Description - Chapter 4			√	
Any discussion about building a smelter in Canada rather that shipping overseas?	The Canadian smelter option is Trail, BC. It would be very difficult to permit and build a new smelter in Canada - and very expensive.	N/A	Mine Design	N/A			√	
What kind of minerals are you mining?	Copper, lead, zinc, silver, and gold.	N/A	Mine Design	Project Description - Chapter 4				√
From the flotation mill - where would all the wastewater go?	The design is based on recycling water from the process back to the mill - so it's being recycled.	N/A	Mine Design	Project Description - Chapter 4				√
Will it be an open pit mine? How many pits will be constructed?	One pit with two lobes with, an underground component to reach the deepest part of the deposit for the last few years of mining.	N/A	Mine Design	Project Description - Chapter 4				√
Will you be covering the tailings piles as you mine? Want to make sure that the Faro mine problems don't happen at KZK.	There will be one tailings storage facility which will be constructed with progressive reclamation techniques, which means that it will be continually covered. This operation will be a dry stack facility, which is a completely different system than Faro.	N/A	Mine Design	Project Description - Chapter 4				√
You've covered a lot of detail about your baseline data. But what are you going to do to the environment? Will you dam the creek?	BMC is now in the process of looking at the various alternatives for how to mine the deposit. Next time BMC comes to the community it will have a mine plan that will answer these kinds of questions and ask for further input.	Follow-up response at the second community meeting: There will be no submerged tailings placed in the valley with a dam in perpetuity which was the original plan by Cominco. BMC will have a dry stack tailing facility on the west side of the valley as shown in the figure in the presentation. However, due to the positive water balance of the site, two small temporary dams will be placed in the valley to manage water during construction and operations, but they will be removed at closure.	Mine Design	Project Description - Chapter 4		√		
What sort of a processing plant is in Stewart?	Processing is not taking place in Stewart - we're shipping from Stewart and the ore will be smelted overseas.	N/A	Mine Design	Project Description - Chapter 4			√	
How safe is the containment of the tailings piles - worried about dust in the air and water quality.	Dust will be minimized via dust suppression techniques during construction/progressive reclamation activities.	N/A	Mine Design/ Air Quality	Project Description - Chapter 4 Air Quality - Chapter 6 Air Quality Model Report - Appendix E-1				√
How much time are you allowing for permitting?	BMC is looking to submit a project proposal to YESAB in the last quarter of 2016 and is allowing two years for the permitting process in its schedule.	Follow-up response at the second community meeting: BMC plans to submit in the first quarter of 2017.	Permitting	Introduction - Chapter 1	√			
Want to discuss the possibility of re-routing trucks around the school district which is in place on the Robert Campbell Highway. Might it be possible to construct a road by-pass?	Sounds like a very reasonable option we could jointly discuss with Yukon Government.	Will be addressed as part of ongoing consultation as the Project progresses.	Project Description	N/A			√	

Watson Lake Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised			
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/Section/ Appendix where Question/Comment/ Concern is Further Addressed	Watson Lake Town Council Meeting #1. January 14, 2016 Attendance: 3	Watson Lake Community Meeting #1. January 14, 2016 Attendance: 60	Watson Lake Town Council Meeting #2. Nov. 17, 2016 Attendees: 3	Watson Lake Community Meeting #2. Nov. 17, 2016 Attendees: 30
On closure when will the road be closed down? Worried about moose.	Closure measures will be determined through a consultative process. The ultimate fate of this road will be determined as part of this process.	Although BMC intends to consult on the closure plan during the environmental and socio-economic assessment process, the closure plan for the road contained in this Project Proposal is per the approved closure plan for the existing Tote Road permit.	Reclamation and Closure	Reclamation and Closure Plan - Appendix H-1				√
Will the Kaska benefit from the mine?	Yes, there is a Socio-economic Participation Agreement in place, which is currently being updated - that allows full participation and will ensure benefits are maximized.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
Is it going to be a dry camp?	Yes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15 Fitness for Work Policy - Appendix A-5				√
What about apprenticeship? Training?	Apprenticeship, education and training are a cornerstone of BMC's corporate policy.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
Where was the scholarship information posted?	This information was posted at the band office, at the schools in Ross River and Watson Lake and online. Teachers, Principals, and Yukon College staff got the information out also. We expect there to be more awareness of the scholarship availability, and public knowledge will increase in the coming years as the program gains more public awareness.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
Do you have a program for high school students to work in the summer?	Once the mine has been approved and is in operation, it is expected, the range of employment will dramatically increase. There will likely be a number of job opportunities for high school students.	N/A	Socio-economic	Project Description - Chapter 4 Socio-economic Effects Assessment - Chapter 15				√
Would Kaska members that live outside of the area be eligible to work at the mine?	Yes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
Qualified people don't seem to be getting jobs - only hearing about jobs that require training. Look outside of Ross River and consider the LFN for workers.	BMC is currently only hiring seasonally for the exploration programs and so there is a limited amount of jobs available, many more would be available during construction and operations. BMC's protocol is contained within the SEPA.	N/A	Socio-economic	Project Description - Chapter 4 Socio-economic Effects Assessment - Chapter 15				√
Will LFN benefit from the mine or just RRDC? When? How?	LFN would see benefits as the SEPA is relevant to all Kaska Citizens, although RRDC is the lead community as per the Kaska Collaboration Agreement.		Socio-economic	Socio-economic Effects Assessment - Chapter 15				√
Will there be opportunities for expediters?	Yes.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√		
What's the main river/water system and where does it flow?	Geona Creek basin, which flows into Francis Lake, and then flows into the Liard.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8			√	
How safe is the water that reaches the spawning ground?	Completely safe.		Surface Water	Surface Water Quality Baseline Report - Appendix D-1				√
Will the wildlife habitat be protected?	Yes, BMC's closure and reclamation plan is fussed on returning the land to pre-Project conditions which includes caribou habitat.	N/A	Wildlife	Reclamation and Closure Plan - Appendix H-1				√

2.8.3 Faro

Community presentations were held in Faro on January 11, 2016 and November 15, 2016. Table 2-11 presents a summary of the consultation during the meetings.

On January 11, 2016, BMC hosted a community dinner and presentation in Faro (Table 2-11). The meeting focussed on: an introduction and overview of BMC, the 2015 exploration program, status of the prefeasibility study and the ongoing environmental and socio-economic programs. It is noted that some of the questions at the meeting were related to development plans for KZK rather than the exploration activities. For concerns that were not addressed, BMC committed to returning and addressing them once the prefeasibility study was complete. Notice for this meeting is included in Appendix B-6 Section 1 – Notice. A copy of the presentation is included in Appendix B-6 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-12. During the meeting attendees had the opportunity to sign up for the BMC quarterly newsletter. Copies of the newsletters are included in Appendix B-8.

On November 15, 2016 BMC hosted a community presentation in Faro (Table 2-11).

The content of the presentation included:

- BMC Company Overview;
- ABM Deposit and BMC's Regional Exploration;
- KZK Proposed Mine Plan;
- Environmental Management;
- Maximizing Socio-economic Benefits; and
- Permitting and Proposed Timeline.

Notice for this meeting is included in Appendix B-7 Section 1 – Notice. A copy of the Project Overview, presentation and posters are included in Appendix B-7 Section 2 - Consultation Materials. The consultation materials are also posted on the Project website. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-12.

Also, on November 15, 2016 BMC met with the Faro town council. Table 2-11 summarizes the notice and materials provided at the meeting while Table 2-12 summarizes the questions and views presented and BMC’s full and fair consideration of those questions/views.

Table 2-11: Summary of Consultation with the Community of Faro

Event		Community Meeting #1	Town of Faro Meeting #1	Community Meeting #2
Event Date		January 11, 2016	November 15, 2016	November 15, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	Every day in Whitehorse Star from January 4th to 12th, 2016 January 6th and 8th in Yukon News Everyday three times per day on radio (CKRW) from January 4th to 13th Posters were put up around town on January 5th, 2016	emailed letter - Meeting Request - October 21, 2016 Confirmation of meeting by phone and email	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15 Posters were also posted in Faro approximately 1 week before the meeting.
	Recipient	Residents of Faro	Town of Faro (Mayor, 1 councillor, CAO attended)	Residents of Faro
	Subject matter for Consultation	Notice was provided up to 7 days before meeting	Project Details, including mine plan. Provided copy of Presentation given at Open House, plus September, 2016 Newsletter Project Overview was mailed to Town Council prior to meeting.	Community Open House - Power Point Presentation: BMC Minerals (No.1) Company Overview; KZK deposit and BMC's Regional Exploration; KZK Proposed Mine Plan; Environmental Management; Maximizing Socio-economic Benefits; and Permitting and Proposed Timeline.
	Method of Notice	newspapers/radio stations/posters around town	Emails, phone calls	Newspapers/radio stations/What's Up/posters/Facebook
	Documentation in Consultation Record	Appendix B-6, Section 1. Notice Appendix B-6, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials
2. A reasonable period of time to prepare views	**Recipient**	Notice was provided up to 7 days before meeting	Notice was provided by email October 21, 2016, follow-up emails and phone calls. Also the Project Overview was mailed to Mayor and Council October 28, 2016	Notice was provided for up to 13 days prior to meeting
	Period of Time to Prepare Views	Residents of Faro At the January 11 meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to the residents of Whitehorse up until the Project Proposal data cut off date of December 15th.	Town of Faro Opportunities to present views were available to the residents of Whitehorse up until the Project Proposal data cut off date of December 15th.	Residents of Faro Most attendees were present for the PowerPoint Presentation presented by the BMC team, followed by a question and answer period. Technical posters were set up and the team members were available for one-on-one questions - most questions were answered at that time. Most attendees signed in with their email addresses so that BMC could put them on the Newsletter email list. Opportunities to present views were available to the residents of Faro up until the Project Proposal data cut off date of December 15th.
3. Opportunity to Present Views	**Recipient**	Residents of Faro (10 people attended presentation)	Town of Faro: Mayor Jack Bowers, Diana Rogerson (councillor), Ian Dunlop CAO attended	Residents of Faro (10 people attended)
	Description of Recipient's Response	Categories of questions included but are not limited to: Construction, General, Exploration, Mine Design, Surface Water. Refer to Table 2-12 for record of questions presented to BMC.	Categories of questions included but are not limited to: General, Geology, Mine Design, Surface Water. Refer to Table 2-12 for record of questions presented to BMC.	Categories of questions included but are not limited to: Construction, General, Geology, Groundwater, Mine Design, Schedule, Surface Water. Refer to Table 2-12 for record of questions presented to BMC.
	Method	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	Table 2-12: Faro Views Presented and BMC's Full and Fair Consideration	Table 2-12: Faro Views Presented and BMC's Full and Fair Consideration	Table 2-12: Faro Views Presented and BMC's Full and Fair Consideration

Table 2-12: Views Presented by Faro and BMC's Full and Fair Consideration

Faro Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised		
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/Comment/Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	Faro Community Meeting #1. January 11, 2016 Attendance: 10	Town of Faro Meeting #1. Nov. 15, 2016 Attendees: 3 Mayor, CAO, Councillor	Faro Community Meeting #2. Nov. 15, 2016 Attendees: 10
Will you construct over winter?	Yes, but construction will likely slow down during the winter months.	N/A	Construction	N/A			√
Do you have a mine contractor?	We will be looking for an Engineering, Procurement, and Construction Management Company to lead the construction.	N/A	Construction	N/A			√
So you won't own your own equipment for construction?	No	N/A	Construction	N/A			√
The experience with Wolverine shows that heavy truck traffic really beats up the Campbell Highway. Have you talked with YG about the road? Will BMC ore trucks be subject to load limits?	The Yukon government has told BMC that there are funds set aside for improving the highway and that work on it is ongoing. BMC will abide by all load limits and restrictions.	N/A	Construction/Operations	N/A	√		
Will BMC pay extra fees to YG for heavy road use and damage to the highway?	No, not as far as we know.	N/A	Construction/Operations	N/A	√		
Why do you consult? Is it because you have to?	Consultation is a requirement under YESAB, but it's also part of BMC's core policies to earn a social licence to operate and consolation is in-part how we earn the social licence.	N/A	Consultation	Community and Fist Nations Consultation - Chapter 2			√
Is your camp too small?	In 2015 the 49-person camp was too small. BMC was moving different aspects of the Project forward in parallel rather than sequentially and so we needed to rent other accommodation for some crews. BMC is not expecting this to be an issue in 2016.	N/A	Exploration	N/A	√		
Do you have other claims or projects in the area?	Yes, we have other claims in the area, we have the Pelly Claims and the Wolf Claims, although these claims are not part of the Project that we are presenting today, they are part of our long term plan in Yukon.	N/A	Exploration	N/A			√
Do you need permission from the Kaska to drill on your other claims?	We have a good working relationship with RRDC and we are currently working on an Exploration Memorandum of Understanding with the Kaska for exploration of our claims in their traditional territory. For the KZK claims we have a Socio-economic Participation Agreement that covers exploration.	N/A	Exploration	N/A			√
What is the drill spacing in the area of the deposit?	25 m nominal spacing.	N/A	Exploration	N/A			√
Do you have financing in place?	Yes, Project budget for 2016 is approved and the money is in place.	N/A	Exploration	N/A	√		
Is the current drilling infill of known deposits or for exploration looking for new ore?	Both infill and exploration drilling is happening. There has also been some HQ core sampling for metallurgical testing.	N/A	Exploration	N/A	√		
What jobs are you hiring for in the coming (2016) season?	Hiring will likely start in March of 2016. Applications can be made to the email address on the website. Jobs will include: first aid attendants, geotech, and cooks. Equipment operators should talk to Cliff Mcloud and Tim Moon who have been getting earthmoving work.	N/A	Exploration / Socio-economic	Socio-economic Effects Assessment - Chapter 15	√		
What does Kudz Ze Kayah mean?	The name means "Caribou Country" in Kaska.	N/A	General	N/A	√		
How is KZK different from Yukon Zinc?	Yukon Zinc is a state owned Chinese corporation. BMC is a private firm.	N/A	General	N/A		√	
Do you have other mines operating in Yukon or in Canada?	KZK is currently our focus, we don't have other operating mines. However, BMC's senior management team has worked together in the past developing and operating mines in Australia.	N/A	General	N/A			√
Why such a complicated name for a project?	The name means "Caribou Country" in Kaska.	N/A	General	N/A			√
Is there financing for more than this year?	Yes, BMC has $150 million in financing to find and develop base metal mining projects. KZK is the prime focus at this time. Approximately $8 million was spent in 2015 and about the same is budgeted in 2016.	N/A	General	N/A	√		

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Would you please tell us what the various minerals are in the core samples?	Galena, pyrite, chalcopyrite, sphalerite are the primary minerals that constitute the deposit.	N/A	Geology	N/A		√	
Is the geology the same at KZK as Wolverine?	Yes, it's similar.	N/A	Geology	N/A			√
Is this part of the Tintina Trench?	The Tintina trench is west/south west of the Project.	N/A	Geology	N/A			√
Curious about the origin of the KZK property.	It formed in a back arc basin, an environment similar to modern day Japan. Abundant volcanism in the arc (Japan) create heat and hydrothermal fluids like hot springs circulate through the crust picking up metals and depositing them in certain areas due to temperature and chemical changes. Those metal deposits are what becomes the massive sulphide deposits. Fast forward 350 million years and those volcanic islands have been slammed up and onto north America ending up in southeast Yukon.	N/A	Geology	N/A			√
What does First Resource mean?	It's the story of the first exploration program. The results in this First Resource were good.	N/A	Geology	N/A			√
What is an updated resource?	It is the estimation of the amount of metal and its concentration in the deposit.	N/A	Geology	N/A			√
Why can't you use the term "analysis" instead of "resource"?	The term recourse implies compliance with regulations and is required language. The process includes comprehensive analyses of the rocks and statistical analyses of the analytical results.	N/A	Geology	N/A			√
What kind of minerals are you mining?	Copper, lead, zinc, silver, gold.	N/A	Geology	Project Description - Chapter 4			
What is the chemistry of the groundwater?	The chemistry of the groundwater various substantially across the site and depth of the water. There are some exceedances but it depends on depth and location. The groundwater characterization has been summarized in the Project Overview Document and will be described in detail in BMC's Project Proposal Submission.	N/A	Groundwater	Groundwater Quality and Flow - Chapter 9 Hydrogeology Baseline Report - Appendix D-3			√
What percentage of ore gets shipped? How will waste be segregated?	Up to 90% of the ore minerals are recovered in the milling process and this concentrate is shipped. Waste rock is classified according to its geochemical characteristics which are determined through daily sampling and analysis of the rock as mining progresses.	N/A	Mine Design	Project Description - Chapter 4		√	
Will you re-use the water or treat and discharge?	Most water to be reused. Some makeup water will be required for water lost in the processing of the ore. That being said the Project has a positive water balance so some water will be treated and discharged.	N/A	Mine Design	Project Description - Chapter 4		√	
Will the tailings be covered and sealed?	Yes, it will be compacted and then covered with an engineered low permeability liner, and then with compacted till and a frost protection layer of Class C waste rock, then covered with topsoil and revegetated.	N/A	Mine Design	Project Description - Chapter 4 Reclamation and Closure Plan - Appendix H-1		√	
Where is the Wolverine Mine?	Approximately 25 km east of Kudz Ze Kayah (BMC pointed to the location map).	N/A	Mine Design	Chapter - Project Location			√
How many trucks per day will be transporting the ore?	There will be approximately 19 trucks per day (one way).	N/A	Mine Design	Project Description - Chapter 4			√
Will you stockpile the minerals for processing at a later time (i.e., for different minerals for better economic conditions)?	We will stockpile some, but it's more of a logistics solution rather than an economic decision.	N/A	Mine Design	Project Description - Chapter 4			√
What is the life of the mine?	Approximately 10 years.	N/A	Mine Design	Project Description - Chapter 4			√
How many tonnes/day will be mined?	Approximately 5,500 tonnes/day.	N/A	Mine Design	Project Description - Chapter 4			√
How far is the highway from camp?	Approximately 20 km.	N/A	Mine Design	Project Description - Chapter 4			√
For post closure what year is that? (based on the post closure slide).	That is approximately 16 years after the Project closes (this is the estimated time when the ABM lake will be filled and flow naturally into Geona Creek).	N/A	Mine Design	Project Description - Chapter 4			√
Will you operate year-round?	Yes.	N/A	Mine Design	Project Description - Chapter 4			√

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Will you have a contractor for mining?	Yes, the mining of the open pit and underground will be conducted by a mine contracting company.	N/A	Mine Design	Project Description - Chapter 4			√
What if you find more resources?	The ABM Deposit has been completely delineated, so the Project is based on 20 million tonnes of resource.	N/A	Mine Design	Project Description - Chapter 4			√
What's your YESAB timeline?	18 months to 2 years.	N/A	Permitting	Introduction - Chapter 1			√
What phase of permitting is the longest?	The YESAB process and Water Licence process are about the same length.	N/A	Permitting	Introduction - Chapter 1			√
What is the order of the permitting process?	The order is YESAB, Quartz Mining License (QML), Water Board but we won't get the final QML until the water licence is issued.	N/A	Permitting	Introduction - Chapter 1			√
Is there an appeal process?	There is an appeal process for the water licence and there are unofficial channels available for the QML process.	N/A	Permitting	N/A			√
Does YESAB require funds be set aside to cover final costs? Is there bonding money required to be deposited prior to Project?	YESAB does not require funds; however, during the quartz mining and water licensing processes, security is reviewed and must be in place prior to commencement of mining. The water licence covers this and will require bonding. The amount is reviewed and updated as appropriate every two years.	N/A	Permitting	N/A		√	
What bonding or environmental security will you be putting up to make sure that the site is cleaned up when you are done?	BMC will provide the environmental bonding or security that is required by the regulators at each stage of the Project.	N/A	Permitting	N/A	√		
Will you be starting permitting at square 1?	The existing Type A water licence runs through 2018 and BMC can therefore apply for an extension of it or apply for a new licence. The Quartz Mining Licence requires starting from the beginning and BMC is working on a project proposal to submit to YESAB.	N/A	Permitting	Introduction - Chapter 1	√		
We have an IFR rated 4,000' airstrip - could it be used for your staff changes? Will the mine be responsible for transport of staff?	The primary airstrip for crew changes will be the Finlayson airstrip closer to the Project. BMC will provide staff transport.	N/A	Project Description	Project Description - Chapter 4		√	
What grain size are you finding, fine or coarse? What are the implications for mill recovery rates?	Both fine and coarse grain size in the deposit. Need more metallurgical testing to fully understand the implications for mill recovery rates.	At the second community meeting BMC Responded: The additional metallurgical test work did not show any recovery issues due to grain size.	N/A	N/A	√		
What metallurgical challenges do you have?	Nothing out of the ordinary for this type of deposit. BMC is working on the metallurgy now and expects to improve on Cominco's metallurgical results through the use of modern technology and reagents.	N/A	Project Description	Project Description - Chapter 4	√		
Is selenium an issue (from an economic perspective)?	KZK has about one tenth the level of selenium as Wolverine. Selenium may end up in the concentrate or in the tails. If in the concentrate selenium may have a smelter credit or penalty. Will have to wait on more testing and markets during operations to know for sure.	N/A	N/A	N/A	√		
Will it be an open pit or an underground operation? How deep is the deposit?	KZK will be an open pit to start and then go underground from the pit. The deposit is 250m deep at its deepest point.	N/A	Project Description	Project Description - Chapter 4	√		
The Faro airport is instrument capable (not visual flight rules only like Ross River) and BMC may want to consider it as part of any fly-in set up for the mine.	Noted.	At the second community meeting BMC Responded: The primary airstrip for crew changes will be the Finlayson airstrip closer to the Project. However, in the event of a storm the airstrip in Faro or Ross River may be used. Also, Faro will be one of the points of hire for the Project, so depending on the numbers of people in the crew, they may be flown to site rather than bussed from Faro.	Project Description	Project Description - Chapter 4	√		

Faro Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised		
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Where will BMC truck its concentrate once mining starts?	BMC is currently looking at both Stewart and Skagway as options for port of shipment. Stewart is currently the most likely option.	Stewart has been selected.	Project Description	Project Description - Chapter 4	√		
Where are you in your Project timeline (based on the project video).	The Project schedule in the video shows construction, operation, closure and post closure. We are currently approximately 4 years from construction if the permitting process goes smoothly.	N/A	Schedule	N/A			√
Are there economic agreements in place with the Ross River Dena Council?	Yes, there is an existing SEPA first drawn up with Cominco in 1994 and then updated in 2004 with Teck.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√		
Will it be a fly-in camp operation or can people commute?	It will be shift work (e.g., two weeks in two weeks out). No commuting will be allowed both because of distance and for safety reasons.	At the second community meeting BMC responded: It will be shift work (e.g., two weeks in one week out). No commuting will be allowed both because of distance and for safety reasons.	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√		
Other mines have not always treated Faro employees equitably with other employees when it comes to paid travel and paid travel time.	BMC will have a consistent policy for all employees regarding paid travel and paid travel time.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√		
Faro would like to see more people living in the community and there are still plenty of houses available.	No response at meeting.	At the second community meeting BMC responded: Faro will be one of the points of hire for the Project, this could bring new residents to Faro.	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√		
Is there an evidence of natural current contamination from minerals at surface or near surface? Is there background selenium in the water? Will selenium in the water increase as mining occurs?	KZK appears to be typical of the types of sites with surface and near-surface mineralization. There are very low levels of selenium in the water now. The levels occurring in the water now will be part of the baseline and as mining proceeds the allowable level of selenium and other metals will be set in the relevant licences.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Baseline Report - Appendix D-1	√		
Is there enough re-charge in Geona Creek to re-charge reservoirs?	The site has a positive water balance with the bulk of the water coming from the dewatered mine, which will temporarily be stored in the Water Management Ponds prior to discharge to the receiving environment.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Receiving Environment Water Balance Report - Appendix D-6		√	
How long will water treatment be required?	It is expected to stabilize early in the post-closure period.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8 Reclamation and Closure Plan - Appendix H-1		√	
Does Geona Creek drain into Finlayson?	Yes.	N/A	Surface Water	Surface Water Quality and Quantity - Chapter 8			√
Selenium was a problem in the past - is it not a problem now?	The water management plan for the Project will ensure that selenium in the discharge water meets the site specific water quality objectives. Selenium is not considered a problem for the Project.	N/A	Water Quality	Project Description - Chapter 4 Surface Water Quality and Quantity - Chapter 8 Surface Water Quality Model Report - Appendix D-7 Preliminary Water Quality Objectives Report – Appendix D-8		√	

2.8.4 Whitehorse

Community presentations were held in Whitehorse on January 13, 2016 and November 16, 2016.

On January 13, 2016, BMC hosted a presentation in Whitehorse (Table 2-13). The meeting focussed on: an introduction and overview of BMC, the 2015 exploration program, status of the prefeasibility study and the ongoing environmental and socio-economic programs. It is noted that some of the questions at the meeting were related to development plans for KZK rather than the exploration activities. For concerns that were not addressed, BMC committed to returning and addressing them, once the prefeasibility study was complete. Notice for this meeting is included in Appendix B-6 Section 1 – Notice. A copy of the presentation is included in Appendix B-6 Section 2 - Consultation Materials. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-14. During the meeting attendees had the opportunity to sign up for the BMC quarterly newsletter. Copies of the newsletters are included in Appendix B-8.

On November 16, 2016 BMC hosted a community presentation in Whitehorse (Table 2-13).

The content of the presentation included:

- BMC Company Overview;
- ABM Deposit and BMC's Regional Exploration;
- KZK Proposed Mine Plan;
- Environmental Management;
- Maximizing Socio-economic Benefits; and
- Permitting and Proposed Timeline.

Notice for this meeting is included in Appendix B-7 Section 1 – Notice. A copy of the Project Overview, presentation and posters are included in Appendix B-7 Section 2 - Consultation Materials. The consultation materials are also posted on the Project website. A list of concerns and BMC responses were compiled in the consultation log and are summarized in Table 2-14.

Also, on November 16, 2016 BMC met with representatives from the City of Whitehorse. Table 2-13 summarizes the notice and materials provided at the meeting while Table 2-14 summarizes the questions and views presented and BMC's full and fair consideration of those questions/views.

Table 2-13: Summary of Consultation with City of Whitehorse

Event		Community Meeting #1	City of Whitehorse Meeting #1	Community Meeting #2
Date of Event		January 13, 2016	November 16, 2016	November 16, 2016
1. Provision of Notice in Sufficient Form and Detail	**Date of Notice**	Every day in Whitehorse Star from January 4th to 12th, 2016 January 6th and 8th in Yukon News Everyday three times per day on radio (CKRW) from January 4th to 13th	emailed letter - Meeting Request - October 21, 2016 Confirmation of meeting by phone and email	Yukon News: Nov. 2, 10 Whitehorse Star: Nov. 2, 4, 9 CKRW: 15 spots Nov. 7-16 What's Up: Nov. 2 CHON-FM: 14 spots Nov. 9-15
	Recipient	Residents of Whitehorse	City of Whitehorse - Mayor and Council	Residents of Whitehorse
	Subject Matter for Consultation	Community Meeting - Power Point Presentation: • BMC Corporate Overview • Summary of 2015 Project Activities (Exploration, Environmental, Community) • Anticipated Project Timelines • Anticipated 2016 Project Activities • Overview of our Engagement Plan	Project Details, including mine plan. Provided copy of Presentation given at Open House, plus September, 2016 Newsletter Project Overview was mailed to Town Council prior to meeting.	Community Open House - Power Point Presentation: BMC Minerals (No.1) Company Overview; KZK deposit and BMC's Regional Exploration; KZK Proposed Mine Plan; Environmental Management; Maximizing Socioeconomic Benefits; and Permitting and Proposed Timeline.
	Method of Notice	newspapers/radio stations	Letter emailed, emailed confirmation from Christine Smith, City Manager	Newspapers/radio stations/What's Up Email of notice of Open House with attached Project Overview to "Other Interested Parties"
	Documentation in Consultation Record	Appendix B-6, Section 1. Notice Appendix B-6, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials	Appendix B-7, Section 1. Notice Appendix B-7, Section 2. Consultation Materials
2. A reasonable period of time to prepare views	**Recipient**	Residents of Whitehorse At the January 13 meeting all attendees were given the opportunity to ask questions in person, most questions were answered at the time of the meeting. For questions that were not able to be answered BMC committed to providing a response at the next community meeting. Contact information was provided and attendees were encouraged to contact BMC representatives if they had any additional questions or concerns. Opportunities to present views were available to the residents of Whitehorse up until the Project Proposal data cut off date of December 15th.	City of Whitehorse - Mayor and Council At the November 16 Meeting at the City of Whitehorse, BMC representatives discussed the Project Overview (which had been mailed to Council previously) with City representatives. Opportunities to present views were available to the residents of Whitehorse up until the Project Proposal data cut off date of December 15th.	Residents of Whitehorse 2016-11-16 - Most attendees were present for the PowerPoint Presentation presented by the BMC team, followed by a question and answer period. Technical posters were set up and the team members were available for one-on-one questions - most questions were answered at that time. Most attendees signed in with their email addresses so that BMC could put them on the Newsletter email list. Opportunities to present views were available to the residents of Whitehorse up until the Project Proposal data cut off date of December 15th.
	Period of Time to Prepare Views	Notice was provided up to 9 days before meeting.	Notice was provided 26 days prior to meeting. Also Project Overview was mailed to Mayor and Council October 28, 2016.	Notice was provided up to 14 days prior to Open House.
3. Opportunity to Present Views	**Recipient**	Whitehorse Residents (40 people attended the Open House)	City of Whitehorse - City Manager Christine Smith and Councillor Dan Boyd	Residents of Whitehorse (40 people attended the Open House)
	Description of Recipient's Response	Categories of questions included but are not limited to: General, Heritage, Project Description, Socio-economic. Refer to Table 2-14 for record of questions presented to BMC.	Categories of questions included but are not limited to: Exploration, General, Mine Design, Project Description. Refer to Table 2-14 for record of questions presented to BMC.	Categories of questions included but are not limited to: General, Mine Design, Project Description, Surface Water. Refer to Table 2-14 for record of questions presented to BMC.
	Method	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website	In person at meeting, email, phone, KZK website
4. Full and Fair Consideration of Views Presented	**Documentation in Consultation Record**	Table 2-14: Whitehorse Views Presented and BMC's Full and Fair Consideration	Table 2-14: Whitehorse Views Presented and BMC's Full and Fair Consideration	Table 2-14: Whitehorse Views Presented and BMC's Full and Fair Consideration

Table 2-14: Views Presented by Whitehorse and BMC's Full and Fair Consideration

Whitehorse Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised		
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/ Comment /Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	Whitehorse Community Meeting #1. January 13, 2016 Attendance: 40	City of Whitehorse Meeting #1. Nov. 16, 2016 Attendees: 2	Whitehorse Community Meeting #2. Nov. 16, 2016 Attendees: 40
It is important to have a ceremony at the site before mining starts to show respect and honour those who have come before and to acknowledge that we are taking things from the land without putting them back. Cominco had a ceremony but BMC is a new company and new people so it is important to have another.	BMC would very much like to host a ceremony at the site.	N/A	Culture/Heritage	N/A	√		
Have you found any show stoppers? Rare plants, fish, pumping out the lake on site?	No show stoppers have appeared to date. No rare plants have been found and there are few fish (and no mature reproducing fish) at the site. The "lake" is actually a shallow pond. In the 1990s the screening and licensing process found the ponds could be drained.	N/A	Environment	Effects Assessment Chapters - Chapters 6 through 16	√		
Any chance the mine life will be extended beyond the 10 years?	BMC is concentrating on the Project now, there are other opportunities that we might consider in the future.	N/A	Exploration	N/A		√	
What date will work start on site this year?	BMC does not yet have a fixed date but is hoping to start in April, weather and snow conditions permitting. Job and contracting opportunities will be circulated in March.	N/A	Exploration	N/A	√		
Will you be hiring environmental staff for the exploration field season next year?	That will depend on the size of the exploration project; but our environmental consultants will be on site every month next year.	N/A	Exploration	N/A			√
Will BMC do any reverse circulation drilling on the site?	BMC has no current plans to do reverse circulation drilling on site but may consider it in the future.	N/A	Exploration	N/A	√		
It may be very good timing to do the planning and permitting now while metal prices are low and then start mining on a price upswing.	BMC did not plan this Project in a deliberate effort to time a metal price cycle. One advantage of having a multi-metal deposit is that it is not entirely dependant on any one metal price, as they do not all necessarily move together either up or down.	N/A	General	Project Description - Chapter 4	√		
What kind of concentrate will you be exporting?	We'll be shipping three different types of concentrate - approximately 185,000 tonnes of zinc concentrate annually, approximately 35,000 tonnes of copper concentrate annually (which will include the gold), and approximately 30,000 tonnes of lead annual (which will include the silver).	N/A	Mine Design	Project Description - Chapter 4		√	
Can you describe the number of people at each phase of the timeline?	Construction: 350 people (250 full time), pre-stripping: 50 - 70 people, Operations: 300 approximately (camp sized for 250).	N/A	Mine Design	Project Description - Chapter 4		√	
What about electricity?	The territorial grid is too far away - would need to tie into Ross River. BMC will be using LNG - and can operate on diesel if necessary.	N/A	Mine Design	Project Description - Chapter 4		√	
What do you mean by frost protection?	The placement of 3 - 5 m of Class C waste rock on top of the A and B Facilities will prevent penetration of seasonal frost into the low permeability layer.	N/A	Mine Design	Project Description - Chapter 4			√
What is the ground slope where the Class A and B Facilities will be constructed and what slope will the facilities be constructed to at closure?	The Class A Storage Facility will be constructed to a 4:1 slope and the Class B storage facility will be constructed at a slope of 3:1.	N/A	Mine Design	Project Description - Chapter 4			√
What will the site look like in 400 years? Will permafrost enter the base of the storage facilities during closure and potentially destabilize them?	The site will be in the post-closure phase and fully reclaimed. Climate change scenarios are projecting an increase in temperature and not a decrease in temperature, therefore permafrost is not anticipated to be in a location where it currently hasn't been found.	N/A	Mine Design	Project Description - Chapter 4 Reclamation and Closure Plan - Appendix H-1			√
What type of cover will be placed on the storage facilities?	A low permeability engineered cover including frost protection will be placed on the Class A Storage Facility. A low permeability till cover including frost protection will be placed on the Class B Storage Facility. The Class C Storage Facility will have a till cover. All covers will be revegetated using available stockpiled soil and seeded with native seed mix.	N/A	Mine Design	Project Description - Chapter 4			√
How thick (tall) is the buttress for the Class A Storage Facility?	Approximately 35 metres.	N/A	Mine Design	Project Description - Chapter 4			√

Whitehorse Question/Comment/Concern	BMC's Full and Fair Consideration				Meeting Where Question/Comment/Concern was Raised		
	Response to Question/Comment/Concern During Meeting	Consideration and/or Follow-up (if response was not provided at meeting or follow-up required)	Topic of Question/ Comment /Concern	Project Proposal Chapter/SectioN/Appendix where Question/Comment/Concern is Further Addressed	Whitehorse Community Meeting #1. January 13, 2016 Attendance: 40	City of Whitehorse Meeting #1. Nov. 16, 2016 Attendees: 2	Whitehorse Community Meeting #2. Nov. 16, 2016 Attendees: 40
How will the sludge be managed during operations and closure?	Sludge produced during operations will be disposed of in the Class A Storage Facility with the filtered tailings. The sludge disposal options for closure are currently being evaluated and final disposal method will be included in the Project Proposal.	N/A	Mine Design	Project Description - Chapter 4			√
Will the ditches/diversions remain at closure?	No, they will be removed and reclaimed.	N/A	Mine Design	Project Description - Chapter 4 Reclamation and Closure Plan - Appendix H-1			√
The permits that you had under the *Canadian Environmental Assessment Act* - are they grandfathered?	The Project is not grandfathered in and will undergo a new environmental assessment under YESAB. Permits need modernizing - new requirements and new permitting guidelines are in place now. However, it is important to note that from the social side of things Cominco and Teck had good relationships and a socio-economic agreement with RRDC (which has been transferred to BMC).	N/A	Permitting	Introduction - Chapter 1		√	
Will it be an open pit or an underground operation? How deep is the deposit?	KZK will be an open pit to start and then go underground from the pit in year 3 of operations. The deposit is 250 m deep at its deepest point.	N/A	Project Description	Project Description - Chapter 4	√		
What kind of mill are you planning?	Ball mill.	N/A	Project Description	Project Description - Chapter 4	√		
Is there one pit or more than one planned?	BMC is currently planning one open pit on the ABM Deposit on the KZK site.	The Project is planned to have one open pit with two lobes (ABM Zone and Krakatoa Zone).	Project Description	Project Description - Chapter 4	√		
Where will BMC truck its concentrate once mining starts?	BMC is currently looking at both Stewart and Skagway as options for port of shipment. Stewart is currently the most likely option.	Stewart has been selected.	Project Description	Project Description - Chapter 4	√		
What are your barriers to making this Project happen?	Metals prices, and also Permitting is a 4-year process. Financially we have the funds in the bank, but shareholders still need to determine how to structure the company so that it turns a profit.	N/A	Project Description	N/A		√	
Have you made your financial deposit (bond)?	It's covered in the regulations and BMC will follow that schedule when we get to the permitting stage.	N/A	Project Description	N/A		√	
When will the Prefeasibility Study be final and available for review?	The first quarter of 2017.	N/A	Project Description	N/A			√
How can we help you? City of Whitehorse is working on affordable housing as the city is currently at capacity for housing and experiencing a growth of 1%/an and no growth area available for real estate.	BMC looks forward to working with the City of Whitehorse as our proposed Project evolves.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15		√	
Are RRDC Elders supporting this Project?	BMC is in discussions with the RRDC chief and council and RRDC citizens. Because no mine plan has been presented yet it is too early to say whether Elders or RRDC citizens in general are supportive of the Project. It appears that the RRDC and citizens are generally supportive of the exploration program.	N/A	Socio-economic	N/A	√		
Does BMC have a bidding process or hand picked contractors?	Generally, it is an open bid process within a structure set by the Socio-economic Participation Agreement that BMC has with Kaska.	N/A	Socio-economic	Socio-economic Effects Assessment - Chapter 15	√		
Where does the water flow to from the mine?	The water ends up in Finlayson Creek.	N/A	Surface Water	Project Description - Chapter 4			√
What type of water treatment is proposed?	Two treatment technologies will be proposed during operations, which consist of pH adjustment and a selenium treatment technology.	N/A	Surface Water	Project Description - Chapter 4			√
It is important that a Traditional Knowledge study is conducted.	BMC is working with the RRDC on conducting a Traditional Knowledge study for the Project area as well as cultural awareness training for all BMC management.	Cultural awareness training was provided to BMC and Equity Exploration management in 2016.	Traditional Knowledge	Ethnographic Overview of Kudz Ze Kayah Project - Appendix F-3	√		

2.9 FUTURE CONSULTATION (POST SUBMISSION)

As the YESAB process and subsequent Quartz Mining and then Water Licensing processes are iterative and can result in changes to the originally proposed Project, BMC will continue its thorough consultation efforts after the Project Proposal has been initially submitted to YESAB. Periodic update meetings will be held with stakeholders and other interested parties as the Project progresses through the entire permitting process. Parties to be considered for this post-submission consultation and engagement will continue to include the broad scope of parties:

- Kaska First Nations;
- Residents of Faro, Watson Lake, Ross River and Whitehorse;
- Trapline concession holders and Yukon Big Game Outfitters;
- Government regulatory agencies and specialist departments;
- Stakeholders including non-Government organizations; and
- The general public.

This consultation effort will include topic-specific workshops with Government agencies. For example, closure planning, tailings and waste rock management, water management, and focussed workshops with public and other stakeholders regarding various aspects of the proposed Project. This will continue through environmental and socio-economic assessment phase, and into subsequent quartz mining and water licensing phases.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
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11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

3 PROJECT LOCATION 3-1
3.1 GEOGRAPHICAL LOCATION 3-1
3.2 LAND TENURE 3-1
3.3 TRADITIONAL TERRITORY 3-4
3.4 YUKON LAND USE PLANNING REGION 3-4
3.5 CONSISTENCY WITH OTHER PLANS 3-6

LIST OF FIGURES

Figure 3-1: Proximity to Mining Projects in Southeast Yukon 3-2
Figure 3-2: Land Tenure Map 3-3
Figure 3-3: Yukon Land Use Planning Regions 3-5

3 PROJECT LOCATION

3.1 GEOGRAPHICAL LOCATION

The Project is located in the southeast Yukon on National Topographic System (NTS) Map Sheet 105G07 to 105G10. The coordinates are 61°28'N latitude and 130°36'W longitude.

The Project lies within the Pelly River and Pelly Mountain ecoregions and is within the northern foothills of the Pelly Mountains of the Yukon Plateau. The elevations around Project area generally vary 800 to 1,800 metres above sea level (masl). The Project is located on the east side of the divide between the Pelly River and the Liard River drainage basin, in the Upper Liard Drainage (Figure 3-1). The Project is located in the Geona Creek watershed which drains to Finlayson Creek. Finlayson Creek meets the outflow of Finlayson Lake north of the Robert Campbell Highway and flows east to eventually join the Frances River, and ultimately, the Mackenzie River.

The Project is located approximately 115 km southeast of Ross River (home community of Ross River Dena Council) and approximately 260 km northwest of Watson Lake (home community of the Liard First Nation), as shown in Figure 1-1. Access to the Project is via a 24 km existing single lane gravel Tote Road (that will be upgraded to an Access Road) that connects the Project to the Robert Campbell Highway (Figure 1-2).

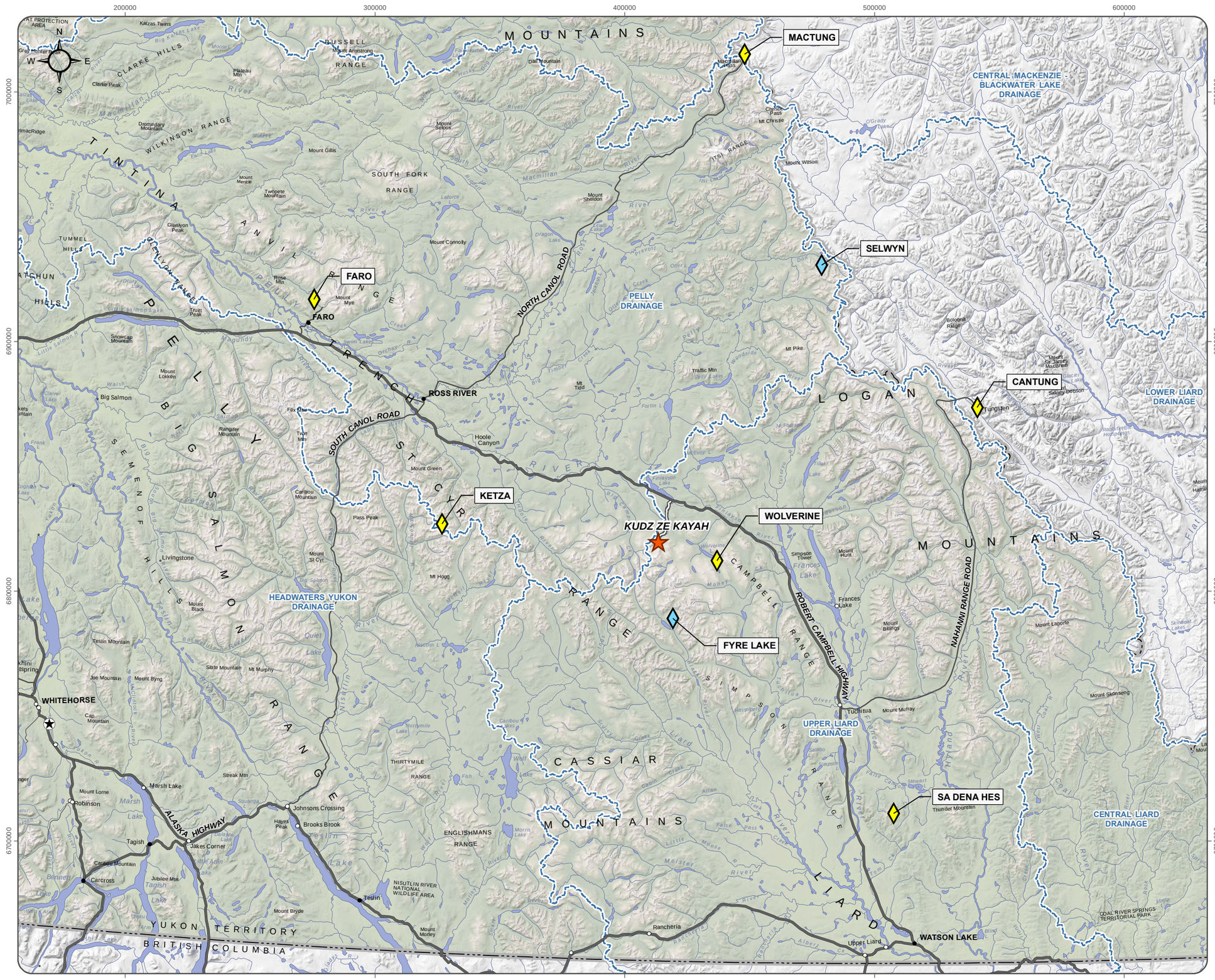
3.2 LAND TENURE

The KZK property contains 923 quartz claims held by BMC which are shown on Figure 3-2. Nearby quartz mineral claims to the Project with Land Use Permits include Bolt, Boot, Fyre Lake, and Wolverine (Figure 3-1). Other land tenure adjacent to the Project includes an interim protected Category A Settlement Lands Rural Block (R-block) for the Ross River Dena Council (RRDC) (R-15A) located adjacent to the southeast claims.

The Project is located within outfitting concession #20 (held by Yukon Big Game Outfitters) and within Game Management Subzone 10-07. The Project boundary overlaps with two trapping concessions; the Tote Road and the west portion of the claims overlap with group trapline concession #405 (held by Ross River group), and the eastern portion of the claims overlap trapline concession #250.

The location of the Project in relation to other major mine sites in the area is show in Figure 3-1, including the temporarily closed Wolverine mine (owned by Yukon Zinc Corp.) located to the east (approximately 25 km), the closed Ketza River Mine (abandoned) to the west (approximately 92 km), and Fyre Lake in exploration phase in closer proximity to the Project. Other mine sites in the region include Faro (abandoned), Sa Dena Hes (permanent closure), Cantung (abandoned), Selwyn (exploration by Selwyn Chihong Mining Ltd.), and Mactung (closed, owned by Government of Northwest Territories).

No other land tenure or land uses overlap or are adjacent to the Project.



BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 3-1
PROXIMITY TO MINING PROJECTS IN SOUTHEAST YUKON

NOVEMBER 2016

Kudz Ze Kayah Project

Closed Mine

Mine in Exploration or Licensing Phase

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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Datum: NAD 83; Projection UTM Zone 9N

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BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 3-2
LAND TENURE

JANUARY 2017

Kudz Ze Kayah Project

Quartz Land Use Permits Property

- Bolt (Valid)
- Boot (Valid)
- Fyre Lake (Valid)
- Fyre Lake (Expired)
- Kudz Ze Kayah (Valid)
- Pelly Exploration (Valid)
- Wolverine (Valid)
- Wolverine (Expired)
- Tsa Da Glisza (Expired)
- Helen (Expired with Completion)

Current Ownership/Tenure & Land Use

- BMC Minerals (No.1) Ltd. Mineral Claims
- Quartz Mineral Claims
- Land Disposition
- Parks & Campground
- Utility

Interim First Nation Settlement Lands

- Category A
- Category B
- Group Trapline Concession
- Outfitting Concession

Other Map Features

- Location of Proposed Mine Infrastructure
- Waterbody
- Watercourse
- Tote Road/Proposed Access Road

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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3.3 TRADITIONAL TERRITORY

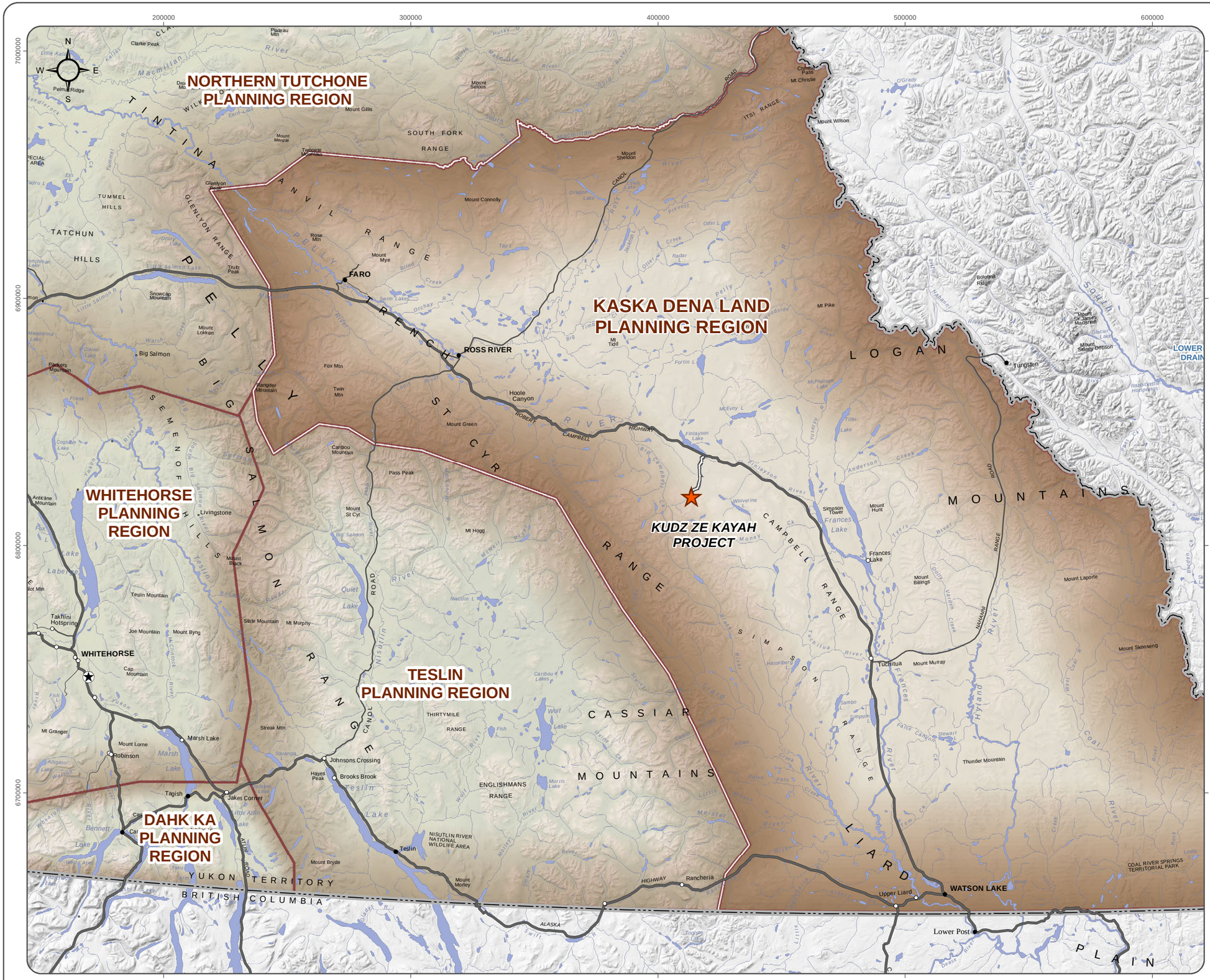
As previously noted, the Project is located in the traditional territories of the RRDC and the Liard First Nation (LFN), both of which are Kaska nations (Figure 2-1).

The Project claims do not overlap any interim protected land parcels; however, an interim protected Category A Settlement Lands R-block for the RRDC (R-15A) is located adjacent to the southeast claims (Figure 3-2).

3.4 YUKON LAND USE PLANNING REGION

YESAA requires proponents to identify the Land Use Planning Region (LUPR) in the Project area, and to detail any regional land use plans in effect and any implications.

The Project is located within the Kaska Land Use Planning Region (RRDC and LFN traditional territory) (Figure 3-3); however, at this time, regional plans cannot be finalized in the Kaska region because of unsettled land claims. Discussions with the RRDC have indicated that they have submitted a Draft Land Use Management Plan for their asserted Traditional Territory to Yukon Energy, Mines and Resources (EMR) for review and discussion. The status of the review is uncertain. Notwithstanding, details from the Draft Land Use Management Plan, which may be relevant to environmental protection in the Project area, have been requested.



BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 3-3
YUKON LAND USE PLANNING REGIONS

NOVEMBER 2016

Kudz Ze Kayah Project

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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3.5 CONSISTENCY WITH OTHER PLANS

This section outlines other plans relevant to the Project area and considers their consistency with the proposed Project. The following plans were identified as applicable to the Project area:

- Management Plan for the Northern Mountain Population of Woodland Caribou (*Rangifer tarandus caribou*) in Canada. *Species at Risk Act* Management Plan Series (Environment Canada, 2012);
- Forever Faro (Town of Faro, 2013);
- Integrated Community Sustainability Plan (Town of Watson Lake, 2007, 2013);
- Yukon Wolf Conservation and Management Plan (Yukon Government, 2012);
- Management Plan for Yukon Amphibians (Yukon Government, 2013);
- Best Management Practices for Works Affecting Water in Yukon (Yukon Government, 2011);
- Climate Change Action Plan Progress Report 2015 (Yukon Government, 2015); and
- Facility Greenhouse Gas Reporting (Government of Canada, 2016).

The "Management Plan for the Northern Mountain Population of Woodland Caribou (*Rangifer tarandus caribou*) in Canada" is part of the species at risk management plan series prepared by Environment Canada. The goal of the management plan is to prevent the northern mountain population from becoming threatened or endangered, by having responsible agencies cooperatively work together to carefully manage caribou and their habitat. The Project area is within the Finlayson caribou herd range which is covered under this plan. The plan provides management objectives and an implementation strategy for protection of the caribou populations and habitats. The caribou population and habitat have been considered through the development of the Project Proposal, with the existing conditions, potential effects, proposed mitigation and monitoring discussed further in Chapter 13, as well as Section 18.7 (Wildlife Protection Plan).

"Forever Faro" is a three-volume plan comprising Faro's Integrated Community Sustainability Plan, Official Community Plan, and Corporate Strategic Plan (Town of Faro, 2013). It provides the high-level guide to inform decision-making, action planning, and implementation in Faro for the next ten years. It was developed through a comprehensive and streamlined approach of engaging the community in creating a vision for the future and then immediately integrating that vision into other policies and plans to ensure implementation. The Project will support Faro in community development through employment, economic growth, and housing, as outlined in Chapter 15 and Section 18.14 (Socio-economic Effects Management Plan).

The "Integrated Community Sustainability Plan" provides a sustainable development framework for the community of Watson Lake. The plan raises concern with regards to increase in greenhouse gases and metal levels in nature as a result of mining activities in relation with the community's sustainability principles. The Project Proposal addresses potential effects of greenhouse gas emissions (Chapter 6), considers metal levels in the soils (Chapter 11), effects on aquatic ecosystems (Chapter 10), and effects on vegetation (Chapter 12). The conceptual management plans for the

above-mentioned effects are discussed in Chapter 18. The Project contribution to the development of the community through employment, economic growth, and housing is outlined in Chapter 15, and mitigations and enhancement measures are presented in Chapter 15 (Socio-economic Effects Assessment).

The "Yukon Wolf Conservation and Management Plan" is intended to guide wolf conservation and management throughout Yukon. The management plan introduced in 2012 was an update to the original management plan released in 1992. The updated plan released in 2012 recognizes that temporarily reducing wolf numbers in defined areas is not a sustainable solution to increasing prey numbers, and therefore, aerial control is no longer a recommended management tool. The 2012 management plan recommends seven management goals to provide long term guidance on how wolf populations should be managed in Yukon. This plan can be applied to the Project area given that wolf populations are known to occur in the area. The wolf population and their associated habitat has been considered through the development of the Project Proposal, with the existing conditions, potential effects, proposed mitigation and monitoring discussed in Chapter 13, as well as Section 18.7 (Wildlife Protection Plan).

The "Management Plan for Yukon Amphibians" has been developed to provide a broad framework to guide the management of Yukon amphibians. The plan recognizes there is much that is not understood about Yukon amphibian populations such as trends in abundance, distribution, limiting factors and threats. The goals of the plan are to maintain healthy populations of amphibians across their ranges in Yukon to prevent species from becoming Threatened or Endangered. The plan also aims to increase public appreciation, awareness, and stewardship of amphibians and their habitats. Although no amphibians have been observed in the Project area (Section 13.3), this management plan will be used as a guidance document to identify and maintain key amphibian habitat, and assess and mitigate threats to amphibian populations, if detected.

The "Best Management Practices (BMP) for Works Affecting Water in Yukon" is an approach to help developers comply with environmental regulations and avoid or mitigate the negative environmental impacts of development activities. The premise of the BMP approach is that a project will be in compliance if the developer adheres to a number of key principles and prescribed work practices, and develops work plans in consultation with regulators. The focus of the guide is to provide Yukon-specific BMPs that prescribe practical work-site guidelines that will help planners and developers protect water resources and comply with water regulations. The water management on site is described in Section 4.10; the surface water existing conditions and potential effects on surface water are described in Chapter 8; the conceptual surface water management plan is described in Section 18.4; conceptual sediment and erosion control plan is described in Section 18.6.

The "Climate Change Action Plan Progress Report 2015" identifies actions undertaken to date to address climate change in Yukon, and identifies 28 new initiatives to support the governments climate change goals. The plan highlights the Government of Yukon's actions to reduce greenhouse gas emissions and adapt to the impacts of the changing climate. The report details the numerous adaptation efforts to protect the integrity of Yukon's water, forests, food security, infrastructure and public health, among others. In particular, the departments of Environment and Energy, Mines and Resources have developed a voluntary reporting protocol for large stationary facilities, i.e., electrical

generators emitting over 2.5 kilotonnes of greenhouse gas emissions per year. Reporting will help identify conservation opportunities, helping to reduce both greenhouse gas emissions and electricity generation expenses. The greenhouse gas emissions for the Project are calculated in Section 6.4.

Since March 2004, the Government of Canada has required facilities across Canada to report their greenhouse gas (GHG) emissions annually through the Greenhouse Gas Emissions Reporting Program (GHGRP). Currently, the GHGRP applies to all facilities that emit the equivalent of 50 kilotonnes or more of GHGs in carbon dioxide equivalent units per year. The Government of Canada is currently considering lowering the reporting threshold from 50 kilotonnes to 10 kilotonnes, as well as reporting of additional data and applying specific quantification methods to determine emissions. Reporting of GHG emissions contributes to the development, implementation and evaluation of climate change and energy use policies and strategies by providing a more precise picture of the sources and amounts of GHG emissions from Canada's largest emitters. The greenhouse gas emissions for the Project are calculated in Section 6.4.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
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2. First Nation and Community Consultation
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6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

4 PROJECT DESCRIPTION 4-1

4.1 PROJECT IDENTIFICATION 4-1
4.2 SCOPE OF THE ASSESSMENT 4-3
4.2.1 Outside the Scope of the Assessment 4-7
4.3 PROJECT PHASES AND SCHEDULING 4-7
4.3.1 Project Schedule 4-7
4.3.2 Construction Phase 4-10
4.3.3 Operations Phase 4-11
4.3.4 Decommissioning, Reclamation and Closure Phase 4-15
4.4 GEOLOGY 4-17
4.4.1 Regional Geology 4-17
4.4.2 Project Geology 4-17
4.4.3 Exploration and Data Collection 4-22
4.5 MINERAL RESOURCE 4-22
4.5.1 Resource Classification 4-22
4.5.2 Mineral Resource Estimate 4-23
4.6 MINE PLAN (OPEN PIT) 4-24
4.6.1 Open Pit Development 4-24
4.6.2 Pit Geometry and Slope Stability 4-28
4.6.3 Blasting and Explosives Management 4-30
4.6.4 Loading 4-31
4.6.5 Hauling 4-31
4.7 MINE PLAN (UNDERGROUND) 4-34
4.7.1 Underground Development 4-34
4.7.2 Mining Methods 4-34
4.7.3 Underground Geotechnical Study 4-40
4.7.4 Ventilation and Air Quality 4-41
4.7.5 Compressed Air 4-43
4.7.6 Power 4-43
4.7.7 Blasting and Explosives Management 4-43
4.7.8 Communications 4-44
4.7.9 Mine Warning System 4-44
4.7.10 Refuge Chambers 4-45
4.7.11 Escapeways 4-45
4.7.12 Paste Backfill 4-45
4.8 ORE PROCESSING 4-46
4.8.1 Overview 4-46
4.8.2 Metallurgical Studies 4-46
4.8.3 Process Plant Description 4-48

4.8.4 Processing Plant Location and Layout 4-52
4.8.5 Reagents 4-55
4.9 WASTE ROCK MANAGEMENT 4-56
4.9.1 Waste Characterization 4-56
4.9.2 Waste Rock Identification and Management 4-59
4.9.3 Deposition of Tailings and Mine Rock 4-59
4.9.4 Class A Storage Facility 4-62
4.9.5 Class B Storage Facility 4-67
4.9.6 Class C Storage Facility 4-70
4.9.7 Overburden Stockpile 4-73
4.10 WATER MANAGEMENT 4-75
4.10.1 Construction 4-75
4.10.2 Operations 4-82
4.10.3 Water Use 4-85
4.10.4 Site Water Balance 4-87
4.10.5 Closure 4-91
4.10.6 Geona Creek 4-92
4.11 SUPPORT INFRASTRUCTURE 4-92
4.11.1 Paste Fill Plant 4-92
4.11.2 Warehouse and Administration Complex 4-93
4.11.3 Workshop 4-94
4.11.4 Assay and Metallurgical Laboratory 4-94
4.11.5 Emergency Facility 4-94
4.11.6 Fuel Storage and Distribution 4-95
4.11.7 Fire Protection 4-96
4.11.8 Sewage Collection and Treatment 4-97
4.11.9 Waste Management Plan 4-97
4.11.10 Communications 4-98
4.11.11 Site Roads 4-99
4.11.12 Borrow Sources 4-99
4.11.13 Explosives Use and Storage 4-100
4.11.14 Site Accommodations 4-100
4.11.15 Site Power Supply 4-101
4.12 ACCESS AND TRANSPORTATION 4-102
4.12.1 Tote Road Upgrade to Access Road 4-102
4.12.2 Finlayson Lake Airstrip 4-107
4.12.3 Concentrate Transport to Port of Stewart 4-111
4.12.4 Transportation Volumes 4-112
4.13 DECOMMISSIONING AND RECLAMATION PLAN 4-113
4.13.1 Closure Phases 4-114
4.13.2 Mine Site Decommissioning and Restoration 4-119
4.13.3 Water Management and Water Quality Control Measures 4-123
4.13.4 Waste Management 4-125
4.13.5 Monitoring, Maintenance and Schedule 4-126

4.13.6 Access Road Closure 4-126
4.14 WORKFORCE, PROCUREMENT, HIRING AND TRAINING 4-127
4.14.1 Construction 4-127
4.14.2 Operations 4-128
4.14.3 Decommissioning 4-131
4.14.4 Closure 4-131
4.14.5 Post-Closure 4-131
4.14.6 Employee Health and Well-being 4-132
4.15 ALTERNATIVES AND CHOSEN APPROACH 4-132
4.15.1 Introduction 4-132
4.15.2 Methods 4-133
4.15.3 Alternatives to the Project 4-134
4.15.4 Alternative Means of Carrying out the Project 4-135
4.16 TECHNOLOGIES 4-147
4.16.1 Flotation Ore Processing 4-147
4.16.2 Filtered Tailings 4-147
4.16.3 Filtered Tailings Reclamation 4-148
4.16.4 Paste Backfill 4-149
4.16.5 Containerized Transportation of Lead Concentrates 4-149
4.16.6 Treated Wetlands 4-149

LIST OF TABLES

Table 4-1: Activities within the Scope of Assessment 4-3
Table 4-2: Activities Outside the Scope of Assessment 4-7
Table 4-3: Kudz Ze Kayah Project Phases and Schedule 4-7
Table 4-4: Kudz Ze Kayah Life of Project Schedule 4-9
Table 4-5: Construction Schedule for Kudz Ze Kayah Project 4-13
Table 4-6: ABM Deposit Lithological Units 4-18
Table 4-7: Summary of Drilling at the Project 4-22
Table 4-8: Project Mineral Resource Estimate 4-23
Table 4-9: Open Pit Mining Schedule 4-26
Table 4-10: Rock Slope Configuration Based on Kinematic Analysis 4-30
Table 4-11: Underground Mine Schedule 4-35
Table 4-12: Average UCS values, Grades and Terms for Ore and Waste Domains 4-40
Table 4-13: Summary of Point Load Test Results 4-40
Table 4-14: Preliminary Ground Support Recommendations for 5 m Span and 5 m Height 4-41
Table 4-15: Process Plant Reagents, Storage and Estimated Consumption 4-55
Table 4-16: Geodomain Characteristics 4-57
Table 4-17: Combined ARD Mining Waste Schedule 4-61
Table 4-18: Class A Facility Design Basis 4-62
Table 4-19: Class B Facility Design Basis 4-67

Table 4-20: Modelled Stability of Class B Storage Facility 4-68
Table 4-21: Class C Facility Design Basis 4-70
Table 4-22: Modelled Stability of Class C Storage Facility 4-71
Table 4-23: Temporary Overburden Stockpile Design Basis 4-73
Table 4-24: Modelled Stability of Temporary Overburden Stockpile 4-74
Table 4-25: Pond Design Specifications 4-79
Table 4-26: Results from Average Climatic Conditions in Year 10 (m^3/month) 4-88
Table 4-27: Results from 1 in 10 Year Dry Climatic Conditions in Year 10 (m^3/month) 4-89
Table 4-28: Results from 1 in 50 Year Wet Climatic Conditions in Year 10 (m^3/month) 4-90
Table 4-29: Summary of Fuel Storage and Distribution 4-95
Table 4-30: Waste Storage Locations and Disposal Method 4-98
Table 4-31: Design Specifications 4-103
Table 4-32: Proposed Haul Route 4-111
Table 4-33: Estimated Operations Traffic Volume 4-112
Table 4-34: Closure Schedule and Execution Strategy Summary 4-118
Table 4-35: Potential Hazardous Materials at Closure and Disposal Requirements 4-125
Table 4-36: Estimated Site Labour Requirements 4-130
Table 4-37: Summary of Alternatives for Tailings Disposal Methods and Locations 4-139
Table 4-38: Summary of Alternatives for Waste Rock Storage Facility Locations 4-140
Table 4-39: Summary of Alternatives for Waste Rock Management 4-141
Table 4-40: Summary of Alternatives for Airstrip Access 4-142
Table 4-41: Summary of Alternatives for Power Generation 4-143
Table 4-42: Summary of Alternatives for Concentrate Transport Route 4-145
Table 4-43: Summary of Alternatives for Mining Methods 4-147
Table 4-44: Examples of Passive Treatment in Northern Environments 4-150

LIST OF FIGURES

Figure 4-1: Project Location 4-2
Figure 4-2: Project Mine Site Layout (Year 1) 4-12
Figure 4-3: Project Mine Site Layout (Year 10) 4-14
Figure 4-4: Project Layout in Post-Closure Period (Year 27+) 4-16
Figure 4-5: Plan View of ABM Deposit, Selected Drill Intercepts, and Cross Section 4-21
Figure 4-6: Final ABM Open Pit 4-27
Figure 4-7: Haul Road Design 4-33
Figure 4-8: Isometric Views of Main Access and Ventilation Ramps (Looking East) 4-36
Figure 4-9: Cut and Fill Extraction Sequence 4-37
Figure 4-10: General Long Hole Stoping with Fill Sequence 4-38
Figure 4-11: Isometric View of Underground Stope Distribution (Looking West) 4-39
Figure 4-12: Ventilation Network Schematic (Looking Southwest) 4-42
Figure 4-13: Process Flowsheet 4-47
Figure 4-14: Process Plant Facility Layout 4-54

Figure 4-15: Cross Section of Class A Storage Facility....4-63
Figure 4-16: Cross Section of Class A Storage Facility Progressively Reclaimed....4-66
Figure 4-17: Geona Creek Subcatchments....4-77
Figure 4-18: Operational Water Management Schematic....4-84
Figure 4-19: Access Road Alignment and Potential Borrow Sources....4-104
Figure 4-20: Finlayson Airstrip Extension....4-108
Figure 4-21: Proposed Finlayson Airstrip Extension....4-109
Figure 4-22: General Arrangement in the Active Closure Period (Year 13)....4-116
Figure 4-23: Project Layout in Transitional Closure Period (Year 20)....4-117
Figure 4-24: Tailings Storage Facility Alternatives....4-137

4 PROJECT DESCRIPTION

4.1 PROJECT IDENTIFICATION

This section of the Project Proposal provides a description of the principal Project components and activities that make up the Kudz Ze Kayah Project (the Project).

The Project is located on the northern flank of the Pelly Mountain Range, 260 km northwest of Watson Lake and 115 km southeast of Ross River, Yukon (Figure 4-1). The Project area lies approximately 24 km south of Finlayson Lake and 25 km west of the Wolverine Mine, in the upper portion of the Geona Creek valley, at approximate Universal Transverse Mercator (UTM) coordinates of 415,000 mE, 6,815,500 mN, Zone 9N NAD 83. The Project area is a located at approximately 1,400 metres above sea level (masl) elevation in a broad, gently sloping valley.

The Project is in the Traditional Territory of the Kaska Nation. The Project is the subject of a Socio-economic Participation Agreement that was signed in 2004 between Ross River Dena Council (RRDC) (on behalf of Kaska nation) and Teck Resources Ltd and which was subsequently assigned to BMC Minerals Limited when they acquired the Project. BMC and RRDC are currently reviewing the SEPA with a view to modernising it.

BMC is proposing construction, mining and mineral processing activities for the ABM Deposit, of which there are two zones; the ABM Zone and the Krakatoa Zone. The ABM Deposit is a polymetallic volcanogenic massive sulphide (VMS) deposit containing economic concentrations of copper, lead, zinc, gold, and silver. Mining is planned to be conducted utilizing both Open Pit and Underground mining methods, with ore processed into separate copper, lead, and zinc concentrates via sequential flotation through a processing plant with a nominal design capacity of 2 Mt per annum (Mtpa). Tailings will be deposited in a purpose built dry stack tailings Storage Facility on the western slope of the Geona Creek valley, while waste rock will be classified according to acid generating and metal leaching potential and stored in purpose built waste storage facilities. Strongly acid generating material will be co-disposed with the tailings or alternatively stored as cemented paste backfill or waste rock fill in the mined out underground workings. Other waste rock material will be placed within the surface storage facilities noted above.

The mine is planned to operate for a minimum of 10 years, producing an average 180,000 t zinc, 60,000 t copper, and 35,000 t lead concentrates annually. Concentrate will be transported to the port of Stewart in British Columbia for sale to export markets in North America, Europe and Asia.

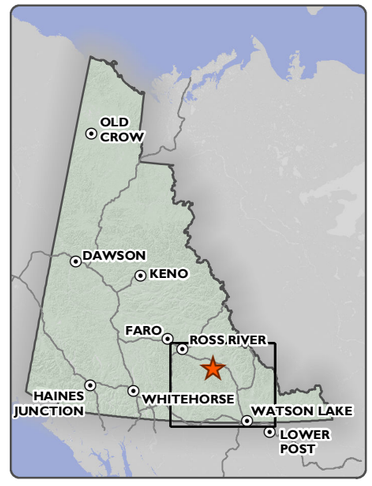
BMC has engaged with government agencies, boards, First Nations, various stakeholder groups, and interested parties, and has consulted with these parties regarding the proposed Project, the Project planning and design, Project Proposal content, and permitting strategies. The outcomes from those discussions and the input provided by these parties has been used by the Company to inform the development of the Project plan which aims to minimize negative effects on the natural environment while enhancing beneficial effects on the socio-economic environment through Project design, as described thoughout this Chapter.

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-1
PROJECT LOCATION

DECEMBER 2016



★ KUDZ ZE KAYAH PROJECT

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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Drainage areas obtained from National Hydrology Network 2011

Datum: NAD 83; Projection UTM Zone 9N

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4.2 SCOPE OF THE ASSESSMENT

The scope of the assessment for the purposes of the effects assessment (EA) and this Project Proposal is provided in Table 4-1. The post-closure phase is not included in the list of activities (Table 4-1) as no physical activities will occur during this phase. Project effects may continue into post-closure phase and will be identified as such in the corresponding assessment sections.

Table 4-1: Activities within the Scope of Assessment

Project Activity	Activity Description	Section of Chapter 4 where Activity is Further Described
Construction		
Tote Road upgrade to Access Road	Upgrade of the existing Tote Road to a 5 m wide, single lane, all weather Access Road.	Section 4.12.1
Finlayson Lake airstrip upgrade	Lengthen the airstrip from 1,800 ft (549 m) to 3,100 ft (914 m) to the southeast with an approximate area of new disturbance of 14,000 m^2. Estimated weekly flights during construction is 6.	Section 4.12.2
Site preparation and clearing	Vegetation and topsoil will be removed from each mine component with appropriate machinery.	Section 4.3.2
Site grading, including soil and overburden removal and stockpiling	Topsoil will be scraped off each facility with appropriate machinery and stockpiled in strategic locations around the Project area. Transport of topsoil and overburden material will be kept to a minimum and the resulting stockpiles will be revegetated to enhance stability.	Section 4.3.2
Off site traffic (construction equipment and materials delivery)	Construction equipment and materials delivery amounts during the construction phase will vary dependent upon the stage of construction of various facilities. It is anticipated that there will be an average delivery of seven loads a day over the construction period. This traffic will likely come in surges with a high rate of traffic one week and then minimal traffic in following periods.	Section 4.12.4
On site traffic	Two categories of roads will be constructed. Mine haul roads will be designed for, and used by, mine haul trucks and will link the ABM open pit to the Process Plant, the Waste Storage Facilities and the Overburden Stockpile. Access and service roads will link all operating areas of the Project and will be constructed to handle light duty and commercial vehicles.	Section 4.6.5
ABM open pit development (including dewatering and Fault Creek diversion)	Pre-production stripping period with approximately 2.8 Mt of Class C waste being mined and 1.3 Mt of overburden, during a nominal 17-month period; diversion of Fault Creek to the south will be undertaken prior to the dewatering of the ABM open pit area; Pit Rim Pond will be constructed prior to the commencement of dewatering operations of the overburden in the ABM open pit area.	Section 4.3.2
Infrastructure construction	Construction of: Process Plant Facility; waste and water management facilities, camp, truck shop, explosives management facility, fuel storage facilities, power plant, and communications tower.	Section 4.11
Waste management	Waste handling will be managed initially using the existing infrastructure until the Waste Management Facility is constructed (which will be in the first season of Year -1).	Section 10

Project Activity	Activity Description	Section of Chapter 4 where Activity is Further Described
Water use and management	Site Diversion Ditches will be constructed as required to divert non-contact water away from Project facilities. Construction of all water management facilities and storage ponds including the Lower and Upper Water Management Ponds. Overburden dewatering. Construction phase water supply sources include: groundwater wells; and water from the Open Pit dewatering.	Section 4.10.1
Power generation	Power requirements for construction are estimated at less than 3 MW and will vary dependent upon the phase of construction. The operational power plant will be constructed in Year -1 and Project power will be supplied from LNG/Diesel with an installed capacity of 25.2 MW (6 generators), with four in use at one time in operations (16.8 MW), after it is commissioned. Prior to the power plants commissioning, power will be supplied by appropriately sized temporary standalone diesel generators located near power consumption centres.	Section 4.11.15
Worker transport	Transportation of personnel during the construction phase will be via the Finlayson Lake airstrip with transport from there to the Project using buses. Aircraft will be chartered to transport construction workers to the Project from the Whitehorse Airport on a rotational basis. There will also be buses or vans available for transportation of employees and contractors from the three nearest communities; Ross River, Faro, and Watson Lake. The number of flights will depend on the amount of personnel employed on site at any one time and the local hire content, but will approximate an average of six (18 passenger) charter flights per week over the construction period.	Section 4.14.1
Construction camp operation	The construction camp will be sized to accommodate 100 personnel initially, with the camp being upgraded to accommodate 350 personnel during the height of construction.	Section 4.11.14 Section 4.14.1
Workforce, Procurement, Hiring and Training	Personnel requirements will vary over the construction period, but are expected to peak at 350 people. The primary work roster expected to be adopted for construction work will be a three week on, one week off roster, common to many construction projects in Western Canada. Variations on this roster allowing for shorter work periods on site may be adopted as required.	Section 4.14.1
Operations		
ABM open pit operations (including blasting and dewatering)	The majority of the ABM Deposit will be mined by Open Pit mining methods. A single pit will be mined, with mining of the ABM Zone staged into three separate phases to manage overall waste stripping requirements and the adjacent Krakatoa Zone mined in a single phase. All Open Pit mining is planned to be completed over a period of approximately 10.5 years, including a 17-month pre-production period to provide construction materials and build ore stockpiles to maintain continuity of ore to the processing plant. Open Pit dewatering will continue throughout operations, with dewatering flows being directed to the Pit Rim Pond.	Section 4.6
Underground operations	Underground mining will only occur in the Krakatoa Zone of the Deposit. The underground mine is planned to commence at the end of Year 2 and operate until the end of Year 9.	Section 4.7
Ore processing	The Process Plant and associated service facilities will process run-of-mine (ROM) ore at a nominal rate of 2.0 Mtpa, to produce separate copper, lead, and zinc concentrates and tailings. The process will consist of crushing and grinding of the ore, separate sequential pre-float, rougher and cleaner flotation of copper, lead and zinc and regrind of copper, lead and zinc rougher concentrates. Concentrates will be thickened, filtered, and stockpiled on site prior to being loaded onto trucks for transport to third party smelters via the port of Stewart.	Section 4.8

Project Activity	Activity Description	Section of Chapter 4 where Activity is Further Described
On site traffic	On site-traffic will primarily include haul trucks and service trucks, but will also include vehicles transporting personnel from the Finlayson Lake airstrip, explosives, LNG, diesel, gas, reagents, concentrate, supplies, and cement.	Section 4.11.11 Section 4.6.5
Off site traffic (highway)	During operations the number of trucks on the roads between the site and the supply points is estimated to be 52 at any given time, during any 24 hour period. The traffic volume includes, but is not limited to vehicles transporting personnel from the Finlayson Lake airstrip, explosives, LNG, diesel, gas, reagents, concentrate, supplies, and cement.	Section 4.12.3
Finlayson Lake airstrip operations	During operations approximately seven flights will be required each week.	Section 4.14.2
Storage facilities management (Class A, B, and C)	Waste rock material from the Open Pit and underground workings will be classified and stored based on three categories comprising Class A, Class B, and Class C. Class A material is strongly potentially acid generating (SPAG) and high potential for metal leaching totaling approximately 11.6 Mt; Class B material is mildly potentially acid generating and moderate potential for metal leaching totaling approximately 47.3 Mt; and Class C material is non potential acid generating and low potential for metal leaching totaling approximately 64 Mt.	Section 4.9.3
Progressive reclamation of storage facilities	Class A and B Storage Facilities will be progressively reclaimed with an engineered low permeability cover material, and approximately 3 to 5 m of Class C material for frost protection. Progressive reclamation will be conducted in conjunction with on-going environmental monitoring to ensure that sediment control and water quality objectives are met. The closure of the facility will include the resloping of the Facility faces to facilitate the placement of soil and revegetation and to allow for water breaks.	Section 4.9.4, 4.9.5, and 4.9.6
Water use (potable and non-potable)	The camp will be supplied with potable water from a groundwater well at a nominal rate of up to 3.7 m^3/hour (up to 350 people at 250 l/day). The water will be pumped into a storage tank in camp and treated as required. The camp will be constructed with a sewage treatment plant that will include a septic field that will eventually discharge treated water into Geona Creek. Non-potable water will be required for dust supression, wash bays, and primarily for the Process Plant facility and Paste Fill Plant facility.	Section 4.10.3
Mine water management and treatment (including effluent discharge)	The water management plan involves collecting and managing site runoff from disturbed areas and maximizing the recycle of process water. Surplus water will be stored on site within the Upper and Lower Water Management Ponds and used for processing, with the excess water being released to Geona Creek and to Finlayson Creek once it has been determined to meet discharge quality requirements.	Section 4.10.2 Section 4.10.1.4
Waste management	The Project will have a Waste Management Facility. It will contain all waste, recyclables and contaminated materials, excluding waste oil (which will be stored in a tank by the workshop). It will include an incinerator, a small Land Treatment Facility, and a small landfill area. The entire facility will be surrounded by a wildlife proof fence.	Section 4.11.9
Power generation	The Project power supply will be a site based bi-fuel (natural gas and/or diesel) fueled power plant, located adjacent to the processing plant facilities.	Section 4.11.15
Worker transport	Personnel numbers are expected to range between 100 and 345. Transportation of personnel during operations will be via the Finlayson Lake airstrip with transport from there to the Project using buses. Aircraft will be chartered to transport personnel to the Project from the Whitehorse Airport on a rotational basis. There will also be buses or vans available for transportation of employees and contractors from the three nearest communities; Ross River, Faro, and Watson Lake. The number of flights will depend on the amount of personnel employed on site at any one time, and the local hire content, but will approximate an average of seven (18 passenger) charter flights per week over the operation period.	Section 4.14.2

Project Activity	Activity Description	Section of Chapter 4 where Activity is Further Described
Camp operation	At the commencement of the operations phase any temporary construction camp modules will be removed and the camp will have its ultimate capacity of 250 personnel. Forty rooms will be available with ensuite bathroom facilities while the remaining rooms will utilize shared facilities located within each accommodation block.	Section 4.11.14
Workforce, Procurement, Hiring and Training	Personnel numbers are expected to range between 100 and 345. The majority of personnel will be employed on a two week on, one week off roster, while certain staff will be employed on a nine day on, five day off roster.	Section 4.14.2
Closure		
Process Plant decommissioning and site reclamation	Closure measures for the Process Plant as well as the associated Warehouse and Administration Complex include dismantling and removing buildings, trailers, and related infrastructure. Prior to dismantling and removal, buildings will be inspected for hazardous materials. Any hazardous materials will be removed and disposed of either on or off site in an appropriate landfill or Storage Facility. Non-hazardous materials that have no salvage value will be disposed of in an approved landfill site on the mine site.	Section 4.13.2
ABM lake filling	The Open Pit and surrounding areas will undergo reclamation to the extent of ensuring that the pit walls are stable and pose no danger to the general public or local wildlife. Berms will be created around high wall edges to prevent access by people or wildlife. The Open Pit will be allowed to flood as dewatering will cease, and equipment will be removed. Fault Creek will be redirected to the ABM open pit.	Section 4.13.2
Final storage facilities reclamation	All three waste storage facilities will have growth medium placed on top and will be revegetated to reduce erosion and to meet the end land use objective of returning the area to the current wildlife habitat.	Section 4.13.2
Support infrastructure removal and site reclamation	At the end of mine life, all buildings, offices and associated infrastructure will be removed or demolished and buried to return land to original wildlife land use with no active operation or maintenance.	Section 4.13.2
Water management, treatment and discharge	Water retention and sediment control structures, and appurtenances will be decommissioned or upgraded in such a way as to ensure that drainage at, and adjacent to the site, is stable in the long term. Additionally, flows will be conveyed into and throughout the mine footprint, and off the site in a controlled, stable fashion under a range of reasonably anticipated conditions.	Section 4.13.3
On site traffic	Traffic will use existing site roads for access to the various facilities requiring closure. As facilities are revegetated and the access roads are deemed no longer necessary they will be reclaimed and revegetated.	Section 4.13.2 Section 4.13.6
Off site traffic	Equipment and materials delivery and removal during the Closure phase will vary dependent upon the stage of closure of various components. It is anticipated that there will be an average of three truckloads a day over the active closure period with minimal traffic over the transition and post-closure periods.	Section 4.13.2
Access Road reclamation	Road reclamation will involve the removal of the culverts and drainage structures and decommissioning of the roadbed. Culverts, bridges, and drainage structures will be removed and disposed of off site at an appropriate location. Exposed soils along the length of the road will be stabilized and contoured to prevent surface erosion, then seeded with an appropriate seed mix.	Section 4.13.6

Project Activity	Activity Description	Section of Chapter 4 where Activity is Further Described
Workforce, Procurement, Hiring and Training	It is expected that two work rosters will be utilized on site during closure. Most staff engaged in dayshift only positions will be employed on a nine day on, five day off roster, while regular shift workers and certain other staff will be employed on a two week on, one week off roster. Total employee numbers are estimated at up to 80 people during active closure and 6-10 people for transition and post-closure.	Section 4.14

4.2.1 Outside the Scope of the Assessment

Table 4-2 presents the activities that are considered outside of the scope of the assessment.

Table 4-2: Activities Outside the Scope of Assessment

Activity	Rationale	Applicable Authorization
Current exploration activities including operating a camp, drilling, geophysical surveys, etc.	Assessed by YESAB in 2015 (YESAB project #2015-0028)	LQ00424

4.3 PROJECT PHASES AND SCHEDULING

The following section provides an overview of the Project phases and scheduling. Additional detailed descriptions of each Project component are provided in the subsequent sections of this Chapter.

4.3.1 Project Schedule

The Project phases are described as construction, operations, and closure (including: active closure, transition closure, and post-closure). A summary of the anticipated duration of each phase is included in Table 4-3. A life of Project Schedule for the main activities that make up the Project are presented in Table 4-4.

Table 4-3: Kudz Ze Kayah Project Phases and Schedule

Project Phase	Project Year	Duration
Construction	Year -2 to Year 1	2 years
Operations	Year 1 to Year 10	10 Years
Active Closure	Year 11 to year 13	3 Years
Transition Closure	Year 14 to Year 26	13 Years
Post-Closure	Year 27 to Year 36	10 Years

Construction will commence when the necessary permits and financing are in place. The construction phase is expected to last a period of approximately two years with the first year activities being

seasonally controlled. The first stages of construction will be extending the Finlayson Lake airstrip, and upgrading the existing Tote Road to an Access Road capable of being used by heavy haulage trucks. These two items need to be completed prior to construction of the major Project components to facilitate the transport of personnel and materials to the site.

A construction camp will be built, with the required infrastructure, and this will be upgraded in size through the construction phase to reach the final capacity required. Once the necessary housing and transport are available, construction of the Process Plant, Water Management Facilities, Class A Waste Storage Facility (WSF) Buttress, Run of Mine (ROM) pad, and pre-stripping of the Open Pit will commence.

The operations phase of the Project will commence at the end of the pre-commissioning period of the Process Plant facilities and be signalled by the first throughput of ore and production of concentrate from the processing plant. Operations will commence with progressive commissioning of the processing plant facilities, initially at a low production rate and progressively increased over the following months to the nominal capacity of 167,000 tonnes per month before the end of the first year. This rate will be maintained for the operational life of the Project with the last months treating low grade feed.

The processing plant feed will come entirely from the ABM open pit in the first two years and then will be supplemented by the Krakatoa underground operations in years 3 through 9.

Concurrent reclamation will be part of the operations phase as far as is practicable; however, the active closure phase will commence at the end of the operational life of the Process Plant in Year 10. The phase is expected to last three years and during this period, the majority of the surface facilities will be removed, and the KZK mine site will be fully reclaimed according to the reclamation objectives established in the final Closure and Reclamation Plan for the Project by BMC in consultation with Yukon Government, First Nations, and other relevant interested parties. The Fault Creek diversion will be removed in the first year to enable Fault Creek to return to its original channel and to begin filling the ABM open pit.

Transition closure will commence with the majority of the major earthworks completed and the ABM open pit continuing to fill with water from Fault Creek and natural groundwater. The transition closure phase is expected to last 13 years. Wetland treatment systems will be constructed and commissioned at the beginning of this period and monitoring and maintenance of the reclamation earthworks will be undertaken during this period as the waste cover systems and revegetation are established. The period will end once ABM lake outflow begins to discharge into Geona Creek.

The post-closure period will commence with the spilling of the ABM lake water into Geona Creek. It is currently planned to be a 10-year period of primarily monitoring and maintenance. The on-going monitoring will evaluate the predicted results of reclamation with on site conditions. It is expected that a year or two will be required to ensure that the passive water treatment systems are achieving performance expectations with the new water contribution from the ABM lake. Once these objectives and performance criteria are achieved, the active water treatment plant and remaining infrastructure will be demobilized/decommissioned, and site water management will be passive in nature.

Table 4-4: Kudz Ze Kayah Life of Project Schedule

Project Activity	Project Phase (Year from Commencement of Operations)																				
	Construction		Operations										Active Closure			Transition Closure/Post-Closure					
	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+
Construction activities (refer to construction schedule in Table 4-5)																						
Open pit operations (including blasting and dewatering)																						
Underground operations																						
Ore processing																						
On site traffic (Access Road/mine site)																						
Off site traffic (highway)																						
Finlayson Lake airstrip operations																						
Worker Transport																						
Storage facilities management (Class A, B, and C)																						
Progressive reclamation of storage facilities																						
Water use (potable and non-potable)																						
Mine water management and treatment (including effluent discharge)																						
Waste management																						
Power plant operations																						
Construction camp operation																						
Operations camp operation																						
Process plant decommissioning and site reclamation																						
ABM lake filling																						
Post-Closure Monitoring																						
Final storage facilities reclamation																						
Support infrastructure removal and site reclamation																						
Access Road reclamation																						

4.3.2 Construction Phase

4.3.2.1 Overview

This section describes the components, facilities, and activities that are anticipated in the construction phase (Year -2 to Year 1). In general, most construction activities for the Project will occur over a period of two years though some construction activities will occur during the operations phase. Similarly, some Project components such as the ROM pad will be constructed and operational during the construction phase of the Project and are presented in this section. Prior to the start of the construction phase, personnel will utilize existing infrastructure, to the extent practicable, including:

- KZK exploration camp;
- Water supply, sewage treatment facility, and power supply;
- Finlayson Lake airstrip;
- Tote Road;
- Laydown Areas; and
- Fuel storage.

The upgrading of the existing Tote Road and lengthening of the Finlayson Lake airstrip will be given the highest priority to enable personnel and materials to be transported to the construction site.

Primary activities during the construction phase will include:

- Tote Road upgrade to Access Road;
- Finlayson Airstrip upgrade;
- Build Construction Camp;
- Build Waste Management Facility;
- Fault Creek Diversion;
- Construction of Core Storage area;
- Construction of site roads;
- Construction of Site Water Diversion Channels;
- Construction of Water Management and Sediment Control Ponds;
- Construction of Pit Rim Pond and Receiving Environment;
- Overburden Dewatering;
- Pre-stripping of ABM open pit for construction materials;
- Pre-production stripping of ABM open pit including topsoil, subsoil and overburden rock;

- Construction of Waste Storage Facilities sufficient for the commencement of production;
- Construction of ancillary buildings (bulk explosives facility, mine shop and warehouse, fuel and lubricant storage facilities, and office facilities);
- Construction of the main power plant;
- Construction of the Process Plant facilities (crushers, conveyors, ore loading, grinding, flotation, thickeners, filtration, reagents and concentrate storage and loadout and associated infrastructure such as mechanical and electrical maintenance workshops);
- Construction of the Run of Mine (ROM) Pad; and
- Construction of haul roads.

Figure 4-2 shows the Project at the close of the construction phase with all the required facilities locations.

Table 4-5 shows the sequencing of construction phase activities leading to production (Year 1).

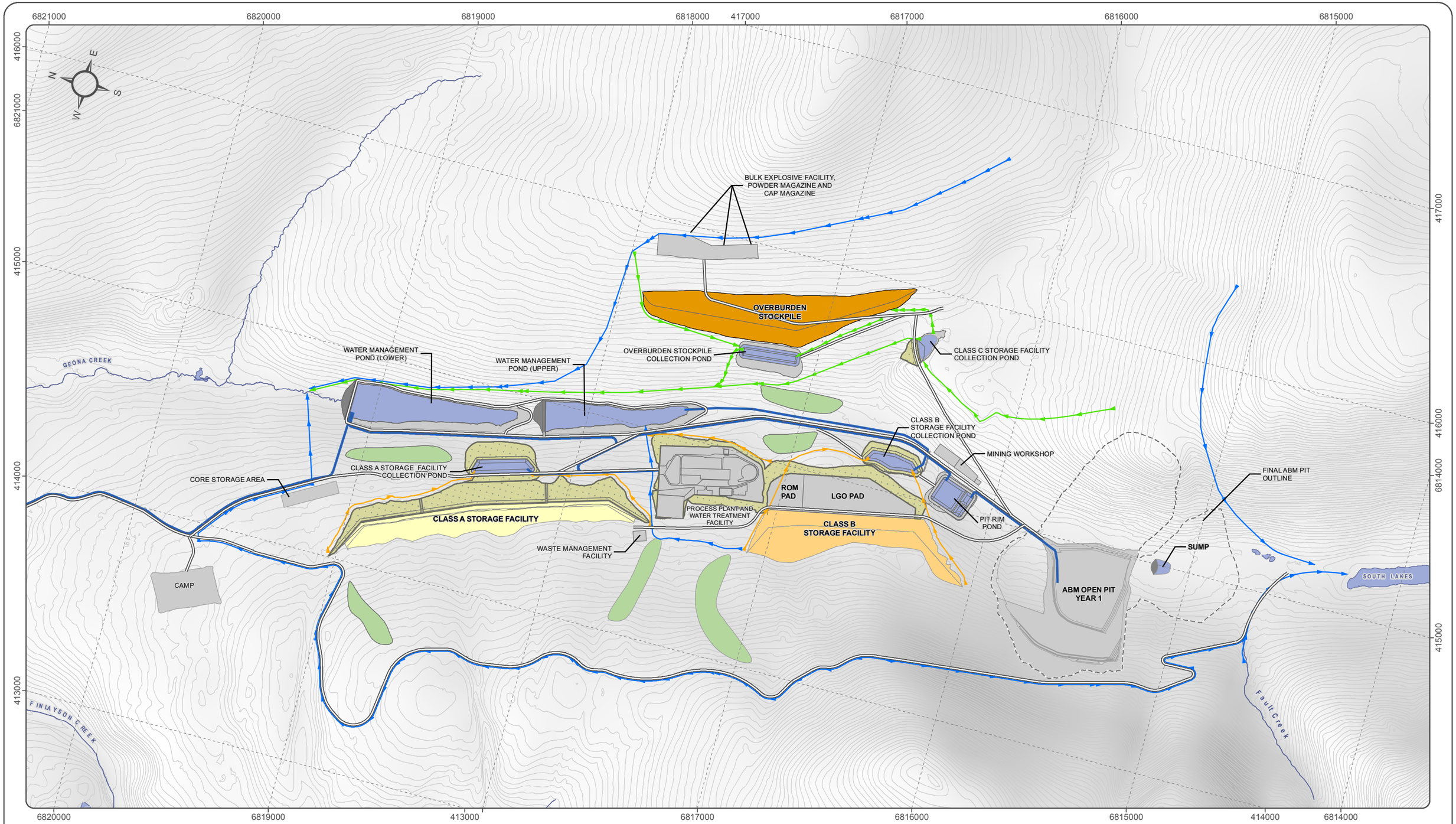
The following factors were considered for the construction schedule planning and execution:

- Seasonal conditions (temperature and precipitation as well as daylight hours);
- Remoteness of the Project; and
- Construction on discontinuous permafrost.

The conceptual construction plan for the Project is included in Appendix C- 1 Conceptual Construction Plan.

4.3.3 Operations Phase

The operations phase encompasses the period when ore is produced at the ABM open pit and underground mine, is then processed and the resultant concentrate is trucked off site. The operations phase of the Project will commence at the end of the pre-commissioning period of the Process Plant facilities and be signalled by the first throughput of ore and finishes with the end of production of concentrates in Year 10. Figure 4-3 presents the Mine site layout at year 10.



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Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

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- Class A Storage Facility
- Class B Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Pipeline
- Final ABM Open Pit Outline
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-2

PROJECT MINE SITE LAYOUT (YEAR 1)

FEBRUARY 2017

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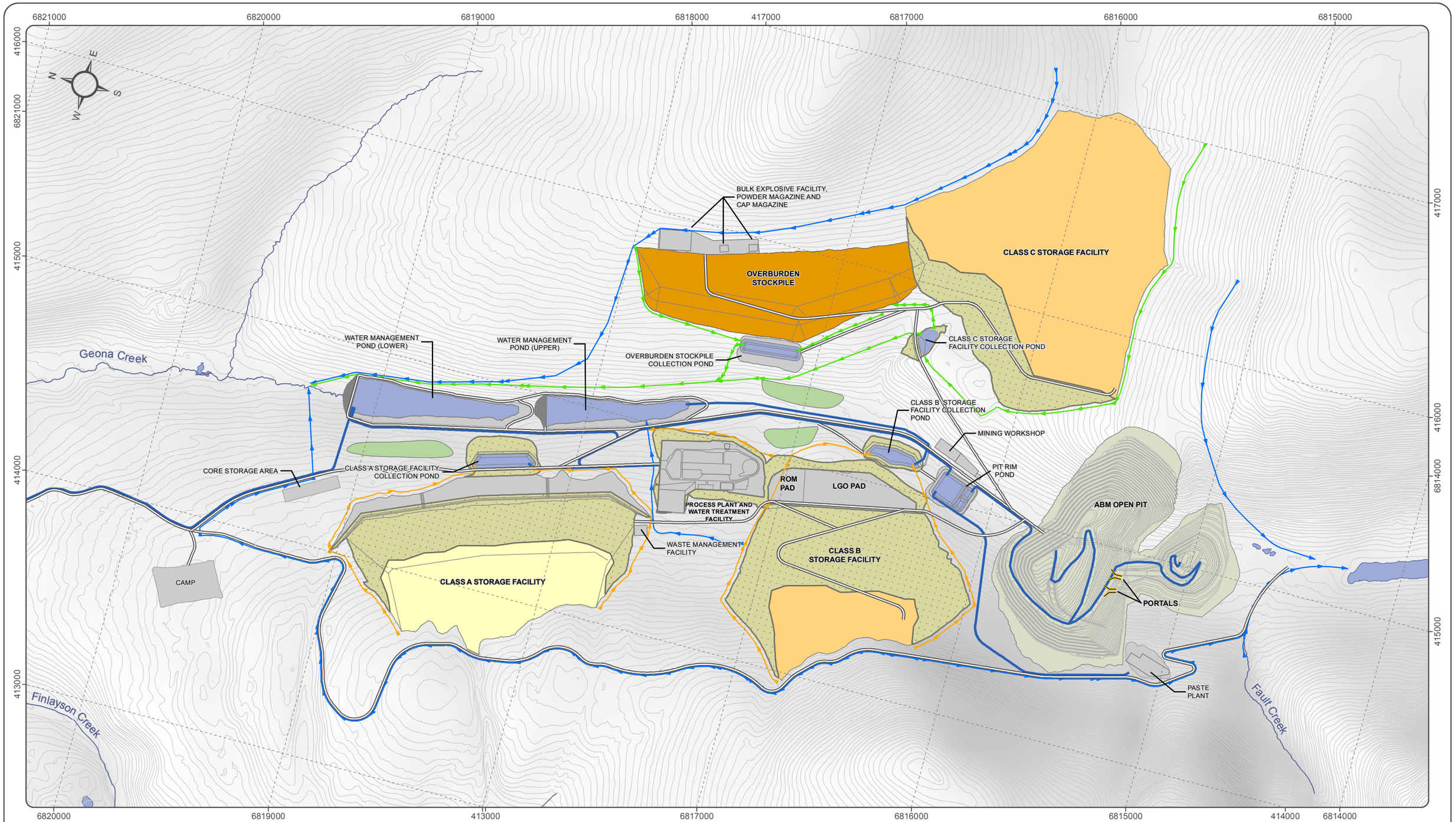
Table 4-5: Construction Schedule for Kudz Ze Kayah Project

Project Component	Pre-Construction				Construction				Operations							
	Pre Year -2				Year -2				Year -1				Year 1			
	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring		
Notice to proceed																
Receive Permits																
Engineering Procurement Construction Management Contract																
Procurement																
Tote Road upgrade to Access Road																
Finlayson Lake airstrip upgrade																
Communications Repeater construction																
Site earthworks																
Construction Camp, Waste Management Facility																
Operations Camp																
Site grading, including soil and overburden removal and stockpiling																
Open pit pre-production stripping																
Fault Creek Diversion																
Geona Ponds Dewatering																
Pit Rim Pond Construction																
Overburden Dewatering																
Site Diversion Channels																
Water collection and Sediment Control Ponds																
Mine workshop, Explosives Facility and Fuel storage																
Pre-stripping for Construction materials																
Infrastructure construction																
Power Plant																
Class A Buttress																
ROM Pad																
Upper and Lower Water Management Ponds																
Process plant Construction																
Process Plant Commissioning																
Production																



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Datum: NAD 83; Map Projection: UTM Zone 8N

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AEG

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Metres
0 250 500 750

- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Pipeline
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-3
PROJECT MINE SITE LAYOUT (YEAR 10)

FEBRUARY 2017

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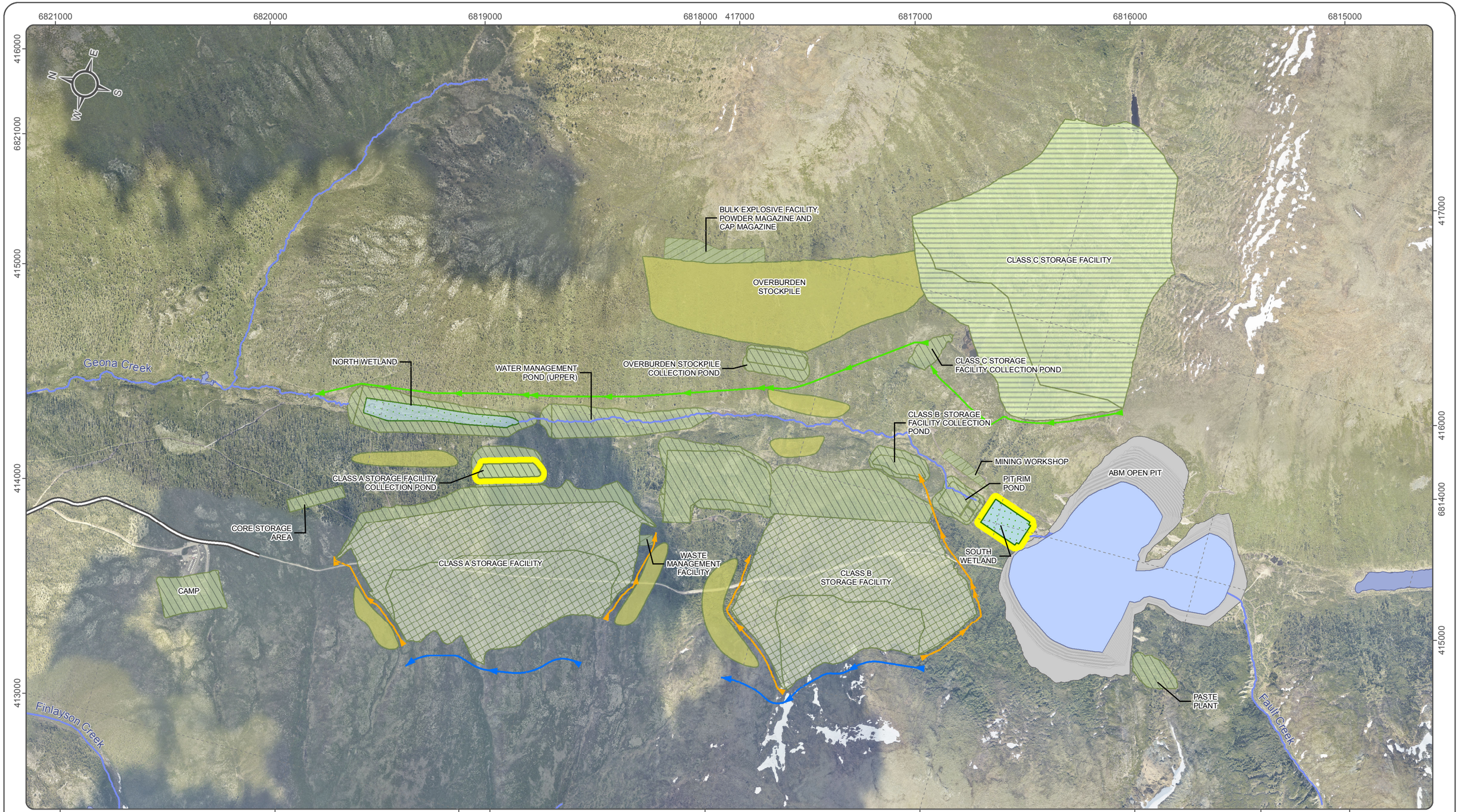
4.3.4 Decommissioning, Reclamation and Closure Phase

BMC's Reclamation and Closure Plan is included in Appendix H-1 and is further summarized in Section 4.13. The closure phase will commence once concentrate production from the Process Plant ceases. In summary, there are three distinct closure phases, or 'periods' for Project reclamation and closure (active closure, transition closure, and post-closure). These have been identified for planning purposes because:

- In some cases, there are different closure objectives for different periods of time following the cessation of mining activities;
- There are distinct physical activities required in each stage to meet the closure objectives; and
- The filling of the ABM open pit to create the ABM lake delays the final water drainage and discharge condition, and creates a transition period prior to ABM lake outflowing to Geona Creek.

Figure 4-4 presents the Project layout in the post-closure period.



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AEG

1:17,000 (when printed on 11 x17 inch paper)

0 250 500 750 Metres

- Closure Activities Occurring in This Closure Period
- Mine Footprint
- Materials used for Reclamation, Footprint Reclaimed and Revegetated
- Covered with Engineered Low Permeability Cover, Surface Revegetated
- Covered with Overburden, Surface Revegetated
- Constructed Wetland Treatment System
- Infrastructure Removed, Footprint Reclaimed and Revegetated
- Water/Pond
- ABM Open Pit Lakes at 1380 masl
- Tote Road/Proposed Access Road
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-4

PROJECT LAYOUT IN POST-CLOSURE PERIOD (YEAR 27+)

FEBRUARY 2017

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4.4 GEOLOGY

4.4.1 Regional Geology

The Project is located with the Finlayson Lake District, a crescent-shaped area approximately 300 km long and 50 km wide that extends from Ross River in the north to Watson Lake in the south. The Finlayson Lake District comprises Devonian to Lower Carboniferous (Mississippian) volcanic, intrusive, and sedimentary rocks assigned to the Yukon-Tanana and Slide Mountain terranes that are interpreted to be exotic terranes accreted eastward onto the ancient continental margin of North America. The combined Yukon-Tanana and Slide Mountain terranes are separated from the ancient continental strata to the northeast by the Inconnu Thrust. While more recent movement along the Tintina Fault has resulted in juxtaposition of the Finlayson Lake District against other Palaeozoic rocks with ancient North American continental margin affinities to the southwest. (Mortensen & Jilson, 1985; Plint & Gordon, 1996; Tempelman-Kluit, 1979). The Yukon-Tanana Terrane of the Finlayson Lake District is contiguous with the main part of the Yukon-Tanana Terrane, which underlies most of west central Yukon, after restoration of approximately 425 km of Late Cretaceous right-lateral, strike-slip movement along the Tintina Fault (e.g., Mortensen, 1992; Peter et al., 2007).

4.4.2 Project Geology

The Project area encompasses rocks of Devonian-Mississippian age within the Big Campbell thrust sheet, one of three thrust sheets underlying the Finlayson Lake District. The Big Campbell thrust sheet contains Pre-Late Devonian quartz-rich sedimentary rocks of the North River Formation; mafic and felsic volcanic, and carbonaceous clastic rocks of the Upper Devonian Grass Lakes Group; Late Devonian to Early Mississippian granitic rocks of the Grass Lakes plutonic suite; carbonaceous clastic and mafic and felsic volcanic rocks of the Lower Mississippian Wolverine Lake Group; and carbonaceous clastic rocks and chert of the Lower Permian Money Creek Formation (Murphy et al., 2006). The Grass Lakes Group is host to the Kudz Ze Kayah VMS deposit and underlies all of the claims that comprise the Kudz Ze Kayah Project.

4.4.2.1 ABM Deposit Geology

The ABM Deposit is a polymetallic Cu-Pb-Zn-Au-Ag rich massive sulphide deposit comprising the ABM Zone and the Krakatoa Zone separated by late-stage faulting. Host rocks to the mineralization are dominated by felsic volcanic and volcanoclastic rocks, with lesser mudstone horizons and discrete mafic intrusive. Geological logging of diamond drill core and field mapping undertaken at ABM, both historically by Cominco Ltd. (Cominco) and more recently by BMC, has focussed on providing a broad lithological framework for future mining activities rather than for the generation of a detailed stratigraphic model. General results of this work are summarised in Table 4-6.

Table 4-6: ABM Deposit Lithological Units

Stratigraphic Unit	Geology Detail Code	Geology Detail Sub-code	Lithology	Description
	OVBN	-	Overburden	Unconsolidated overburden.
Wind Lake Formation	MAFt	-	Mafic volcaniclastic	Confined to Upper Sedimentary and Mafic Volcanic Sequence
	MDU	-	Mudstone and tuffaceous mudstone	Calcareous carbonaceous and mafic tuffaceous mudstones of the Upper Sedimentary and Mafic Volcanic Sequence
Kudz Ze Kayah Formation	SED	-	Undifferentiated sedimentary rock	Variable; includes locally calcareous sandstone, wacke, recrystallized limestone
	MDS	-	Mudstone, tuff and rhyolite	Undifferentiated carbonaceous mudstone, tuffaceous mudstone and carbonaceous coherent rhyolite
		MDSt	Rhyolite tuff-dominant mudstone	Less than 15% carbonaceous component, heterolithic appearance with rare mudstone laminae
		MDSc	Carbonaceous mudstone	Greater than 15% carbonaceous component, weakly heterolithic to semi massive mudstone with slaty cleavage
		MDSw	Coherent rhyolite with minor carbonaceous mudstone	Less than 15% carbonaceous component, laminae of mudstone intercalated with coherent rhyolite
	PEL	-	Pelite	Interpreted sedimentary protolith. Biotite rich rock with quartz, feldspar and/or calcite
		PELc	Calcite rich pelite	Biotite and calcite dominant sedimentary rock
		PELq	Quartz rich pelite	Biotite and quartz dominant sedimentary rock
	CHT	-	Chert	
		CHTc	Chert with interlayered carbonaceous mudstone	
		OA	Magnetite-bearing massive sulphide	Massive sulphide with abundant disseminated euhedral medium-grained magnetite or laminated magnetite. Commonly includes PY+MG+SP+GL±CP±PO
		OB	Wispy laminate, fine buckshot textured, non-magnetite bearing massive sulphide	Fine to coarse-grained massive sulphide consisting of PY+SP+GL±CP±PO±MG. Magnetite is typically trace or absent
		OF	Pyrrhotite-rich sulphide	Massive sulphide with greater than 50% pyrrhotite. Sulphide assemblage of PO+MG±CP±PY±SP±GL
		OH	Pyrite-rich massive sulphide	Fine-grained, homogeneous pyrite dominated (greater than 80% pyrite) massive sulphide
		OC	Chalcopyrite + pyrrhotite net-textured massive sulphide	Fine to coarse-grained massive sulphide comprised of dominantly macroscopic CP+PO comprising greater than 10% to less than 50%
		OD	Brecciated sulphide	Sulphide with crackle breccia to mosaic breccia texture. Sulphide assemblage of PY+SP+GL±CP±PO±MG
		OG	Chalcopyrite-rich sulphide	Semi-massive to massive sulphide with greater than 30% CP. Typical sulphide assemblage of CP+PO+PY+SP±GL±MG
		OI	Heavily disseminated sulphide in schistose host rock	Stringer and disseminated sulphide to semi-massive sulphide mineralization with greater than 20% sulphide

Stratigraphic Unit	Geology Detail Code	Geology Detail Sub-code	Lithology	Description
		OJ	Heavily disseminated sulphide in proximal altered rock	Stringer sulphide to semi-massive sulphide hosted within altered rocks with an alteration assemblage of CL+CI Sulphide assemblage of PY+CP+SP±PO±GL
		OK	Heavily disseminated sulphide and/or stringer style mineralization associated with silicate gangue	Heavily disseminated sulphide and/or stringer style mineralization associated with barite ± quartz ± carbonate gangue
	RHY	-	Undifferentiated rhyolite	Typically altered and difficult to identify
	RHYc	-	Coherent rhyolite	Undifferentiated coherent rhyolite
		RHYcw	Curdy-textured and/or flow-banded	Flows or sub-volcanic intrusions with definitive siliceous flow banding or relict flow banding textures
		RHYcf	Feldspar ± quartz porphyry	Medium to coarse-grained feldspar and quartz porphyritic texture rhyolite
		RHYcq	Quartz porphyry	Medium to coarse-grained quartz-phyric texture
	RHYi		Aphanitic rhyolite	Aphyric massive to semi-massive siliceous rhyolite interpreted as intrusive dykes and sills
	RHYv	-	Volcaniclastic rhyolite	Undifferentiated fine to medium-grained volcaniclastic
		RHYvl	Lapilli tuff	Heterolithic tuff with greater than 15% lapilli typically in an ash-dominated groundmass
		RHYva	Coarse-grained to ash tuff	Phaneritic ash tuff with greater than 10% of crystals occurring as greater than 1mm to less than 2mm typically in an ash-dominated groundmass
		RHYvx	Quartz ± feldspar crystal tuff	Quartz, ± feldspar-phyric (greater than 10%) in an ash-dominated groundmass
	MAFi	-	Mafic intrusions	Chlorite-altered mafic intrusion, primarily in the footwall but also occurs as narrow dykes or sills within the felsic sequence
	FLZ		Fault Zone	
Abbreviations: PY = pyrite, PO = pyrrhotite, MG = magnetite, CP = chalcopyrite, SP = sphalerite, GL = galena, CL = chlorite, CI = cordierite				

Sulphide Mineralization

Massive and stock work sulphide gangue mineralogy predominantly comprises sericite, chlorite, iron-rich carbonate, magnetite, quartz, cordierite, albite (celsian), and barite. Mineralized lenses, comprising a mix of massive and stringer/disseminated sulphide styles, typically occur within an envelope of chlorite and muscovite alteration.

Sulphide mineralization is dominated by pyrite, sphalerite, pyrrhotite (and marcasite), galena, and chalcopyrite, with minor arsenopyrite and a range of sulphosalts predominantly comprising tennantite-tetrahedrite and freibergite. Both the up-dip part of ABM Zone and most of Krakatoa Zone have elevated sulphosalt content relative to the remainder of the ABM Deposit.

ABM Zone

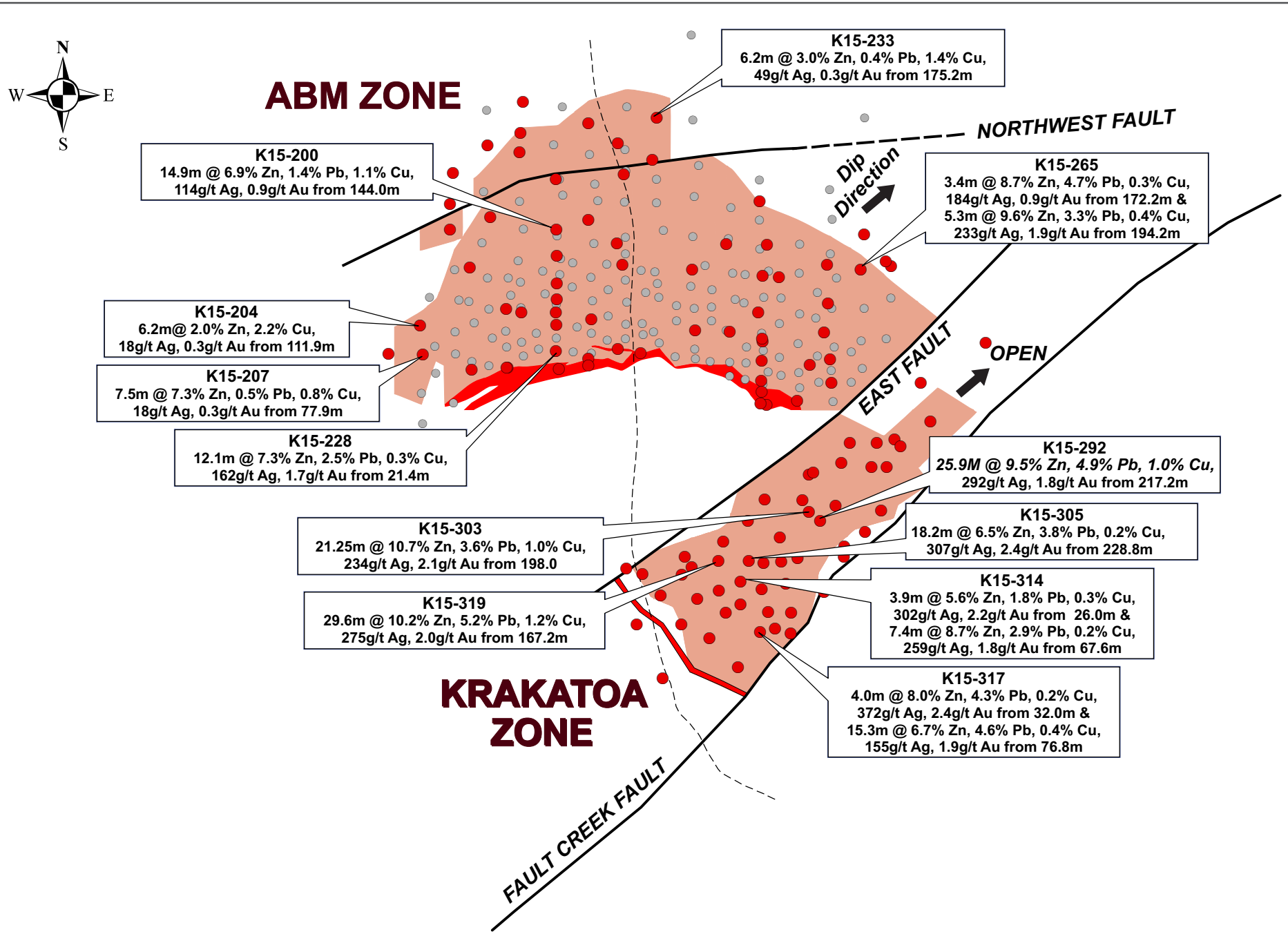
Massive sulphide of the ABM Zone (Figure 4-5) is up to 39 m thick, extending approximately 700 m along strike and approximately 500 m down dip. It dips to the north-northeast at approximately 35° near surface, transitioning to a dip of approximately 15° at around 200 m depth below the valley floor. The up-dip extent of the deposit is truncated by erosion and covered by 2 to 20 m of overburden.

Massive sulphide mineralization of the ABM Zone occurs as several stacked massive sulphide lenses to the west, transitioning to a single massive horizon to the east where it is then truncated by the post-mineralization East Fault.

Krakatoa Zone

Mineralization of the Krakatoa Zone (Figure 4-5) occurs within Kudz Ze Kayah Formation rocks dipping 35° to the north-northeast that are bound to the west by the East Fault and to the east by the Fault Creek Fault. Although of lesser extent, the distribution of mineralization within the Krakatoa Zone is more spatially complex than the ABM Zone. Massive sulphide mineralization occurs within three principal mineralized horizons: (1) the "Upper lens", broadly interpreted as the stratigraphic equivalent to the ABM lens; (2) the "Main lens", the major component of Krakatoa Zone in terms of sulphide mineralization with a true thickness up to 22 m; and (3) a less pronounced and semi-continuous "Lower lens". Mineralization is broadly concordant with stratigraphic layering of the host rocks, extending over about 200 m of strike, at least 300 m down-dip, and up-dip to the base of glacial overburden of 20 to 30 m thickness.

A key difference between Krakatoa Zone and ABM Zone is that the bulk of mineralization comprising Krakatoa Zone occurs both within felsic volcanic rocks immediately beneath the mafic sill and within the mafic sill, whereas the mafic sill below the ABM Zone is only poorly mineralized.



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0 125 250 m

NAD83 UTM Zone 9N

- BMC Drilling Pierce Point
- Historical Drilling Pierce Point
- Fault
- Fault Inferred
- Access Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-5
PLAN VIEW OF ABM DEPOSIT AND SELECTED DRILL INTERCEPTS

JANUARY 2017

4.4.3 Exploration and Data Collection

The ABM Deposit has been sampled using diamond drilling only. All drilling at the Project prior to 2015 was completed by Cominco.

The 2015 and 2016 KZK drilling programs comprised exploration, hydrogeological, metallurgical, resource confirmation/infill, and geotechnical drill holes (Table 4-7).

Table 4-7: Summary of Drilling at the Project

Year	Hole IDs	No. Holes	Metres
1994	K94-001 – K94-052	52	8,518.6
1995	K95-053 – K95-170	119	14,962.1
1996	K96-171	1	99.2
1997	K97-172 – K97-187	16	3,359.1
1998	K98-188 – K98-198	9	1,559.7
2004	K04-199	1	246.0
2015	K15-200 – K15-336	148	25,966.1
2016	K16-337-K16-419	84	19,210.5
Total	***K94-001 – K16-419***	***430****	***73,921.2***

*Includes 11 wedge holes

For the ABM and Krakatoa drilling programs it was necessary that geological information was logged at the appropriate resolution for resource modelling and geo-metallurgical interpretation. Attention was paid to identifying mineralization types (principally based on the original Cominco logging of "ore" types), deposit alteration types, hangingwall and footwall lithology as well as sulphide minerals, carbonate content, and oxidation intensity for use in potential acid generating (PAG) geodomain interpretation (Baker, 2015).

4.5 MINERAL RESOURCE

4.5.1 Resource Classification

The Mineral Resource has been classified as Indicated and Inferred based on the guidelines specified in the JORC Code (2012) and NI 43-101. The classification level is based upon an assessment of geological understanding of the deposit, geological and grade continuity, drill hole spacing, quality control results, search and interpolation parameters, and an analysis of available density information.

The ABM Deposit shows excellent continuity of mineralization within well-defined geological constraints. Drill holes are located at a nominal spacing of 50 m on 25 m north-south oriented sections extending out to 100 m on the peripheries of the deposit. The drill spacing is sufficient to allow the geology and mineralization zones to be modelled into coherent wireframes for each

domain. Reasonable consistency is evident in the orientations, thickness and grades of the mineralized zones.

The 2015 BMC exploration program included re-drilling of several sections within the ABM Zone, 'twinning' historical holes, re-logging and re-sampling of historical core, and re-surveying historical drill collars. This work validated the historical work undertaken by Cominco and improved the confidence level in the historical data and, along with the additional infill drilling, has largely confirmed the continuity of the geology and known mineralization.

The Mineral Resource is classified as Indicated where, in the Competent Person's opinion, sufficient data exists to assume geological and mineralization continuity. For areas with more limited data density, and limited along-strike or down-dip continuity, there is sufficient evidence to imply but not verify geological and grade continuity and these areas are classified as Inferred.

4.5.2 Mineral Resource Estimate

The Mineral Resource Estimate is reported in Table 4-8. The Mineral Resource has not been reported above a cut-off grade as the mineralization zones contain significant grades of Cu, Pb, Zn, Au, and Ag. On this basis it was deemed that a cut-off grade was not required.

Table 4-8: Project Mineral Resource Estimate

Classification	Mt	Cu	Pb	Zn	Au	Ag	Cu metal	Pb metal	Zn metal	Au	Ag
		wt%	wt%	wt%	g/t	g/t	kt	kt	kt	koz	Moz
ABM Deposit: ABM Zone											
Indicated	14.6	1.0	1.6	6.1	1.3	132	141.2	229.7	888.9	615.0	62.2
Inferred	0.4	1.5	1.4	4.2	1.0	107	5.5	5.2	15.5	11.6	1.3
Subtotal	***15.0***	***1.0***	***1.6***	***6.0***	***1.3***	***132***	***146.7***	***234.9***	***904.4***	***626.6***	***63.5***
ABM Deposit: Krakatoa Zone											
Indicated	3.7	0.6	3.1	7.2	1.8	211	23.1	116.7	265.9	213.1	25.2
Inferred	0.5	0.8	1.7	8.9	1.2	161	3.7	8.4	43.5	18.7	2.5
Subtotal	***4.2***	***0.6***	***3.0***	***7.4***	***1.7***	***205***	***26.8***	***125.1***	***309.4***	***231.8***	***27.7***
ABM Deposit (total) – November 2016											
Indicated	18.3	0.9	1.9	6.3	1.4	148	164.4	346.5	1,154.8	828.1	87.4
Inferred	0.9	1.1	1.6	6.9	1.1	138	9.2	13.6	58.9	30.3	3.8
TOTAL	***19.2***	***0.9***	***1.9***	***6.3***	***1.4***	***148***	***173.6***	***360.1***	***1,213.7***	***858.4***	***91.2***

Note: The information in this report that relates to BMC's Mineral Resources and Exploration Results is a compilation of previously published data for which a Competent Person's consent was obtained. Their consent remains in place for subsequent releases by BMC of the same information in the same form and context, until the consent is withdrawn or replaced by a subsequent report and accompanying consent. The information in this report has been extracted from the BMC public releases "Mineral Resource Update for KZK Zn-Pb-Cu-Ag-Au Project, Yukon" dated 10 November 2017 and is available on the BMC website www.bmcminerals.com.

The Project has been the subject of a Prefeasibility Study (PFS) carried out in 2016 and early 2017. The outcomes of the PFS have guided the development of the Project plan, community consultation

and the preparation of this submission. Ore Reserves will be reported by the Company late in the first quarter of 2017 once appropriate documents have been filed on SEDAR in accordance with Federal Regulations.

4.6 MINE PLAN (OPEN PIT)

4.6.1 Open Pit Development

The majority of the ABM Deposit will be mined by Open Pit methods. An assessment of Open Pit mining has been completed by Entech Mining Ltd (Entech, 2016). A single pit will be mined, with mining of the ABM Zone staged into three separate phases to manage overall waste stripping requirements and the Krakatoa Zone mined in a single phase. All Open Pit mining is planned to be completed by a mining contractor over a period of approximately 10.5 years, including a 17-month pre-production period to provide construction materials and build ore stockpiles to maintain continuity of ore to the processing plant.

The complete Open Pit schedule, showing production from both zones, is shown in Table 4-9. The final ABM open pit is shown in Figure 4-6.

4.6.1.1 ABM Zone Open Pit Mining

The main access ramp will exit the pit to the north, near the base of the valley at the elevation of the valley floor, at 1,380 masl. Additional ramp access has been included on the southern wall of the ABM open pit to permit access to be maintained to the Krakatoa Zone.

Due to the broad zones of mineralization evident in the ABM Zone, it is expected that the operational bench height will likely be between five and ten metres when mining mineralized material and ten metres when mining waste. Mining of smaller heights may be required in specific locations where greater selectivity is required due to the dip of the mineralization and narrower zones of mineralization.

The final pit floor of the ABM open pit will be at 1,220 masl, 160 m below the Geona Creek Valley at an elevation of 1,380 masl. Once the pit is completed the eastern highwall will extend vertically from 1,220 masl at the final pit floor to a maximum of 1,573 masl, the point of highest excavation on slopes east of the Geona Creek valley. The lateral extents of the final ABM open pit are 1,250 m east to west and 700 m north to south.

4.6.1.2 Krakatoa Zone Open Pit Mining

The Krakatoa Zone will be mined as a single phase, utilizing the same equipment as the ABM Zone. A smaller excavator will be required for selective mining of the narrower mineralized lenses outside the Main Lens.

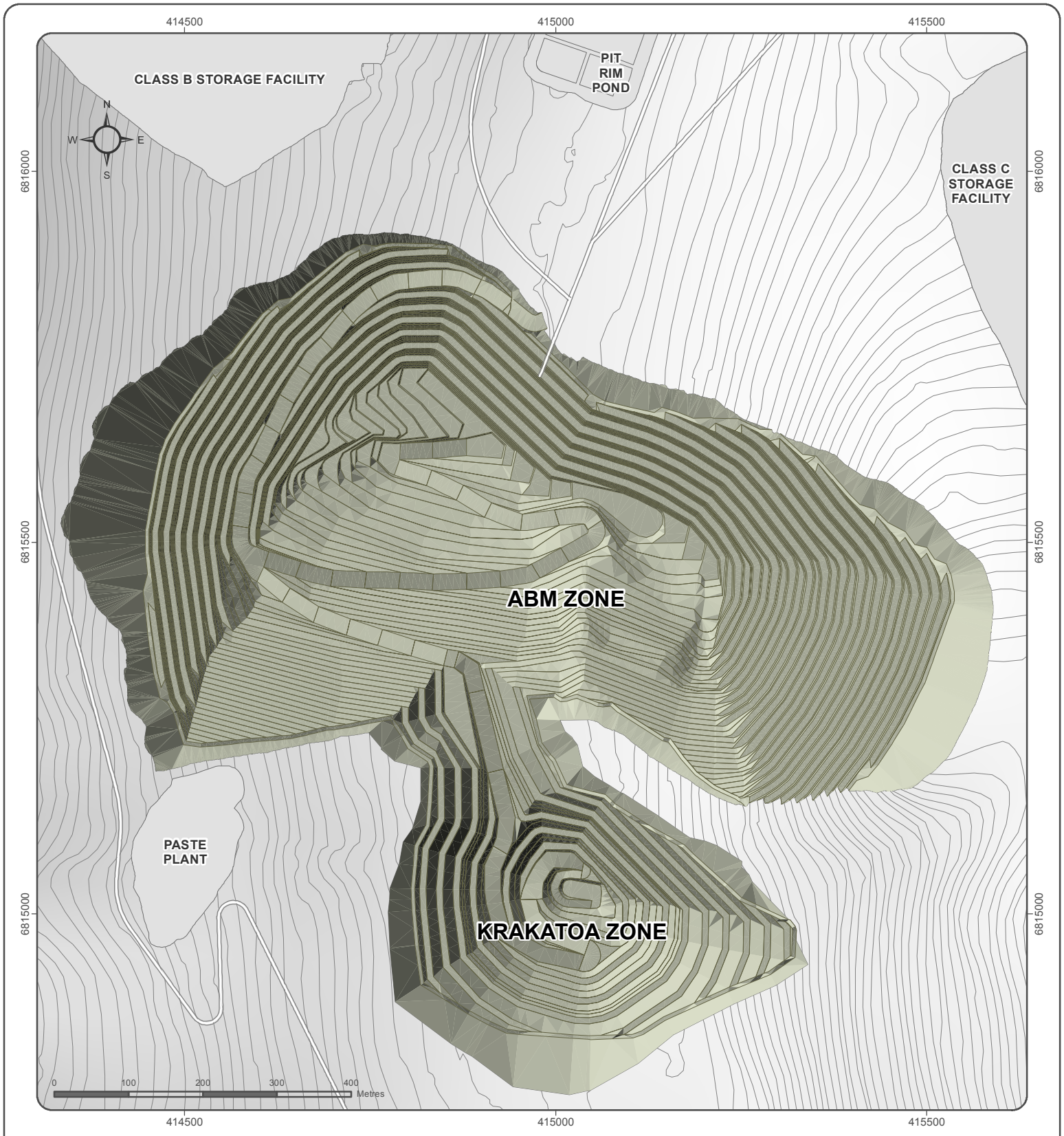
Design parameters for the Krakatoa Zone Open Pit mining contrast with the ABM Zone, particularly slope design as discussed in Section 4.6.2.2. The minimum mining width being reduced to 25 m to

accommodate the tighter pit dimensions compared to that of the ABM Zone. To facilitate access from the Krakatoa Zone to the processing plant and waste storage facilities, the pit ramp has been designed to connect through to the ABM open pit via the ABM south wall ramp.

The Krakatoa Zone within the ABM open pit extends vertically from 1,265 masl at the final pit floor to a maximum of 1,460 masl on the eastern highwall. The lateral extents of the final Krakatoa Zone within the ABM open pit are approximately 550 m east to west and 450 m north to south.

Table 4-9: Open Pit Mining Schedule

	Units	Total	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
ABM Phase 1 Ore	kt	4,661	-	26	1,471	1,834	1,177	153	-	-	-	-	-	-
ABM Phase 2 Ore	kt	6,725	-	-	114	367	588	1,232	1,649	1,581	1,193	-	-	-
ABM Phase 3 Ore	kt	3,267	-	-	-	-	-	-	-	63	522	1,764	918	-
Krakatoa Ore	kt	851	-	-	-	-	-	-	-	-	-	33	818	-
ABM Phase 1 Waste	kt	21,084	-	990	10,492	6,808	2,578	216	-	-	-	-	-	-
ABM Phase 2 Waste	kt	59,377	1,273	4,550	7,570	12,829	14,400	9,847	4,354	3,141	1,414	-	-	-
ABM Phase 3 Waste	kt	37,055	-	-	-	-	1,151	5,911	9,483	8,834	7,329	3,877	469	-
Krakatoa Waste	kt	21,238	-	-	-	-	-	-	-	818	3,559	8,244	8,617	-
Total Ore Mined	kt	15,503	-	26	1,586	2,201	1,765	1,385	1,649	1,645	1,714	1,797	1,735	-
Overburden	kt	16,081	402	921	2,797	1,209	1,123	2,554	1,347	1,524	2,241	1,962	-	-
Total Waste	kt	138,753	1,272	5,540	18,062	19,637	18,130	15,973	13,837	12,792	12,303	12,121	9,086	-



ABM Open Pit

Location of Proposed Mine Infrastructure

ABM Open Pit Contour

Project Site Road

Contour (5 m Interval)

KUDZ ZE KAYAH PROJECT

FIGURE 4-6

FINAL ABM OPEN PIT

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4.6.2 Pit Geometry and Slope Stability

4.6.2.1 ABM Zone

Cominco engaged Golder Associates (one of the world's leading mining geotechnical engineering specialists) to complete a feasibility level geotechnical assessment of Open Pit mining the ABM Zone in 1996. The resulting report (Golder, 1996a), has formed the basis for geotechnical design elements of the ABM Zone pit design. The following is a summary of the findings and recommendations of the report. BMC did not specifically complete a new review of the ABM open pit design recommendations, however the geotechnical data presented in the 1996 Golder report has been reviewed for both Krakatoa Open Pit and underground geotechnical assessments and no concerns on the data were raised during this work.

A series of field and laboratory investigations was conducted to generate appropriate data for geotechnical assessment. These investigations included:

- Detailed and summary geotechnical logging of orientated core from Cominco's 1995 exploration drill program;
- Field Point Load testing of core;
- Test pitting in the proposed Open Pit area to determine the nature of the overburden material;
- Shallow and deep piezometer installations in the proposed Open Pit area for monitoring of ground water levels and water quality;
- Classification testing (grain size and Atterberg limits) of representative overburden samples;
- Strength testing of representative bedrock core samples; and
- Classification tests on bedrock fault gouge.

Based on historical exploration drilling, geotechnical drilling and test pitting, overburden in the vicinity of the ABM Zone was assessed resulting in a thickness from 1.5 m to 12 m along the western margin of the valley and 6 m to 12 m along the eastern margin. In general, poorly sorted loose to compact sand and gravel deposits of colluvial origin are deposited along the eastern and western valley walls. Through the valley base, a thick sequence of apparent glaciolacustrine sediments occur. These consist of dense sandy silt, silty sand, and gravel with cobbles and boulders.

The area of the Open Pit was divided into three separate domains (West, Central, and East). The orientation of faults and joint discontinuities measured in drill core were plotted on stereonets for each of the domains to assess the geotechnical characteristics of the area. Where multiple sets of orientations were presented, the domains were further divided into north central and south subdomains.

Faulting through the ABM Zone is interpreted to generally trend in a northeast – southwest direction. The fault zones are comprised of numerous subparallel normal fault surfaces dipping moderately

steeply to the southeast. The rocks show variation in the degree of natural fracturing as a result of the nature and extent of faulting. In the West and Central domains, the average Rock Quality Designation (RQD) of all core logged was in the order of 65%. In the Eastern domain the rock is more fractured, with an average RQD of 45%.

The results indicate that the various lithologies, with the possible exception of argillite, to be competent and strong to very strong.

The ABM open pit has been designed based on the 1996 Golder's recommendations with additional geotechnical logging and strength laboratory testing data collection undertaken by BMC. This includes slope angles for the overburden in the valley floor of 25°, resulting in a Factor of Safety of 1.3 under static conditions and 1.2 under seismic loading conditions. Along the western and eastern valley walls, slope angles can be increased to 30°. A minimum 5 m wide bench at the pit crest is required to catch any material ravelling down the slopes.

As the initial benches are mined, they will be mapped in detail to confirm whether the data that the designs are based on is representative of mining conditions and if not adjustments to design recommendations can be made prior to excavation of the final pit walls.

Additional drill holes, instrumentation, field and laboratory testing will be conducted for the ABM open pit during the final design to further refine the pit parameter.

4.6.2.2 Krakatoa Zone

BMC carried out a geotechnical data collection and analysis program to support the rock slope design for the Krakatoa Zone Open Pit (Rockland, 2016b). The program included:

- Geotechnical drill program;
- Geotechnical logging;
- Discontinuity orientation of cores recovered;
- Point Load Test (PLT); and
- Unconfined Compressive strength (UCS) test.

Based on the results of data analysis and rock quality as well as available site geology information, geotechnical domains were delineated. Given the relatively consistent nature of geologic material and similar rock quality at Krakatoa for defining geotechnical domains based on area, the pit was divided into four main design sectors.

Kinematic analysis was completed to determine appropriate Bench Face Angle (BFA) and Inter-ramp Angle (IRA) slope angles for pit design purposes. Both deterministic and probabilistic analyses were carried out. Using the rock fabric data collected during the field data collection program, three modes of failure were evaluated: planar failure, wedge failure and toppling failures. The results are summarized in Table 4-10.

Table 4-10: Rock Slope Configuration Based on Kinematic Analysis

Sector	BFA	Height	Bench Width	IRA
Sector 1	55	20	8.5	42
Sector 2	70	20	8.5	52
Sector 3	46	20	8.5	36
Sector 4	48	20	8.5	37

The overall slope assessment was evaluated for each sector applying commercially available Limit Equilibrium (Slide software) and Finite Element (RS^2 software) methodologies. Both dry and partially saturated slopes with and without joints were evaluated, and resulted in a Factor of Safety of 1.3 under static conditions and 1.2 under seismic loading conditions.

4.6.3 Blasting and Explosives Management

Several regulations and legislative bodies oversee the management of explosives, including:

- Fisheries and Oceans Canada policy for the use of explosives in or near fish bearing waters;
- *Explosives Act* magazine licence requirements with respect to storage and handling of explosives; and
- Necessary permits including Blasting Permit, Magazine licence, Factory licence, ANFO Certificate, Purchase and Possession Permit, and Explosives and Hazardous Materials Transport Permit.

Bulk explosives and blasting agents will be utilized for all mining activities and will be stored and handled on the mine site as per the requirements listed above. Further details may be found in Section 4.11.1.

Explosives will be stored in secure, fenced facilities separate from the main activity areas, adjacent to the Overburden Stockpile (Figure 4-2). Bulk explosives for Open Pit blasting purposes will be stored within the bulk explosives facility. A packaged explosive magazine will store all explosive requirements for the underground mine as well as cast boosters and other explosive products required for Open Pit operations. A separate detonator magazine will be available for storage of all detonators.

Qualified personnel will be retained to provide blasting services and will mix and dispense explosives into the blast holes. The blast sequences will be established by agreement between the blasting personnel and mining personnel. Safety protocols will be observed during blasting operations. The applicable conceptual management plans related to the safe storing and handling of explosives are included in Chapter 18 (Section 18.3 – Hazardous Waste Management Plan, Section 18.5 - Spill Contingency Plan, and Section 18.15 - Health, Safety and Emergency Response Plan).

4.6.4 Loading

Primary loading of ore and waste will be by excavators in backhoe configuration, to allow improved ability to remove overlying waste from the flat dipping ore as compared to a front shovel configuration. Two different sized excavators will be required due to the difference in densities between ore and waste and to allow greater selectivity for mining of ore.

Bulk mining of waste will be completed with a 260 to 300 t class excavator with a bucket capacity of 15 to 17 m^3. Mining of ore will be completed with a 185 to 200 t class excavator with a bucket capacity of 7.5 to 8.0 m^3. Utilising a bucket any larger than this is likely to overload the excavator increasing maintenance and associated downtime. The smaller sized bucket will also assist in control of dilution as the bucket will typically be 2.0 m wide.

A 50 t class excavator may also be required for more selective mining of the narrower zones of mineralization at Krakatoa to manage mining dilution. This machine will also be utilised for cleaning and dressing of pit walls.

Mining of the hangingwall and footwall contacts will require competent operating practice and supervision to ensure that the introduction of waste dilution is minimized. In principle, each bench will be mined from hangingwall to footwall. Bulk mining of waste in the hangingwall will be permitted to the point where the bottom of the excavation bench is within three metres of the hangingwall contact. Waste will then be pulled down the bench face by the excavator until the ore contact is exposed, at which point ore mining will progress through to within three metres of the footwall contact. Ore will then be pulled down the bench face by the excavator until all the ore has been removed for loading into trucks.

In addition to the primary loading excavators, a large front end loader (100 t class) will also be available for support activities such as pit floor cleanup and to cover truck loading requirements when excavators are undergoing maintenance.

4.6.5 Hauling

All bench berm widths and face angles used in the designs have been in accordance with the geotechnical design parameters. Haul roads have been designed at a maximum gradient of 1:9, with widths to suit the use of 90 t class haul trucks (11 m for single lane ramps and 22 m for double lane, inclusive of safety windrows and drains, as illustrated in Figure 4-7).

There are four primary destinations for hauling material from the pit:

- The ROM pad;
- Class A Waste Rock and Tailings Storage Facility;
- Class B Waste Rock Storage Facility; and
- Class C Waste Rock Storage Facility.

Surface haul roads have been designed to be nominally flat where practicable to maximize hauling productivities. Haul trucks will have right of way on all surface and in pit haul roads. Speed limits will typically be 30 km per hour; however, reduced speed limits will be enforced at selected locations (i.e., near the four destinations listed above and the workshop). Further details may be found in Section 4.11.11.

Ancillary equipment requirements include graders, bulldozers, and water trucks. A large capacity grader is anticipated to be utilized for the Project, with a blade width of 4.9 m to enable maximum productivity for road maintenance activities. The grader will also manage clearing of snow in the pit and roads during the winter months.

Haul roads will be inspected and maintained regularly (i.e., ploughed, watered, and repaired). A water truck will be required for dust control in the summer months. This truck will also provide emergency water supply in the event of scrub fires. The conceptual management plans that are applicable to hauling are included in Chapter 18 (Section 18.5 Spill Contingency Plan, Section 18.10 – Noise Management Plan, Section 18.11 - Air Quality Management Plan, and Section 18.12 - Traffic and Access Management Plan).

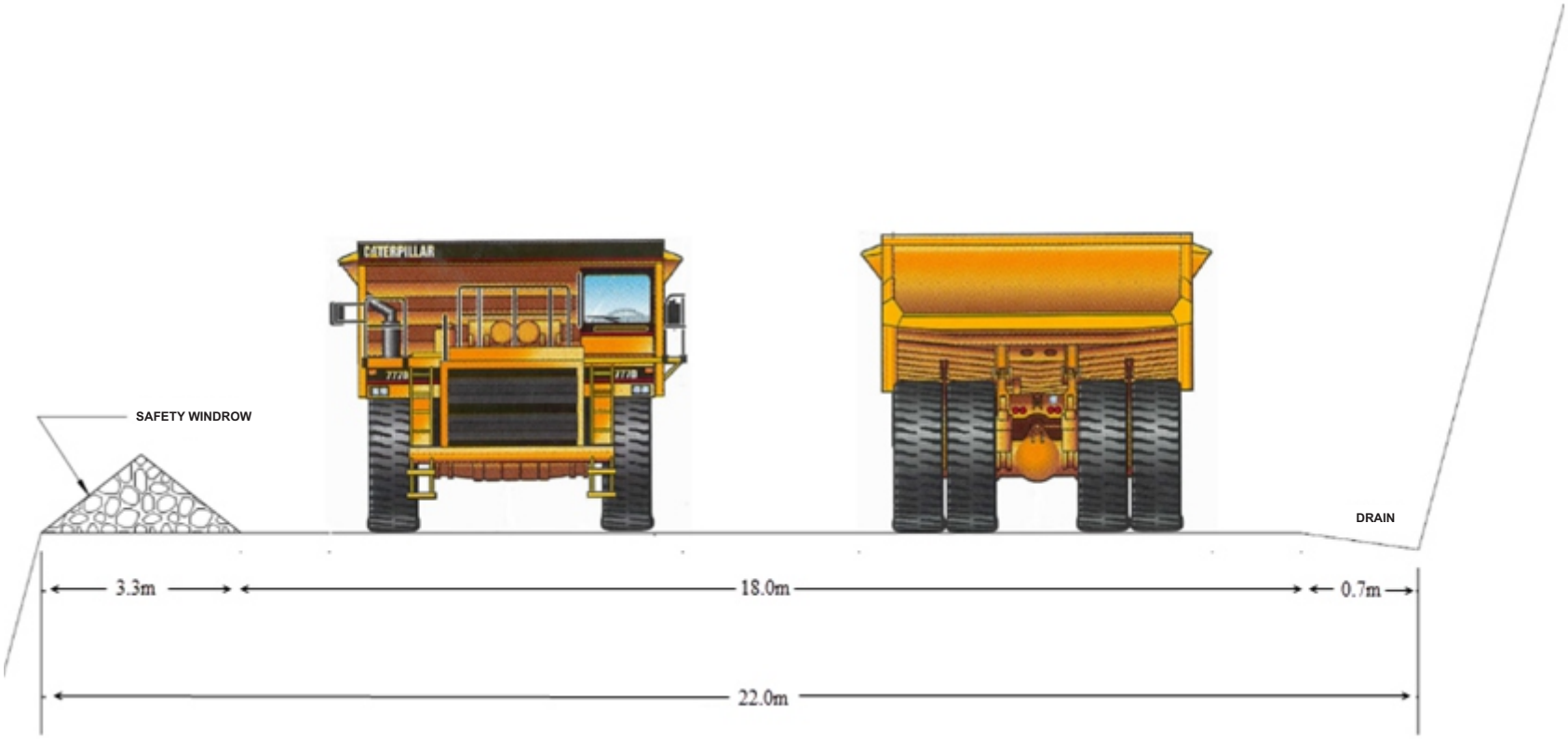

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FIGURE 4-7
HAUL ROAD DESIGN

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4.7 MINE PLAN (UNDERGROUND)

Underground mining will only occur in the lower Krakatoa Zone of the ABM Deposit. The development of the underground mine is planned to commence at the end of Year 2 when the ABM Zone Stage 1 Open Pit has progressed down to the 1,340 masl bench. Underground mining will finish just prior to completion of Open Pit mining at the end of Year 9 as shown in Table 4-11.

4.7.1 Underground Development

Access to the underground mine will be via the main access ramp collared at 1,340 masl bench from within the Stage One ABM open pit. Access to the underground portal location will become available in the second half of Year 2 of Open Pit production. Trucks will haul ore and waste out of the underground mine and temporarily place it adjacent to the portal, at which point the Open Pit load and haul fleet will transfer it to the ROM pad or one of the three waste storage facilities, as appropriate.

A second ramp will be constructed for ventilation purposes. The second ramp will also act as a second means of egress, if the main ramp becomes compromised. The dual portal configuration is presented in Figure 4-8.

The minimum stand-off distance from the ramp to stopes is 50 m. An arched profile ramp with a nominal width of 5.2 m and height of 5.7 m with a shoulder radius of 1 m is contemplated for all ramp development. The ramp is designed at a maximum gradient of 15% with radius of curvature of 25 m.

The access to each level will be nominally 50 m in length with the first 20 m of each level access drift having the same profile as the ramp and stockpiles.

4.7.2 Mining Methods

The Krakatoa Zone mineralization is comprised of three separate lenses. The Lower and Upper lenses will be mined using long hole mining methods and cut and fill methods will be utilized for mining the Main Lens. These two mining methods are illustrated in Figure 4-9 and Figure 4-10, with mining sequences notated from A to C and A to F respectively.

Stopes for the long hole stoping will be up to 5 m wide, by 15 m height, by approximately 60 m long while the stopes for cut and fill will be up to 5 m wide, by 5 m high, by approximately 50 to 100 m long. An overview of the underground stope distribution is provided in Figure 4-11.

Table 4-11: Underground Mine Schedule

Underground Physical Schedule	Units	Total	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Total Ore	t	2,053,680	-	-	-	-	53,903	619,617	507,946	319,896	196,619	185,824	169,877	-
Waste	t	396,312	-	-	-	36,922	189,052	79,238	34,735	19,595	10,523	18,915	7,333	-
Total Mined	t	2,449,992	-	-	-	36,922	242,954	698,854	542,680	339,491	207,142	204,739	177,210	-

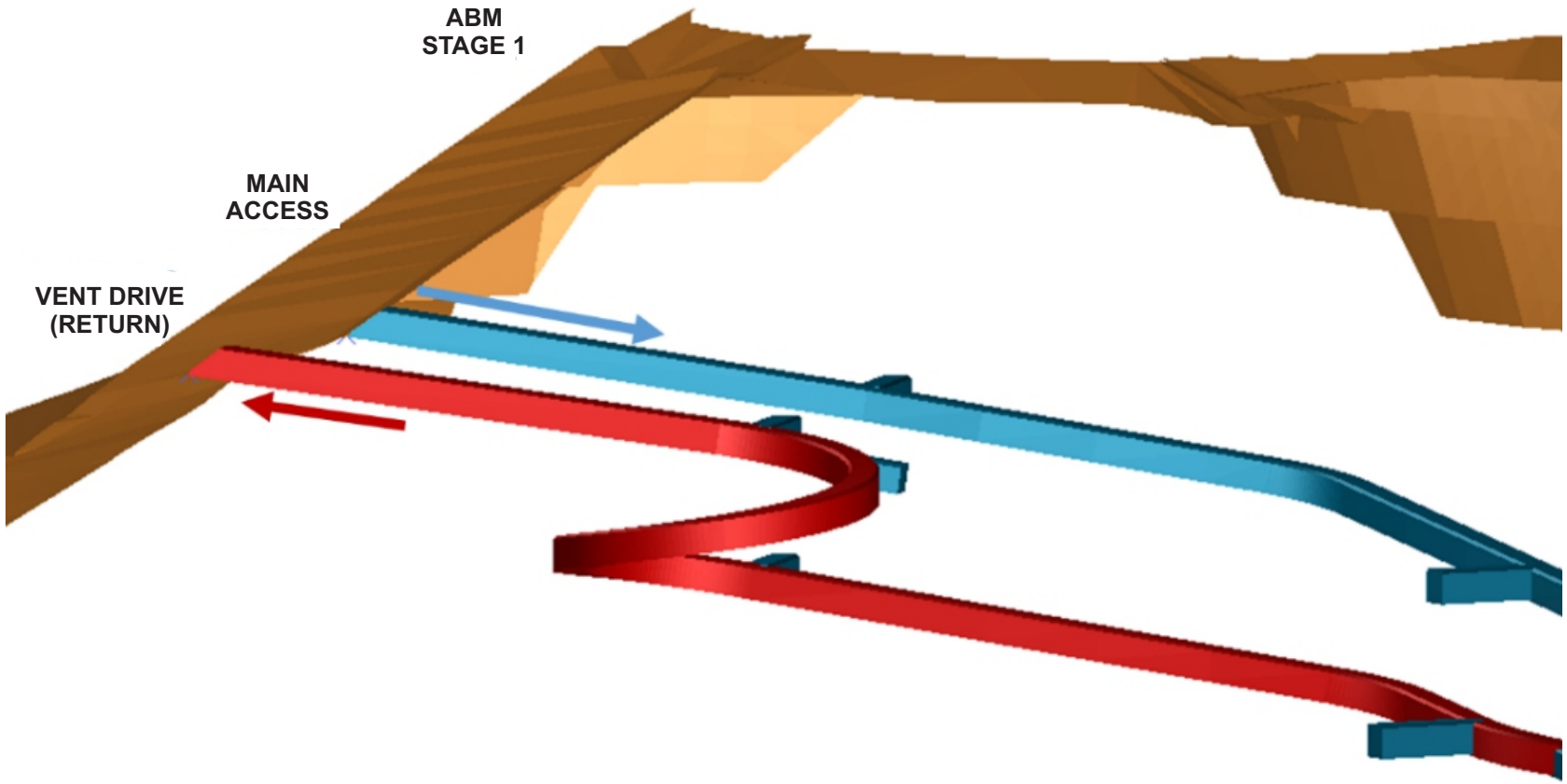

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FIGURE 4-8
ISOMETRIC VIEWS OF MAIN ACCESS AND VENTILATION RAMPS (LOOKING EAST)

JANUARY 2017

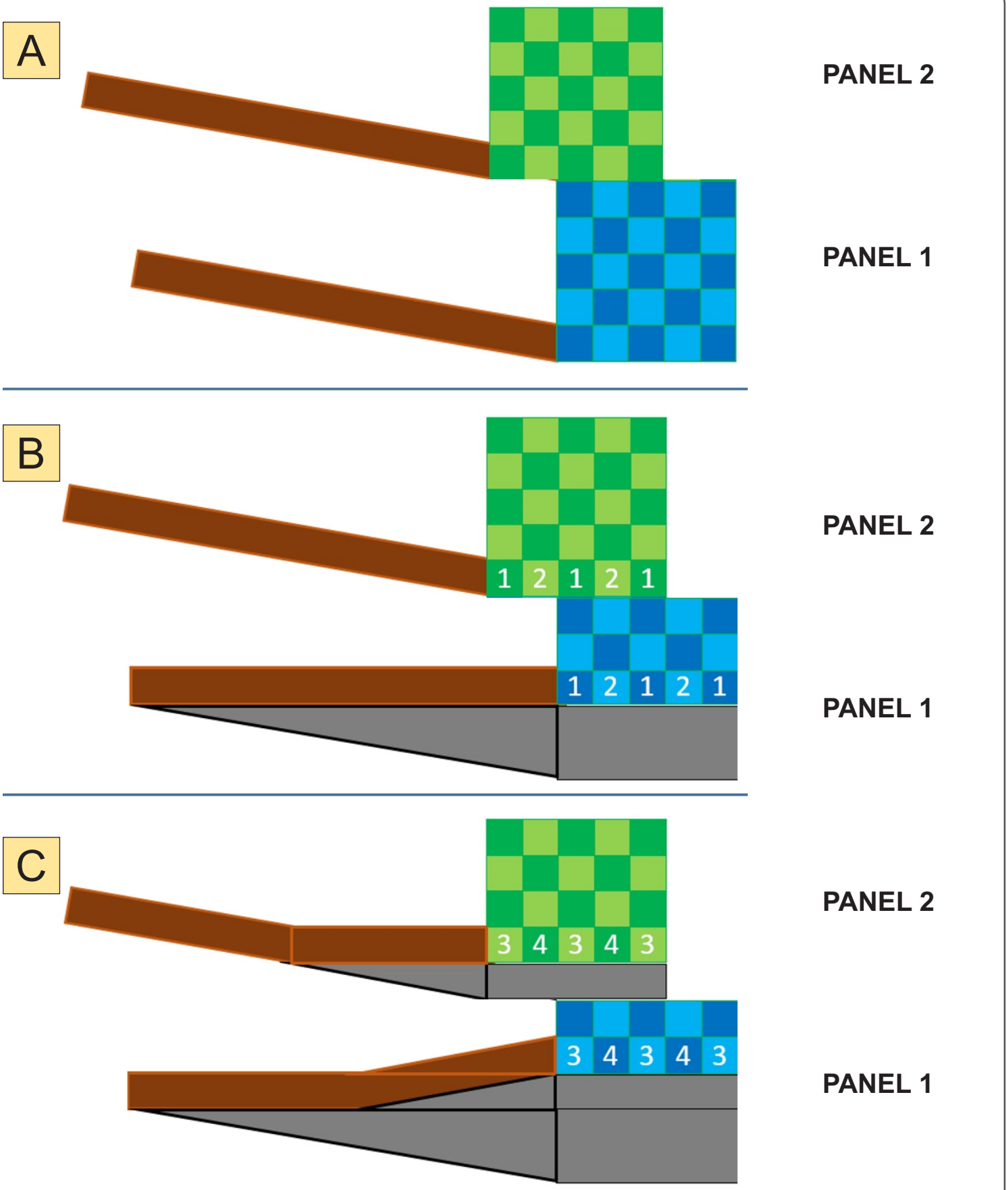

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FIGURE 4-9
CUT AND FILL EXTRACTION SEQUENCE

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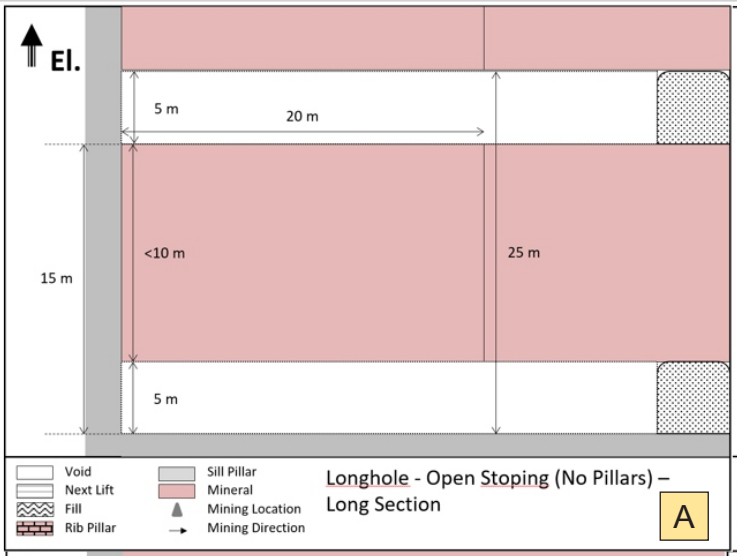

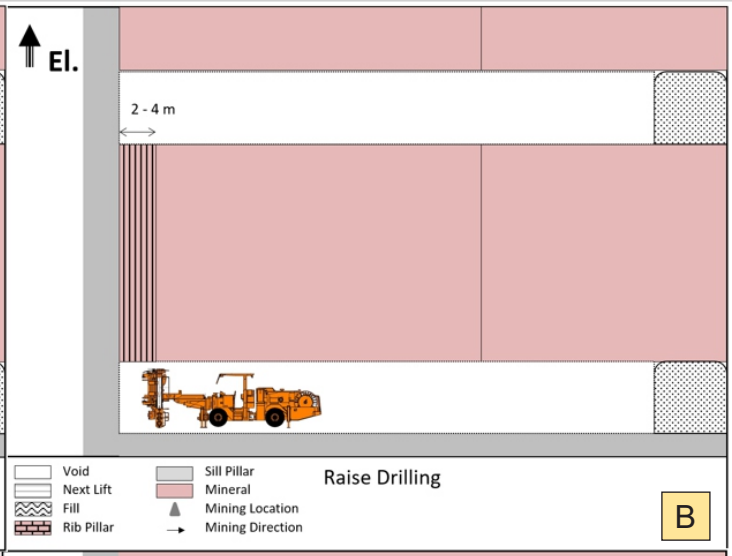

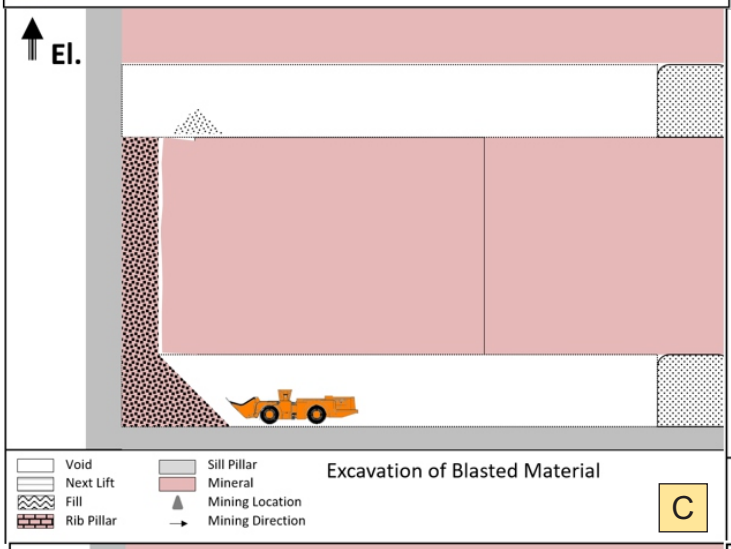

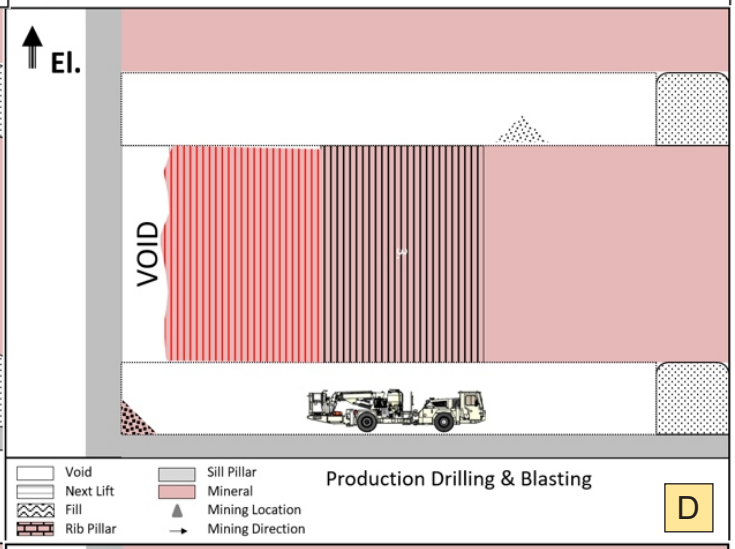

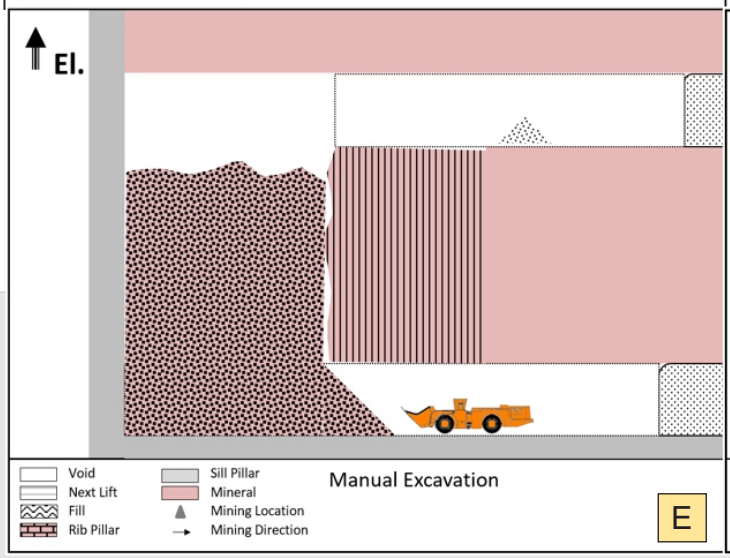

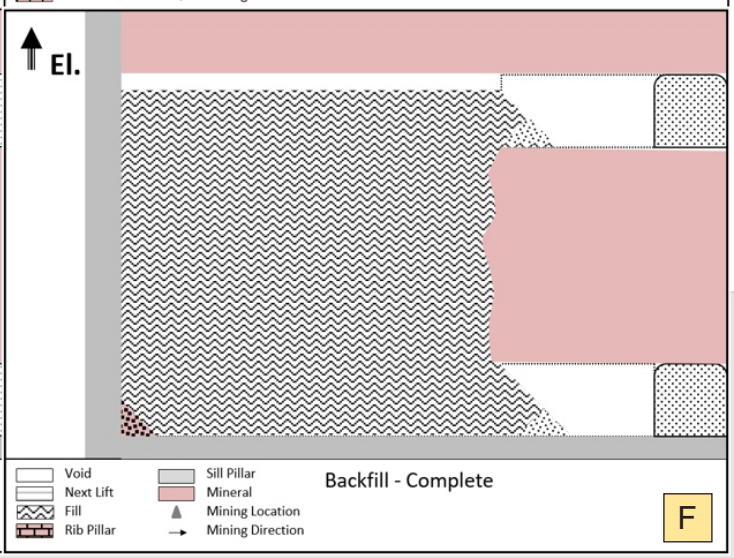

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FIGURE 4-10
GENERAL LONG HOLE STOPING WITH FILL SEQUENCE

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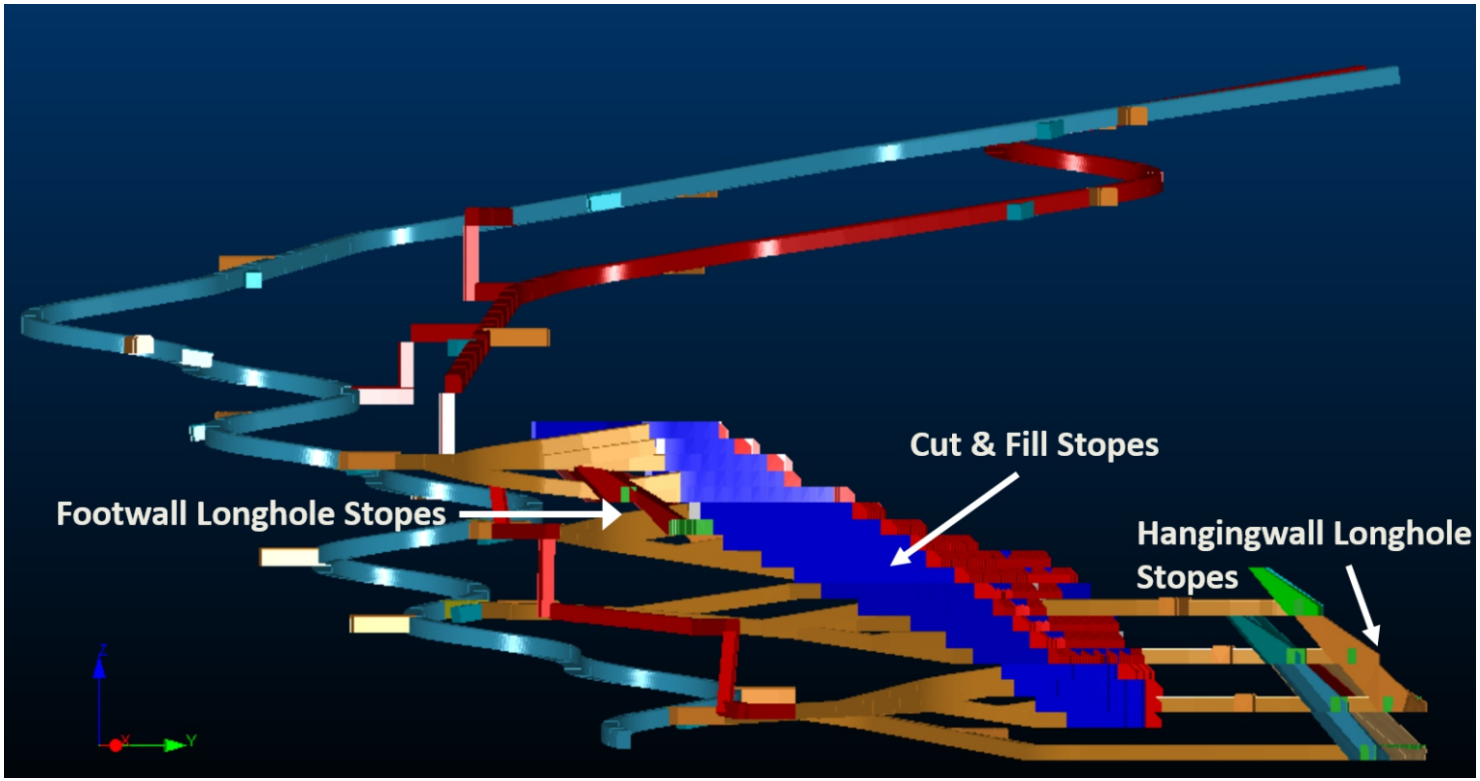

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FIGURE 4-11

ISOMETRIC VIEW OF UNDERGROUND STOPE DISTRIBUTION (LOOKING WEST)

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4.7.3 Underground Geotechnical Study

A geomechanical study, including geotechnical drilling, field data collection, and analyses was completed for the underground component of the Project in 2016 (Rockland, 2016a). The field data collection program consisted of geotechnical drilling and logging, Point Load test and commercial laboratory tests, Unconfined Compressive Strength (UCS), on representative core samples. Summary of field and laboratory strength testing are summarised in Table 4-12 and Table 4-13.

Table 4-12: Average UCS values, Grades and Terms for Ore and Waste Domains

Domain	Rock Types	Average MPa	Grade and Term
Waste	RHY_c and MAF_i	25.2-45.5	R3 "Medium Strong"
	RHY and RHY_v	56.1-65.7	R4 "Strong"
	RHY_i	104.6	R5 "Very Strong"
Ore Stringer	OJ (Stringer), OI (Stringer)	40.9	R3 "Medium Strong"
Ore	OA, OB, OI	99.35	R4 "Strong"

Table 4-13: Summary of Point Load Test Results

Rock Type	Average $I_{s(50)}$ (MPa)	Grade and Term for Point Load Test
Ore	4.14	R5 - Very Strong
Ore Stringer	2.79	R4 - Strong
RHY_c	2.57	R4- Strong
RHY	2.29	R4 - Strong
RHY_i	4.66	R5 - Very Strong
MAF_i	3.93	R4 - Strong
RHY_v	2.84	R4 - Strong

The underground mine design was based on the parameters derived from the geotechnical program and ground support recommendations were provided for four domains: Immediate Hangingwall Domain (HWD), Ore Domain (OD), Immediate Footwall Domain, and Footwall Domain (FWD). The proposed ground support recommendations are tabulated in Table 4-14.

Table 4-14: Preliminary Ground Support Recommendations for 5 m Span and 5 m Height

Type of Excavation	Domain	Bolt (a, b, c, d)				Shotcrete
		Location	Type	Length m (ft)	Pattern m x m (ft x ft)	Thickness cm (in)
Permanent headings (life of the mine, Ramp and Permanent Accesses)	FWD	Back	Resin Rebar	2.4(8')	1.2x 1.2 (4'x4')	
		Walls		2.4 (8')	1.5x1.5 (5'x5')	
	FWD with very weak rock quality (e.g., faults, damaged and microdefect zones)	Back and Walls	Swellex rock bolt or similar	2.4 (8')	1.0x1.0 (3'x3')	7.5cm (3")
Temporary headings (Production Stopes, Sill Drifts and Haulages)	Immediate HWD	Back	Resin Rebar	2.4 (8')	1.2x1.2 (4'x4')	
		Walls	Split Sets	2.4 (8')	1.5x1.5 (5'x5')	
	Immediate HWD with very weak rock quality (e.g., faults, damaged and microdefect zones)	Back and Walls	Swellex rock bolt or similar	2.4 (8')	1x1 (3'x3')	7.5 (3")
	OD	Back	Resin Rebar	2.4 (8')	1.5x1.5 (5'x5')	
		Walls	Split Set	2.4 (8')	1.5x1.5 (5'x5')	
	Immediate FWD	Back	Resin Rebar	2.4(8')	1.2x1.2 (4'x4')	
		Walls	Split Sets	2.4 (8')	1.5x1.5 (5'x5')	

(a) Use Resin Rebar #7 (22 mm) for permanent and temporary excavations.

(b) Use Split Set 39 mm for temporary excavations

(c) All walls and back: Use Welded Wire Mesh or equivalent for permanent and temporary excavations

(d) For very weak domain such as fault / damage zones and broken zones, apply shotcrete and implement tighter bolting pattern. Spot bolt visible wedges and slabs as required.

In addition, the geomechanical aspects of the proposed mining method and the crown pillar with respect to Open Pit and excavation were evaluated.

4.7.4 Ventilation and Air Quality

Yukon Occupational Health and Safety Regulations section 15.61 (2) defines the minimum ventilation standards for an underground mine as:

- *The ventilation system shall be mechanically controlled, and capable of supplying to the operating area an air current;*

  (a) of sufficient volume to dilute all the exhaust gases of the equipment to a concentration that does not exceed the permissible levels as in the Occupational Health Regulations;

(b) of at least 0.06 cubic metres per second for each kilowatt (100 cfm/brake hp) of power of the diesel-powered equipment operating in the workplace; and

(c) that will reduce the time weighted average exposure of a worker to airborne respirable combustible dust to not more than 1.5 milligrams per cubic metre of air.

The primary ventilation network consists of the main ramp being the intake airway with the ventilation ramp being the return airway.

The primary ventilation network for the underground mine will consist of the installation of two primary ventilation fans in a bulkhead 20 m inside the portal of the ventilation ramp to draw fresh air into the mine via the main ramp (Figure 4-12). The bulkhead will also have a man door to enable it to act as a secondary egress. Internal exhaust raises will be fitted with escape ladderways to provide a second means of egress in event of the main ramp being compromised.

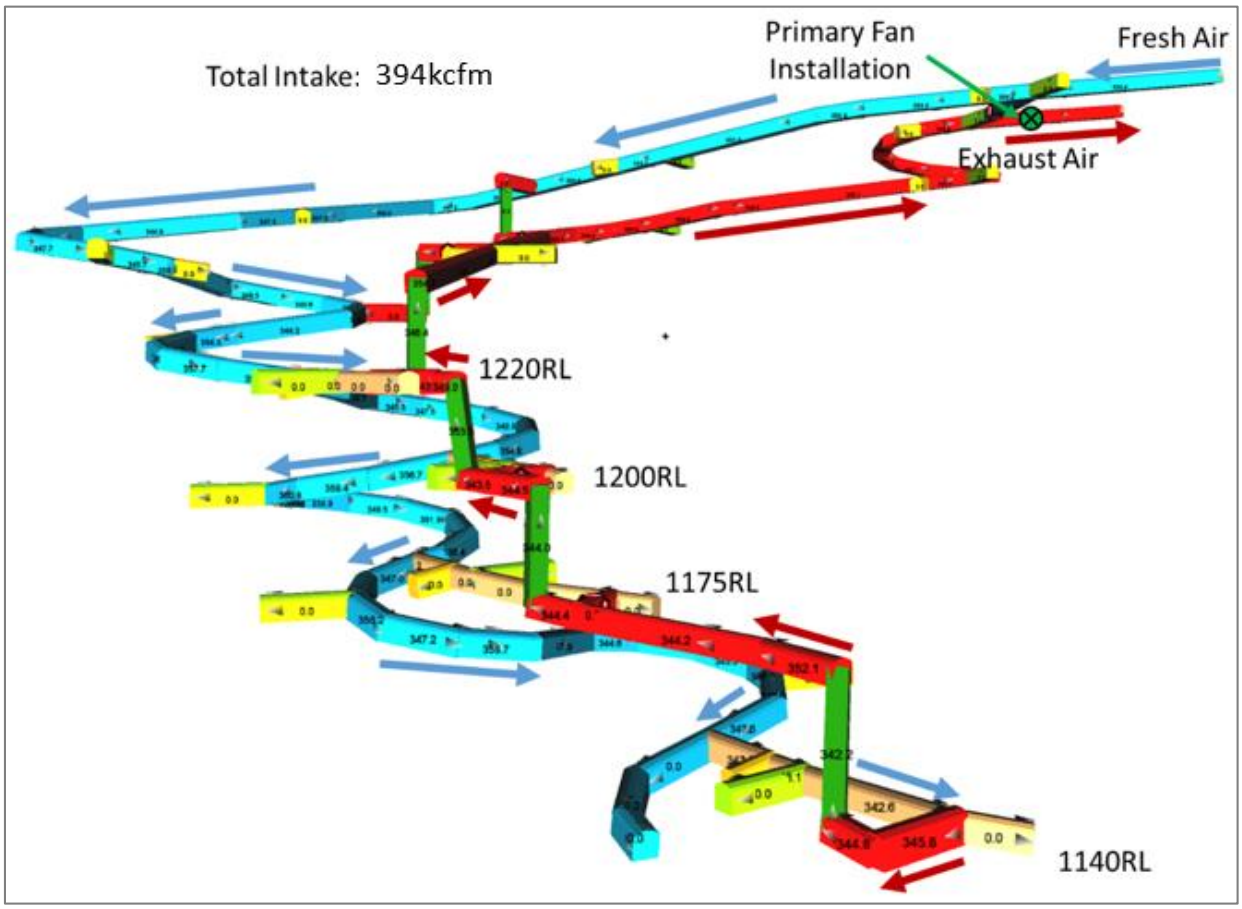


Figure 4-12: Ventilation Network Schematic (Looking Southwest)

The nature of the Yukon climate requires that the air entering the portals be heated during the coldest part of the year. This will be achieved with a portal fan which heats air using diesel fired burners and then injects the air into the intake airway using a 75 kW fan. Diesel consumption will vary depending on ambient air temperature and heating required.

The ventilation system capacity is approximately 189 m^3/s (400 kcfm).

To meet the air flow and distance requirements of the mining areas, 150 hp or similar fans are proposed to provide fresh air to working areas. Two auxiliary ventilation fans (150 hp) per panel will provide fresh airflow to the active headings. Fans will be configured so that one 150 hp fan will provide ventilation to the long hole stopes and the other fan to the cut and fill zones.

4.7.5 Compressed Air

Compressed air will be required for shotcreting, refuge stations, possibly for oilers on the drilling jumbos and rock bolters, and for miscellaneous work where electrical power is not available. A 1,000 cfm electric compressor will be situated outside the main ramp portal to supply air to commence underground mine development. The compressor will be relocated to the upper part of the ventilation ramp upon completion of the 1,280 masl crosscut.

4.7.6 Power

Electrical power will be reticulated underground with cables energized at 4,160 V. Separate 4,160/600 V step down transformers will be used to supply voltages suitable for equipment usage for each mining area.

4.7.7 Blasting and Explosives Management

Emulsion style explosives will be used for most underground blasting. ANFO (Ammonium Nitrate Fuel Oil) will not be used in proximity to the orebody or any other sulphide rich zone due to its propensity for initiating sulphide dust explosions when used in sulphide-rich orebodies. Emulsion explosives also have a lower rate of nitrate contamination of water compared to ANFO explosives. The emulsion will come in both bulk and cartridge form with the majority used being bulk.

Bulk emulsion will be stored in the surface magazine facilities for the initial stages of mine development and an underground magazine may be developed in the future. The emulsion will be transported and loaded into development or production blast holes with a specialist purpose designed “powder truck”. The standard trucks with gasification equipment required for pumpable emulsion are readily available from multiple suppliers and used elsewhere in North America and overseas.

Appropriate primers will be used with the bulk explosive and non-electric detonators will be used to initiate each hole in accordance with recommendations by the manufacturers and relevant regulations.

Additional information regarding blasting and explosives management was presented in Section 4.6.3 and 4.11.13.

4.7.8 Communications

A designated 'Underground' channel will be incorporated into the site radio system. To integrate the surface radio communications with the underground, the proposed communication platform is the "Becker Varis" Leaky Feeder solution although other manufacturers' solutions will be considered and if appropriate, adopted.

Mobile radios will be installed in underground equipment and base radio stations will be installed in primary underground working locations and refuge areas.

Underground phone systems will be installed as a secondary form of communication.

Log books will be maintained daily and communicated with all personnel involved in underground operations at shift meetings. It will contain gas test readings, ground support and geology instructions, and conditions affecting the safety of personnel.

4.7.9 Mine Warning System

A three part mine warning system will be used:

- Part 1: Radio Communication. Protocols will be in place for early warning for the entire mine workforce in the event of any emergency situation;
- Part 2: Portal Warning Lights: Main Ventilation Failure warning lights will be positioned at the portal and visible to all vehicles entering and leaving the underground mine. If the main ventilation system fails, the lights will go off and the next vehicle passing through the portal will be able to raise the alert. The lights will also be incorporated into the "leaky feeder" communication system so that if the fans go off an automatic alert will be broadcast over the radio; and
- Part 3: Stench Gas alert system. The mine warning system that will be implemented underground is a stench gas automated release system. A cylinder of ethyl mercaptan, which is a colourless organic liquid that contains a strong odor when released, will be used as part of the mine warning device, common to many underground mining operations throughout the world. The system will rely on the sense of smell and mine ventilation and can be either turned on manually or automatically.

Underground equipment will contain fire extinguishers and fire suppression systems. In addition, fire extinguishers will be placed in strategic underground working locations with visible signage.

The Health, Safety and Emergency Response Plan (Section 18.5) will include a module on the Mine Warning System.

4.7.10 Refuge Chambers

Refuge chambers will be installed in various locations to provide safe refuge for mining personnel when required. All refuge chambers will be fitted with radio communications, drinking water, breathing air sufficient for a minimum of 36 hours of refuge and emergency subsistence rations.

Portable four-person refuge chambers will also be provided by the mining contractor for use in single entry headings where the escape route is potentially obstructed by heavy mobile machinery in operation. Twelve-person refuge chambers (or larger if required) will be installed in disused ramp stockpiles at various locations to minimize the distance required to travel to refuge chambers from underground working areas. Walking distances to the nearest refuge chamber are not expected to be greater than 750 m.

In addition, a second means of egress will be established inside the return air system. This will enable egress from the mine in the case that the main access (the ramp) becomes inaccessible.

The Health, Safety and Emergency Response Plan (Section 18.5) will include a module on the locations and use of the refuge chambers.

4.7.11 Escapeways

The two main escapeways will be the main ramp and the ventilation ramp. The Health, Safety and Emergency Response Plan (Section 18.5) will include a module on emergency evacuation details and use of escapeways.

4.7.12 Paste Backfill

Paste backfill will be placed in mined stopes to fill voids and assist with ground control.

Delivery of paste backfill to the underground workings will be via an overland pipeline from the paste backfill plant to the underground portal to connect to the underground ramp system for distribution to production areas.

The paste backfill plant will be located to the south west of the Open Pit, as shown in Figure 4-3**.** The selected location allows for delivery of filtered tailings to the backfill plant by trucks, while keeping fill distribution pipeline lengths to a reasonable minimum. This will minimize the amount of water required to flush the line following completion of stope filling. The paste backfill plant will be constructed in the third year of operations to meet underground backfill schedule requirements.

Paste backfill production requirements are 1,000 m^3 of backfill per day and delivered underground via a positive displacement pump.

Paste fill will be contained within the stope by constructing a fill fence in the access as close to the stope entrance as possible. The fill fence will consist of welded wire mesh anchored to the ribs with burlap cloth attached to it and 200 mm of shotcrete applied to the surface area of the fence.

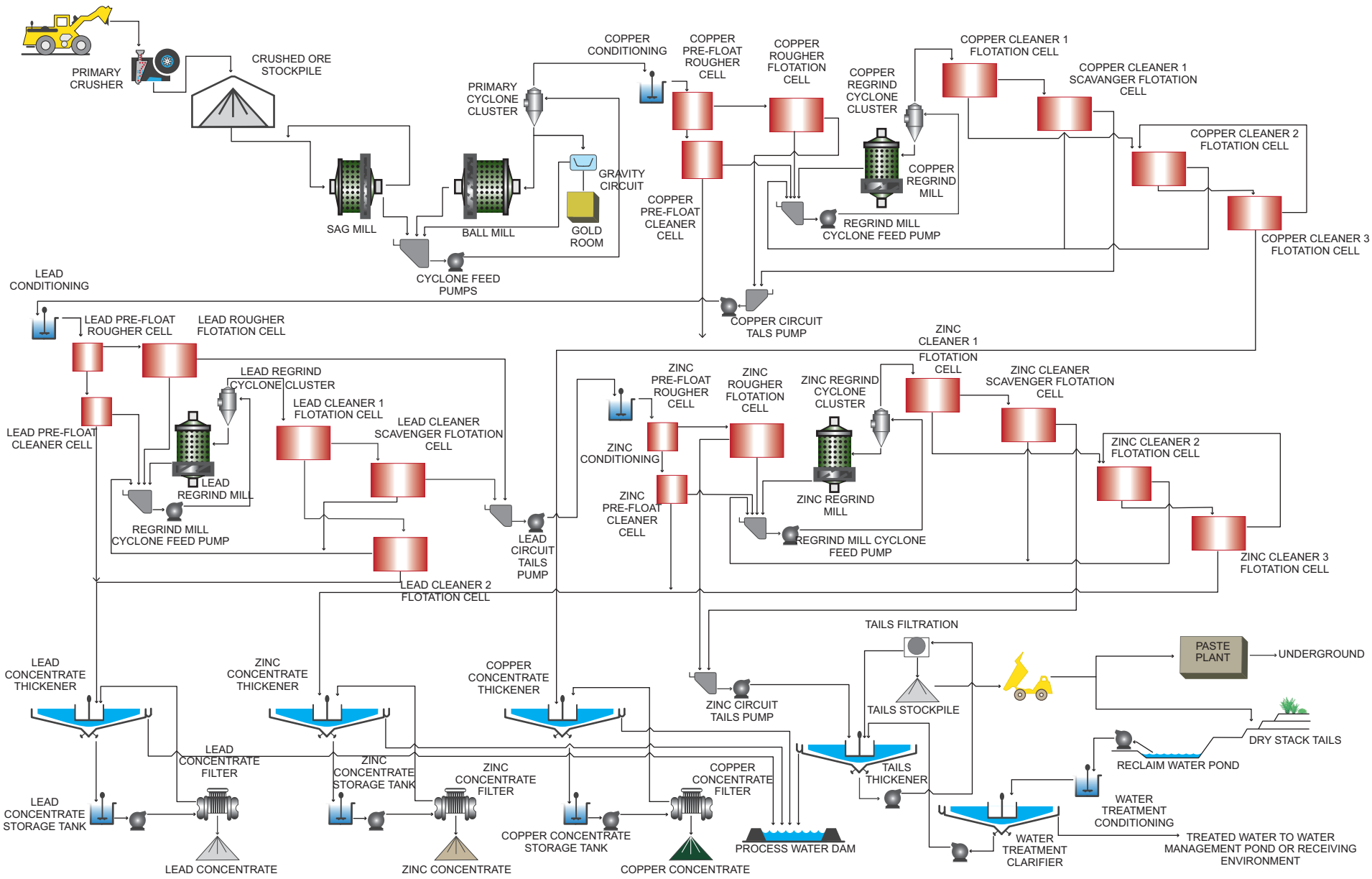
4.8 ORE PROCESSING

4.8.1 Overview

The Kudz Ze Kayah Process Plant and associated service facilities will process run-of-mine (ROM) ore at a nominal rate of 2 Mtpa, to produce separate copper, lead, and zinc concentrates and tailings. The process will consist of crushing and grinding of the ore, separate sequential pre-floatation, rougher and cleaner flotation of copper, lead, and zinc, and regrind of copper, lead, and zinc rougher concentrates. Concentrates will be thickened, filtered, and stockpiled on site prior to being loaded onto trucks for transport to third party smelters. The flotation tailings will be dewatered by thickening and filtration before the tailings are transported either for disposal at the Class A WSF or combined with cement to produce underground paste backfill. The proposed flowsheet is summarised in Figure 4-13.

4.8.2 Metallurgical Studies

The metallurgical performance of the ABM Deposit mineralisation was studied in detail by Cominco in the 1990s and by BMC since acquiring the Project. BMC used the historical metallurgical testwork as a basis for conducting its own assessment, confirming that the ABM Deposit mineralisation responds well to conventional flotation techniques and modern reagent regimes to produce saleable copper, lead, and zinc concentrates (Allnorth Consultants Ltd., 2016b).



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KUDZ ZE KAYAH PROJECT

FIGURE 4-13
PROCESS FLOWSHEET

JANUARY 2017

4.8.3 Process Plant Description

The proposed Process Plant design is based on a flowsheet (Figure 4-13) with unit operations that are well proven in the international and Canadian base metals industry, incorporating the following unit process operations:

- Primary crushing using a jaw crusher to produce a crushed product size of nominally 80% passing (P_{80}) 75 to 120 mm based on the soft nature of the ore;
- Stacking of ore onto a conical, covered stockpile with a nominal 12 to 16-hour live capacity;
- Semi-autogenous grinding (SAG) mill / ball mill (SAB) configuration comminution circuit to produce a P_{80} grind size of 70 to 80 µm;
- Gravity gold recovery on part of the cyclone underflow in the grinding circuit using a centrifugal concentrator, with secondary upgrade in the gold room with a shaking table;
- Sequential flotation of copper, lead, and zinc using conventional pre-float, rougher and cleaner flotation cells;
- Regrinding of copper, lead and zinc rougher concentrate with fine grinding mills;
- Thickening and filtration of the separate copper, lead, and zinc concentrates;
- Storage of the concentrate and load-out via front end loader (FEL) and truck;
- Dewatering of the flotation tailings by thickening and filtration prior to trucking to either the Class A WSF for disposal or the Paste Fill Plant for paste backfill production; and
- Concentrator water and air services and associated infrastructure.

4.8.3.1 Crushing

Run of mine (ROM) ore will be transported from the Open Pit and underground to the ROM pad stockpiles by mine haul trucks. ROM ore will be reclaimed from the stockpiles by FEL and fed into a ROM bin. ROM ore will be withdrawn from the bin by an apron feeder and fed to the crusher.

A dust suppression system with a baghouse filter will be installed in the crushing system and discharge conveying system to minimize dust. Spray nozzles will also be used around the ROM bin and transfer points.

The crushed ore stockpile will provide a minimum of 3,000 t of live storage capacity with two or more reclaim apron feeders located in an under-pile tunnel.

The live stockpile will be conical in shape with a cover designed to minimize dust generation.

4.8.3.2 Grinding

The grinding circuit will comprise a SAG mill and ball mill in circuit with cyclones to produce a final product of P_{80} 70 to 80 µm at approximately 245 tph.

4.8.3.3 Flotation

The flotation circuit will be a sequential circuit, with copper, lead, and zinc recovered from the circuit in that order. All flotation cells will be agitated, forced air conventional cells.

Copper Flotation

The slurry will flow by gravity to the first of the copper flotation cells, with concentrate being removed from the first cell as a pre-float rougher stage. This concentrate will be pumped to a single pre-float cleaner cell, where the concentrate will be upgraded and directed straight to the final concentrate hopper. Tailings will flow by gravity, where they will be combined with the copper rougher concentrate collected from the subsequent rougher cells, and pumped via duty/stand-by pumps to the copper regrind cyclone cluster for classification and regrinding. Tailings from the copper rougher cells will flow by gravity to the copper flotation tails hopper.

Combined copper rougher flotation concentrate and pre-float cleaner tails will be classified in a cluster of cyclones, with the cyclone overflow having a P_{80} of 25 to 40 µm. Cyclone overflow will be directed to the copper cleaning circuit, while the underflow will be directed to the copper regrind mill.

Reground rougher copper concentrate will flow to a copper cleaning circuit. The copper cleaner flotation circuit will consist of three stages of cleaning, with cleaner scavenging on the first stage.

The first copper cleaning stage will consist of a number of cleaner cells in series. Concentrate from the first copper cleaning stage will be pumped to the second copper cleaning stage, with tailings flowing to the copper cleaner-scavenger cells. Concentrate from the copper cleaner scavenger cells will be pumped to the copper rougher flotation concentrate hopper for regrinding. Tails from the copper cleaner-scavenger cells will flow to a conditioning tank, where lead flotation reagents will be added. The overflow from the conditioning tank will flow to the copper flotation tails hopper, where it will be combined with the copper rougher tailings and pumped to the lead flotation circuit.

The second stage of copper cleaning flotation will consist of several cleaner cells in series. Concentrate from the second copper cleaner stage will be pumped to the third copper cleaning stage, with tailings pumped to the copper rougher flotation concentrate hopper for regrinding.

The third stage of copper cleaning flotation will consist of a number of cleaner cells in series. Concentrate from the third copper cleaner stage will be pumped to the final concentrate hopper, where it will be combined with the copper pre-float cleaner concentrate before pumping to concentrate dewatering, and tailings will be directed to the second stage of copper cleaning flotation.

Lead Flotation

Tails from the copper flotation circuit will be pumped to the first of two agitated lead conditioning tanks, where reagents will be added. Conditioned slurry will flow to the first of the lead rougher flotation cells, with concentrate removed from the first cell as a pre-float rougher stage. This concentrate will be pumped to a single pre-float cleaner cell, where the concentrate will be upgraded and directed straight to the final concentrate hopper. Tailings will be combined with the lead rougher concentrate collected from the subsequent rougher cells and pumped via duty/stand-by pumps to the lead regrind cyclone cluster for classification and regrinding. Tailings from the lead rougher cells will flow to the lead flotation tails hopper.

Combined lead rougher flotation concentrate and pre-float cleaner tails will be classified in a cluster of cyclones, with the cyclone overflow having a P_{80} of 20-40 µm. Cyclone overflow will flow to the lead cleaning circuit, while the underflow will flow to the lead regrind mill.

Re-ground rougher lead concentrate will flow to the lead cleaning circuit. The lead cleaner flotation circuit will consist of two stages of cleaning, with cleaner scavenging on the first stage.

The first lead cleaning stage will consist of a number of cells in series. Concentrate from the first lead cleaning stage will be pumped to the second lead cleaning stage for recleaning, and tailings will flow to the lead cleaner-scavenger cells. Concentrate from the lead cleaner-scavenger cells will be pumped to the lead rougher flotation concentrate hopper for regrinding. Tails from the lead cleaner-scavenger cells will flow to the lead flotation tails hopper, where it will be combined with the lead rougher tails and pumped to the zinc flotation circuit.

The second stage of lead cleaning flotation will consist of several cleaner cells in series. Concentrate from the second stage will be pumped to the final concentrate hopper, where it will be combined with the lead pre-float cleaner concentrate before pumping to concentrate dewatering. Tailings will be pumped to the lead rougher flotation concentrate hopper for regrinding.

Zinc Flotation

Tails from the lead flotation circuit will be pumped to the first of two agitated zinc conditioning tanks, where reagents will be added.

Conditioned slurry will flow to the first of the zinc rougher flotation cells, with concentrate removed from the first cell as a pre-float rougher stage. This concentrate will be pumped to the pre-float cleaner cells, where the concentrate will be upgraded and directed straight to the final concentrate hopper. Tailings will be combined with the zinc rougher concentrate collected from the subsequent rougher cells and pumped via duty/stand-by pumps to the zinc regrind cyclone cluster for classification and regrinding. Tailings from the zinc rougher cells will flow by gravity to the tails hopper.

Combined zinc rougher flotation concentrate and pre-float cleaner tails will be classified in a cluster of cyclones, with the cyclone overflow having a P_{80} of 30 to 40 µm. Cyclone overflow will flow to the zinc cleaning circuit, while the underflow will flow to the zinc regrind mill.

Re-ground zinc concentrate will flow to a zinc cleaning circuit. The zinc cleaner flotation circuit will consist of three stages of cleaning, with cleaner scavenging on the first stage.

The first zinc cleaning stage will consist of a number of cleaner cells in series. Concentrate from the first zinc cleaning stage will be pumped to the second zinc cleaning stage, with tailings flowing by gravity to the zinc cleaner-scavenger cells in series. Concentrate from the zinc cleaner scavenger cells will be pumped to the zinc rougher flotation concentrate hopper for regrinding. Tails from the zinc cleaner scavenger cells will flow to the tails hopper.

The second stage of zinc cleaning flotation will consist of several cleaner cells in series. Concentrate from the second zinc cleaner stage will be pumped to the third zinc cleaning stage, and tailings will be pumped to the zinc rougher flotation concentrate hopper for regrinding.

The third stage of zinc cleaning flotation will consist of a number of cleaner cells in series. Concentrate from the third zinc cleaner stage will be pumped to concentrate dewatering, and tailings flow by gravity to the second stage of zinc cleaning flotation.

4.8.3.4 Concentrate Dewatering

Copper, lead, and zinc final concentrates will be thickened in purpose designed thickeners. The overflow from each thickener will flow to a common thickener overflow tank, where the streams will be combined and pumped to the process water pond. Thickened concentrates, at nominally 60% solids weight per weight (w/w) will be stored in agitated storage tanks providing nominally 24 hours of residence time.

Thickened concentrates will be dewatered using vacuum or pressure filters to nominally 9 to 10% moisture. Filtered concentrates will be dumped into bunkers directly below the respective filter.

Filtered concentrate will be removed by FEL and stacked inside a storage shed, with nominally 7 to 10 days storage capacity for each concentrate. Copper and zinc concentrate will be bulk loaded into trucks for transport off site and sale to third parties. Lead will be transported in 30 t sealed containers.

4.8.3.5 Tailings Dewatering

Zinc flotation tailings will be collected in a tails hopper before the tailings are pumped to a purpose designed thickener for dewatering. The tailings thickener overflow water will flow to the process water pond for reuse. Thickener underflow, that has been dewatered to nominally 60% solids w/w, will be fed to a splitter box which evenly distributes the flow between two agitated filtration feed tanks. Each filtration tank will feed a filter which dewaters the tailings to a produce a filter cake with a moisture content of approximately 15% with the assistance of flocculant. The filtrate will flow back to the tailings thickener, while the filter cake will be stockpiled for reclaim and transport by truck to either the Class A WSF or the paste backfill plant.

4.8.4 Processing Plant Location and Layout

4.8.4.1 Site Selection

Criteria used for Process Plant site selection was similar to that adopted by Cominco in their 1995 prefeasibility study (Cominco, 1995). The following four assessment criteria were considered:

1. Geotechnical - the processing plant will be sited so that the heavy equipment (grinding mills and generators) can be founded on competent rock. The presence of permafrost must be very carefully evaluated if the facilities are located on soil type materials;

2. Distance from the mine - The Process Plant will be located close to the mine to minimize the haulage distances but far enough away to minimize traffic interference and production interruption due to blast vibration and fly rock;

3. Environmental - The Process Plant is located so that any spillage from the plant or runoff from the plant site can be collected and pumped back to the Process Plant for treatment;

4. Terrain - Installation on flat or gently sloping terrain simplifies the installation and operation. The facilities have been sited to avoid natural hazards such as avalanches and debris torrents.

The selected Process Plant location is approximately in the same location as that adopted by Cominco (Figure 4-2). The rationale for the site selection included:

1. The geotechnical assessment conducted by Knight Piesold Ltd., which is summarized in Section 4.8.4.2, found the location to be geotechnically suitable (Appendix C- 2 Geotechnical Characterization of Processing Plant Facility Area);

2. Distance to the Open Pit (approximately 1.5 km away, which is about as close as possible given the location of the waste rock storage areas);

3. The Water Management Facilities are located down gradient of the Process Plant Location and runoff from the plant site can be collected and pumped back to the Process Plant for treatment; and

4. The slopes on the west side of Geona Creek are flat enough to allow easy excavation and eliminate the potential for either avalanches or debris slides.

4.8.4.2 Geotechnical Evaluation

Six test pits and three drillholes were completed in the proposed Process Plant Facility area (Appendix C- 2 Geotechnical Characterization of Processing Plant Facility Area).

Surficial deposits in the Process Plant Facility area are shallow with encountered depths ranging from 1.6 to 5.0 mbgs. The typical overburden profile consists of an organic layer ranging from 0.1 to 0.5 m

overlying silty sand and sandy silt deposits with varying amounts of gravel and cobbles. The soils are generally well graded, low to medium plasticity, light to medium greyish brown, massive, and wet. The deposits can be described as "compact" with field Standard Penetration Test (SPT) N values ranging from 9 to 19 and typically increasing with depth. Many SPTs resulted in refusal on cobbles and boulders. Five overburden samples were sent for laboratory testing. Field logging of test pits confirms the presence of cobbles and boulders in varying concentrations across the site:

- Natural Moisture Content: Average of 11%; and
- Particle Size Distribution Average: Gravel – 23%, Sand – 46%, Silt – 29%, Clay – 4%.

"Fair" quality bedrock was encountered at approximately 4 mbgs, with the exception of one drillhole which was highly broken and rubblized until approximately 15 mbgs. Lithologies encountered include foliated carbonaceous mudstone and mafic volcaniclastics.

Bedrock in the Process Plant Facility Area was found to have the following geotechnical properties:

- A mean RQD value of 48;
- A rock strength classification of "strong" with UCS laboratory test results ranging from 23 to 59 MPa. Field UCS estimates ranging from 0.1 to 150 MPa with a mean value of 83 MPa; and
- RMR_{89} values ranging from 24 to 79, with a mean RMR_{89} of 53 which corresponds to "fair" quality rock.

Eleven bedrock hydraulic conductivity packer tests were performed in this area at depths ranging from 4.2 to 46.2 mbgs. Hydraulic conductivity (K) values for the tested zones range from 4×10^{-7} m/s to 1×10^{-5} m/s, with a geometric mean K of 1×10^{-6} m/s.

Further geotechnical characterization is planned to be completed prior to the final design of the Process Plant Facility.

4.8.4.3 Site Layout

The layout of the Process Plant Facility is shown in Figure 4-14.

The crusher is located at the southern end of the processing plant, and crushed ore will be conveyed via two conveyors to the crushed ore stockpile. Crushed ore will be reclaimed from the crushed ore stockpile and fed into the grinding circuit located at the southern end of the main processing plant building. Capacity exists to also produce a supply of crushed -75 mm rock for use underground as road base

Slurry from the grinding circuit will be pumped into the flotation section of the plant, located in the central part of the main processing plant building. Concentrate thickening, filtration, storage, and loadout is completed at the northern end of the main processing plant building.

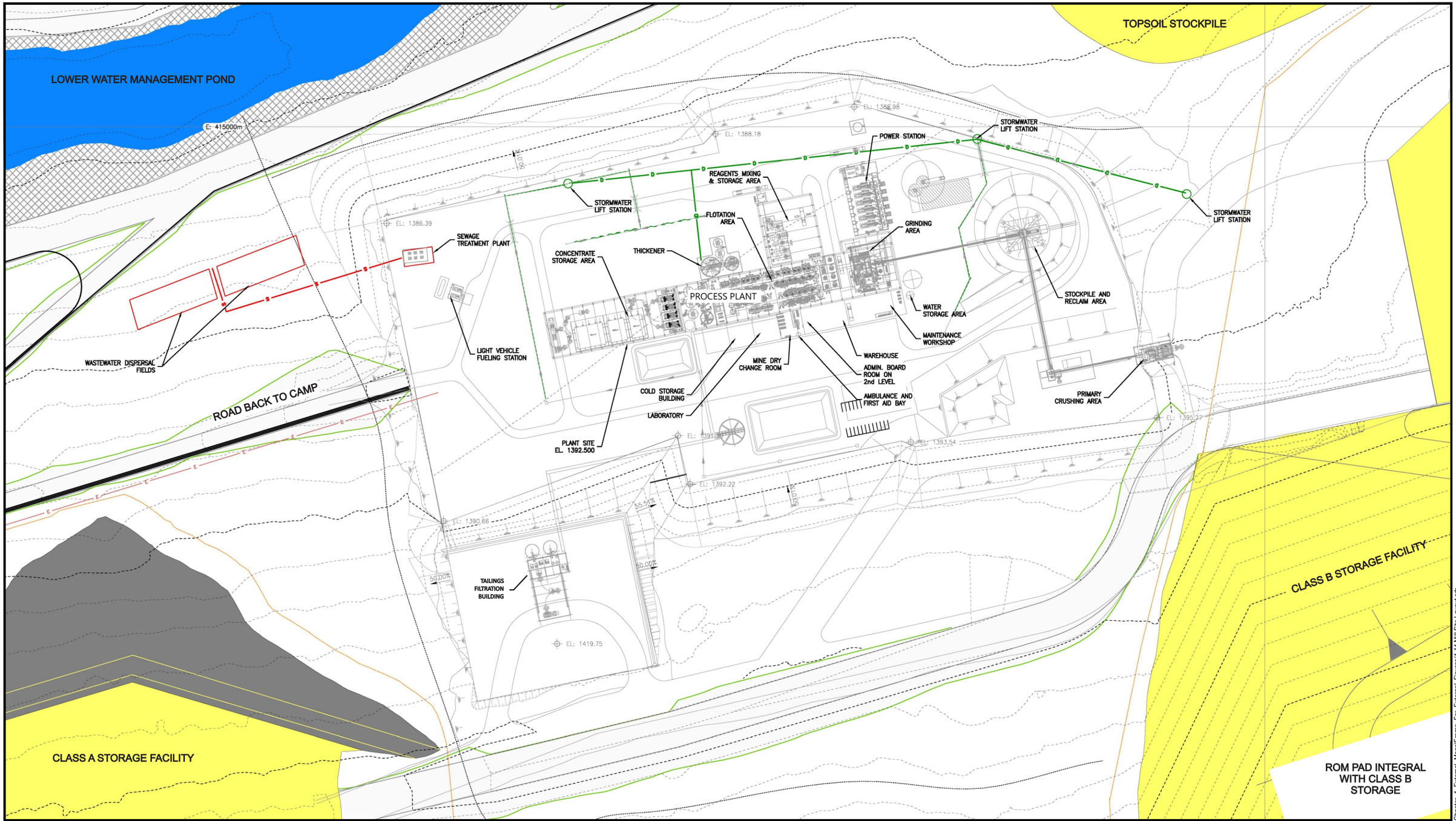

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FIGURE 4-14

PROCESS PLANT FACILITY LAYOUT

JANUARY, 2017

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Reagent storage is located on the eastern side of the main processing plant building. The western side of the main processing plant building will house the warehouse and administration complex. This will be a two level facility, with the upper level used for personnel offices. The lower level will include processing maintenance shop, warehouse and cold storage, assay lab, mine dry and first aid, and ambulance facilities.

Tailings filtration building will be located to the west of the main processing plant building, near the Class A Storage Facility.

4.8.5 Reagents

Reagents requiring handling, mixing, and distribution systems in the processing plant facility are summarized in Table 4-15. While reagent consumption will vary depending on the specific characteristics of the ore being treated, typical estimated annual consumption rates of the reagents are also detailed in Table 4-15.

Table 4-15: Process Plant Reagents, Storage and Estimated Consumption

Reagent	Delivered Product Size	Storage Location	Use in Plant	Annual Consumption (t)
Lime	40 t bulk delivery	Lime silo	pH modifier	6,400
Sodium Metabisulphite (SMBS)	1,000 kg bulk bags	Reagent storage shed	Copper circuit depressant	1,400
Zinc Sulphate	1,200 kg bulk bags	Reagent storage shed	Lead circuit depressant	800
3418A	1,000 l bulk liquid box	Reagent storage shed	Lead circuit collector	25
Copper Sulphate	1,200 kg bulk bags	Reagent storage shed	Zinc circuit activator	1,300
A208	1,000 l bulk liquid box	Reagent storage shed	Zinc circuit collector	190
Flocculant	750 kg bulk bags	Reagent storage shed	Flocculant	60
Sodium Cyanide	1,000 kg bulk bags	Reagent storage shed	Lead circuit depressant	275
A3894	1,000l bulk liquid box	Reagent storage shed	Copper circuit collector	65
Methyl Isobutyl Carbinol (MIBC)	1,000l bulk liquid box	Reagent storage shed	Frother	65

Applicable MSDS are readily available for review

Dry reagents will be stored under cover, then mixed in reagent tanks and transferred to distribution tanks for process use. The reagent storage tanks will be equipped with volume level indicators and instrumentation to ensure that spills do not occur during operation. The reagent mixing and distribution area has been designed as a wet area, with sloped concrete floors draining to sumps for containment. In addition, appropriate ventilation and fire and safety protection will be provided. The reagent storage shed will be a steel framed structure with metal roofing; metal siding will be installed to keep reagents dry and protected from the sun.

The conceptual management plans that are relevant to the safe use, handling and storage of the reagents are included in Chapter 18 (Section 18.3 – Hazardous Materials Management Plan, Section 15.5 – Spill Contingency Management Plan, Section 18.12, Traffic and Access Management Plan, and Section 18.15 – Health Safety and Emergency Response Plan).

4.9 WASTE ROCK MANAGEMENT

4.9.1 Waste Characterization

The Project acid rock drainage and metal leaching characterization report is presented in Appendix D-5. The following sections provide a summary of the report findings.

4.9.1.1 Historical Assessment

A geochemical characterization program for the ABM Deposit was completed in 1996 by Norecol, Dames and Moore, based on diamond drill programs and metallurgical testing conducted by Cominco in 1994 and 1995. The characterization program consisted of static geochemical characterization of 273 samples from four diamond drill holes (DDH's) including acid-base accounting (ABA) (all 273 samples), carbonate speciation (45 of 273 samples) and petrography (101 of 273 samples). Detailed elemental characterization Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analysis was conducted on 2,400 samples from 37 DDH's. Carbonate speciation and ABA analyses were also conducted on five samples of tailings.

Kinetic testing was completed on select materials from the four DDH's involved in the static testing as well as the tailings samples. A total of 40 kinetic tests were conducted including humidity cell and subaqueous column tests.

Based on the findings of the geochemical characterization program, Cominco's mine plan included segregating waste rock into three waste types:

1. Strongly Potentially Acid Generating (SPAG): Rock containing very high concentrations of sulphide minerals and expected to be acid generating, planned subaqueous disposal in a tailings pond;

2. Weakly Potentially Acid Generating (WPAG): Rock containing lower concentrations of sulphide minerals and not expected to be acid generating in the mine life. This material would be stockpiled during operations and eventually backfilled into the completed pit to be flooded upon closure; and

3. Potentially Acid Consuming (PAC): Rock containing low concentrations of sulphide minerals and not expecting to be acid generating to be disposed of sub-aerially (i.e. covered surface dumps).

Management criteria were developed for the waste rock by Cominco. WPAG was differentiated from SPAG if acid potential (AP) was less than 92 kg $CaCO_3$/t (or less than 2.9% Sulphur) and neutralization potential (NP) was greater than 18 kg $CaCO_3$/t. PAC was differentiated from WPAG if the neutralization potential ratio (NPR = NP/AP) was greater than 1.7.

4.9.1.2 Current Assessment

A review of the 1990s data found that it was fit for use and therefore the current assessment is supplemental to the historical data set.

BMC approached the supplemental ML/ARD program by defining volumes of rock anticipated to have similar geochemical characteristics as inferred from visually discernable and readily estimated geological features. In total ten geodomains (Table 4-16) that, in general, show a spatial relationship to the ABM Deposit were defined. These ten domains were then used as a basis for sampling and characterization based on their relative abundance and location relative to proposed mining. The main geological features considered in the geodomain interpretation include, lithology, carbonate content (calcite, ankerite), disseminated sulphide minerals, muscovite, and chlorite.

Table 4-16: Geodomain Characteristics

Geodomain ID	Features	Comments
AK RHYc	Moderate-strong ankeritic coherent rhyolite	Strong ankeritic zone in upper parts of hanging wall that crosses lithology
AK RHYv	Moderate-strong ankeritic volcaniclastic rhyolite	Strong ankeritic zone in upper parts of hanging wall that crosses lithology
CA CL MAF	Calcite-chlorite mafic intrusive	Distinct unit in footwall of deposit interpreted to be an intrusive. Consistently calcite-bearing
CARB MDS/RHY	Felsic volcanic rock (coherent and volcaniclastic) with carbonaceous material and associated with thin mudstone intervals. Generally with disseminated pyrite and muscovite, locally minor ankerite	Carbonaceous mudstone/rhyolite dominated intervals lumped together
MDS	Upper, thick mudstone package	Within fault offset (down-dropped) block; confined to southeastern corner of deposit
MU PY RHY	Moderate-strong muscovite-altered rhyolite with disseminated pyrite	Generally proximal to massive sulphide, characterized by coarse sericite (muscovite)
PY AK RHYc	Moderate-strong ankeritic coherent rhyolite with disseminated pyrite	Below AK RHYc/v in disseminated pyrite halo to deposit
PY AK RHYv	Moderate-strong ankeritic volcaniclastic rhyolite with disseminated pyrite	Below AK RHYc/v in disseminated pyrite halo to deposit
PY CL RHY	Chloritic rhyolite coherent and volcaniclastic rhyolite with disseminated pyrite	Smaller unit proximal to massive sulphide in hanging wall characterized by chlorite
RHYi	Hard, siliceous, fine-grained felsic intrusive typically with 2-3% disseminated pyrite	Confined to Krakatoa Zone

In 2015, 324 additional samples were collected from the exploration drill core to expand the geographic range of the samples, resulting in an ABA static dataset of 567 samples. Measurements of the acid generating potential (AP) and acid neutralizing potential (NP) indicated that the bulk of waste rock associated with the upper portion of the hanging wall (AK RHYc and AK RHYv) and the footwall (CA CL MAF) were not potentially acid generating (non-PAG). MDS samples from the southeastern corner of the ABM Zone were also largely non-PAG. Geodomains located proximal to the orebody (PY CL RHY, MU PY RHY, and to a lesser extent CARB MDS/RHY) tended to have higher

sulphide content and were predominantly potentially acid generating. Although sulphide was not particularly elevated in RHYi samples from the Krakatoa Zone, NP was generally low resulting in the majority of these samples also being classed as PAG. Shake flask extraction (SFE) testing indicated that, where present, elevated soluble trace element concentrations were mainly associated with the PY CL RHY, MU PY RHY, and CARB MDS/RHY geodomains. Elevated levels of SFE-soluble arsenic were also observed for the footwall CA CL MAF samples, related to its relatively high bulk arsenic content.

Ore and tailings samples were all PAG, however, their moderate to elevated NP content will likely delay the onset of acidic leachate. Ore samples had elevated concentrations of SFE-soluble selenium, lead, and zinc. Tailings samples also returned high soluble concentrations of the same elements in addition to copper and cadmium. Overburden soil and rock samples collected across the Project area were non-PAG, with limited metal leaching potential.

Humidity cell kinetic testing indicated that the time to acid generation in the majority of waste rock material is likely longer term than short term. Calculations of humidity cell AP and NP depletion times, in combination with the average rates of acid production and neutralization observed in the humidity cell data suggest that a site-specific NP/AP ratio of 1.9 may be used to delineate PAG (NP/AP less than 1.9) and non-PAG material. Ongoing trickle leach column and field barrel kinetic testing suggests that trace element leaching at circumneutral pH is a concern for selenium, antimony, uranium, and arsenic. The majority of elevated concentrations were associated with PAG material, although some arsenic leaching was observed in the non-PAG CA CL MAF field barrel.

Waste rock classification criteria were developed based on the potential for acid generation and trace element leaching. Three classes of material were identified:

- Class A is strongly PAG material with an associated high potential for metal leaching over the short term. Waste rock with a total sulphur content greater than 2.9 wt.% or a NP less than 10 kg $CaCO_3$/t were placed in this category. Drainage from this Storage Facility requires containment, management and treatment during operations and closure;
- Class B is mildly PAG with a more moderate potential for metal leaching over the long term. Following satisfaction of the Class A criteria, waste rock is Class B if it has an NP/AP ratio that is less than 1.9. Regardless of its sulphur and NP content, all of the CA CL MAF material is identified as Class B due to its tendency to leach arsenic at elevated concentrations. Drainage from this Storage Facility is expected to become acidic in the long term (expected to be greater than 50 years), but unlikely during operations. Trace element leaching from this waste rock may require management and treatment as needed during operations; and
- Class C is non-PAG with a relatively low potential for metal leaching. Waste rock with an NP/AP ratio greater than 1.9 is placed in this class (apart from CA CL MAF). Drainage from this Storage Facility is expected to remain circumneutral and is not anticipated to require treatment during operations or post-closure.

4.9.2 Waste Rock Identification and Management

The expected methodology for identification and management of the different classes of waste rock is presented below. This methodology will be tested and refined in practice to ensure efficient and effective identification and management of each class of waste rock.

Samples of cuttings from each open pit blast hole will be collected for waste rock classification purposes. One sample will be collected per hole and submitted for aqua regia digestion (3:1 hydrochloric acid: nitric acid) with ICP-MS finish to provide a multi-element suite for each sample. Based on the relationships established in the ML/ARD testwork, the aqua regia ICP-MS sulphur and calcium concentrations will be used to produce surrogate AP and NP values, respectively. Using these data, the waste rock will be classified based on its sulphur concentration, NP content, and NP/AP ratio. Visual examination of the rock will also be used to guide waste rock classification (e.g., all CA CL MAF material that would otherwise be classified as Class C will be designated as Class B). As a precaution, and consistent with accepted practice, regular spot checks of the surrogate ABA data will occur such that conventional ABA testing (total sulphur by Leco and NP by the modified Sobek method) will be performed for approximately every 35 surrogate tests.

The laboratory test results will be imported into the mining software package. As part of the grade control process, different classes of waste will be identified with different polygons for mine operations for day to day planning and material dispatch.

In the Open Pit mine, the polygons identifying the different classes of waste will be used by the excavator operator and geologists to inform truck drivers what the destination is of each load of waste.

Waste rock from the underground mine will be visually checked and sampled when it is deposited on the underground stockpile located adjacent to the underground portals. The visual checks and laboratory results will be used to determine the final location of this waste. Open pit trucks will transfer underground waste from the underground stockpile area to the final Waste Storage Facility destination. The loader operator will be responsible for informing truck drivers what the destination is of each load of waste, based on the identification completed by site geologists.

4.9.3 Deposition of Tailings and Mine Rock

Waste rock material from the ABM open pit and underground workings will be classified into three categories, based on the ARD test results:

- Class A material: strongly potentially acid generating and high potential for metal leaching – approximately 11.6 Mt;
- Class B material: mildly potentially acid generating and moderate potential for metal leaching – approximately 47.3 Mt; and
- Class C material: non potential acid generating and low potential for metal leaching – approximately 64 Mt.

The classification of waste rock material from ABM open pit and underground workings tabulated by year for the LOM is summarised in Table 4-17.

Class A waste rock material will be encapsulated in the filtered tailings mass in the Class A Storage Facility located north of the proposed Process Plant on the western slope of Geona Creek valley. The total design volume of the Class A Storage Facility is approximately 15 Mm^3 and will be progressively reclaimed with an engineered low permeability cover material, and approximately 3 to 5 m of Class C material for frost protection.

Class B waste rock material is to be stored on the surface of the western slopes, adjacent to the Open Pit. This location is similar to the location identified in the Cominco study (Golder, 1996b). The total design volume of Class B Storage Facility is approximately 25 Mm^3, assuming a nominal bulk density of 2.0 t/m^3 and will be progressively reclaimed with a low permeability cover material, and approximately 3 to 5 m of Class C material for frost protection.

Class C waste rock material will be stored on surface adjacent to the Open Pit in the East Hanging Valley area, in approximately the same location as proposed in the Cominco study (Golder, 1996b). The total design volume of the Class C Storage Facility is approximately 34 Mm^3. This Storage Facility will not require low permeability encapsulation but depending upon the availability of suitable material, BMC may also partially or fully encapsulate prior to covering in topsoil and reseeding, as part of the long term reclamation program.

Prefeasibility level designs and stability assessments were conducted by Knight Piesold Ltd. (KP) in 2016 and are included as Appendices: Appendix C- 4 Kudz Ze Kayah Pre-Feasibility Study - Class A Storage Facility Stability Assessment and Appendix C- 6 Kudz Ze Kayah Pre-Feasibility Study - Design of Class B and Class C Storage Facilities and Overburden Stockpile.

Table 4-17: Combined ARD Mining Waste Schedule

Waste Classification	Units	LOM	Preproduction Years		Production Years									
			-2	-1	1	2	3	4	5	6	7	8	9	10
Class A Waste	kt	11,629	90	423	1,190	1,324	1,605	1,564	1,126	966	813	1,261	1,267	-
Class B Waste	kt	47,342	371	1,782	6,211	7,338	7,086	4,881	2,888	3,239	3,667	4,705	5,174	-
Class C Waste	kt	64,097	409	2,414	7,864	9,802	8,505	7,054	8,511	7,082	5,592	4,212	2,652	-
Overburden	kt	16,080	402	921	2,797	1,209	1,123	2,554	1,347	1,524	2,241	1,962	-	-
Total Waste	kt	139,148	1,272	5,540	18,062	19,673	18,319	16,053	13,872	12,811	12,313	12,140	9,093	-

4.9.4 Class A Storage Facility

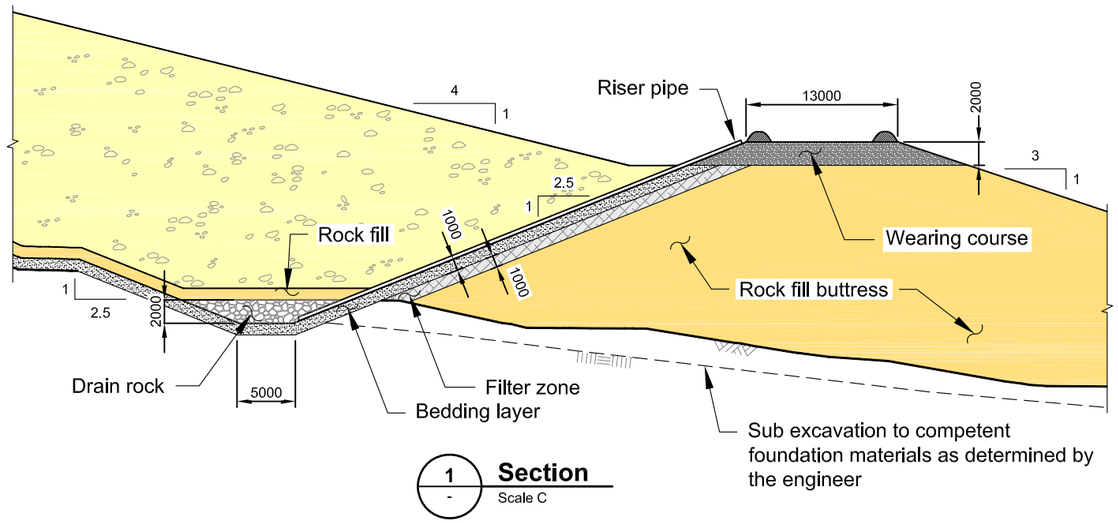
The Class A Storage Facility will be used to manage filtered tailings and Class A waste rock material. The waste rock will be co-disposed with the filtered tailings solids. The Class A Storage Facility is located north of the Process Plant on the western hillside of Geona Creek (Figure 4-2 and Figure 4-3). Runoff from the Class A Storage Facility will be collected in the Class A Storage Facility Collection Pond, which is described Section 4.10 (Water Management).

4.9.4.1 Design

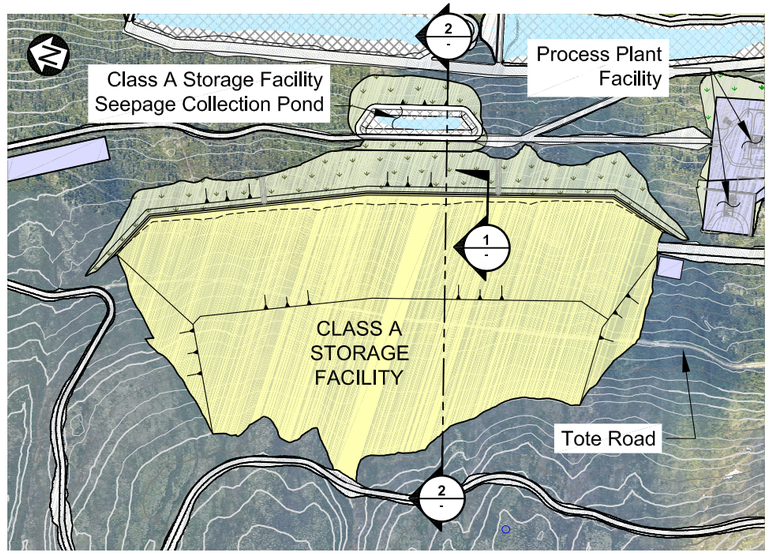
The design parameters used for the Class A Storage Facility are shown in Table 4-18 (KP, 2016a). Figure 4-15 shows a cross section of the Class A Storage Facility.

Table 4-18: Class A Facility Design Basis

Design		Value
Tailings	Tonnage	15.1 Mt
	Dry Bulk Density	2.1 t/m^3
	Calculated Volume	7 Mm^3
Class A Waste Rock	Tonnage	11.6 Mt
	Dry Bulk Density	2.0 t/m^3
	Volume	6 Mm^3
Facility Details	Maximum elevation	1,495 m
	Slope	4H:1V
	Design Storage Volume	15Mm^3
	Minimum Factor of Safety	1.5
	Low permeability till foundation	1 m



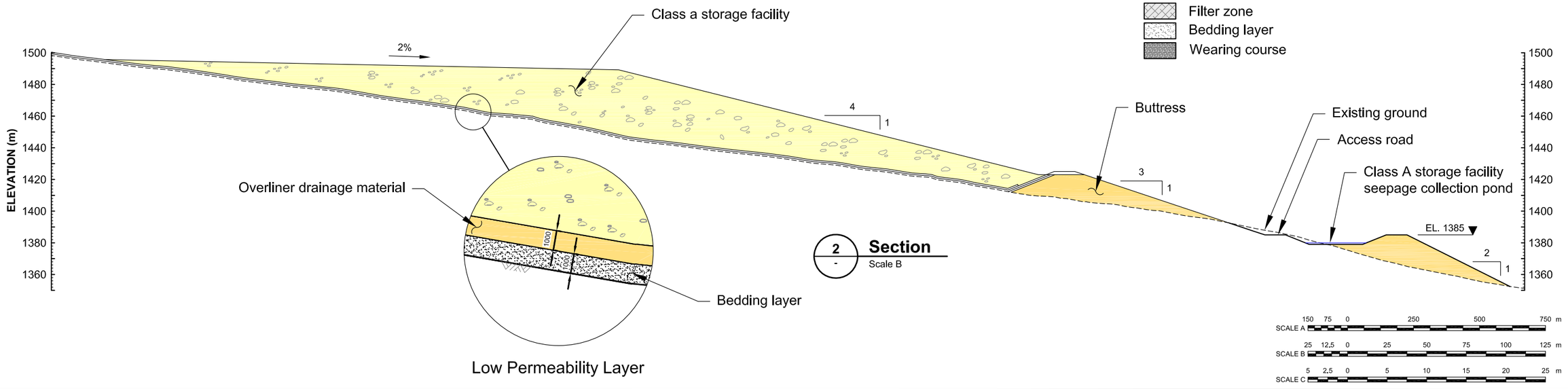
1 - **Section**
Scale C



Key Plan
SCALE A

LEGEND:

- Filtered tailings and rock fill material
- Rock fill material
- Drain rock
- Filter zone
- Bedding layer
- Wearing course



2 - **Section**
Scale B

SCALE A: 150 75 0 250 500 750 m
SCALE B: 25 12.5 0 25 50 75 100 125 m
SCALE C: 5 2.5 0 5 10 15 20 25 m

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2016-12-15	Draft for review	A	KJM	–

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES, UNLESS NOTED OTHERWISE.
2. CONCURRENT RECLAMATION OF CLASS A STORAGE FACILITY NOT SHOWN.

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BMC MINERALS

Kudz Ze Kayah
Conceptual Reclamation and Closure Plan
Drawing No: VA16-01970 B50

FIGURE 4-15
CROSS SECTION OF CLASS A STORAGE FACILITY

REVISION: A	2016-12-15	PROJECT No.: 101-640/2
DRAWN BY: KJM	DESIGNED BY: MAP	REVIEWED BY: LJG

4.9.4.2 Geotechnical Evaluation

The Class A Storage Facility and Collection Pond are located at the northern end of the western slope of the Project valley. Thirty-one test pits and seven drillholes have been completed in the vicinity of the proposed Class A Storage Facility and Collection Pond (Appendix C- 3 Kudz Ze Kayah Pre-Feasibility Study - Geotechnical Site Characterization Summary).

The overburden was generally found to consist of glacial till described as loose to compact silty sandy gravel with cobbles, with occasional localized pockets of fine-grained silts and clays. Overburden depths ranged from 0.2 to 10.4 mbgs with depths increasing towards the north end of the facility. Organic silt and moss were often noted at surface up to 0.5 m thick.

Test pits completed within the Class A Storage Facility footprint did not report permafrost. None of the thermistors installed in the Class A Storage Facility indicate freezing conditions in their data records, however, these thermistors were all installed lower in the Geona Creek valley.

Measured groundwater levels within the footprint of the facility range from 0.4 to 5.0 mbgs.

Bedrock was intercepted at 0.2 to 10.4 mbgs. Bedrock was described as weathered and fractured interbedded argillite mudstone, mafic tuff, and chlorite calcite schist.

4.9.4.3 Stability Analyses

Preliminary stability analyses utilizing limit equilibrium analysis for the Class A Storage Facility was completed for the Project (Appendix C- 4 Kudz Ze Kayah Pre-Feasibility Study - Class A Storage Facility Stability Assessment).

In accordance with the Canadian Dam Association guidelines (CDA, 2014) and standard industry practice the minimum acceptable Factor of Safety (FOS) for the facility under static conditions is 1.5 during construction and for long term (post-closure) of the Storage Facility. The model conservatively assumes instantaneous construction to the full height of the facility for this preliminary stability assessment. Class A material was conservatively modelled as tailings only (i.e., without Class A waste rock). The commingling of waste rock in the facility will increase the overall stability of the facility however this has not been included in the current assessment and will be evaluated at a later design stage.

The calculated static and seismic factors of safety were 1.55 and 1.01 respectively which exceed minimum factor of safety requirements.

4.9.4.4 Construction, Operation, and Closure

The footprint of the Class A Storage Facility will be cleared of trees and topsoil stripped, exposing the relatively thin layer of overburden and weathered bedrock. Overburden will be completely removed to bedrock under the Class C buttress and a 1 m layer of low permeability glacial till will be placed and compacted in thin lifts, to provide a low permeability seepage barrier beneath the facility.

Basin underdrains will be constructed from Class C material on top of the low permeability seepage barrier to provide a pathway for seepage beneath the low permeability tailings material. The facility will be graded to collect and convey flows to the Class A Storage Facility Collection Pond. The grading plan, seepage collection system and overliner are shown in Appendix C- 5 Site Management Drawings and Features.

A Class C material buttress will be constructed for confinement at the downstream slope of the Class A Storage Facility which improves the overall factor of safety of the facility. There is a surplus of Class C material on site and the embankment will be constructed with selectively sourced Class C material. The buttress will be constructed with a 2.5H:1V upstream slope and 3H:1V downstream slope.

Tailings material will be transported from the Process Plant by truck and placed in the Class A Storage Facility. Class A waste rock from the Open Pit and underground will be transported to the site and commingled with the tailings and compacted with the tailings in controlled lifts. The particular method of commingling will be determined during the final design phase and could potentially include one, or more, of the following options:

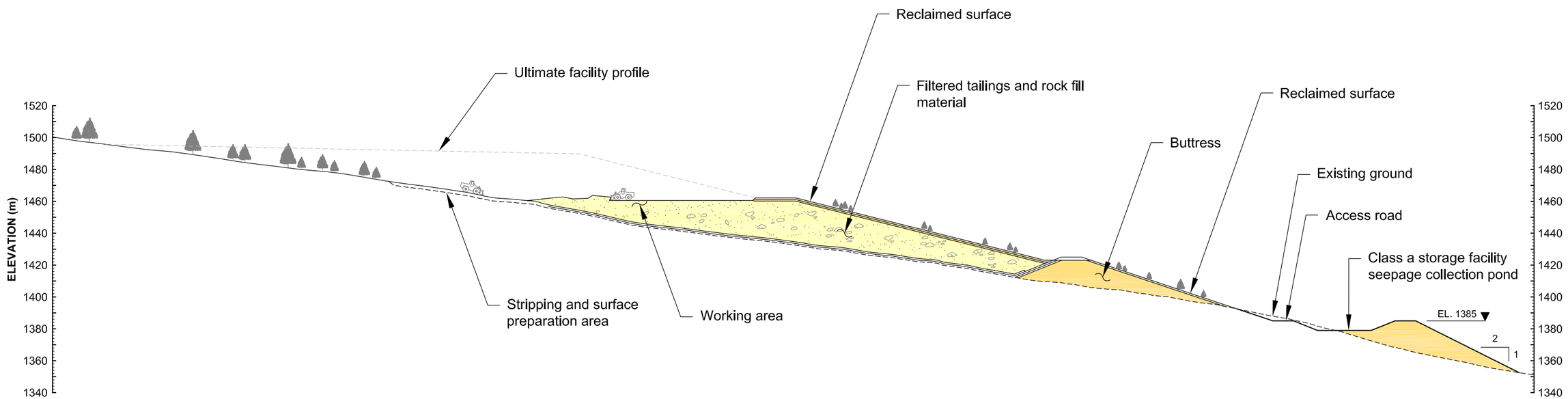
- Waste rock placed in lifts;
- Waste rock placed in cells and surrounded by tailings; and
- Waste rock mixed with tailings and placed in lifts.

The Class A Storage Facility will be constructed at an overall slope of 4H:1V, and will be progressively reclaimed with an engineered low permeability cover material, and approximately 3 to 5 m of Class C material for frost protection. Topsoil will be spread and the facility will be revegetated up to a pre-determined elevation to mimic the current site conditions (Figure 4-16).

There are multiple alternative methods that can be employed to produce this very low permeability, ranging from a complex cover with a geosynthetic (i.e., high density polyethylene), a geosynthetic clay liner (GCL), or a modified complex soil cover. Reclamation research will assist in determining the details of the approved cover method prior to implementation.

On-going monitoring of the Class A Storage Facility will be required for mine closure. The design of the post-closure monitoring program will be developed over the mine life as experience is gained during the construction and operation of the facilities. On-going monitoring will be defined in the closure design for the Class A Storage Facility. The preliminary closure requirements for the Class A Storage Facility are expected to include:

- On-going monitoring of surface and groundwater quality and flow rates;
- Regular periodic inspection of the waste piles;
- Deformation monitoring; and
- Revegetation monitoring.



2 4-20 FIG **Section**
Scale A

LEGEND:

- Filtered tailings and rock fill material
- Rock fill material
- Reclaimed and revegetated zone

SCALE A 25 12.5 0 25 50 75 100 125 m

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2016-12-15	Draft for review	A	KJM	–

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS IN METRES, UNLESS NOTED OTHERWISE.

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BMC MINERALS

Kudz Ze Kayah
Conceptual Reclamation and Closure Plan
Drawing No: VA16-01970 B51

FIGURE 4-16
CROSS SECTION OF CLASS A STORAGE FACILITY PROGRESSIVELY RECLAIMED

REVISION: A	2016-12-15	PROJECT No.: 101-640/02
DRAWN BY: KJM	DESIGNED BY:MAP	REVIEWED BY: LJG

4.9.5 Class B Storage Facility

The Class B Storage Facility will be used to manage Class B material. The Class B Storage Facility is located on the western hillside of Geona Creek adjacent to the Open Pit (Figure 4-2). The ROM Pad and Low Grade Ore (LGO) Stockpile are incorporated into the design of the Class B Storage Facility.

4.9.5.1 Design Criteria

The design criteria of the Class B Storage Facility is shown in Table 4-19 (KP, 2016a). Plan and sections of the Class B Facility are shown in Appendix C- 5 Site Management Drawings and Features.

Table 4-19: Class B Facility Design Basis

Design		Value
Class B Material	Tonnage	47.3 Mt
	Dry Bulk Density	2.0 t/m^3
	Calculated Volume	24 Mm^3
Facility Details	Crest elevation	1,570 m
	Slope	3H:1V
	Design Storage Volume	25 Mm^3
	Bench height	15 m
	Low permeability till foundation	1 m

4.9.5.2 Geotechnical Evaluation

The Class B Storage Facility is north of the Open Pit, along the west slope of the valley at the southern end. The Class B Storage Facility is located in the same location as proposed in the 1996 Cominco feasibility study, and it also includes the LGO and ROM pad, as well as the Collection Pond downstream of the facility. Twenty test pits and five drill holes were completed in the vicinity of the proposed Class B Storage Facility, LGO and ROM pad, and Collection Pond.

The overburden material consists of a thin (less than 0.5 m) organic layer overlying glaciofluvial, glaciolacustrine, and glacial till, typically compact to dense, varying from sand with some silt, to sandy gravel with some silt and trace cobbles. Overburden depths ranged from 0.1 to 7 mbgs, with the deepest deposits encountered in the valley bottom.

Frozen ground conditions were observed in test pits TP95G-10 and TP-96-G5, at 3.3 and 1.7 mbgs, respectively. Test pits TP-96-G2 and TP-96-G4 reported ice lenses (2 to 4 mm thick) between 0.4 and 0.8 mbgs. However, there was no permafrost identified in any of the test pits excavated.

Bedrock was intercepted from 0.1 to 10 m. Bedrock is described as weathered and fractured chlorite calcite schist with tuff fragments. Bedrock includes carbonaceous mudstone, mafic intrusive rocks and mafic volcaniclastic rocks.

Measured groundwater level ranged from artesian to 6.2 m below ground surface. The typical profile consists of an organic layer overlying sandy silt deposits with varying amounts of gravel and cobbles.

4.9.5.3 Stability Analyses

Preliminary stability analyses have been completed for the Class B Storage Facility, the Class C Storage Facility and the Overburden Stockpile (Appendix C- 6 Kudz Ze Kayah Pre-Feasibility Study - Design of Class B and Class C Storage Facilities and Overburden Stockpile).

Cross sections for the analyses were selected based on the height of each facility and grade of the original ground surface, such that the analyses would conservatively consider the tallest slopes and steepest foundations. Overburden thickness was assumed to be a consistent 10 m thick layer for both models, based on measured overburden depths from the 1996 and 2015 geotechnical drilling programs. Groundwater was modelled by defining the phreatic surface within the overburden layer to simulate saturated overburden and bedrock conditions.

Four scenarios were analyzed for each model:

- Static (non-seismic) conditions with unfrozen overburden;
- Static conditions with frozen overburden;
- Seismic conditions with unfrozen overburden; and
- Seismic conditions with frozen overburden.

The results of the stability analysis are summarized in Table 4-20. A Factor of Safety of 1.5 was targeted for static conditions, and above 1.1 for seismic conditions and were exceeded under all scenarios.

Table 4-20: Modelled Stability of Class B Storage Facility

Facility	Overburden Condition	Factor of Safety	
		Static Conditions	Seismic Conditions
Class B Storage Facility	Unfrozen	2.3	1.6
	Frozen	2.3	1.6

4.9.5.4 Construction, Operation and Closure

The Class B Storage Facility footprint will be cleared of trees and stripped, exposing the relatively thin layer of glacial till overburden and weathered bedrock. A 1 m layer of glacial till will be placed and compacted, to provide a seepage barrier beneath the facility. The foundation will be graded to collect and convey waste rock seepage to the Class B Storage Facility Collection Pond. The grading plan, seepage collection system and overliner are shown in Appendix C- 5 Site Management Drawings and Features.

The pre-production phase shall include the following tasks:

- Determine temporary run-off and erosion controls for construction. These controls are applied on an as needed basis. Controls may include run-off collection channels, settlement ponds, silt fences, etc. and can be decommissioned once operations begin;
- Construct the permanent diversion channels and run-off collections ponds; and
- The Storage Facility foundation areas should be cleared and grubbed and growth medium will be stockpiled in preparation for revegetation of the storage facilities as required for closure and reclamation.

General operations considerations are as follows:

- Rock will be transported from the pit using haul trucks. The material may be area dumped on the floor of the facility or short dumped and pushed by dozer over a live rock face advancing across the floor of the facility; and
- Trial sections may be constructed in the field during the initial stages of development to monitor rock pile stability and foundation performance. The various rock materials may be sampled for characterization and for durability test work to confirm the design parameters.

Detailed construction and operation guidelines will be developed during future design phases

The Class B Storage Facility will be constructed at an overall slope of 3H:1V for long-term physical stability and to allow for recontouring for closure and reclamation.

As much as practical reclamation will be carried out concurrent with mine operations. It is anticipated reclamation of the Class B Storage Facility will begin as sectors become inactive. Reclamation will be conducted in conjunction with on-going environmental monitoring to ensure that sediment control and water quality objectives are met. The closure of the facility will include the resloping of the facility faces to facilitate the placement of soil and revegetation and to allow for water breaks.

The final facility bench crests will be rounded and the faces sloped to improve the long-term erosion stability of the waste facility. The Class B Storage Facility will have a low permeability capping layer placed over the surface to prevent the ingress of water and subsequent acid generation and leaching. A 3 m layer of Class C material will be placed above this layer for frost protection and this will be covered by a layer of growth medium and revegetated up to a pre-determined elevation.

On-going monitoring of the Class B Storage Facility will be required for mine closure. The design of the post-closure monitoring program will be developed over the mine life as experience is gained during the construction and operation of the two facilities.

On-going monitoring will be defined in the closure design for the Class B Storage Facility. The preliminary closure requirements for the Class B Storage Facility are expected to include:

- On-going monitoring of surface and groundwater quality and flow rates;

- Regular periodic inspection of the waste piles;
- Deformation monitoring; and
- Revegetation monitoring.

4.9.6 Class C Storage Facility

The Class C Storage Facility will be used to manage Class C material. The Class C Storage Facility is located in a small valley along the eastern slopes of Geona Creek valley (Figure 4-2). Runoff from the Class C Storage Facility is collected in the Class C Storage Facility Collection Pond, which is described in Section 4.10 (Water Management).

4.9.6.1 Design Criteria

The Class C Storage Facility is designed to hold a total stored volume of 34 Mm^3. This volume accounts for the overall quantity of Class C material produced and does not account for material used in construction and for reclamation. The facility will be constructed at an overall slope of 3H:1V for long-term physical stability and to allow for recontouring for closure and reclamation. The design of the Class C Storage Facility is shown in Table 4-21 (KP, 2016a). Plan and sections of the Class C Storage Facility are shown in Appendix C- 5 Site Management Drawings and Features.

Table 4-21: Class C Facility Design Basis

Design		Value
Class C Material	Tonnage	64.1 Mt
	Dry Bulk Density	2.0 t/m^3
	Calculated Volume	32 Mm^3
Facility Details	Crest elevation	1,530 m
	Slope	3H:1V
	Design Storage Volume	34 Mm^3
	Bench height	15 m

4.9.6.2 Geotechnical Evaluation

Two test pits and six drillholes have been completed in the vicinity of the proposed Class C Storage Facility.

Overburden depths ranged from 6 to 20 mbgs. The typical profile consists of an organic layer overlying glaciofluvial and weathered colluvium deposits, typically compact to dense gravelly, silty, sands with trace clay. Varved clay and silt deposits were also encountered between more sandy layers (Appendix C- 3 Kudz Ze Kayah Pre-Feasibility Study - Geotechnical Site Characterization Summary).

One drillhole in the Class C Facility encountered frozen soil and ice in the SPT samples at approximately 1.5 and 5 mbgs. Permafrost has been encountered in the northern portion of the facility, in excess of 3 m deep, however none has been observed in the southern portion of the facility.

Bedrock was intercepted at 4.7 mbgs to 19.2 mbgs. Bedrock was described as weathered and fractured interbedded argillite mudstone, mafic tuff, and chlorite calcite schist.

Groundwater levels ranged from 2.4 to 13.3 mbgs (Appendix C- 3 Kudz Ze Kayah Pre-Feasibility Study - Geotechnical Site Characterization Summary).

4.9.6.3 Stability Analyses

Preliminary stability analyses have been completed for the Class B Storage Facility, the Class C Storage Facility and the Overburden Stockpile (Appendix C- 6 Kudz Ze Kayah Pre-Feasibility Study - Design of Class B and Class C Storage Facilities and Overburden Stockpile).

Cross sections for the analyses were selected based on the height of each facility and grade of the original ground surface, such that the analyses would conservatively consider the tallest slopes and steepest foundations. Overburden thickness was assumed to be a consistent 10 m thick layer for both models, based on measured overburden depths from the 1996 and 2015 geotechnical drilling programs. Groundwater was modelled by defining the phreatic surface within the overburden layer to simulate saturated overburden and bedrock conditions.

Four scenarios were analysed for each model:

- Static (non-seismic) conditions with unfrozen overburden;
- Static conditions with frozen overburden;
- Seismic conditions with unfrozen overburden; and
- Seismic conditions with frozen overburden.

The results of the stability analysis are summarized in Table 4-22. A Factor of Safety of 1.5 was targeted for static conditions, and above 1.1 for seismic conditions and were exceeded under all scenarios.

Table 4-22: Modelled Stability of Class C Storage Facility

Facility	Overburden Condition	Factor of Safety	
		Static Conditions	Seismic Conditions
Class C Storage Facility	Unfrozen	2.3	1.6
	Frozen	2.4	1.7

4.9.6.4 Construction, Operation and Closure

The footprint of the facility will be cleared and growth medium stripped for later use in reclamation. The facility will be constructed at an overall slope of 3H:1V for long-term physical stability and to allow for recontouring for progressive reclamation and closure. The facility will be progressively reclaimed with overburden material and growth medium to promote revegetation of the slopes.

The pre-production phase shall include the following tasks;

- Determine temporary run-off and erosion controls for construction. These controls are applied on an as needed basis. Controls may include run-off collection channels, settlement ponds, silt fences etc. and can be decommissioned once operations begin;
- Construct the permanent diversion channels and run-off collections ponds; and
- The Storage Facility foundation areas should be cleared and grubbed and growth medium will be stockpiled in preparation for revegetation of the storage facilities as required for closure and reclamation.

General operations considerations are as follows:

- Rock will be transported from the pit using haul trucks. The material may be end dumped over the face or spread by bulldozers over the crest of the storage facilities;
- Trial sections may be constructed in the field during the initial stages of development to monitor rock pile stability and foundation performance. The various rock materials may be sampled for characterization and for durability test work to confirm the design parameters; and
- Rock material may be end dumped over the crest to allow for maximum segregation of the coarser material at the base of each bench.

Detailed construction and operation guidelines will be developed during future design phases.

As much as practical, reclamation will be carried out concurrent with mine operations. It is anticipated reclamation of the Class C Storage Facility will begin as sectors become inactive. Reclamation will be conducted in conjunction with on-going environmental monitoring to ensure that sediment control and water quality objectives are met. The closure of the facility will include the resloping of the facility faces to facilitate the placement of growth medium and revegetation and to allow for water breaks.

The final facility bench crests will be rounded and the faces sloped to improve the long-term erosion stability of the waste facility. A cap of growth medium will be placed on the facility and revegetation will take place up to a pre-determined elevation. During the Closure phase, all overburden not used in other reclamation activities will be transported to the Class C Storage Facility, placed in a layer, covered by a layer of growth medium, and revegetated.

On-going monitoring of the Class C Storage Facility will be required for mine closure. The design of the post-closure monitoring program will be developed over the mine life as experience is gained during the construction and operation of the two facilities.

On-going monitoring will be defined in the closure design for the Class C Storage Facility. The preliminary closure requirements for the Class C Storage Facility are expected to include:

- On-going monitoring of surface and groundwater quality and flow rates;
- Regular periodic inspection of the waste piles; Deformation monitoring; and
- Revegetation monitoring.

4.9.7 Overburden Stockpile

Overburden stripped from the ABM open pit excavation, including various surface infrastructure areas, is required for initial construction and for closure activities. Overburden material not required for initial construction will be placed in a temporary stockpile along the valleys eastern slope, north of the Class C Storage Facility (Figure 4-2). Runoff is collected in the Overburden Collection Pond for sediment control prior to discharge to Geona Creek. This pond is described in Section 4.10.

4.9.7.1 Design Criteria

The Overburden Stockpile has been sized at approximately 9.0 Mm^3. This volume accounts for the overall quantity of Overburden material produced and does not account for material used in construction and for reclamation. The stockpile is a temporary structure and will be constructed at a slope of 2.2H:1V. The design of the Overburden Stockpile is shown in Table 4-23 (KP, 2016a). Plan and sections of the Class C Storage Facility are shown in Appendix C- 5 Site Management Drawings and Features.

Table 4-23: Temporary Overburden Stockpile Design Basis

Design Parameters		Value
Overburden Material	Tonnage	16 Mt
	Dry Bulk Density	1.8 t/m^3
	Calculated Volume	9.0 Mm^3
Facility Details	Crest elevation	1,500 m
	Slope	2.2H:1V
	Design Storage Volume	9 Mm^3

4.9.7.2 Geotechnical Evaluation

Five test pits and two monitoring wells have been completed in the vicinity of the proposed Overburden Stockpile footprint. Details are in Appendix C- 3 Kudz Ze Kayah Pre-Feasibility Study - Geotechnical Site Characterization Summary.

Test pits and monitoring well installations found the overburden was glacial till and glaciolacustrine sediments, comprised of compact to very dense sandy silt to silty sand and gravel with occasional cobbles and boulders.

Permafrost was reported in three of the test pits between 0.6 and 1.8 mbgs.

Bedrock was intercepted between 2.4 and 8.4 mbgs. Bedrock was described as weathered and fractured interbedded argillite mudstone, mafic tuff, and chlorite calcite schist.

Measured groundwater levels ranged from 0.6 to 8.1 mbgs.

4.9.7.3 Stability Analyses

Preliminary stability analyses have been completed for the Class B Storage Facility, the Class C Storage Facility and the Overburden Stockpile (Appendix C- 6 Kudz Ze Kayah Pre-Feasibility Study - Design of Class B and Class C Storage Facilities and Overburden Stockpile).

Cross sections for the analyses were selected based on the height of each facility and grade of the original ground surface, such that the analyses would conservatively consider the tallest slopes and steepest foundations. Overburden thickness was assumed to be a consistent 10 m thick layer for both models, based on measured overburden depths from the 1996 and 2015 geotechnical drilling programs. Groundwater was modelled by defining the phreatic surface within the overburden layer to simulate saturated overburden and bedrock conditions.

Four scenarios were analysed for each model:

- Static (non-seismic) conditions with unfrozen overburden;
- Static conditions with frozen overburden;
- Seismic conditions with unfrozen overburden; and
- Seismic conditions with frozen overburden.

The results of the stability analysis are summarized in Table 4-24. A Factor of Safety of 1.5 was targeted for static conditions, and above 1.1 for seismic conditions and were exceeded under all scenarios.

Table 4-24: Modelled Stability of Temporary Overburden Stockpile

Facility	Overburden Condition	Factor of Safety	
		Static Conditions	Seismic Conditions
Temporary Overburden Stockpile	Unfrozen	1.5	1.1
	Frozen	1.6	1.2

4.9.7.4 Construction, Operation, and Closure

Overburden from the ABM open pit excavation, including various infrastructure areas, will be excavated and stockpiled. Glacial till material will be selectively sourced from the stockpile or directly from the ABM open pit area, including various infrastructure areas, and used as the low permeability foundation and closure cover layers for the Class A and Class B Storage Facilities, and for construction of the Water Management and Collection Ponds. Material in the Overburden Stockpile will be utilized during the mine life as reclamation material and at closure any remaining material in the Overburden Stockpile will be transported to the Class C Storage Facility and used for reclamation purposes.

General operations considerations are as follows:

- Overburden materials will be transported from the pit using haul trucks. For overburden materials, end dumping short of the crest of the dump and dozing over may be required.
- Trial sections may be constructed in the field during the initial stages of development to monitor overburden pile stability and foundation performance. The various overburden materials may be sampled for characterization and for durability test work to confirm the design parameters; and
- Detailed construction and operation guidelines will be developed during future design phases.

4.10 WATER MANAGEMENT

The Project is situated within the Geona Creek catchment which is part of the Finlayson Creek watershed. The Geona Creek catchment has been subdivided into eleven sub-catchments, as shown on Figure 4-17. These Geona Creek sub-catchments include the ABM open pit, Class A Storage Facility, Class B Storage Facility, Class C Storage Facility, Overburden Stockpile, Process Plant, south diversion, northwest diversion, northeast diversion, Upper Water Management Pond, and Lower Water Management Pond.

4.10.1 Construction

The construction phase will include the following activities:

- Construction of water diversions and ditches;
- Dewatering;
- Construction of the Water Management Ponds, including: Upper and Lower Water Management Ponds; Class A, B, and C Storage Facility Ponds; Overburden Stockpile Pond and Pit Rim Pond;
- Construction of the water treatment plant (WTP); and
- Establishment of freshwater supply (installation of a groundwater well at the camp and installation of a groundwater well at the Process Plant).

Each of these activities is described in the following sections.

4.10.1.1 Water Diversions and Ditches

Diverting clean water around the Project is one of the main objectives of the Project's water management plan. Reducing the volume of contact water requiring management and treatment is critical to the success of the water management strategy for the Project. The Project includes three major diversions (Appendix C- 5 Site Management Drawings and Features).

The Fault Creek and associated Southern Diversions will re-route water that would otherwise flow into the ABM open pit and will divert it to South Creek. The design incorporates a lined diversion ditch constructed alongside the Access Road; however, future site investigation of the area may demonstrate that alternative and/or additional measures are required to successfully divert the water in Fault Creek. Plan and section of the Fault Creek diversion are shown in Appendix C- 5 Site Management Drawings and Features.

The Northwestern Diversion will route water above the Class A Storage Facility and the Class B Storage Facility past the water management ponds into Geona Creek.

The Northeastern Diversion will redirect water above the Class C Storage Facility and Overburden Stockpile. The runoff from the Class C Storage Facility and Overburden Stockpile will also enter the Northeastern Diversion, which will be directed into Geona Creek below the Lower Water Management Pond.

The water balance has assumed the diversions have a nominal 50% efficiency rating other than the Fault Creek diversion which has assumed a nominal 100% efficiency rating. All diversion ditches will be designed to manage a 1 in 200-year flood event.

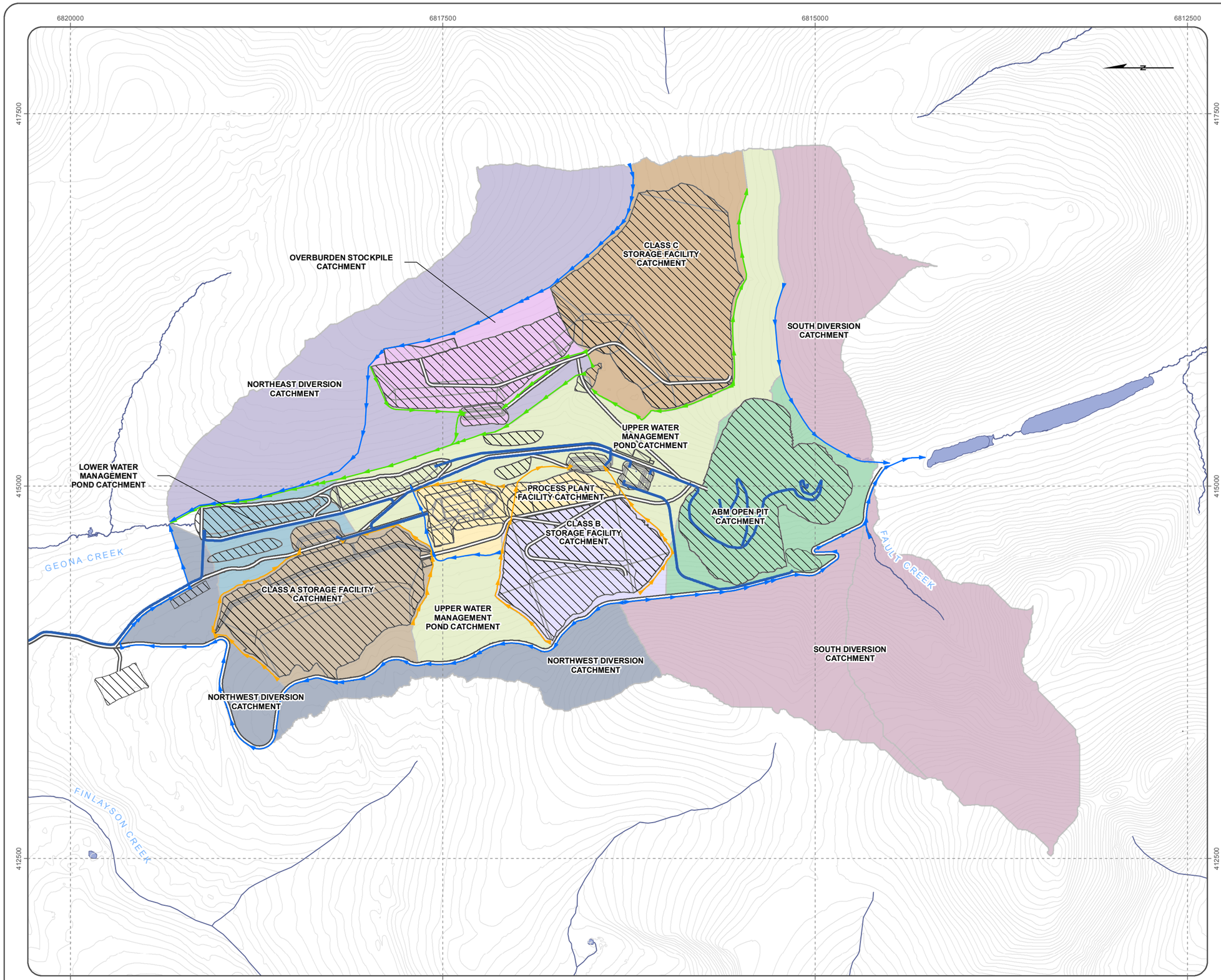

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FIGURE 4-17

GEONA CREEK SUBCATCHMENTS

JANUARY 2017

Water Conveyance

- Pipeline
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion

Water Management Catchments

- Class A Storage Facility
- Class B Storage Facility
- Class C Storage Facility
- ABM Open Pit
- Process Plant Facility
- Lower Water Management Pond
- Upper Water Management Pond
- South Diversion
- Overburden Stockpile
- Northwest Diversion
- Northeast Diversion

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Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Projection UTM Zone 9N

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4.10.1.2 Dewatering

The dewatering strategy is presented in the Kudz Ze Kayah Hydrogeological Model Report (Appendix D-4). Initial dewatering of the overburden and the Open Pit will take place over an estimated period of 18 months during the construction phase. Water will be pumped to the Pit Rim Pond, allowed to settle, and from there piped to a discharge point below the Lower Water Management Pond (LWMP) site once the water quality is suitable for discharge.

Overburden Dewatering

Prior to the initial mine development, overburden drainage will be conducted by excavating a trench to the top of the fractured/weathered bedrock approximately along the alignment of the former Geona Creek watercourse. Based on borings, the trench is expected to be approximately 15 to 20 m deep. Simulations have demonstrated that a trench excavated to the top of the weathered bedrock will permit efficient drainage of the overburden in the area of the proposed Open Pit. Excavation of the trench will begin near the northern-most extent of the ABM Zone in the form of a sump extending to bedrock and used to dewater the overburden. As water levels are reduced in the overburden by pumping from the sump, the trench will be further extended to the south along the channel of Geona Creek until it reaches the southern extent of the proposed Krakatoa Zone.

To more efficiently dewater the overburden two trenches, approximately 300 m long, will be excavated west of the central drainage trench. The establishment of the trench, which will extend the entire length of the eventual pit, will minimize the likelihood of the overburden re-saturating as drainage paths will be kept as short as practicable. Permanent sumps will be established at the north and south ends of the trench to remove water on a continual basis.

A sump may also be excavated in the Krakatoa Zone area to enhance drainage of the overburden material in advance of the extension of the trench, as indicated in Figure 4-2.

Pit Bedrock Dewatering

Dewatering of the underlying weathered/fractured bedrock will be a longer-term sustained process (starting during the construction period and extending through to year 10), but one which will not benefit from systematic active dewatering of the general bedrock area. Initial simulations of weathered-bedrock dewatering using various configurations of dewatering wells showed that the permeability of the weathered bedrock is low enough that dewatering wells would have a very limited radius of dewatering influence in which the tight cone-of-depression would result in drawdown of about 5 m extending only 25 to 50 m from the pump location. This means that for dewatering of the weathered/fractured rock to be efficacious, a large number of wells would potentially need to be bored which is unlikely to be cost effective.

Instead, the modified conceptual dewatering strategy for bedrock consists of a combination of fault-zone dewatering wells and a system of horizontal drains within the pit for dewatering and pit-wall depressurization. Dewatering wells are planned to intersect each of the three major fracture zones associated with the East Fault, the Northwest Fault, and Fault Creek Lineation. Each of these wells

will be drilled to a depth of 150 to 200 m. The current configuration of the groundwater model predicts that these wells should each be pumped at a rate of 1.3 to 2.5 l/s (20 to 40 US gpm) for the six months of initial dewatering. As each of these faults is anticipated to represent a significant contribution of water flow to the pit, an early strategy of dewatering from the lineations will likely result in less flow to the pit during later years. After the initial dewatering period, the rate at which each of these wells can be pumped will decrease as the saturated thickness declines. Higher permeability and more extensive fracture zones will likely produce at the higher end of this range.

The in-pit dewatering strategy is essentially unchanged from that originally proposed by Golder (1996a). Competent bedrock will drain naturally through the high wall and end wall of the ABM open pit. Horizontal drain holes will be installed in areas of high pore pressure or structural instability. Competent, unfractured bedrock is not anticipated to generate significant rates of seepage due to its low permeability; however, it is anticipated that zones of fracturing are likely to be present and represent sources of higher rates of flow. Installation of horizontal drains in these zones will be used to dissipate the hydraulic head as necessary. Drainage from the walls and horizontal drains will be conveyed to sumps located on each of the bench levels and at the pit floor. Collected water will be pumped from the sumps to the surface where it will be directed to the Pit Rim Pond.

4.10.1.3 Water Management Ponds

The pond design specifications are provided in Table 4-25.

Table 4-25: Pond Design Specifications

Parameter	Class A Storage Facility Pond	Class B Storage Facility Pond	Class C Storage Facility Pond	Overburden Stockpile Pond	Lower Water Management Pond	Upper Water Management Pond	Pit Rim Pond
Nominal Capacity	60,000 m^3	40,000 m^3	50,000 m^3	20,000 m^3	500,000 m^3	250,000 m^3	60,000 m^3
Design	1:200 year 24 hour storm event and freshet inflow	1:200 year 24 hour storm event and freshet inflow	1:10 year 24 hour storm event, freshet inflow and 30 days of storage	1:10 year 24 hour storm event, freshet inflow and 30 days of storage	1:200 year 24 hour storm event	1:200 year 24 hour storm event	1:100 year 24 hour storm event
Freeboard	1 m	1 m	1 m	1 m	1 m	1 m	1 m

Class A and Class B Storage Facility Collection Ponds

The Class A and Class B Storage Facilities have each been designed with collection ponds to both store storm event water and provide settling of solids prior to water conveyance to other facilities or prior to discharge. The Class A and Class B Storage Facility Collection Ponds will be constructed with embankments consisting of a C Class material core, a bedding layer of compacted glacial till, and with 80 mm HDPE liners. The slopes of the dams will be 2H: 1V and a berm will be provided on both sides of the crest where vehicle traffic is anticipated. The ponds have been sized to manage a 1 in 200-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. Wildlife

barriers such as a fences will surround all ponds with geosynthetic liners. Egresses will also be constructed in each of the ponds in the unlikely event that wildlife are able to pass the wildlife barrier.

Water collected from the Class A and B Storage Facility Collection Ponds will be directed to the Water Treatment Plant which will be located at the Process Plant Facility. After treatment water will either be directed to the Lower Water Management Pond or to the Process Plant for reuse. A plan and section of the Class A and B Facility Collection Ponds are shown in Appendix C- 5 Site Management Drawings and Features.

Overburden Stockpile and Class C Storage Facility Collection Ponds

The Overburden Stockpile and Class C Storage Facility Collection Ponds will be constructed with a compacted glacial till (low permeability) liner and an embankment consisting of Class C material. The slopes of the dam will be 2H: 1V and a berm will be provided on both sides of the crest when vehicle traffic is anticipated. The ponds have been designed to provide 30 days' storage from seepage, surface runoff for a 1 in 10-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. Flow from the ponds will be conveyed downstream of the Lower Water Management Pond and discharged into Geona, as it is predicted to meet the water quality objectives for Geona Creek (Appendix D-7 – Surface Water Quality Report).

A plan and section of the Overburden Stockpile and Class C Storage Facility Collection Ponds are shown in Appendix C- 5 Site Management Drawings and Features.

Lower and Upper Water Management Pond

An Upper and Lower WMP (UWMP and LWMP) with nominal capacities of 250,000 and 500,000 m^3 respectively will be constructed to store and manage discharge of site water from the following sources:

- Runoff from Class A Storage Facility (via the WTP);
- Runoff from Class B Storage Facility (via the WTP);
- ABM open pit dewatering (via Pit Rim Pond);
- Site surface runoff including losses from ditches and diversions; and
- Spillage or runoff from the Process Plant Facility.

The UWMP and LWMP will be connected with water conveyed from the UWMP to the LWMP. Discharge of water to the receiving environment will be controlled at the LWMP.

The core of the embankments will be constructed of Class C waste with downstream and upstream slopes of 2.5H: 1V. The upstream slope will have a 1 m layer of compacted filter sand and a 1 m layer of compacted glacial till with a HDPE liner lining the upstream face and the water storage area. A fence will surround the water management ponds to limit wildlife access and egresses will be constructed in the unlikely event of wildlife access. The design and sections of the two Water Management Ponds are shown in Appendix C- 5 Site Management Drawings and Features.

Pit Rim Pond

The Pit Rim Pond will temporarily store water that is pumped from construction and Open Pit Dewatering activities. Water from the Pit Rim Pond will be used in the Paste Fill Plant, pumped to the Water Treatment Plant, or routed to the Upper Water Management Pond, as required.

The Pit Rim Pond will consist of a minimum of three separate cells with embankments consisting of compacted Class C material. All the cells, and the embankments, will be lined with a compacted layer of glacial till and an HDPE liner. The cells will be connected with spillways and or other flow mechanisms to enable progressive settling and decanting of the inflows prior to usage, or discharge. A fence will surround the Pit Rim Pond to limit wildlife access and egresses will be constructed in the unlikely event of wildlife access. The Plan and section of the Pit Rim Pond are shown in Appendix C-5 Site Management Drawings and Features.

ROM Pad and LGO Stockpile

The ROM and LGO stockpiles will be integrated into the buttress of the Class B Storage Facility. The buttress will be constructed of Class C and Class B Waste material and a low permeability layer will be constructed on the crest of the buttress to limit water infiltration and provide a stable platform for truck traffic. The area will be graded to direct ROM and LGO contact water to a sump where water will be collected and transferred to the Water Treatment plant through pumping or by gravity.

4.10.1.4 Water Treatment Plant

The water treatment plant (WTP) will be constructed at the Process Plant Facility and designed to treat:

- Class A contact water from the Class A Storage Facility Collection Pond;
- Class B contact water from the Class B Storage Facility Collection Pond; and
- Runoff from the Process Plant Facility site collected in the perimeter sumps, including LGO and ROM contact water.

The WTP will have additional capacity to treat ABM open pit dewatering, as required. The treatment will consist of pH adjustment, clarification, and any other processes that may be required to bring the water to a suitable standard for discharge to the environment. The treated effluent will be discharged to the LWMP for final polishing before discharge to the receiving environment or may be used in the processing circuit.

4.10.1.5 Freshwater Supply

The Project includes a 350-person camp for construction. The camp will be supplied with potable water from a groundwater well at a nominal rate of up to 3.7 m^3/hour (up to 350 people at a nominal daily demand of 250 l/day). The water will be pumped into a storage tank in camp and treated as

required. The camp will be constructed with a sewage treatment plant that will include a septic field that will eventually discharge treated water into Geona Creek.

4.10.1.6 Mitigation Measures

The conceptual management plans that are most applicable during the construction of the water management structures and facilities are: Section 18.3 – Surface Water Management; Section 18.5 Spill Contingency Plan; Section 18.6 Sediment and Erosion Control Plan; Section 18.9 Fish and Aquatic Habitat Management Plan; Section 18.13 - Heritage Resources Management Plan; and Section 18.15 - Health Safety and Emergency Response Plan.

4.10.2 Operations

4.10.2.1 Operational Water Management

The aim of the water management plan is to utilize water within the Project area to the maximum practicable extent. The water management plan involves collecting and managing site runoff from disturbed areas and maximizing the recycle of process water. Surplus water will be stored on site within the Upper and Lower Water Management Ponds and used in the Process Plant, with the excess water being released to Geona Creek and to Finlayson Creek.

The water supply sources for the Project are as follows:

- Precipitation runoff from the mine site facilities;
- Freshwater from groundwater for camp and Process Plant;
- Groundwater from Open Pit and underground dewatering; and
- Treated septic and grey water, in small quantities, from the camp and processing / administration facility.

All water in contact with the mine facilities, including the Class A, Class B Storage Facilities, the Open Pit, and the Process Plant and other infrastructure will be collected and conveyed to the Upper and Lower Water Management Ponds as appropriate and ultimately released to Finlayson Creek and Geona Creek (Figure 4-18). In contrast, water from Class C Storage Facility and Overburden Stockpile will be routed below LWMP and released directly to Geona Creek once solids have been settled out and it is confirmed that it meets water discharge specifications. The specific water management plan for the main site facilities during operations is outlined in the following sections.

Class A Storage Facility

All surface runoff will be routed to the Class A Storage Facility Collection Pond via appropriate grading of the Class A Storage Facility and collection ditches.

Seepage from the facility will be collected in the French drain system and sent to the Class A Storage Facility Collection Pond.

All collected runoff and seepage will be stored in the Class A Storage Facility Collection Pond prior to being pumped to the Water Treatment Plant or used in the Process Plant as make-up water.

Class B Storage Facility

All surface runoff will be routed to the Class B Storage Facility Collection Pond via appropriate grading of the Class B Storage Facility and collection ditches.

Seepage from the facility will be collected in the French drain system and sent to the Class B Storage Facility Collection Pond.

All collected runoff and seepage will be stored in the Class B Storage Facility Collection Pond prior to being routed to the Water Treatment Plant or used in the Process Plant as RAW water or Process make-up water.

Class C Storage Facility

All surface runoff from the facility will be routed to the Class C Storage Facility Collection Pond via appropriate grading of the Class C Storage Facility and collection ditches.

The Class C Storage Facility and Overburden Stockpile runoff water will be conveyed from their settling ponds directly to Geona Creek downstream of the Lower Water Management Pond.

Retention time in the pond will allow sediment to settle to an appropriate level before routing the water to Geona Creek.

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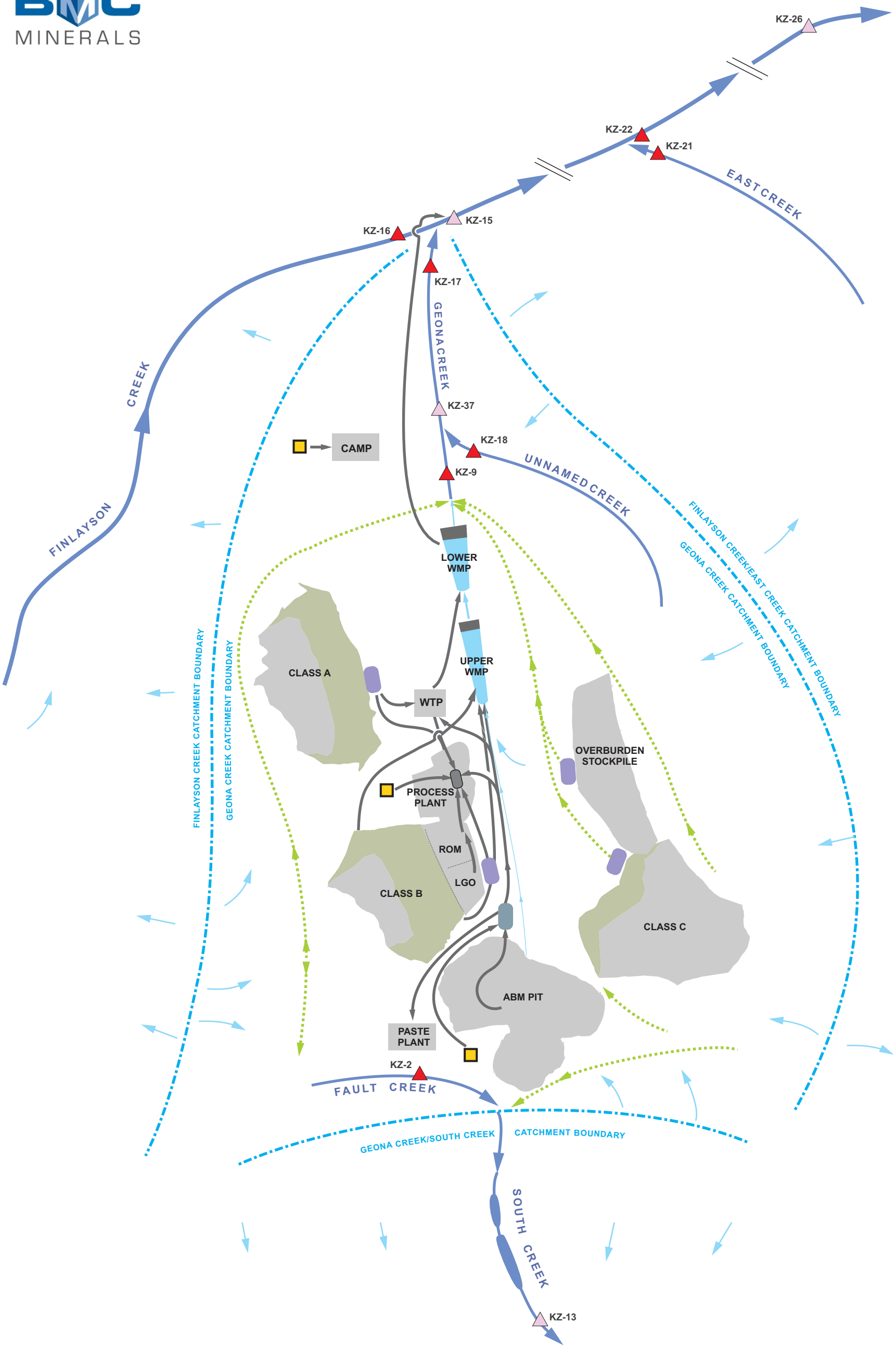

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- Progressive Reclamation Footprint
- Mine Feature Footprint
- Process Plant Pond
- Storage Facility Collection Pond
- Pit Rim Pond
- Surface Water Monitoring Station
- Modelled Location
- Groundwater Well
- Water Management Pond
- Pipeline
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant
ROM - Run of Mine
LGO - Low Grade Ore

KUDZ ZE KAYAH PROJECT

FIGURE 4-18
OPERATIONAL WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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Overburden Stockpile

All surface runoff from the facility will be routed to the Overburden Collection Pond via appropriate grading of the Overburden Stockpile and collection ditches.

Retention time in the pond will allow sediment to settle to an appropriate level before routing the water to Geona Creek.

ABM Open Pit

ABM open pit dewatering will continue throughout the mine life with dewatering flows being directed to the Pit Rim Pond and then to the Process Plant and underground (if required) for use, Upper Water Management Pond for settling and eventual discharge or the Paste Fill Plant.

Underground

As in the strategy for in-pit dewatering, the dewatering strategy for the underground workings will involve the collection of seepage water augmented by horizontal drains, as needed, to reduce bedrock saturation near the tunnel face in the event of elevated flow rates or structural instability. Drainage from the walls and horizontal drains will be conducted to a series of sumps to be located at the deepest level of the workings. Collected water will be pumped in stages from the sump to the surface Pit Rim Pond and then to the Process Plant for use and/or it will be directed to the Upper Water Management Pond. Details of the underground dewatering design are provided in Appendix C- 7 Water Balance Model Report.

Process Plant

The ROM pad and LGO stockpile are located at the base of the Class B Storage Facility, adjacent to the Process Plant. Runoff from the Process Plant Site area will be collected at the Process Plant Site and treated before discharge. All surface runoff from the ROM Pad and LGO Stockpile will be routed to the Process Plant Site via appropriate grading and collection sumps.

4.10.3 Water Use

4.10.3.1 Process Plant Water

The five primary sources of water usage for Process water are:

- Class A Storage Facilicity Collection Pond water;
- Class B Storage Facilicity Collection Pond water;
- Open pit water from the Pit Rim Pond;
- Process Plant site runoff; and
- A groundwater well(s) at the Process Plant.

The site water balance model was run using average case precipitation conditions and an annual process water requirement for the Process Plant of 276,000 m^3 (240,000 m^3 from contact water and 36,000 m^3 from a groundater well(s)) (Appendix C- 7 Water Balance Model Report). Water management assumptions, such as diversion ditch efficiencies, were applied as placeholders and are intended to be refined as the design process advances. The preliminary results are summarized below and are intended to be used to guide discussions on water management planning. These results should not be used for detailed design purposes.

- Non-contact and sediment laden contact water diverted around site: 1.6 Mm^3/year;
- Contact water discharged to environment: 4.6 Mm^3/year, which includes;
- Treated water surplus of 1.4 Mm^3/year; and
- Untreated water surplus of 3.2 Mm^3/year.

Alternative water sources include water from the Class B Collection Pond and the Upper and Lower Water Management Ponds. A Process Plant pond will be constructed, within the Process Plant site, to allow for surface runoff from the Process Plant footprint (including the Run of Mine and low grade ore stockpiles) to be collected and will be used as a reclaim pond to recycle water for processing. Surface water collected in the Process Plant pond generally only occur in April to October when runoff is occurring.

Process water requirements will initially be met from groundwater well(s). The water will be recycled within the processing circuit, with minimal additional raw water requirements during normal operation. The majority of any additional water required during operations will be sourced from contact water sources noted above, however certain processes (for example the potable water plant) will continue to draw groundwater from the well(s). Process water will be stored in a lined earth pond. Due to the positive water balance, any non-contact water reclaimed from site precipitation run-off will disposed directly to the environment.

4.10.3.2 Miscellaneous

Water will be required for other components of the mine operations including dust suppression, wash bays, and paste-fill production. Dust suppression will utilize water from Lower Operations Water Management Pond, and the water quality will be monitored regularly to ensure that it is of suitable quality for use. Dust suppression will only be required during the snow free months and will occur as required to maintain air quality for the Project.

4.10.3.3 Paste Fill Plant Water

A Paste Fill Plant will be constructed near the ABM open pit to provide paste backfill using cement and tailings in the underground mine. The source water for the Paste Fill Plant will be from the Pit Rim Pond or the dewatering wells upgradient of the ABM open pit.

4.10.3.4 Potable Water

The Project includes a 350-person camp for construction. The camp will be supplied with potable water from a groundwater well at a nominal rate of up to 3.7 m^3/hour (up to 350 people at a daily demand of 250 l/day). The water will be pumped into a storage tank in camp and treated as required.

Groundwater will be required for reagent mixing for ore processing, as well as potable water within the processing plant and administration facility. One or more groundwater wells will be installed near the Process Plant to nominally supply 5.5 m^3/hour.

4.10.4 Site Water Balance

A water balance model has been prepared to provide information to guide the development of the water management strategy for the Project (Appendix C- 7 Water Balance Model Report and Appendix D-7). A site wide water balance model was prepared using the GoldSim© modeling software to provide information to guide the development of a preliminary water management strategy for the Project. The following tables provide the annual operations water volumes for average climatic conditions (Table 4-26), year 10 for a dry - 1:10 year drought event (Table 4-27), mean and wet year - 1:50 year storm event (Table 4-28).

Water sources for the Project include precipitation runoff from mine storage facilities, groundwater used for the camp and ore processing and water (groundwater and surface water) collected from the ABM open pit.

Table 4-26: Results from Average Climatic Conditions in Year 10 (m^3/month)

Average Case Precipitation Scenario															
Month	No Treatment		Treatment Potentially Needed				Total Surplus	Process Water Use		Lower WMP Discharge		Non-Contact Water Diverted Around Site			
	Upper WMP	Lower WMP	Pit Rim Pond	Process Plant Site Runoff	Class A	Class B		WTP	Pit Rim Pond	To Geona Creek	To Finlayson Creek	South	North (Wetland)		
													Class C	Overburden Stockpile	Remainder
Jan	11,000	16,000	196,000	0	1,000	7,000	231,000	5,000	15,000	24,500	100,000	25,000	7,000	2,000	14,000
Feb	9,000	12,000	194,000	0	1,000	6,000	222,000	5,000	15,000	17,250	70,000	20,000	5,000	1,000	11,000
Mar	9,000	12,000	194,000	0	1,000	6,000	222,000	5,000	15,000	13,750	52,000	20,000	5,000	1,000	11,000
Apr	11,000	34,000	215,000	6,000	9,000	24,000	299,000	5,000	15,000	47,000	255,000	23,000	20,000	6,000	12,000
May	119,000	270,000	415,000	35,000	168,000	165,000	1,172,000	5,000	15,000	235,000	990,500	247,000	143,000	44,000	134,000
Jun	118,000	278,000	427,000	38,000	183,000	175,000	1,219,000	5,000	15,000	270,000	949,000	248,000	152,000	47,000	135,000
Jul	68,000	146,000	314,000	18,000	78,000	86,000	710,000	5,000	15,000	158,000	730,000	150,000	80,000	24,000	82,000
Aug	57,000	126,000	294,000	16,000	66,000	73,000	632,000	5,000	15,000	130,000	515,000	123,000	68,000	21,000	67,000
Sep	64,000	132,000	296,000	14,000	63,000	73,000	642,000	5,000	15,000	133,000	500,000	135,000	69,000	21,000	74,000
Oct	42,000	64,000	235,000	2,000	5,000	32,000	380,000	5,000	15,000	78,000	310,000	94,000	30,000	8,000	51,000
Nov	23,000	31,000	207,000	0	1,000	14,000	276,000	5,000	15,000	49,000	205,000	51,000	13,000	3,000	28,000
Dec	15,000	21,000	200,000	0	1,000	9,000	246,000	5,000	15,000	34,000	145,000	34,000	9,000	2,000	19,000
Annual (m^3/yr)	546,000	1,142,000	3,187,000	129,000	577,000	670,000	6,251,000	60,000	180,000	1,189,500	4,821,500	1,170,000	601,000	180,000	638,000

Table 4-27: Results from 1 in 10 Year Dry Climatic Conditions in Year 10 (m^3/month)

1:10 Year Dry Scenario															
Month	No Treatment		Treatment Potentially Needed				Total Surplus	Process Water Use		Lower WMP Discharge		Non-Contact Water Diverted Around Site			
	Upper WMP	Lower WMP	Pit Rim Pond	Process Plant Site Runoff	Class A	Class B		WTP	Pit Rim Pond	To Geona Creek	To Finlayson Creek	South	North (Wetland)		
													Class C	Overburden Stockpile	Remainder
Jan	9,000	13,000	194,000	0	1,000	6,000	223,000	5,000	15,000	17,500	75,000	20,000	6,000	1,000	11,000
Feb	7,000	10,000	192,000	0	1,000	5,000	215,000	5,000	15,000	12,500	53,000	16,000	4,000	1,000	9,000
Mar	7,000	10,000	192,000	0	1,000	5,000	215,000	5,000	15,000	10,000	39,000	16,000	4,000	1,000	9,000
Apr	9,000	27,000	209,000	5,000	7,000	19,000	276,000	5,000	15,000	37,000	235,000	18,000	16,000	5,000	10,000
May	95,000	215,000	369,000	28,000	130,000	130,000	967,000	5,000	15,000	189,000	1,040,000	197,000	115,000	35,000	107,000
Jun	93,000	221,000	379,000	31,000	142,000	138,000	1,004,000	5,000	15,000	212,000	1,000,000	198,000	121,000	37,000	108,000
Jul	53,000	116,000	288,000	14,000	58,000	67,000	596,000	5,000	15,000	108,000	490,000	120,000	64,000	19,000	65,000
Aug	45,000	100,000	272,000	13,000	48,000	56,000	534,000	5,000	15,000	97,000	450,000	98,000	54,000	16,000	53,000
Sep	51,000	105,000	274,000	11,000	46,000	56,000	543,000	5,000	15,000	97,000	400,000	108,000	55,000	16,000	59,000
Oct	33,000	51,000	225,000	2,000	4,000	26,000	341,000	5,000	15,000	57,000	225,000	75,000	24,000	6,000	41,000
Nov	18,000	24,000	203,000	0	1,000	11,000	257,000	5,000	15,000	35,500	155,000	41,000	11,000	3,000	22,000
Dec	12,000	17,000	197,000	0	1,000	7,000	234,000	5,000	15,000	24,500	106,000	27,000	7,000	2,000	15,000
Annual (m^3/yr)	432,000	909,000	2,994,000	104,000	440,000	526,000	5,405,000	60,000	180,000	897,000	4,268,000	934,000	481,000	142,000	509,000

Table 4-28: Results from 1 in 50 Year Wet Climatic Conditions in Year 10 (m^3/month)

1:50 Year Wet Precipitation Scenario															
Month	No Treatment		Treatment Potentially Needed				Total Surplus	Process Water Use		Lower WMP Discharge		Non-Contact Water Diverted Around Site			
	Upper WMP	Lower WMP	Pit Rim Pond	Process Plant Site Runoff	Class A	Class B		WTP	Pit Rim Pond	To Geona Creek	To Finlayson Creek	South	North (Wetland)		
													Class C	Overburden Stockpile	Remainder
Jan	16,000	22,000	201,000	0	1,000	11,000	251,000	5,000	15,000	28,500	85,000	35,000	10,000	2,000	19,000
Feb	13,000	17,000	197,000	0	1,000	8,000	236,000	5,000	15,000	21,000	60,000	28,000	8,000	2,000	15,000
Mar	13,000	17,000	198,000	0	1,000	8,000	237,000	5,000	15,000	17,250	42,000	28,000	8,000	2,000	15,000
Apr	16,000	48,000	228,000	9,000	20,000	35,000	356,000	5,000	15,000	66,000	320,000	33,000	28,000	9,000	18,000
May	170,000	384,000	512,000	49,000	249,000	238,000	1,602,000	5,000	15,000	335,000	1,264,000	350,000	204,000	63,000	191,000
Jun	170,000	399,000	530,000	54,000	270,000	253,000	1,676,000	5,000	15,000	405,000	1,196,750	352,000	216,000	67,000	192,000
Jul	98,000	211,000	368,000	25,000	121,000	126,000	949,000	5,000	15,000	356,000	960,000	213,000	113,000	34,000	116,000
Aug	82,000	181,000	340,000	22,000	103,000	107,000	835,000	5,000	15,000	179,000	695,000	174,000	97,000	29,000	95,000
Sep	91,000	188,000	343,000	20,000	99,000	107,000	848,000	5,000	15,000	215,000	815,000	192,000	98,000	29,000	105,000
Oct	60,000	91,000	256,000	3,000	13,000	46,000	469,000	5,000	15,000	95,000	253,000	133,000	42,000	11,000	73,000
Nov	32,000	44,000	217,000	0	2,000	20,000	315,000	5,000	15,000	58,000	176,000	72,000	19,000	5,000	39,000
Dec	22,000	29,000	206,000	0	1,000	13,000	271,000	5,000	15,000	39,500	123,000	48,000	12,000	3,000	26,000
Annual (m^3/yr)	783,000	1,631,000	3,596,000	182,000	881,000	972,000	8,045,000	60,000	180,000	1,815,250	5,989,750	1,658,000	855,000	256,000	904,000

4.10.5 Closure

4.10.5.1 Closure

The closure objective for site water management is to breach diversions around the mine site and return water courses to their natural alignment. The Class A and Class B Collection Ponds will be pumped to the Water Treatment Plant until such time that water quality is suitable for passive release from the ponds perpetually. Open Pit dewatering will cease and Fault Creek will be redirected to the Open Pit to facilitate pit filling once active mining from the pit has ceased. All Open Pit benches and slopes will be reclaimed in such a manner to prevent erosion and minimize suspension of sediments.

4.10.5.2 Active Closure Water Management Phase

The active closure phase is the three-year period immediately following cessation of operations, where most consequential decommissioning and reclamation work is done. Mining equipment will be removed, most infrastructure will be decommissioned, and the Fault Creek diversion will be removed to allow Fault Creek to return to its pre-mining channel and to begin filling the ABM open pit. ABM open pit lime and carbon source addition water treatment will begin in year 11 if required and continue through the transition closure phase as needed.

Most major reclamation earthworks will be completed during this phase. The portions of the Class A and B Storage Facilities not reclaimed progressively during operations will have their reclamation completed, with the cover placement being finalized. The camp will be partially decommissioned. All operational water treatment and management systems (i.e., seepage collection and conveyance) are retained and functional, and monitoring and inspection regimens will remain in place, unchanged from the operational phase.

4.10.5.3 Transition Closure Phase

This phase is nominally a 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to overflow to Geona Creek. The wetland treatment systems will be constructed and commissioned at the start of this phase, and the operational water management systems (i.e., seepage collection and conveyance) will remain on site and functional until such time as the constructed wetland treatment system (CWTS) is performing as required to meet water quality objectives and effluent discharge standards. The water treatment plant and management systems will be retained in a ready state as a contingency.

4.10.5.4 Post-Closure Phase

The Post-closure phase commences with the spilling of the ABM lake water into Geona Creek. It is currently planned to be a 10-year period of primarily monitoring and maintenance. It is expected that a year or two will be required to ensure that the passive water treatment systems are achieving performance expectations with the new water contribution from the ABM lake. Once these objectives

and performance criteria are achieved, the active water treatment plant and remaining infrastructure will be demobilized/decommissioned, and site water management will be passive in nature.

4.10.6 Geona Creek

Geona Creek currently flows through the proposed Open Pit, which includes the Fault Creek watershed, a small headwater tributary to Geona Creek. Fault Creek will be redirected to an adjacent watershed (South Creek) during the construction and operations phases of the Project. This will result in reduced flows to Geona Creek and a corresponding increase in flows to South Creek.

Diversion ditching will be used to convey runoff to an outlet structure in Geona Creek, where adequate retention time will allow sediment to settle prior to release to the receiving environment downstream. Collection ditching will be used within the Project footprint to collect and convey contact runoff to the various water management ponds, where the water will be retained until it is used in for ore processing or treated and released to the environment.

Runoff from the Class C Storage Facility is collected in the Class C Collection Pond for sediment control prior to discharge to Geona Creek. Similarly, runoff from the Overburden Stockpile Facility is collected in the Overburden Stockpile Collection Pond for sediment control prior to discharge to Geona Creek. Discharge from the Lower Water Management Pond will be at a minimum ratio to 3:1 (receiving environment:discharge) to Geona Creek and 2:1 (receiving environment:discharge) to Finlayson Creek to maintain stream flows similar to baseline conditions. The storage of water in the Water Management Ponds and associated increased discharge during freshet will be offset by the diversion of Fault Creek and the southern diversions to South Creek that would normally be part of the Geona Creek flow. Surplus water will be stored on site within the Upper and Lower Water Management Ponds and used for ore processing as required, with excess water released to Geona Creek and to Finlayson Creek.

4.11 SUPPORT INFRASTRUCTURE

4.11.1 Paste Fill Plant

The Paste Fill Plant will be constructed in Year 3 of operations and the volume of paste required will vary from year to year.

Dry tailings will be trucked to the Paste Fill Plant facility from the Process Plant. At the Paste Fill Plant the tailings will be placed inside an enclosed building, which will have a graded concrete floor. The dry tailings will be transported by a FEL into a dump hopper, which will feed the tailings to a pug type paste mixer, where the tailings will be mixed with metered amounts of cement and water. The paste will then be transferred to a paste collection hopper for delivery underground by gravity assisted by pumps. Water for paste production will be pumped from the Pit Rim Pond and cement will be trucked to the Paste Fill Plant and stored in a cement silo.

In summary, the Paste Fill Plant facility comprises the following processing units:

- Dry tailings bulk storage;

- Paste production;
- General purpose and instrument quality compressed air systems; and
- Water service systems.

The entire facility will be enclosed, which will reduce the potential for air quality and noise effects. The conceptual management plans that are relevant to the safe transportation of water, cement, and tailings to the Paste Fill Plant as well as the handling of the cement and tailings at the Paste Fill Plant are included in Chapter 18 (Section 18.3 – Hazardous Materials Management Plan, Section 15.5 – Spill Contingency Management Plan, Section 18.12, Traffic and Access Mangement Plan, and Section 18.15 – Health Safety and Emergency Response Plan).

4.11.2 Warehouse and Administration Complex

The warehouse and administration complex has been designed to be a component of the Process Plant Facility (Figure 4-14) This complex will consist of two floors (Allnorth, 2016b).

The lower level will include the following:

- Maintenance area, including a drive through bay to the processing plant;
- Water Pump room to house water pumps and potable water treatment equipment;
- First Aid Room/Ambulance Bay;
- Warehouse for receiving, dispatch and storage of equipment and supplies. Large pieces of equipment such as mill liners and truck tires will be stored in a fenced storage area adjacent to the building. An unheated cold storage building will be used for storing bulk supplies which do not require heated storage;
- Assay Laboratory, with the ability to carry out both conventional wet assaying and fire assaying;
- Mine Dry, with separate Male and Female facilities with lockers provided for street clothes and baskets for working clothes. Showers, washbasins and toilet facilities will also be provided;
- Cold Storage area; and
- Fenced Storage Area (adjacent to building).

The upper level will include the following:

- Administration area, complete with individual offices for administration, managers and maintenance offices, open plan multi person areas with cubicles and a kitchen/coffee area;
- Board Room; and
- Additional area available for office, storage, or other requirements.

The conceptual management plan that is most relevant to the operating of the Warehouse and Administration Complex is presented in Section 18.15 – Health Safety and Emergency Response Plan.

4.11.3 Workshop

Workshop facilities will be constructed north east of the ABM open pit (Figure 4-2). They will include service bays, drive through lube bays and wash bays for maintenance of Open Pit and underground mining equipment as well as light vehicles. Wash bays will have a sump with water recovery and bobcat clean out. The truck shop will include a compressor bank with air dryer and air distribution, exhaust extraction and lubrication systems.

The conceptual management plans that are most relevant to the operations of the workshop are included in Chapter 18 (Section 18.2 - Waste Management Plan, Section 18.3 – Hazardous Materials Management Plan, Section 15.5 – Spill Contingency Management Plan, Section 18.12, Traffic and Access Mangement Plan, and Section 18.15 – Health Safety and Emergency Response Plan).

4.11.4 Assay and Metallurgical Laboratory

An on site laboratory will be included in the Process Plant Facility. The laboratory will have the analytical equipment to evaluate mine grade control, mine waste classification, and Process Plant control requirements. Exploration and environmental assay requirements will largely be met by independent off site laboratories.

Laboratory equipment is expected to include drying, crushing, splitting and pulverising equipment for sample preparation, furnace, and inductively coupled plasma equipment for sample analysis, and other ancillary equipment such as balances.

Grade control samples will be assayed for copper, lead, zinc, gold, silver and iron. Process plant control samples will assay for a similar suite, with the addition of moisture of each concentrate. Concentrates will also be assayed for penalty elements including arsenic, mercury, bismuth, antimony, cadmium and fluoride. Waste rock samples will be assayed for sulphur and calcium.

The conceptual management plans that are most relevant to the operations of the laboratory are included in Chapter 18 (Section 18.2 - Waste Management Plan, Section 18.3 – Hazardous Materials Management Plan, Section 15.5 – Spill Contingency Management Plan, Section 18.12, and Section 18.15 – Health Safety and Emergency Response Plan).

4.11.5 Emergency Facility

The Project will have a fully equipped first aid facility within the warehouse/administration complex (Figure 4-14). It will be staffed by a qualified medic at all times for first aid treatment. An ambulance will be maintained on site for first responder medical treatment.

Serious medical emergencies will be transported to Whitehorse for further medical treatment. The preferred method of transportation will be via helicopter with a helipad located adjacent to the

Process Plant Facility for this event. An alternative to transportation by helicopter is the Finlayson Lake airstrip that will be used for regular air commuting.

An emergency response team will be maintained on site, trained in all aspects of mines rescue. Regular training will be provided by BMC to ensure that a high standard of emergency preparedness is maintained on site. Where appropriate, reciprocal mine rescue agreements will be established with other mining operations in the district to provide mutual support services on an as required basis.

The conceptual management plan that is most relevant to the operations of the emergency facility is Section 18.15 – Health Safety and Emergency Response Plan.

4.11.6 Fuel Storage and Distribution

A number of fuel sources will be required for the Project including LNG, diesel, gasoline, and propane, with natural gas and diesel being the primary fuel source as summarized in Table 4-29.

Table 4-29: Summary of Fuel Storage and Distribution

Fuel Type	Storage Area	Amount
LNG	Power Plant Facility	264,000 litres
Diesel - Power Generation	Power Plant Facility	700,000 litres
Diesel - Mining Operations	Bulk fuel Storage Facility located adjacent to the Mine Workshop	400,000 litres
Gasoline	Process Plant Facility	30,000 litres
Aviation Fuel	Adjacent to the helipad at camp	Nominally 5,000 litres
Waste Oil	Storage tank by Mine Workshop	10,000 litres

LNG will be used for power generation. Due to the high capital costs of LNG vapourization and storage facilities, two days site storage capacity will be available, with diesel available to maintain continuity of power should an interruption to LNG supply arise. LNG will be stored in two 132,000 litre Type C vacuum insulated tanks. Tanks will be located within either an earthen containment berm, lined with an HDPE liner or an equivalent engineered concrete bunker, and sized to hold 110% of the tank volume.

Currently LNG can be sourced from Dawson Creek, BC, although by the time that the Project is likely to be in production, additional LNG facilities may be available at Fort Nelson, BC. From either of these locations , LNG will be transported to site via bulk tankers. At a 99% LNG / 1% diesel fuel mix for power generation, five tankers of LNG will be required to be delivered every two days.

Diesel for power generation will be stored in a 700,000 litre facility in purpose designed tanks, sufficient for 10 days operation at a 0% LNG / 100% diesel fuel mix. Diesel consumption is expected to be significantly lower than this with the use of LNG and will be resupplied on an as required basis.

The storage tank will be located within a containment berm, lined with an HDPE liner, and sized to hold 110% of the tank volume.

Diesel for mining operations will be stored in a separate bulk fuel Storage Facility located adjacent to the workshop (Figure 4-2). It will include four 100,000 litre tanks within a containment berm, lined with an HDPE liner, and sized to hold 110% of the tank volume. The facility will include a fuel unloading and distribution module, with truck off-loading and fuel distribution pumps. The tanks will provide sufficient storage capacity for ten days supply for Open Pit and underground mining operations.

Diesel will be delivered by bulk tanker, nominally in 48,000 litre deliveries. Approximately 18 fuel deliveries will be required each week to meet the mining fuel requirements.

A 30,000 litre gasoline tank will be maintained on site for ancillary gasoline use. Storage will be within a lined earthen containment berm or an equivalent engineered concrete bunker.

A small supply (nominally 5,000 litres) of aviation fuel will be maintained on site for exploration activities requiring helicopter support. It will also serve as a fuel supply for emergency helicopter evacuation should the need arise. Aviation fuel will be stored adjacent to the helipad, at camp, in a single fuel tank within a lined containment berm.

Diesel or natural gas will be required for heating of air entering the underground mine during the winter months, heating of the camp facilities and available for supplementary heating of the processing facility if insufficient heat is available from the heat reclaim system on the power generation equipment.

Waste oil storage located in the Mine Workshop will be used as a fuel source for a waste oil burner to warm the workshop in winter months. The storage tank for waste oil storage will have a capacity of 10,000 litres.

The conceptual management plans that are relevant to the safe use, handling and storage of fuels are included in Chapter 18 (Section 18.3 – Hazardous Materials Management Plan, Section 15.5 – Spill Contingency Management Plan, Section 18.12, Traffic and Access Mangement Plan, and Section 18.15 – Health Safety and Emergency Response Plan).

4.11.7 Fire Protection

A fire water distribution system will be installed around the Process Plant site and camp area with wall hydrants at strategic locations, capable of delivering a nominal rate of 400 m^3/hr of water for a two-hour period. Fire water will be drawn from a raw water tank and will be provided by a skid-mounted system incorporating an electric main pump and jockey pump and diesel back-up pump.

The conceptual management plan that is most relevant to fire protection is presented in Section 18.15 – Health Safety and Emergency Response Plan.

4.11.8 Sewage Collection and Treatment

Sewage from the accommodation complex will be collected by buried sewers at a 2.0 m cover for insulation. The raw sewage will be gravity fed to a package sewage treatment plant designed to treat an average daily flow of 67.5 m^3/day. The raw sewage will be processed to meet Type C effluent requirements (45 mg/L Biochemical Oxygen Demand (BOD), 45 mg/L Total Suspended Solids (TSS)). The treated effluent will then be discharged to ground via an on site in ground disposal field. The sewage treatment plant will produce a bio-sludge which will require periodic removal. This sludge will require sanitary burial on–site in an approved location.

Sewage from the Processing Plant and Administration complex will be collected by buried sewers at a 2.0 m cover for insulation. The raw sewage will be gravity fed to a package sewage treatment plant designed to treat an average daily flow of 26.4 m^3/day. The raw sewage will be processed to meet Type C effluent requirements (45 mg/L Biochemical Oxygen Demand (BOD), 45 mg/L Total Suspended Solids (TSS)). The treated effluent will then be discharged to ground via an on site in ground disposal field. The sewage treatment plant will produce a bio-sludge which will require periodic removal. This sludge will require sanitary burial on–site in an approved location.

The operation of the sewage treatment plant will be part of a regular monitoring and maintenance program so that deficiencies in operation, pipeline rupture, pump/power breakdown and the like, will be reported to relevant Maintenance Manager for rectification action with an alert to the Environment and/or Health Managers (or alternate). In the event of power failure, the standby generator will be put into operation. Similarly, in the case of a pump failure, the backup pump will be put on-line. If there is any danger of wastewater becoming mixed with a body of freshwater in the event of a raw sewage pipe rupture, a containment structure will be constructed immediately. Alternatively, the leaked wastewater may be stored temporarily in an empty tank and then pumped into the sewage plant for treatment. Any spills inside the treatment plant will be contained therein and pumped back into the system.

4.11.9 Waste Management Plan

Conceptual Waste Management and Hazardous Waste Management Plans have been developed for the Project and are included in Section 18.2 and 18.3 of this Project Proposal. The following provides a brief summary these plans.

The objective of the plans is to ensure that the handling, storage, transportation, and disposal of all wastes (i.e., solids, liquids, and Special Wastes) generated by the Project are conducted in such a manner to reduce potential adverse environmental effects.

The Project will have a Waste Management Facility. The location of the facility is presented on Figure 4-2. It will contain all waste, recyclables and contaminated materials, excluding waste oil (which will be stored in a tank by the workshop). It will include an incinerator, a small Land Treatment Facility, and a small landfill area. The entire facility will be surrounded by a wildlife proof fence.

Table 4-30 presents the waste storage locations and disposal methods for the various wastes that will be generated by the Project.

Table 4-30: Waste Storage Locations and Disposal Method

Type	On Site Storage Location	Disposal
Solid Waste		
Kitchen Waste	Bear-proof containers	Incinerator
Beverage Containers and other recyclables	Recycling Bins	Off site disposal
Office and Camp Garbage	Garbage Bins/Bear-proof containers	Incinerator
Untreated Wood	Open Burn Area	Open burned
Treated Wood	Waste Management Facility	Incinerator
Heavy Plastics	Waste Management Facility	Incinerator
Light Plastics/Cardboard	Waste Management Facility	Open burned /Incinerator
Steel / Copper / Rubber	Waste Management Facility	Off site Disposal facility
Ash from Incinerator/Open burn area	Ash Bin	Landfill
Tires	Waste Management Facility	Off Site Disposal
Special Waste		
Waste Oil: used crankcase oil, used automatic transmission fluid, used hydraulic oil, used fuel oils #2, #4 and #5	Storage Tank by Mine Workshop	Waste Oil Burner for heating of workshop
Batteries	Waste Management Facility	Shipped to licensed recycle or disposal facility on regular basis
Antifreeze (and used containers)	Waste Management Facility	Shipped to licensed recycle or disposal facility on regular basis
Solvents (and used containers)	Waste Management Facility	Shipped to licensed recycle or disposal facility on regular basis
Sewage		
Sewage and Grey Water	Sewage treatment plant at camp and Process Plant	Treated water diverted to septic field
		Bio-solids dried and deposited in the landfill
Contaminated Wastes		
Contaminated Soils and Snow	Waste Management Facility	Land Treatment Facility

4.11.10 Communications

The two principal design options considered for phone and data communication links to/from site were terrestrial microwave and satellite. The primary voice/data communication system selected for the Project is a terrestrial microwave licensed option (Total North, 2016) with an emergency satellite back up system.

Telephone, data and facsimile services will be integrated through major site and office buildings. Internet and cable television will be provided to each dormitory and at the main accommodation building.

In addition to phone/data systems, there will be local radio communications. The site radio communications on the property will be linked to a remote repeater through the terrestrial microwave. The radio coverage consists of a channel plan to reflect site requirements and road coverage, base station radios situated at major infrastructure locations, and an underground leaky feeder radio system.

From the full path analysis, a single intermediate repeater site was chosen to optimize link capacity located approximately 2 km south from the camp.

As part of the required infrastructure, one remote shelter will be built near the Project office and a second at the remote repeater location. The purpose of the remote shelters will be to integrate networking and radio communications through mining and site activities. A generator will be the principal source of power at the repeater to enable communications.

4.11.11 Site Roads

Two categories of roads will be developed for the Project (haul roads and service roads).

Mine haul roads will be designed for, and used primarily by, mine haul trucks and will link the ABM open pit to the Process Plant, the Class A, B, and C Waste Storage Facilities and the Overburden Stockpile. Haul roads have been designed at a maximum gradient of 1:9, with widths to suit the use of 90 t class haul trucks (11 m for single lane ramps and 22 m for double lane, inclusive of safety windrows and drains, as illustrated in Figure 4-7. All haul roads will be constructed in accordance with safety requirements such as roll over berms, as set out in the Yukon Occupational Health and Safety Regulations.

Access and service roads will link all operating areas of the Project and will be constructed to handle light duty and commercial vehicles.

Traffic along all site roads will be managed in accordance with the Traffic and Access Management Plan (Section 18.12). Site access will be controlled by staffing the existing gatehouse 24 hours a day and limiting entry to Project specific traffic. An option exists to use an alternative remotely controlled access system utilising security cameras, voice links and remote controls however this has not been considered at this stage. All roads will be subject to radio control protocols.

All roads will be inspected and maintained regularly (i.e., graded, ploughed, watered, and repaired). A water truck will be utilized for dust control in the summer months. This truck will also provide emergency water supply in the event of scrub fires. In additional to the Traffic and Access Management Plan, the other conceptual plans that are applicable to site roads are: Section 18.5 - Spill Contingency Plan; Section 18.10 – Noise Management Plan; and Section 18.11 - Air Quality Management Plan.

4.11.12 Borrow Sources

Pre-stripping of the Open Pit will provide enough materials for mine construction; therefore, no borrow sources for the mine site are currently planned.

Borrow sources will be required for the Finlayson Lake airstrip extension as well as the upgrade to the existing Tote Road to an Access Road. Further information on the borrow sources required for the Project components may be found under Section 4.12.

4.11.13 Explosives Use and Storage

Bulk explosives and blasting agents will be utilized for all mining activities and will be stored on the mine site at permitted locations as per the *Explosives Act.*

Explosives will be stored in secure, fenced facilities separate from the main activity areas, adjacent to the Overburden Stockpile (Figure 4-2). Bulk explosives for Open Pit blasting purposes will be stored in the bulk explosives compound. A packaged explosive magazine will store all explosive requirements for the underground mine as well as cast boosters and other explosive products required for Open Pit operations. A separate detonator magazine will be available for storage of all detonators.

The design of all storage facilities will meet government regulations and will be located according to required separation distances as regulated by the Explosives Regulatory Division of Natural Resources Canada (NRCan). The minimum separation distance from inhabited buildings has been assessed as 960 m and the selected storage sites exceed this distance.

Bulk ammonium nitrate prill and bulk ammonium nitrate emulsion will be transported to site in 25 tonne bulk transport trailers and 20 tonne tanker trailers respectively. Bulk products will be stored in separate prill and emulsion silos in the bulk explosive compound. The bulk explosive compound will also have a garage for the explosives loading trucks and a small office for explosives personnel.

Packaged explosives and detonators will be delivered by approved explosives freight trucks.

Explosives will not be manufactured on site; however, the explosives trucks for the Open Pit operation will be capable of mixing ammonium nitrate prill and emulsion in varying ratios as required to meet the specific requirements of each blast including the presence of wet holes and variations in explosive density.

4.11.14 Site Accommodations

The camp is planned to be located in the vicinity of the current exploration camp (Figure 4-2). This will ensure that workers who are off shift will not be adversely impacted by the day to day operations of the mine and processing facility.

The accommodation facilities will be of modular construction, prefabricated off site. All modules will be transported to the prepared site via truck and placed on blocking and skirted. Connections between the separate accommodation blocks will be via enclosed 'arctic' corridors. Site preparation and infrastructure will consist of providing grading, storm drainage, and all weather surface gravelling. Utility connection will be via underground service including potable and fire protection water, sanitary sewage collection, electrical and communications.

The construction camp will be sized to accommodate 100 personnel initially, with the camp being upgraded to accommodate 350 personnel during the height of construction. At the commencement of the operations phase the construction camp modules will be removed and the camp will have its ultimate capacity of 250 personnel. Forty rooms will be available with ensuite bathroom facilities while the remaining rooms will utilize shared facilities located within each accommodation level.

Additional facilities in the camp complex include:

- Kitchen and mess facilities;
- Administration office;
- Recreational facilities, comprising a weight / exercise room and a TV / entertainment room;
- Laundry facilities; and
- Lockers and storage facilities.

The camp complex will be bordered by a wildlife barrier to reduce the potential for wildlife interactions.

The conceptual management plans that are most applicable to the camp operations include: Section 18.2 – Waste Management Plan; Section 18.3 – Hazardous Materials Management Plan; Section 18.7 – Wildlife Protectin Plan; Section 18.10 – Noise Management Plan; Section 18.11 – Air Quality Management Plan; Section 18.12 - Traffic and Access Management Plan; and Section 18.15 – Health, Safety and Emergency Response Plan.

4.11.15 Site Power Supply

The Project power supply will be a site based bi-fuel (natural gas and/or diesel) fueled power plant, located adjacent to the processing plant facilities. The power plant will consist of six 4.2 megawatt (MW) continuous rated generators in an N+2 configuration. The engines will run a variable ratio of natural gas (NG) to diesel from 100% diesel to 99% NG giving great flexibility in fuel usage depending on fuel prices or for times of road closure or supply difficulties. The generators will be rated 3 phase, 60 Hz, 4,160 V.

The generators will be connected to a switchgear assembly also located in the power plant. The power plant will contain all of the equipment required to operate and control each generator. This will include generator governor controls, voltage regulators, synchronization equipment, and annunciator panels.

Full heat recovery from the generators has been designed to provide heat to the Process Plant during winter.

The Project's 24-hour average electrical requirements per year is expected to be approximately 15,000 kW while the annual estimated consumption is 120 GW, depending on weather conditions.

Surface installations requiring power supply include the camp, offices, underground mine, Paste Fill Plant, workshop, pit dewatering bores, and the explosives facility. Power will be distributed to these

locations via buried electrical cables from the power plant. Small pumping facilities for surface water collection sumps may be powered by the power plant if buried power distribution permits, otherwise small standalone diesel generators will be used.

Power required for generator auxiliaries on black start operation will be from a purpose sized black start generator of 100 to 150 kW. The accommodation complex will also be equipped with a 1,000 kW emergency generator.

4.12 ACCESS AND TRANSPORTATION

4.12.1 Tote Road Upgrade to Access Road

4.12.1.1 Overview

The Tote Road was originally licensed and constructed in 1995 and was used extensively by Cominco for the Project from the mid to late 1990s (Lease 105G07-001). This lease was assigned to BMC in April of 2015. The Tote Road is approximately 24 kilometres in length and extends from the Robert Campbell Highway, south to the Project area (Figure 4-19). The Tote Road was originally constructed as a winter road and was one of three possible routes reviewed by Cominco.

The Tote Road generally follows the gentle benches and ridges above the valley bottom leading to the Project area. Slopes are gentle with many flat wet areas dissected by low winding ridges. There is one bridge crossing Finlayson Creek in a broad gentle draw (at approximately the kilometre 17 marker). There are a number of small streams and low, wet swales along the Tote Road. The alignment climbs slowly from approximately 1,040 masl to 1,400 masl at the Project area.

Soils are predominantly sand and gravel deposits intersected by areas of silty soils with a large component of gravel to boulder sized material derived from the local schist outcrops.

In 2015, the Tote Road was repaired to return it to a safe standard suitable for the ongoing exploration program. Washouts were fixed, culverts replaced as required, the road prism was re-established and the bridge deck at the Finlayson Creek crossing was replaced. The L100 Bridge (at approximately kilometre 17 mark on Tote Road) has a Gross Vehicle Weight rating of 91 t, and will be adequate up to and including the construction and operations phases of the Project.

Access to site is controlled with a gatehouse located on the Tote Road, immediately after turning off the Robert Campbell Highway.

The Tote Road in its present state is not suitable for the vehicle traffic load anticipated during construction and operations phases. Upgrades to the road will begin where the access road leaves the Robert Campbell Highway and extend to approximately the 19.8 km mark. Currently the existing road provides seasonal access for low volumes of traffic traveling at low speeds. Upgrades and realignment of the existing road are proposed to improve road user safety, increase the travel speed, and provide all-season access.

4.12.1.2 Proposed Upgrades

The work proposed to upgrade the Tote Road to an Access Road includes:

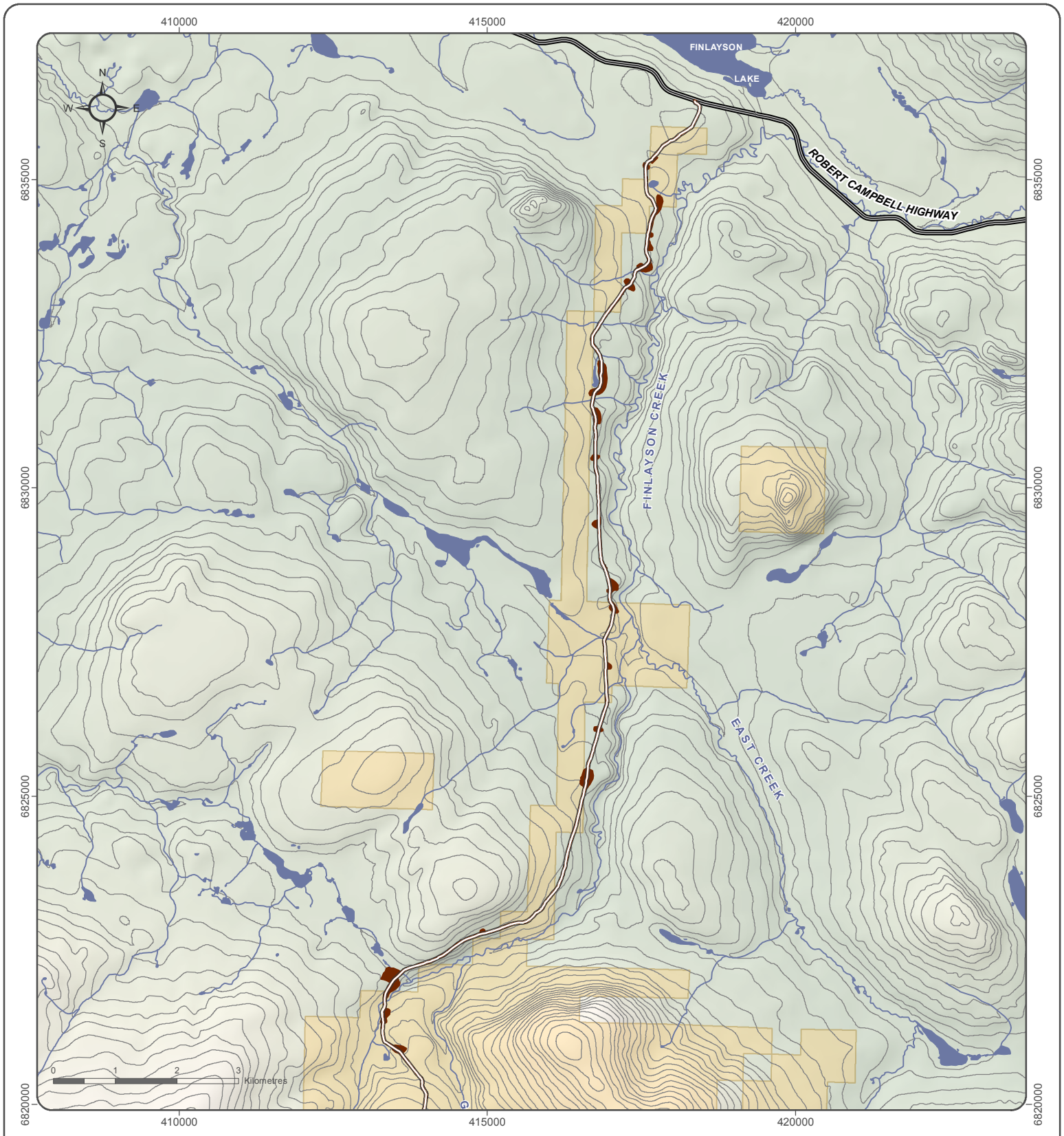
- Improving horizontal and vertical alignment;
- Drainage improvements;
- Watercourse crossing upgrades; and
- All weather surfacing.

The completed road will be a single lane road with pullouts to support two-way traffic travelling at design speeds of 50 km/hr. The specifications to meet these design speeds are summarized in Table 4-31. The road design for the upgrades was completed by Onsite Engineering Ltd. (Onsite, 2016).

Table 4-31: Design Specifications

Components	Specification
Maximum Road Grade	8% (up to 10% on short pitches)
Tightest Vertical Curve	1% grade change over 12 m (11 m for crest curves)
Minimum Curve Length	50 m
Minimum Stopping Sight Distance	135 m
Minimum Horizontal Curve Radius	80 m
Minimum Cross Drain Culvert Diameter	500 mm
Ditch Size	0.5 m deep with 0.6 m wide base
Road Width	5 m
Pullout Size	Additional 4 m width, 30 m long with a 7.5 m long taper at each end

New bridges or bridge replacements are not required for the upgrades. The only bridge on the existing Tote Road is at the Finlayson Creek crossing, which was repaired in 2015.



Tote Road/Proposed Access Road

Potential Borrow Sources

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Waterbody

Watercourse

Contour (40 m interval)

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FIGURE 4-19
ACCESS ROAD ALIGNMENT AND POTENTIAL BORROW SOURCES

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AEG

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The current lease is for 24 km of road with a 20 m right of way (RoW). During the permitting process BMC intends to submit an amendment application for the road lease, which would include 20 km of road with a 30 m RoW. The remaining 4 km of road, under the existing lease, would become part of the QML, as it will overlap with the mine operations. Appendix C- 8 (Proposed Right of Way for Access Road and Typical Cross Sections for Road Upgrade) presents the existing RoW and the proposed new RoW. The existing permitted area from 0 to 20 km is 39.9 ha. The proposed amended area would be 60 ha equating to a new disturbance of 20.1 ha (excluding borrow sources).

4.12.1.3 Construction

Timing and Logistics

Road construction will be scheduled to take advantage of seasonal conditions with construction taking place during drier periods in the warmer months. Multiple work areas are planned to be advanced simultaneously to limit total construction time, dependent upon equipment and manpower availability. Construction time is expected to be approximately six weeks.

The existing exploration camp will be used to provide accommodation for road construction personnel, with fuel stored at the existing site facility. Laydowns for equipment and material will be at identified locations along the road alignment.

Preparation

A 30 m wide RoW corridor of trees will be cleared ahead of road construction activities. In areas where cut and fill slopes extend outside of the 30 m cleared corridor, the clearing width will be increased to 3 m beyond the extent of the cut slope and/or 10 m beyond the extent of the fill slope. Clearing widths within 30 m of creeks will be reduced to 10 m or 3 m beyond cut and fill slopes, whichever is greater. Besides opening the area for road construction, this clearing will increase sight lines for traffic, provide sunlight access for drying/melting, and provide storage area for snow removal. Cleared material will be stored in windrows along the low side of the road to be used later for reclamation purposes. If all spoil and borrow sites are fully utilized and the road is built as designed, a total area of 102 ha will be cleared. Not all borrow and spoil sites will necessarily be utilized.

With the exception of portions of the road built over undisturbed, shallow, ice-rich permafrost, the road will be upgraded on exposed soil. To accomplish this, stripping of the organic soil layer is required. Organic soil depths vary by site from none in areas such as the built road to a maximum of 0.7 m along realignment sections. The average stripping depth outside the existing road prism is 0.3 m.

In areas where the existing road traverses sections of undisturbed, shallow, ice-rich permafrost, the existing organic layer will be left intact. In permafrost, where proposed fill slopes extend beyond either side of the existing road prism, the portion of fill beyond the existing road edge will be constructed by filling over a geotextile separation layer. Care will be taken to minimize the amount of vegetative cover to be cleared, limiting the amount of soil exposed to reduce permafrost

degradation and thaw along the roadway. This will also reduce the potential for soil erosion and sediment deposition in riparian and wetland ecosystems.

Road construction activities will be accessed by using the Robert Campbell Highway. During construction, multiple, small staging areas will be used. Staging areas will advance with road headings using pullouts, depleted borrow sites, spoil sites, and suitable previously cleared areas within the RoW. No additional clearing or road construction activities are proposed to create specific staging areas. Staging areas will be used to store heavy equipment, materials, and tools.

Appendix C- 8 shows the typical cross sections for the upgrades from the Tote Road to the Access Road.

4.12.1.4 Cut and Fill

Wherever practicable, conventional cut and fill construction will be utilized to minimize material movement. In some locations alternative construction techniques such as overland construction in ice rich permafrost will be required.

4.12.1.5 Road Drainage and Stream Crossings

The road will be tracked in lifts and subgrade and surfacing material will be compacted with a drum roller to create a durable surface that limits rutting and pooling on the road. To ensure surface water is directed off of the compacted road surface (reducing the likelihood of prism saturation and rutting), the road will be built with a 2% crown.

Once water is directed off the road surface, ditches will move surface water from the cut slope and road surface towards offtake ditches and/or cross drain culverts. Once at a cross drain culvert or offtake ditch the water will be directed away from the road prism and watercourses onto vegetated soil. Where it is impractical to redirect ditch water away before entering a watercourse, settling ponds will be installed to ensure all sediment settles before the water enters the stream.

The KZK Access Road utilizes 10 stream crossings (Appendix C- 8 Proposed Right of Way for Access Road and Typical Cross Sections for Road Upgrade), 9 of which are culverts on non-fish bearing streams, while the 10th is the bridge crossing at Finlayson Creek, which is fish bearing. All stream crossing culverts require upgrades, 8 of which will require complete structure replacement.

Instream work on all streams will be minimized and completed at times of low flow.

4.12.1.6 Borrow Sources and Spoil Sites

Borrow Sources

Borrow sources have been identified for subgrade material, surfacing material, and riprap. Subgrade sources will be used to address a mass haul deficit for subgrade construction. Deficits are expected in areas where the volume generated by conventional cut and fill construction is limited due to

horizontal/vertical alignment constraints or cut and fill construction is undesirable and overlanding (fill only embankment) is required. Multiple borrow sources were identified and sampled in the field (Onsite, 2016) (Figure 4-19). All of the potential borrow sources are identified on the Figure; however, only some of them will be required for construction. All potential sources have been identified to optimize productivity during construction. The identified sources for subgrade borrow materials are suitable for subgrade construction and will not require any sorting beyond stripping of organic soils before developing the site.

The following estimated volumes are expected to be sourced from borrow sites:

- Subgrade Material – 31,510 m^3;
- Surfacing Material – 17,991 m^3; and
- Riprap Material – 1,400 m^3.

Spoil Sites

Throughout the majority of the road the designed clearing width will provide room to spoil excess material, stripped organics and room to layback the historic stripped overburden windrows where required. In locations where considerable excess volume is expected, as a result of alignment constraints not favouring a balanced mass haul, spoil sites have been identified as shown Appendix C-8 or Figure 4-19.

All of the management plans presented in Chapter 18 are applicable to the Tote Road upgrades and operation of the Access Road.

4.12.2 Finlayson Lake Airstrip

4.12.2.1 Overview

The Finlayson Lake airstrip is located at km 246 on the Robert Campbell Highway and is approximately 12 km from the Tote Road entrance (Figure 4-20). This airstrip is currently the primary air access to and from the Project. The airstrip is owned and controlled by the Airport Branch of the Yukon Transportation Department.

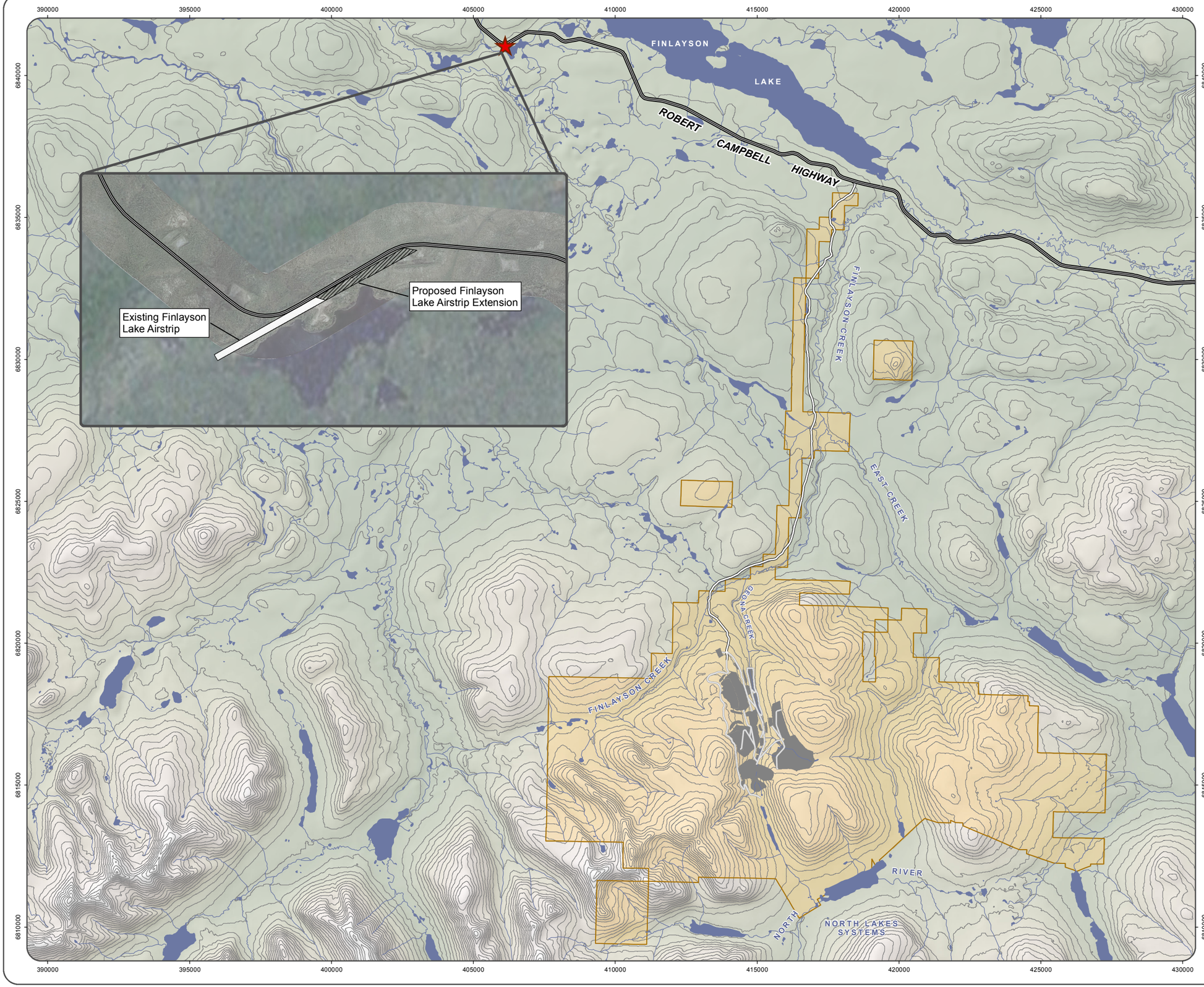

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FIGURE 4-20

FINLAYSON AIRSTRIP EXTENSION

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- Existing Finlayson Lake Airstrip
- Proposed Finlayson Lake Airstrip Extension
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Watercourse
- Waterbody

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It is proposed that the Finlayson Lake airstrip be utilized for future servicing of the Project. While BMC will be using the airstrip for the Project servicing, the airstrip will continue to be available for current and future non-BMC related operational uses without posing any restrictions or interference. Contingency plans will be in place due to the variability of weather which may affect flight conditions, which may include busing or landing in Ross River or Faro.

4.12.2.2 Proposed Upgrades

An extension of Finlayson Lake airstrip was originally proposed in 2007, by the Yukon Department of Transport. The extension is currently proposed by BMC to accommodate an 18-person aircraft and allow for crew changes. The main scope of the upgrades will be to lengthen the airstrip from 1,800 ft (549 m) to 3,000 ft (914 m) to the southeast (Figure 4-21) with an approximate area of new disturbance of 14,000 m^2 (14 ha). Extending the airstrip to the northwest to cater for aircraft of a suitable size and capability is not viable due to drainage from "Unnamed" Lake, and a ridge that lies in the flight line.

Preliminary discussions with Yukon Government Department Transportation of Highways, Transportation and Public Works have indicated that BMC will be responsible for the upgrades and associated permitting.

A Light Detection and Ranging (LiDAR) topographic survey of the Finlayson airstrip has been obtained to develop an engineering plan for airstrip modifications and liaison with Yukon Transportation Department for construction design, timing and materials.

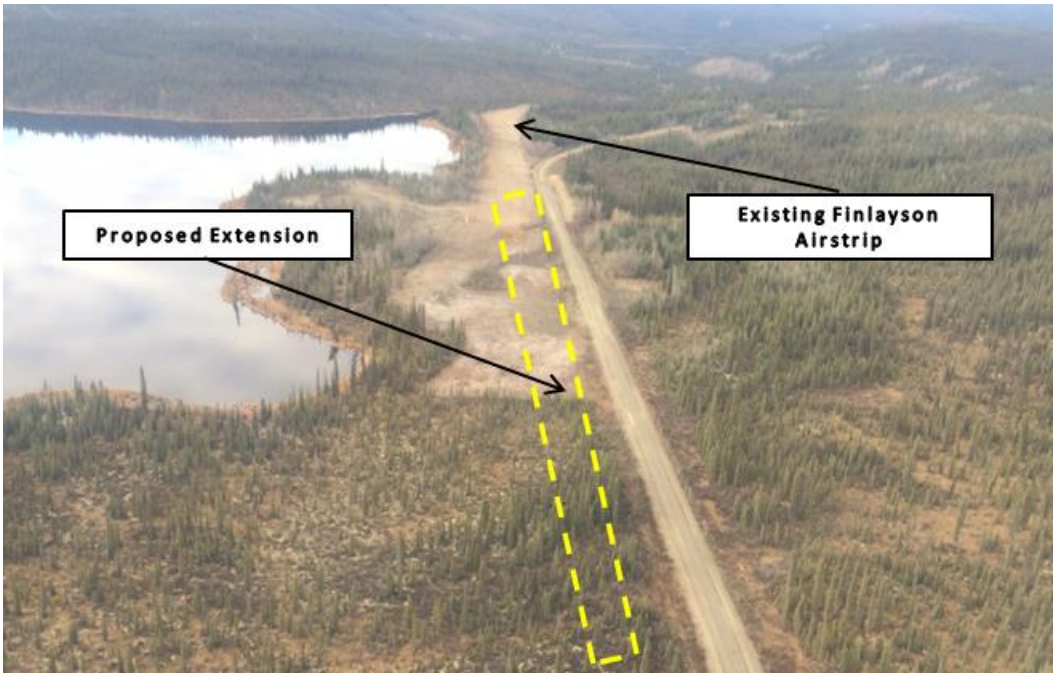


Figure 4-21: Proposed Finlayson Airstrip Extension

The final design will take into consideration that:

- Construction and designs will need to be approved by Yukon Transportation Department;
- Construction timing is independent of the Project permitting and could be commenced at any time, once the appropriate permits are in place; and
- The work required will not be within 30 m of the "Unnamed" Lake.

During construction of the extension it is intended that materials from two Yukon Government borrow pits, on the Robert Campbell Highway approximately 2 km from the Finlayson airstrip, will be utilized.

It is estimated that total siteworks cut and fill requirements will be approximately 24,000 t of material.

The Finlayson Lake airstrip extension will have a high priority during the construction period to simplify the transport of personnel during mine construction. Due to the distance from the Project mine site, the upgrade will be largely independent of the Project infrastructure with personnel either travelling daily from Ross River or housed at a temporary construction camp at the existing gatehouse.

4.12.2.3 Maintenance

As the Finlayson Lake airstrip is owned and operated by the Yukon Transportation Department they will be responsible for the continued maintenance. It is anticipated that grading and compaction will be completed following spring thaw, during fall for winter preparation, and following a period of precipitation when the surface is moist.

Dust suppression measures (i.e., water) may be applied during the summer months, depending on the severity of dust. Dust control chemicals such as calcium chloride, slow curing liquid asphalt or "road oils" will not be used for the Project.

Due to permafrost climatic conditions and coarse grained materials such as silt and clay susceptible to frost, seasonal thawing and refreezing may occur. To prevent loss of bearing strength, the upper layer (active layer) will be of sufficient thickness to prevent thaw from reaching the subgrade and California Bearing Ratio (CBR) measurements will be performed to maintain the integrity of the shear strength.

During the winter months and in heavy snow fall periods, BMC may need to clear the run-way (if Yukon Transportation is unable to complete the clearing in a timely fashion). Therefore, BMC may keep a grader at the gatehouse during the winter months, which would be mobilized to the airstrip in the event that YG is unable to clear it.

4.12.2.4 Infrastructure

The only infrastructure at the Finlayson Lake airstrip will be a small shed for the storage of de-icing equipment, spill kit and first aid equipment. Fuel will not be stored at the airstrip. If additional fuel is needed it will be transported to the airstrip from the mine site upon request of the airline.

The conceptual management plans that are most applicable to the airstip construction and operations include: Section 18.2 – Waste Management Plan; Section 18.3 – Hazardous Materials Management Plan; Section 18.5 – Spill Contingency Plan; Section 18.7 – Wildlife Protectin Plan; Section 18.8 – Plant Management; Section 18.10 – Noise Management Plan; Section 18.11 – Air Quality Management Plan; Section 18.12 - Traffic and Access Management Plan; 18.13 - Heritage Resources Management Pant; and Section 18.15 – Health, Safety and Emergency Response Plan.

4.12.3 Concentrate Transport to Port of Stewart

BMC proposes to transport copper, zinc, and lead concentrates to Stewart Port via road haulage. Copper and zinc concentrates will be transported in bulk trailers while lead concentrate will be transported in containers.

The proposed route and road type to the Stewart Port is summarized in Table 4-32.

Table 4-32: Proposed Haul Route

Route	Road Type and Distance (km)				Total One Way Trip (km)	Total Round Trip (km)
	Gravel Road	Gravel Highway	Seal coat / asphalt narrow highway	Double lane, asphalt highway		
Stewart Port Hwy 4 south (Robert Campbell Highway) to Watson Lake, Hwy 37 south to Stewart	24	172	411	303	**911**	**1,822**

During the spring thaw break up period, certain portions of the Robert Campbell Highway currently have a 75% legal axle load limit imposed by the territorial government. This allows the winter frost to thaw and the road structure materials to restore to their natural load bearing capacity. This restriction varies from year to year but typically occurs for a six-week period between early April and early June. This will reduce the payload of the concentrate haulage system by 50% for approximately six weeks each year.

To manage this, BMC has a number of mitigation strategies available, including:

- Scheduling processing facility maintenance shutdowns for this period;

- Allowing concentrate stocks to temporarily build up in the processing plant circuit;
- Storage of concentrate in bulk containers (as used for transportation of lead concentrate) on site outside the processing plant building;
- Scheduling processing of lower grade ores during this period to reduce the quantity of concentrate produced;
- Negotiate an agreement with Yukon Transportation to upgrade the relevant sections of the Robert Campbell Highway to achieve 100% legal axle loading; and
- Operating a reload facility closer to Watson Lake beyond the 75% weight restricted road section. During seasonal restrictions, truck units would transport from the mine site to the reload facility at 75%. Concentrate would be reloaded to "top-up" to maximize loads to 100% for the balance of the route.

BMC expects that concentrate haulage requirements will be fulfilled by one or more surface haulage contractors. Staging locations along the transportation route will be established by the contractor(s) to enable continuity of haulage operations to be maintained while meeting legal operating hour requirements. These staging locations will also form the base for tractor and trailer maintenance services as well as break down support.

The most applicable conceptual management plans with respect to concentrate hauling are: Section 18.5 – Spill Contingency Plan; Section 18.8 - Plant Management (with respect to minimizing the introduction of invasive species); and Section 18.12 - Traffic and Access Management.

4.12.4 Transportation Volumes

During construction, the estimated vehicles per day on the Robert Campbell Highway will be 14 while the estimated weekly flights to the Finlayson airstrip will be six.

During operations, the number of trucks on the roads between the site and the supply points is estimated to be 52 at any given time, during any 24 hour period. Table 4-33 presents the estimated numbers based on one-way traffic and thus an equivalent amount of traffic will be entering and leaving the Project area. Where practical, loads will be backhauled from the mine site including recyclables and materials to be disposed of. The traffic volumes include, but are not limited to vehicles transporting personnel from the Finlayson Lake airstrip, explosives, LNG, diesel, gas, reagents, concentrate, supplies, and cement.

Table 4-33: Estimated Operations Traffic Volume

Year 2-Year 9 average	Yearly Requirement	Load/ Truck (average)	Trucks/ year	Trucks/ Month	Trucks/ day
Reagents (t)	15,400	20	770	64	2.1
Operations Fuel (L)	10,201,000	43,900	232	19	0.6
Generator LNG (GJ)	991,200	1,500	661	55	1.8

Year 2-Year 9 average	Yearly Requirement	Load/ Truck (average)	Trucks/ year	Trucks/ Month	Trucks/ day
Explosives (t)	6,400	20	320	27	0.9
Underground Paste Cement (t)	13,300	40	333	28	0.9
Miscellaneous (t)	5,000	20	250	21	0.7
Subtotal			***2,566***	***214***	***7***
Concentrates					
Cu/Zn -Tridem Trucking	250,000	44	5,682	474	15.8
Pb-Containerised Trucking	36,500	33	1,106	92	3.1
Subtotal			***6,788***	***566***	***19***
Total			***9,354***	***780***	***26***

During operations approximately seven flights will be required each week.

During the initial closure period, vehicle and flight volumes will be in the same range as construction. Post-closure, traffic will be in the range of 2 vehicles per week and flights will be limited to approximately 1 every two weeks.

The bulk of the traffic during construction, operations and closure is expected to occur between Watson Lake and the turn-off to the site on the Robert Campbell Highway, as Watson Lake is along the proposed concentrate route and the majority of the supplies will be shipped through this location.

4.13 DECOMMISSIONING AND RECLAMATION PLAN

The reclamation and closure plan (RCP) addresses the long-term physical and chemical stability of the site, including decommissioning of the processing plant and other facilities, reclamation of waste facilities and surface disturbances, and treatment of mining impacted waters (Appendix H-1). The RCP includes a program for site management and monitoring both during implementation of the closure activities, and after decommissioning and reclamation measures are completed. The RCP also contains a cost estimate for the implementation of the proposed closure measures as well as the long-term monitoring and maintenance of the site, and is the basis for establishing the financial security that will be required on the Project.

As most Project facilities are designed for closure (i.e., forms and slopes are appropriate to meet closure objectives), there are only limited requirements for substantial earthworks related to re-sloping facilities prior to the placement of cover systems. Much of this will be undertaken in a progressive fashion during operations, and will use standard earthworks methods with appropriate machinery (e.g., bulldozers and graders).

Revegetation is a key component of mine reclamation (SER, 2002), and is a critical measure employed to meet a variety of mine closure objectives, including erosion control and restoration of land use and habitat capability. Details of the proposed revegetation program are included Section 7.1.2 of the Conceptual Reclamation and Closure Plan (Appendix H-1).

The overall goal of the RCP is to ensure facilities are designed for closure conditions, so as to ensure physical and chemical stability when decommissioned with no active operation and minimum maintenance. This is achieved with closure objectives for each facility and component of the Project, that clearly describe what the selected closure measures aim to achieve. The following provides a brief summary of the RCP.

4.13.1 Closure Phases

The closure phase will commence once concentrate production from the Process plant ceases. This section is based on BMC's Reclamation and Closure Plan (Appendix H-1) and gives an overview of the activities that will occur over the closure phases.

Figure 4-3 shows the expected Project layout, or configuration, at the end of the operational mining period (Year 10). Three distinct closure phases, or 'periods' have been identified for Project reclamation and closure. These have been identified for planning purposes because:

- In some cases, there are different closure objectives for different periods of time following the cessation of mining activities;
- There are distinct physical activities required in each stage to meet the closure objectives; and
- The filling of the ABM open pit to create the ABM lake delays the final water drainage and discharge condition, and creates a transition period prior to the pit water spilling to Geona Creek.

These separate periods are outlined below with the details regarding the associated closure schedule and execution strategy. Appendix H-1 Conceptual Reclamation and Closure Plan summarizes the closure phase schedule and execution strategy.

4.13.1.1 Active Closure Period (Year 11-13)

The Active Closure Period is the three-year period immediately following cessation of operations, where most consequential decommissioning and reclamation work is completed. Mining equipment will be removed, most infrastructure will be decommissioned, and the Fault Creek diversion will be removed to allow Fault Creek to return to its pre-mining channel and to begin filling the ABM open pit. ABM open pit lime and carbon source water treatment will begin in year 11 and continue through the transition closure period.

Most major earthworks will be completed during this period. The portions of the Class A and B Storage Facilities not reclaimed progressively during operations will have their reclamation completed, with the cover placement being finalized. The camp will be partially decommissioned. All operational water treatment and management systems (i.e., seepage collection and conveyance) are retained and functional, and monitoring and inspection regimens will remain in place, unchanged from the operational period.

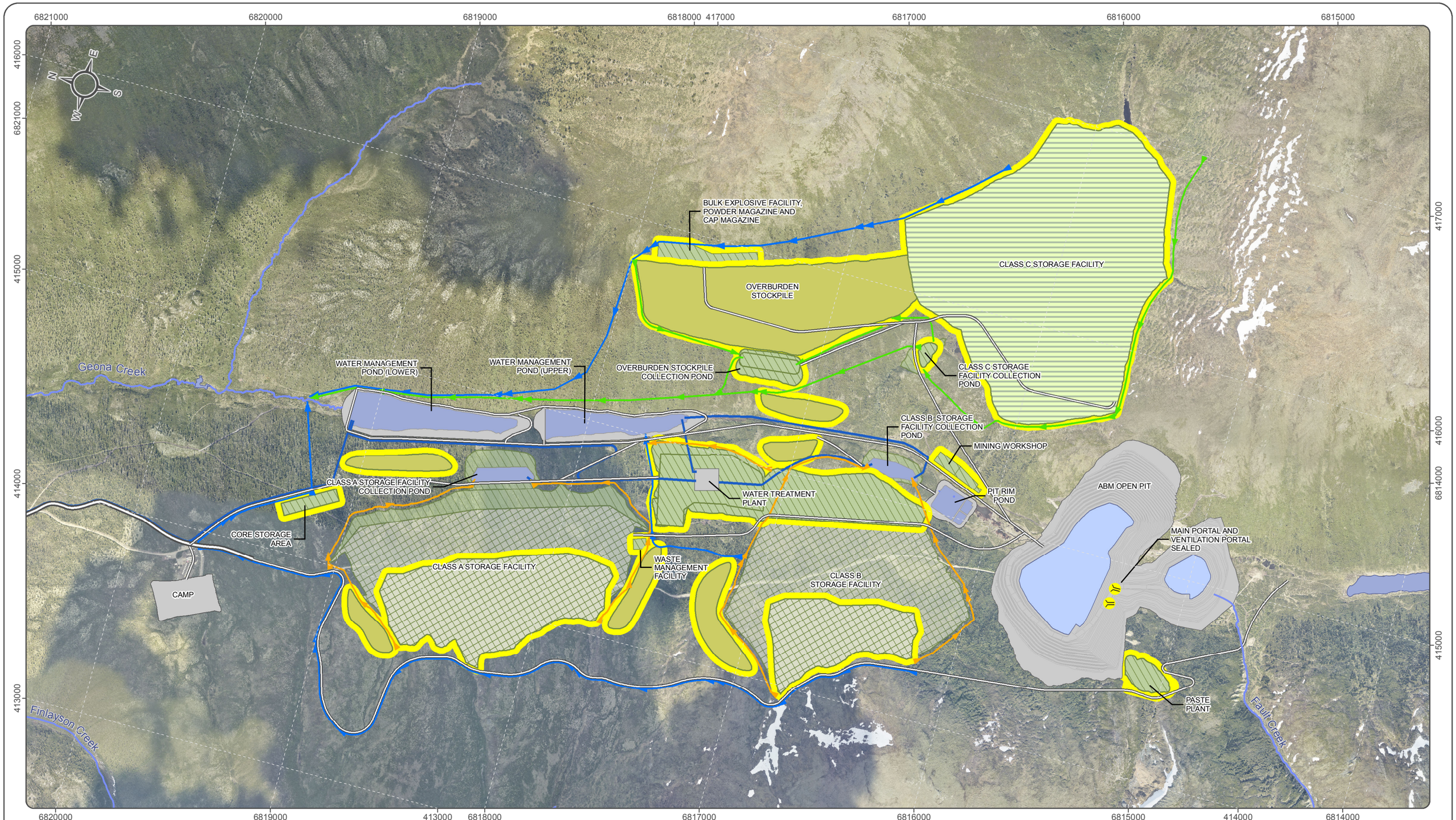
4.13.1.2 Transition Closure Period (Year 14-26)

This period is nominally a 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek. The wetland treatment systems will be constructed and commissioned at the start of this period, and the operational water management systems (i.e., seepage collection and conveyance) will remain on site and functional until such time as the CWTS is performing as required to meet water quality objectives and effluent discharge standards. The water treatment plant and management systems will be retained in a ready state as a contingency.

Monitoring and maintenance of the reclamation earthworks will be undertaken during this period as the waste cover systems and revegetation establish.

4.13.1.3 Post-Closure Period (Year 27-36)

The post-closure period commences with the spilling of the ABM lake water into Geona Creek. It is currently planned to be a 10-year period of primarily monitoring and maintenance. It is expected that a year or two will be required to ensure that the passive water treatment systems are achieving performance expectations with the new water contribution from the ABM lake. Once these objectives and performance criteria are achieved, the active water treatment plant and remaining infrastructure will be demobilized/decommissioned, and site water management will be passive in nature. Figure 4-22 and Figure 4-23 shows the Project area in the post-closure period.



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Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

1:17,000 (when printed on 11 x17 inch paper)

0 250 500 750 Metres

- Closure Activities Occurring in This Closure Period
- Mine Footprint
- Covered with Engineered Low Permeability Cover, Surface Revegetated
- Covered with Overburden, Surface Revegetated
- Infrastructure Removed, Footprint Reclaimed and Revegetated
- Materials used for Reclamation, Footprint Reclaimed and Revegetated
- Pond/Water
- ABM Open Pit Lakes at 1300 masl
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Pipeline
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-22
GENERAL ARRANGEMENT IN ACTIVE CLOSURE PERIOD (YEAR 13)

FEBRUARY 2017

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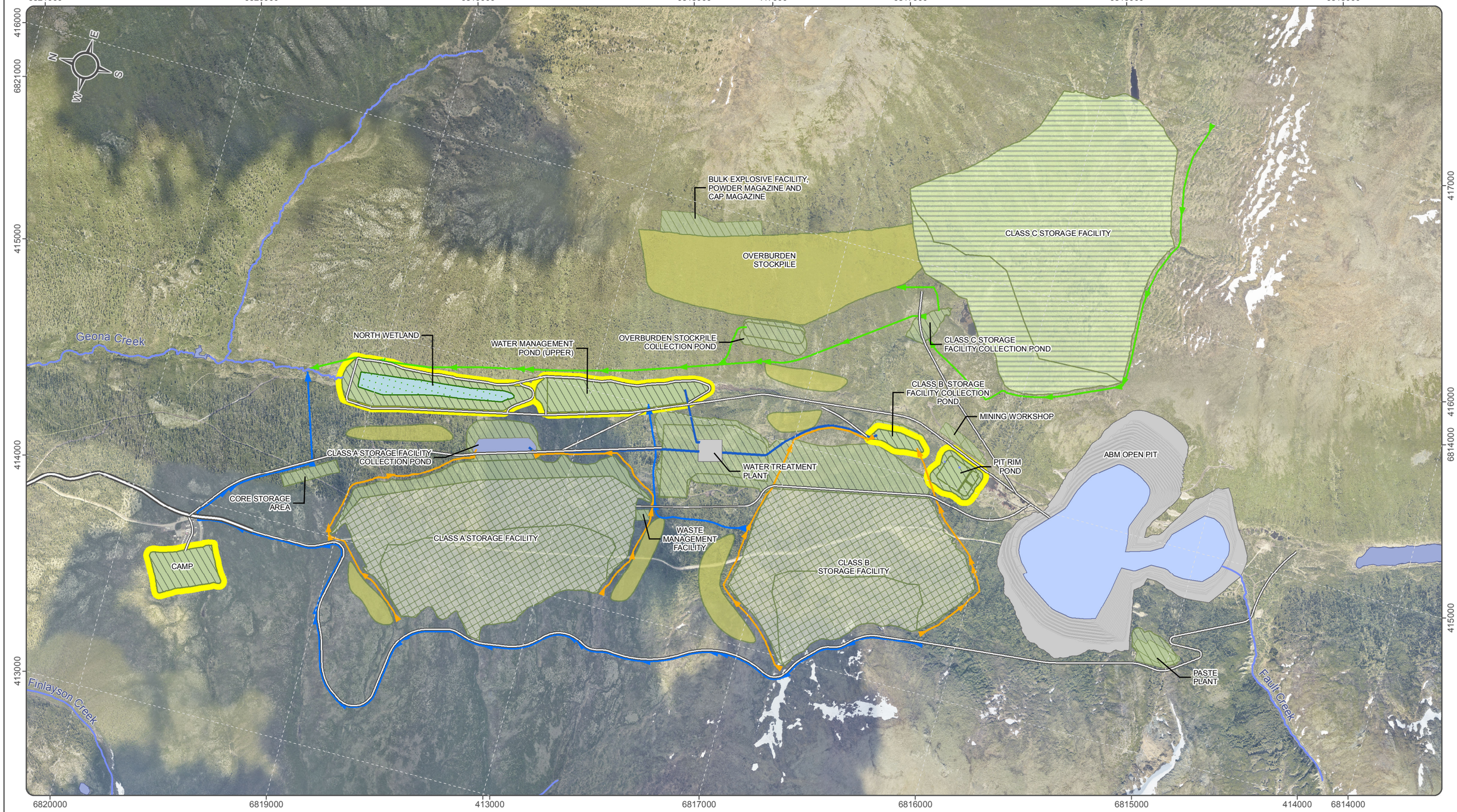
(Last edited by: amatlashevska;06/02/2017/12:36 PM)



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Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

1:17,000 (when printed on 11 x17 inch paper)

0 250 500 750 Metres

- Closure Activities Occurring in This Closure Period
- Mine Footprint
- Materials used for Reclamation, Footprint Reclaimed and Revegetated
- Covered with Engineered Low Permeability Cover, Surface Revegetated
- Covered with Overburden, Surface Revegetated
- Constructed Wetland Treatment System
- Infrastructure Removed, Footprint Reclaimed and Revegetated
- Water/Pond
- ABM Open Pit Lakes at 1350 masl
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Pipeline
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 4-23
PROJECT LAYOUT IN TRANSITION CLOSURE PERIOD (YEAR 20)

FEBRUARY 2017

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Table 4-34: Closure Schedule and Execution Strategy Summary

Development Period	Years (After Construction)	Site Conditions	Closure Activities
Mine Construction	-2 to 1	Construction of mine facilities and stripping of pit and waste facility footprints	• Removal and stockpiling of growth medium from ABM open pit, waste storage facilities, and various site infrastructure footprints
Mining Operations	1 to 10	Active mining operations underway	• Continued removal and stockpiling of growth medium from Waste Storage Facility and Open Pit footprints • Construction of demonstration scale treatment wetland near Process Plant and water treatment plant • Progressive reclamation of Waste Storage Facilities
Active Closure	11 to 13	Active mining operations completed	• Removal of Open Pit equipment and infrastructure • Removal of underground infrastructure and equipment, and sealing of portals • Remove Fault Creek diversion, direct Fault Creek into ABM open pit, pit lime and carbon source water treatment begins, active water treatment if/as required • Place waste covers • Decommission infrastructure and remove from site
Transition Closure	14 to 15	Pit filling	• LWMP Wetland constructed and commissioned – stabilization period • Pit lime and carbon source water treatment continues as required; active water treatment if/as required • ABM open pit spillway constructed • Some roads decommissioned • Routine monitoring and maintenance
	16 to 26	Pit finishes filling	• Routine monitoring and maintenance • Pit lime and carbon source water treatment continues as required; active water treatment if/as required • CWTS preparation for pit water
Post-Closure	27 to 36	Pit spilling to Geona Creek	• Routine monitoring and maintenance • active water treatment if/as required until closure water quality objectives achieved

4.13.2 Mine Site Decommissioning and Restoration

At the end of mine life, all buildings, offices and associated infrastructure will be removed or demolished and buried to return land to original wildlife land use with no active operation or maintenance. Any chemicals, reagents, and hydrocarbons not required for reclamation activities will be removed from site. The processing plant and ore pad areas will be excavated where required to remove contamination and placed in the Class A Storage Facility. Excavated areas will be backfilled with material from the Overburden Stockpile and the processing plant and pad areas will then be regraded and revegetated. Nonessential roads will be reclaimed by scarifying to promote natural revegetation. Key or essential roads will be identified to develop a plan to minimize the advance of invasive plant species.

4.13.2.1 Process Plant

Closure measures for the Process Plant as well as the associated Warehouse and Administration Complex include dismantling and removing buildings, trailers, and related infrastructure. Prior to dismantling and removal, buildings will be inspected for hazardous materials. Any hazardous materials will be removed and disposed of either on or off site in an appropriate landfill or Storage Facility. Non-hazardous materials that have no salvage value will be disposed of in an approved landfill site on the mine site.

Prior to disassembly, buildings will be stripped of all non-attached equipment and materials such as shelving units, office furniture, equipment, etc. Wherever feasible, materials with salvage value will be sold for its value. Modular prefabricated trailer style buildings will, wherever economically feasible, be removed from the site and sold for their salvage value. The remaining service piping, cabling and skirting lumber will be removed and disposed of as either scrap or as salvageable material. Rigid steel frame buildings will be dismantled on site with the support steel being sold for salvage value wherever economically feasible.

Closure measures for the Process Plant building include salvage and removal of the process equipment, and dismantling of the engineered building.

Above grade concrete footings, foundations, concrete floor slabs and below grade concrete foundations will be broken to allow percolation of water and covered with suitable overburden to support revegetation. The covered slabs will be seeded with an appropriate vegetation mix to establish vegetative growth over these areas. The Company intends to carry out further studies prior to closure to identify the potential for other uses for the concrete foundations/slabs/footings including the feasibility for inclusion within the Class A or B storage facilities and/or the underground mine.

The Process Plant area will be recontoured as required to promote positive drainage, and suitably revegetated to provide erosion protection as well as to match the surrounding natural vegetation.

4.13.2.2 ABM Lake Filling

The ABM open pit and surrounding areas will undergo reclamation to the extent of ensuring that the pit walls are stable and pose no danger to the general public or local wildlife. Berms will be created around high wall edges to prevent inadvertent access by people or wildlife. The ABM open pit will be allowed to flood as dewatering will cease, and equipment will be removed. Fault Creek will be redirected to the ABM open pit.

The accumulation of secondary minerals during weathering of the exposed pit walls and pit floor may result in the presence of elevated metal concentrations in pit water during its flooding. Water quality data collected from the pit during its initial filling will be used to determine if lime addition is necessary to control metal concentrations; acidic conditions are not anticipated due to the limited presence of acid generating pit wall lithologies and the alkalinity provided by Fault Creek and groundwater. Should elevated metal concentrations be present, lime will be added to the pit as required to raise the pH to facilitate metals precipitation within the pit.

The pit will fill during the active closure and transition closure periods. The spilling of the pit into Geona Creek will signal the commencement of the post-closure period.

An engineered spillway will be constructed to control outflow from the ABM lake. The wetland treatment system within Geona Creek downstream of the pit will provide both a contingency treatment for those constituents that may not be efficiently ameliorated by ABM lake lime addition (e.g., selenium, uranium, antimony) and a secondary polishing step for other constituents of potential interest (e.g., zinc, lead, cadmium, copper, and arsenic).

4.13.2.3 Final Storage Facilities

Waste rock will be stored in three storage facilities.

The Class A Storage Facility will contain tailings co-deposited with waste rock that has strong potential for acid generation. The Class A Storage Facility will be constructed, and waste deposited, such that it has an overall slope of 4H:1V to ensure long term stability. This facility will be progressively reclaimed with an engineered low permeability cover to provide encapsulation and prevent contact with oxygen as well as to provide a barrier from people and terrestrial animals.

- A three-layer cover will be placed on the surface of the facility (at a 2% grade) and the slopes (4H:1V). The cover will be keyed into the liner underneath the tailings. This cover will comprise:
  - A surface layer of 0.3 m growth medium from local topsoil and overburden to support revegetation, which will be graded at surface to blend with the natural topography;
  - A minimum of 3.0 m of Class C waste rock to act as a frost protection layer and to prevent erosion; and
  - A very low permeability material with approximately 0.2 m of local till to serve as a bedding and a protective layer to prevent damage to the liner.

- A constructed French drain at the toe of the facility will collect drainage during operation and active reclamation, until the cover is established to limit flux through the Storage Facility. Following closure, the non-contact water (run-off from the cover) will be directed away from the cover.

The Class B Storage Facility will contain waste rock that has weak potential for acid generation. The Class B Storage Facility will be constructed similarly to the Class A facility.

- A three-layer cover will be placed on the surface of the facility (at a 2% grade) and the slopes (3H:1V). The compacted till cover will be keyed into the liner underneath the tailings. This cover will comprise:
  - A surface layer of 0.3 m growth medium from local topsoil and overburden to support revegetation, which will be graded at surface to blend with the natural topography;
  - A minimum of 3.0 m of Class C waste rock to act as a frost protection layer and to prevent erosion; and
  - A 1.0 m layer of compacted till directly on the Class B waste rock to minimize net percolation.
- A constructed French drain built into the foundation will collect drainage during operation and active reclamation, until the cover is established to limit flux through the Storage Facility. Following closure, the cover will shed surface water to the environment once monitoring demonstrates it is acceptable for discharge.

The Class C Storage Facility will contain potentially acid consuming waste rock, and as such a cover that reduces net percolation is not required. A 0.3 m growth medium from local topsoil and overburden to support revegetation.

Progressive reclamation of the Class C Storage Facility will be initiated during the operation phase of the Project.

All three facilities will have growth medium placed on top and will be revegetated to reduce erosion and to meet the end land use objective of returning the area the current wildlife habitat. The quick establishment of vegetation may require a preliminary revegetation prescription for stabilization, with slower growing native community establishment to follow.

The Overburden Stockpile is anticipated to be utilized during the mine life as foundation material for the Class A and Class B Storage Facilities and for construction of the Water Management and Seepage Collection Ponds and during closure for use as covers. Upon closure, any remaining materials will be recontoured to stable slopes and the area will be revegetated with a layer of growth medium and reseeding to match the surrounding natural vegetation.

4.13.2.4 Support Infrastructure

Closure measures for fuel storage areas include draining tanks of any remaining fuel and salvaging or recycling as appropriate. Liners will be removed and disposed of in an appropriate landfill. Any

fuel contaminated soils, as determined by a field sampling program, will be excavated and disposed of in the land treatment facility.

The sewage treatment plants will be decommissioned by draining and flushing any tanks and piping with clean water to remove any residual treatment sludge and effluent. The plants will be disassembled and salvaged or recycled as appropriate.

Closure measures for the water treatment plant include disconnection of piping and equipment, which will be salvaged or recycled as appropriate. The treatment plant building will be disassembled with any salvageable materials collected. Debris will be placed in the site landfill or, should the site landfill be closed, to an off site landfill facility.

The land treatment facility will be closed once all soils requiring treatment are fully treated. Generally, treated soils will be spread throughout the site at approved locations. The liner will be disposed of in either the site landfill, or an off site facility if the site landfill is closed at the time of decommissioning. The area will be regraded and revegetated to match the surrounding topography.

The solid waste facility will receive waste throughout the closure of the site. As such, it will not be closed until the active closure period has completed. A decommissioning plan will be submitted to YG for the solid waste facility. Once approved, the facility will be closed with a soil cover and the area will be revegetated.

At closure, any unused explosives, magazines, and other equipment will be returned to their respective suppliers or sold to third parties taking into account any residual obligations for disposal that may be obligated under Canadian law. The prill and emulsion silos will be decommissioned and salvaged as appropriate. The garage and office will be dismantled and salvaged. Any fuel contaminated soils will be excavated and placed in the land treatment facility. The area will be recontoured to match local topography and revegetated.

Mobile equipment including vehicles, compressors, mobile electricity generators and self-contained storage tanks will be decommissioned and removed from site for sale, salvage, or recycling as appropriate.

The truck shop buildings will be dismantled and materials salvaged or recycled as appropriate. Debris which cannot be salvaged will be placed in the site landfill for disposal. Concrete footings, foundations, and floor slabs will be broken to allow percolation of water and covered with suitable overburden to support revegetation. The covered slabs will be seeded with an appropriate vegetation mix to establish vegetative growth over these areas.

Closure measures for the Paste Fill Plant will include the removal of equipment for salvage, and the dismantling of the building. Materials will be salvaged or recycled as appropriate, and debris placed in the solid waste facility. Concrete footings and floor slabs will be broken and buried in place. The area will be recontoured and revegetated.

4.13.2.5 On Site Traffic

Traffic will use existing site roads for access to the various facilities requiring closure. As facilities are revegetated and the access roads are deemed no longer necessary they will be reclaimed and revegetated using methods outlined in Section 4.13.6.

4.13.2.6 Off Site Traffic

Equipment and materials delivery and removal during the closure phase will vary dependent upon the stage of closure of various components. It is anticipated that there will be an average of three truckloads a day over the active closure period with minimal traffic over the transition and post-closure periods.

4.13.3 Water Management and Water Quality Control Measures

Water retention and sediment control structures, and appurtenances will be decommissioned or upgraded to ensure that drainage at, and adjacent to the site, is stable in the long term. Additionally, flows will be conveyed into and throughout the mine footprint, and off the site in a controlled, stable fashion under a reasonable range of anticipated conditions. This will be accomplished by maintaining suitable gradients to permit flow and reduce infiltration and erosion. Facilities will be designed to minimize contact of surface flow with mine influenced soils. Modifications will be performed to flow patterns at site to achieve enhanced stability or accommodate water quality objectives. Temporary (operational) structures, including stream crossings and diversions, such as the Fault Creek diversion, will be removed. The Class A and Class B seepage collection ponds will be pumped back to the Water Treatment Plant until such time that water quality is suitable for passive release perpetually through wetland treatment.

The Upper and Lower Water Management Ponds and associated dams will be retained through the active closure period and will begin to be decommissioned in the transition closure period. Once the covers for the Class A and B Storage Facilities are determined to be effective and meeting their design criteria the LWMP will no longer be required to manage contact water and will be decommissioned. The LWMP will be converted into the CWTS with the decommissioning of the LWMP dam and wetlands constructed during the transition closure period. During the transition closure period any contact water requiring storage will be directed to the Upper Water Management Pond or would be directed to the ABM open pit as a contingency measure.

Upon the successful commissioning of the CWTS and with the waste rock covers for the Class A and B Storage Facilities meeting their design criteria the Upper Water Management Pond and dam will be decommissioned including the removal of its HDPE liner.

The Class A Storage Facility collection pond will be decommissioned following the determination that the cover is meeting its design criteria and the drain down of the Class A material is determined to have ceased and active pumping is no longer is required. If required a horizontal drainage pipe will be installed at the bottom of the French drain to convey water to the CWTS. The Class A Storage

Facility Collection Pond will be decommissioned by removing the HDPE liner, scarifying the surface and revegetating the pond area.

The Class B Storage Facility collection pond will be decommissioned as a water collection feature following the determination that the cover is meeting its design criteria. The Class B Storage Facility Collection Pond may be converted to a passive treatment system if the Class B Storage Facility seepage water quality is of lower quality than predicted. Upon the determination that the Class B Storage Facility water quality is stable in the long term the Collection Pond will be decommissioned by removing the HDPE liner, scarifying the surface and revegetating the pond area.

The Class A and Class B Storage Facilities Collection Ponds will be pumped to the Water Treatment Plant throughout the active closure period and into the transition closure period until such time that the waste rock covers have been established. Once the Class A and Class B waste covers and the CWTS have been determined to meet their design criteria, the Class A and B Storage Facility Collection Ponds will be passively released to the CWTS if the water quality is deemed suitable. Given the time required to construct the covers and wetlands it has been assumed that active treatment would be required for five years.

The Class C Storage Facility Collection Pond will be decommissioned during the transition closure period once the revegetated covered has been determined to be stable in the long term. Following the revegetation of the Overburden Stockpile area and the area deemed stable from erosion the Overburden Stockpile Collection Pond will be decommissioned. Runoff from the Class C Storage Facility and the reclaimed Overburden Stockpile will continue to be conveyed in the ditch to the discharge location below the Lower Water Management Pond dam to minimize clean water entering the CWTS.

Upon closure the Open Pit will be allowed to flood as dewatering will cease and Fault Creek will be redirected to the Open Pit. Temporary (operational) water conveyance structures, including diversions, such as the Fault Creek diversion, will be removed at the cessation of mining. The decommissioning of the Fault Creek diversion and the Southern diversion ditches will redirect water back into the Geona Creek catchment and will contribute to the ABM open pit sub-catchment. For the objective of minimizing contaminant loading from the pit, the closure measures may include batch treatment of the ABM lake by adding lime with the initial filling of the pit to address flushing of secondary mineralization related metal concentrations, with a contingency of wetland treatment in Geona Creek. The construction of an engineered spillway will control outflow from the ABM lake. The objective of ensuring safety of people and terrestrial animals in the pit area will be accomplished with berms around the highwall, at a setback from the crest. To ensure safe egress from the pit, the haul road open will be left open for walking but blocked to vehicle access.

Additionally, flows will be conveyed into and throughout the mine footprint, and off of the site in a controlled, stable fashion under a reasonable range of anticipated conditions during the active closure period. This will be accomplished by maintaining diversions to reduce infiltration and erosion of reclaimed area. Diversions will be maintained during the transition closure period to minimize contact of surface flow with mine influenced soils. Also, modifications will be performed to flow patterns at site to achieve enhanced stability or accommodate water quality objectives during

the transition closure period as mine features are reclaimed (e.g., Storage Facilities, Process Plant, Paste Fill Plant). As an example, portions of the northwest diversion will be decommissioned in stages as the mine features along the western side of the Geona Creek valley have been successfully reclaimed to return drainages to pre-mining conditions to the extent possible.

Once the water from the Class A and Class B Storage Facility Collection Ponds has been routed through the CWTS, the Water Treatment Plant will be placed on standby, but available to treat water if required for the remainder of the transition closure period.

Following the cessation of mining the ABM Deposit the Pit Rim Pond will be decommissioned. Decommissioning of the Pit Rim Pond will include removal of the HDPE liner, scarifying the surface and revegetating the pond area.

Once the ABM lake reaches 1,380 masl (nominally in year 26 following construction) it will begin to spill and discharge to Geona Creek. The pipeline from the ABM open pit to the Water Treatment Plant will remain in place until it has been determined that the water from the ABM open pit does not require active treatment. It has been assumed that up to five years of active treatment may be required during the post-closure phase to integrate the ABM lake discharge into the CWTS system and optimize performance to meet the design criteria. Upon the site being determined to be geochemically stable in the post-closure period the active Water Treatment Plant will be decommissioned. Sludge produced from the active Water Treatment Plant during closure will be placed into the ABM open pit, which will provide additional alkalinity to the water.

4.13.4 Waste Management

During closure, all hazardous materials will be removed from site. Table 4-35 lists the potential hazardous materials on site at closure and handling requirements for disposal and or removal. Incompatible substances will be stored separately to prevent contamination, fires, explosions, gaseous emissions, leaching or other discharges, or other dangerous conditions according to the Material Safety Data Sheets (MSDS). Any unused hazardous materials will be returned to vendors or sold where possible. Some residual hazardous wastes can be incinerated on site and the residual ash disposed of in the on site landfill. Residual hazardous materials will be transported off site by certified hazardous materials transport companies and disposed of at certified facilities. When transporting hazardous materials, the containers will be labelled following Transportation of Dangerous Goods Regulations (SOR/2008-34).

Table 4-35: Potential Hazardous Materials at Closure and Disposal Requirements

Hazardous Material	Removal / Disposal Requirements
Processing reagents (e.g., lime, flocculants, activators, depressants, collectors, frothers)	Return unused reagents to vendors; Transport residual reagents and containers to certified disposal facilities
Waste diesel	Burned on site if permit allows
Fuels	Transported off site and used elsewhere or sold

Hazardous Material	Removal / Disposal Requirements
Aviation fuel (at mine site)	Managed by air service contractors for use on other contracts; no residual fuels or waste barrels are to be left at the Finlayson Lake airstrip
Solvents and lubricants (e.g., paint thinners and strippers, varsols, degreasing fluids, mineral spirits and petroleum distillates)	Shipped to licensed recycle and/or disposal facility
Used oil and filters	Incinerated on site under valid permit with ash disposed of in on site landfill or transported to used oil disposal facility
Propane	Shipped to licensed recycle or disposal facility
Compressed gas	Shipped to licensed recycle or disposal facility
Antifreeze soaked absorbents	Incinerated with ash disposed of in on site landfill
Used batteries	Stored appropriately on wooden pallets with plastic wrap and shipped to a licensed recycle or disposal facility
Aerosol containers	Shipped to licensed recycle or disposal facility
Medical wastes (e.g., syringes, bandages)	Collected in purpose-built sharps containers and incinerated
Hydrocarbon contaminated soils	Managed in on site land treatment facility while the on site facility is permitted, then removal and disposal

4.13.5 Monitoring, Maintenance and Schedule

Monitoring of closure components will continue until such a time that closure objectives have been met. Monitoring programs will consist of three phases:

- Assessment – Baseline conditions of ecosystems that will potentially be impacted by the Project;
- Operational – confirms or refutes accuracy of predictions on impact of the Project that were made during the effects assessment; and
- Transition – monitoring that will begin with the start of the approved decommissioned and reclamation activities.

4.13.6 Access Road Closure

Road reclamation will involve the removal of the culverts and drainage structures and decommissioning of the roadbed. The roadbed will be contoured and rounded throughout its length, and will include the following activities:

- In smaller cuts and fills, ditches will be filled in, and the soils shaped to match the surrounding topography;
- In large cuts and fills, the embankment or excavation footprint will be reshaped to a lesser extent, but all slopes will be flattened or rounded to better suit the surrounding terrain; and

- Surfaces of gradients less than 25% will be scarified where necessary using scarifiers on bulldozers, excavators and graders to better accept seeding.

All culverts, bridges, and drainage structures will be removed and disposed of off site at an appropriate location. The following activities are planned:

- Trenches resulting from the removal of culverts will be swaled or contoured to match the surrounding terrain;
- Where warranted due to fine grain soils, erosion protection will be installed within the remaining swales, to a point where the reclaimed watercourse meets with its original path in undisturbed soil;
- If ditches are to be left intact (potentially required in steeper sections) existing ditch erosion protection may be left in place; and
- The bridge at kilometre 17 (L100 Bridge) will be removed, and the abutments will be excavated to the level of the rip-rap placed during construction.

All exposed soils along the length of the road will be stabilized and contoured to prevent surface erosion, then seeded with an appropriate seed mix.

4.14 WORKFORCE, PROCUREMENT, HIRING AND TRAINING

The Project will have different personnel requirements as it advances through the different stages of construction, operations, decommissioning, closure and post-closure. Personnel requirements for each of these stages is described in this section.

4.14.1 Construction

The majority of the construction work will most likely be managed by an EPCM contractor, acting as an agent for BMC. The EPCM contractor will establish prime contracts for civil / concrete and structural / mechanical / electrical / piping / instrumentation. The contracting plan will be based on utilizing local contractors where practicable to execute the construction work packages to minimize mobilization and travel costs. The EPCM contractor will prequalify local contractors and prepare tender documents to bid and select the most qualified contractor for the various work packages. Some work packages will include the design, supply, and erection for specific facilities which are specialized in nature.

First Nation businesses will be given the opportunity to participate in the bidding process, and successful contractors will be required to adopt BMC's obligations under the SEPA or any other agreement that BMC enters into with First Nations.

BMC will also maintain an owners' team on site to oversee and manage the construction program.

Procurement of major process equipment will be completed by the EPCM contractor, in consultation with BMC. It is intended that equipment will be sourced on a worldwide basis, assessed on the best delivered price and delivery schedule, fit for purpose basis.

Personnel requirements will vary over the construction period, but are expected to peak at approximately 350 people. Personnel numbers will vary seasonally and during the construction of the various infrastructure components.

The primary work roster expected to be adopted for construction work will be a three week on, one week off roster, common to many construction projects in Western Canada. Variations on this roster allowing for shorter work periods on site may be adopted as required.

The construction workforce will comprise of a combination of BMC employees and contractor skilled and unskilled employees. Construction positions are expected to include the following (but not be limited to):

- heavy and light equipment operators;
- crane operators;
- riggers;
- truck drivers;
- mechanics;
- electricians;
- laborers;
- millwrights;
- carpenters;
- pipefitters;
- boilermakers;
- masons;
- sheet metal workers;
- painters;
- warehousemen;
- construction supervisors;
- catering and services;
- surveyors;
- engineers; and
- management.

Training of personnel for construction work will primarily be the responsibility of the individual contractors, with the EPCM contractor and BMC personnel acting in a monitoring role to verify that the works are completed to the required standards and in a safe manner.

4.14.2 Operations

For the operations phase of the Project, it is expected that mining contractors will be engaged as required under BMC Management, to complete both Open Pit and underground mining functions. BMC will employ personnel required for processing plant and administration roles, as well as mining technical and managerial positions.

The number of personnel required for operations will vary by period, depending on the variation of mining activity required to meet processing requirements, as shown in Table 4-36.

Personnel numbers are projected to range between 100 and 345 through the life of the Project. The majority of personnel will be employed on a two week on, one week off roster, while certain staff will be employed on a nine day on, five day off roster.

Procurement of goods for the operation will typically be based on establishing long term supply contracts for goods and services. Local businesses will be given every opportunity to supply goods and services on commercially realistic terms. Examples of contracts that will be established for the operations include camp services, access road maintenance and concentrate haulage.

BMC will actively promote the employment of First Nations peoples within BMC as well as by the contractors that provide services to the operation. All contracts that BMC enters into will include the obligations that BMC has under the SEPA as part of the contract.

Training of personnel will be the responsibility of each primary employer, with BMC ensuring that all work is completed to a good standard and in a safe and efficient manner.

Table 4-36: Estimated Site Labour Requirements

Department	Roster	Preproduction Year		Production Year									
		-2	-1	1	2	3	4	5	6	7	8	9	10
Open Pit	9/5	8	8	8	8	8	8	8	8	8	8	8	0
	2/1	92	95	150	142	142	133	131	122	122	122	119	0
Underground	9/5	0	0	0	0	0	0	0	0	0	0	0	0
	2/1	0	0	0	41	77	83	83	83	61	41	41	0
Processing	9/5	0	0	12	12	12	12	12	12	12	12	12	12
	2/1	0	0	62	62	62	62	62	62	62	62	62	62
Administration	9/5	0	0	18	18	18	18	18	18	18	18	18	18
(Including Camp, Road Maintenance Contractors)	2/1	0	17	26	26	26	26	26	26	26	26	26	26
Total by Roster	9/5	8	8	38	38	38	38	38	38	38	38	38	30
	2/1	92	112	238	271	307	304	302	293	271	251	248	88
Total Personnel		***100***	***120***	***276***	***309***	***345***	***342***	***340***	***331***	***309***	***289***	***286***	***118***
Total Onsite at One Time		***66***	***80***	***183***	***205***	***229***	***227***	***226***	***220***	***205***	***192***	***190***	***78***

4.14.3 Decommissioning

Decommissioning of the site following completion of mining and processing operations will require approximately 30 people to remove the various items of infrastructure from the Project, including but not limited to the Process Plant, Paste Fill Plant and explosives facilities. The decommissioning of facilities will be facilitated through the use of contractors experienced in this type of work. Decommissioning works may be broken down into smaller work packages where it is logical to do so. Prequalified local contractors will be given the opportunity to bid for work packages where appropriate and all contracts will include the obligations that BMC has under the SEPA as part of the contract.

BMC will maintain a small supervisory presence on site to ensure that the decommissioning works are completed in a safe and efficient manner.

It is expected that the work roster adopted for decommissioning by the contractor(s) will normally be a three week on, one week off roster, although shorter rosters may be adopted on an as required basis. Contractors will be encouraged to procure goods and services from local communities where it is economically viable to do so.

4.14.4 Closure

BMC will manage the closure program, with the employment of contractors as required to fulfil the reclamation and closure plan. It is expected that two work rosters will be utilized on site during closure. Most staff positions will be employed on a nine day on, five day off roster, while regular shift workers and certain staff will be employed on a two week on, one week off roster. Total employee numbers are estimated at up to 50 people depending on the season.

Local contractors will be given the opportunity to bid for the provision of the goods and services required to meet the closure plan requirements. BMC will continue to encourage the employment of First Nations peoples through their own direct employment as well as through the contractors engaged for the closure works.

4.14.5 Post-Closure

During the post-closure phase, most personnel will be employed on a two week on, one week off roster. Total personnel numbers are estimated to be between six and ten people depending on the season, with site monitoring the main activity. Local employment will be encouraged by BMC, where the skills required for the tasks are available. BMC's expectation is that training provided to local personnel during the operations phase will equip local personnel with most, if not all, of the skills required for post-closure monitoring requirements.

4.14.6 Employee Health and Well-being

BMC will develop an employee health and well-being program which will be implemented during all Project phases. The purpose of the program is for BMC to promote and support the health and well-being of its employees and their families. Some of the key aspects of the program will be:

1. Provide social assistance/education to all employees and their families including:
    a. Financial management training (including risks of taking on debt)
    b. Drug and alcohol counselling (including time off for employees who need treatment)
    c. Marriage counselling
    d. Healthy living education (i.e. benefits of diet and exercise)
2. BMC will host annual family days at the mine site to show spouses and children of the employees, the mine and associated facilities (BMC's experience is that families are more comfortable with their spouses being away if they have seen the site and facilities first hand);
3. Communications at the site will be individual connections in each room to ensure that employees can easily communicate via skype/facetime etc. with their spouses and children in the privacy of their room rather than in a communal area;
4. BMC will provide recreational facilities at the site and all meal times will have healthy food options, in order to promote health and well-being of employees while on-shift (with the intent that this would also extend to off-shift healthy living);
5. Training of employees (i.e. trades, apprenticeships, management etc.) to promote progression in their careers (which may enhance job satisfaction);
6. Bereavement leave for all employees (up to 4 or 5 days per year) (this has not yet been finalized – but the commitment is there); and
7. The shift rotations will allow for people to take one month off twice per year.

Additional components of the health and well-being program have been incorporated into Chapter 15.

4.15 ALTERNATIVES AND CHOSEN APPROACH

4.15.1 Introduction

In conducting the environmental and socio-economic assessment of the Kudz Ze Kayah Project, The *Yukon Environmental and Socio-economic Assessment Act* section 42. 1. (e) requires that the Executive Committee take into consideration: "alternatives to the Project or existing Project, or alternative ways of undertaking or operating it, that would avoid or minimize any significant adverse environmental or socio-economic effects."

The Executive Committee has published a guidance document for proponents to ensure that Project Proposals include sufficient information to enable Executive Committee to undertake an assessment of projects that also takes Project alternatives into consideration. This section has been prepared in accordance with that guidance.

4.15.2 Methods

4.15.2.1 Mine Components Evaluated

BMC's first step in conducting the evaluation was to determine which components of the Project would have alternative methods of being undertaken that would avoid or minimize environmental or socio-economic impacts.

Seven components of the Project were considered as being relevant for the purposes of evaluating alternative methods:

- Tailings Disposal Methods and Locations;
- Waste Rock Disposal;
- Waste Rock Management;
- Airstrip Access;
- Power Generation Options;
- Concentrate Transport Route; and
- Mining Methods.

4.15.2.2 Performance Criteria and Ranking System

At least two alternative methods were evaluated for each component, and ranked for relative practicality and performance against the following common criteria:

- Cost Effectiveness;
- Minimizes negative effects on the natural environment;
- Maximizes beneficial socio-economic benefits; and
- Amenability to reclamation.

Based on the criteria above, alternatives were ranked qualitatively as:

- **Preferred** – the performance criterion for a particular option is judged to be the best, when judged against the other option(s). For greater certainty, there can only be one preferred option for each component assessed;
- **Acceptable** – the performance criterion for a particular option is considered to have some drawbacks, but within an acceptable range. There can be more than one alternative that receives an acceptable ranking; and
- **Least Preferred** – flaws are seen for the particular option in a certain criterion. For the overall ranking of alternatives for each component, in the case of any one or more

performance criteria which has been ranked 'least preferred', that alternative has been rejected.

After each alternative for the selected options were evaluated against these performance criteria, a final preferred alternative was selected. For each mine component that has undergone this evaluation, the option that is ranked 'preferred' overall has been incorporated into the mine plan.

4.15.3 Alternatives to the Project

Unlike other types of projects for which a number of alternatives to the Project itself would be available, mines are unique because ore bodies have a fixed location, and the only way to proceed with a mining venture is to mine the ore body in place. Consequently, the only realistic Project alternatives for the Project itself would be to:

1. Proceed with the Project in the near-term;
2. Delay the Project, or
3. Abandon the Project.

In consideration of market economics, cost structure of major inputs including fuel, steel, and employee wages the conclusion of the Prefeasibility Study was that to render the Project viable, it should proceed in the near term. From the perspective of maximizing socio-economic benefits, considering Yukon's current economic and employment situation proceeding with the Project sooner rather than later would be the preferred outcome.

With some mining operations, consideration may also be given to mining the ore body on site and transporting the ore to another location for processing. This is not a viable alternative for the Project because of the absence of suitable alternative concentrating facilities in reasonable proximity of the deposit (i.e., none in Yukon), and other potential environmental effects considerations as described below.

During community and Kaska meetings and open houses, the question of why BMC is not planning to use the nearby Wolverine Mine concentrator to process KZK ore was often raised. In consideration of the frequency with which this question was raised during consultation and with the broad range of stakeholders who have shown interest in this question, it is worthwhile to set out here the reasons that BMC considers that processing KZK ore the nearby Wolverine Mine is not a suitable candidate due to:

- The Wolverine Process Plant capacity throughput is 1,700 t per day; BMC has determined that the optimal production rate for the KZK Project is approximately 5,500 t per day; reducing the production rate by greater than 65% would have unacceptable impacts to overall Project viability;
- The Wolverine processing flowsheet does not reflect the optimized flowsheet design for KZK ore;

- The Wolverine tailing Storage Facility is near design storage capacity; also it is a wet tailings method which was not the preferred option for BMC;
- The increased haulage distance (either using existing access roads or constructing a new road between the two sites) would render unacceptable financial impacts to the overall Project;
- Trucking ore to Wolverine mine site would potentially result in impacts to two separate watersheds, and would require two separate licencing approaches; the amendment to Yukon Zinc Type A Water Licence would result in a potentially complicated liability scenario for both companies; and
- Even if KZK ore was taken off site, the Open Pit and underground mine, the waste rock storage facilities, camp, access, haul and site roads, and most site infrastructure would continue to be required at the KZK site; only the tailings and the processing plant would be absent from the Project general facilities arrangement. Therefore, the overall environmental footprint of the KZK Project would not be significantly reduced.

In consideration of the above, this alternative was not considered viable and was not compared to the proposed option.

4.15.4 Alternative Means of Carrying out the Project

4.15.4.1 Tailings Disposal Methods and Locations

The Project's previous owner Cominco conducted exploration, engineering design studies, baseline environmental studies and consultation activities in 1994 and 1995 to support Project design. The Cominco mine plan included Open Pit mining for a nine-year mine life and storage of approximately 72 Mt of waste rock, with tailings deposited in a subaqueous valley-fill tailings facility which include a permanent earthen tailings facility in Geona Creek.

To support this decision, Cominco commissioned a high-level tailings management alternatives study. Golder Associates (Golder, 1996b) prepared a high-level ranking of the alternatives based on storage capacity, distance from the Open Pit, seepage, closure considerations, watersheds impacted, length of creek potentially affected, and the lake areas potentially affected. That desktop study recommended storing slurried tailings as submerged valley fill behind an earthen facility situated in Geona Creek. Cominco did not construct the Project.

With Cominco's work as a baseline, BMC retained internationally renowned Knight Piesold Consulting (Vancouver office) to undertake a Tailings Management Alternatives Assessment to support mine design decisions during the completion of the Prefeasibility Study (KP, 2016a).

The KP study initially identified thirteen potential tailings storage sites within approximately 10 km from the ABM Deposit. Two methods of tailings storage technology for each site were considered: slurry and filtered tailings. The tailings technology for each candidate was selected based on site specific constraints.

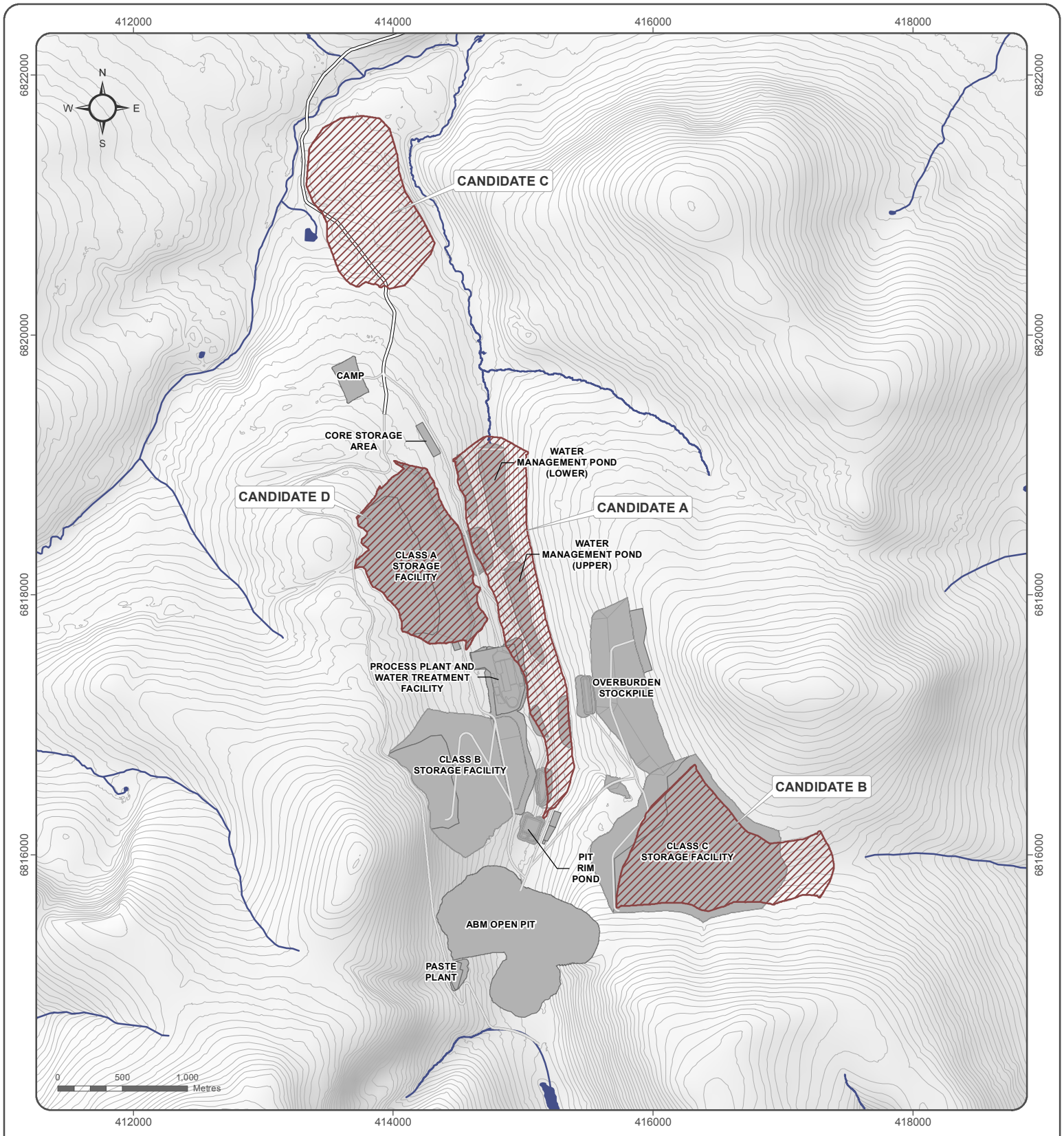
Pre-screening criteria were developed to evaluate and eliminate candidates with evident shortcomings (KP, 2016b). Eight candidates were removed in the pre-screening process and four candidates were advanced to the next assessment phase (Figure 4-24). The four candidates remaining after the pre-screening were:

A. Slurry tailings facility located in Geona Creek;

B. Slurry tailings facility located in the East Hanging Valley;

C. Filtered tailings facility located near the current exploration camp, at the confluence of Geona and Finlayson Creeks; and

D. Filtered tailings facility located on the western hillside of Geona Creek.



Tailings Storage Facilities Alternatives

Location of Proposed Mine Infrastructure

Waterbody

Watercourse

Tote Road/Proposed Access Road

Proposed Mine Road

Contour (10 m)

KUDZ ZE KAYAH PROJECT

FIGURE 4-24
TAILINGS STORAGE FACILITY ALTERNATIVES

JANUARY 2017

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Datum: NAD 83; Projection: UTM Zone 9N

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For the purposes of this alternatives assessment, BMC then evaluated these four final candidate sites and types of deposition alternatives against the common performance criteria.

- ***A. Slurry tailings in Geona Creek:*** This option would involve depositing slurry tailings underwater behind an earthen tailings facility situated directly in Geona Creek. This method relies on deposition underwater to prevent oxygen from contacting the potentially acid generating tailings. This was the option that Cominco originally presented and was permitted by the Yukon Water Board. This alternative was ranked 'preferred' in cost effectiveness criterion due to relatively simple construction and low operating costs, and ranked 'least preferred' in the environmental criterion due to risk of tailings facility failure, permanence of the environmental legacy, and permanent loss of fish habitat in the uppermost reaches of Geona Creek. It was ranked 'acceptable' in socio-economic benefits and 'least preferred' in the amenability to reclamation criterion because these facilities are permanent and not reclaimed.
- ***B. Slurry tailings in east hanging valley:*** This option would involve depositing slurry tailings underwater behind an earthen tailings facility situated in the hanging valley on the east flank of the Geona Creek valley. This method relies on deposition underwater to prevent oxygen from contacting the potentially acid generating tailings. This option was ranked 'acceptable' in cost, effects on the environment and socio-economic criteria, and 'least preferred' in amenability to reclamation because this would be a permanent, non-reclaimed facility. This location would prevent the placement of the Class C Storage Facility in this valley, which has been ranked as the preferred candidate site for that facility.
- ***C. Filtered tailings at confluence of Geona and Finlayson Creeks:*** This option would involve addition of a filter press in the Process Plant to produce a nominal 15% moisture content material. This material can be deposited on sloping land above and away from watercourses, and is normally deposited in facilities that are lined and covered to prevent oxygen from contacting the sulphides within the tailings to prevent acid generation and metal leaching. Construction of these facilities lends itself well to progressive reclamation practices. This alternative presents the option of comingling Class A waste rock in with the filtered tailings in the Class A Storage Facility. The location at the confluence of Geona and Finlayson Creeks is a relatively large area of relatively moderate slope angle. This alternative was ranked 'acceptable' in all four criteria.
- ***D. Filtered tailings, upper valley, Geona Creek:*** This option would involve addition of a filter press in the Process Plant to produce a nominal 15% moisture content material. This material can be deposited on sloping land above and away from watercourses, and is normally deposited in facilities that are lined and covered to prevent oxygen from contacting the sulphides within the tailings to prevent acid generation and metal leaching. Construction of these facilities lends itself well to progressive reclamation practices. This alternative presents the option of comingling Class A waste rock in with the filtered tailings in the Class A Storage Facility. This location is adjacent to the Process Plant. This alternative was ranked 'acceptable' in cost and socio-economic criteria and 'preferred' in environmental effects and amenability to reclamation.

In consideration of the above, filtered tailings located in the upper valley slope above Geona Creek was ranked as the preferred alternative for this component. A summary of the assessment is presented in Table 4-37.

Table 4-37: Summary of Alternatives for Tailings Disposal Methods and Locations

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
Tailings Disposal Methods and Locations	***Cost Effectiveness***	***Minimizes effects on the natural environment***	***Maximizes socio-economic benefits***	***Amenability to reclamation***	
A. Slurry tailings in Geona Creek	Preferred	Least preferred	Acceptable	Least preferred	Least preferred
B. Slurry tailings in east hanging valley	Acceptable	Acceptable	Acceptable	Least preferred	Least preferred
C. Filtered tailings at confluence of Geona and Finlayson Creeks	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
D. Filtered tailings, upper valley slope above Geona Creek	Acceptable	Preferred	Acceptable	Preferred	Preferred option

The Class A Storage Facility will be graded to collect and convey water to the Class A Collection Pond. A buttress of Class C waste rock will be constructed for confinement at the downstream slope of the Class A Waste Storage Facility, which will improve the overall factor of safety of the facility. Filtered tailings material will be placed and compacted in controlled lifts, progressively covering previously deposited tailings to limit the extent of exposure to oxygen. The facility will be constructed at an overall slope of nominal 4H:1V, which approximates the existing valley side slope, and will be progressively reclaimed with an engineered very low permeability cover layer to prevent oxygen ingress, and approximately 3 m of Class C material for frost protection. The facility will be capped with growth media and be revegetated up to a pre-determined elevation to mimic the current site conditions.

4.15.4.2 Waste Storage Facility Locations Alternatives

Waste rock generated from mining the ABM open pit and the underground will be geochemically characterized into three distinct categories, based on their comparative potential to generate acid or produce a metals leachate. While the locations for the Class A and B Facilities were selected according to their geochemistry-driven operations and closure requirements, the alternatives for location of the benign Class C Waste Storage Facility were assessed as follows:

- ***A. Southern Lakes Class C Waste Rock Storage Facility:*** This option would involve deposition of the geochemically benign acid consuming waste rock in a Storage Facility located to the south of the ABM open pit. The option was ranked 'acceptable' for cost, socio-economics and amenability to reclamation, and 'least preferred' in environmental effects due to the location involving expanding the KZK environmental footprint beyond the Geona Creek watershed and into the South Creek watershed. This option was not ranked 'preferred' in any of the performance criteria.

- ***B. Geona Creek Valley Class C Waste Rock Storage Facility:*** This option would involve deposition of the geochemically benign acid consuming waste rock in a Storage Facility located in an elevated hanging valley on the east flank of Geona Creek valley. Even though this clean waste rock does not present the potential for acid generation or metal leaching, locating the Storage Facility within the drainage of Geona Creek would confine the environmental footprint of the mine. For this reason, this option was rated 'preferred' for minimizing effects on the environment, 'preferred' for cost effectiveness (due to lesser haulage distance), and 'acceptable' for socio-economic and reclamation criteria. Essentially, there is no difference between the two options in these last two performance criteria.

In consideration of the above, Geona Creek Valley Class C Waste Storage Facility was selected as the Waste Storage Facility locations alternatives. A summary of the assessment is presented in Table 4-38.

Table 4-38: Summary of Alternatives for Waste Rock Storage Facility Locations

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
Waste Rock Storage Facility Locations	***Cost Effectiveness***	***Minimizes effects on the natural environment***	***Maximizes socio-economic benefits***	***Amenability to reclamation***	
A. Southern lakes PAC waste rock Storage Facility	Acceptable	Least preferred	Acceptable	Acceptable	Least preferred
B. Geona Creek valley PAC waste rock Storage Facility	Preferred	Preferred	Acceptable	Acceptable	Preferred option

The facility will have the capacity to contain approximately 34 million cubic metres of rock. The footprint of the facility will be cleared prior to use and growth medium will be stockpiled for use in reclamation. The facility will be constructed with an overall nominal slope of 3:1 for long-term physical stability and to allow for recontouring for closure and reclamation. The facility will be progressively reclaimed with overburden material and growth medium to promote revegetation.

4.15.4.3 Waste Rock Management Alternatives

Waste rock storage facilities (WRSF), as described above, will be developed according to their comparative geochemical characteristics. There are essentially two management alternatives that could be employed for all three of the facilities, that being either to construct and operate permanent facilities or to deposit rock temporarily and rehandle back into the Open Pit at closure. The two alternatives were assessed as follows:

- ***A. Permanent Surface Deposition of all WRSF's:*** This option would involve employing 'design for closure' principals for the design and operation of the facilities in which to permanently store each of the three categories of waste rock, and constructing and operating the facilities using progressive reclamation techniques. This option was ranked 'preferred' for minimizing cost and impact on the environment (due to permanent closure considerations being a key driver in their engineering design), and 'acceptable' for socio-

economic benefits and amenability to reclamation (due to the design for closure and progressive reclamation aspects of this option). The environmental consideration was also 'preferred' as the potentially acid generating rock can be comingled with the filtered tailings in an appropriately design facility that prevents pollutants being discharged. The 'dry stack' tailings will be deposited permanently on surface in an environmentally robust containment facility on the west flank of the Geona Creek valley.

- ***B. Temporary Surface Storage – Rehandling Waste Rock at Closure:*** This option would involve developing temporary waste rock storage facilities proximal to the Open Pit and rehandling and transport back into the Open Pit at closure. This option was ranked 'least preferred' for cost (due to the requirement to double-handle each tonne of waste rock), 'acceptable' for environmental and socio-economic criteria, and 'least preferred' for the reclamation criteria for two main reasons: firstly, this option would involve depositing potentially acid generating and metal leaching waste rock in the ABM lake that will form the headwaters of Geona Creek at closure), and secondly due to the fact that it would not facilitate progressive reclamation measures being employed as the mine is developed over the ten-year mine life (i.e., no progressive reclamation of the facilities could occur).

In consideration of the above, permanent surface deposition of all Waste Storage Facilities was ranked as the preferred alternative for this component. A summary of the assessment is presented in Table 4-39.

Table 4-39: Summary of Alternatives for Waste Rock Management

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
Waste Rock Management	***Cost Effectiveness***	***Minimizes effects on the natural environment***	***Maximizes socio-economic benefits***	***Amenability to reclamation***	
A. Permanent surface deposition of all Waste Rock Storage Facilities	Preferred	Preferred	Acceptable	Acceptable	Preferred option
B. Temporary surface storage – rehandling waste rock at closure	Least preferred	Acceptable	Acceptable	Preferred	Acceptable

4.15.4.4 Airstrip Access

While most supplies and all of the production from the Project will be transported to and from site via highway trucking, transportation of certain supplies and most employees will be by air to meet the Project schedule. Two options for airstrip construction were considered as follows:

- ***A. Reconstruct Existing Finlayson Airstrip:*** The existing Finlayson gravel airstrip adjacent to the Robert Campbell Highway is located approximately 12 kilometres north of the KZK Tote Road entrance. Although the Airstrip is relatively short and not in excellent condition, it was sufficient for the transportation of supplies and employees during the 2015 and 2016 exploration seasons. For Project development and operations; however, larger aircraft will be required and the Airstrip would require some improvements including surface grading,

and lengthening. There is adequate terrain at the Finlayson Airstrip site to enable safely lengthening it. This option was ranked 'preferred' for cost effectiveness, 'preferred' for lesser environmental impacts than new construction in a different location, and 'acceptable' for socio-economic and reclamation (reclamation criteria not applicable as the reconstructed Finlayson Airstrip would remain as an improved government facility post-closure of the Project).

- ***B. Construct New Airstrip on Property:*** Previous owners Cominco Ltd, had planned to construct a new airstrip closer to the KZK Mine; therefore, this alternative was considered and ranked using the common performance criteria. This option was ranked 'acceptable' for cost, socio-economics and environmental impact. This option would be 'acceptable' from an environmental perspective, but not preferred as it would require greater ground disturbance compared with the first option. It was also not preferred from a socio-economic perspective compared with the first option, as the new airstrip would be completely private and not available for Yukoners to use, compared with the first option. It was ranked 'preferred' in the amenability to reclamation criteria, since the it would be completely reclaimed as part of the mine closure measures.

In consideration of the above, reconstruction of the existing Finlayson airstrip was ranked as the preferred alternative for this component. A summary of the assessment is presented in Table 4-40.

Table 4-40: Summary of Alternatives for Airstrip Access

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
	Cost Effectiveness	*Minimizes effects on the natural environment*	*Maximizes socio-economic benefits*	*Amenability to reclamation*	
Airstrip Access					
A. Reconstruct existing Finlayson Airstrip	Preferred	Preferred	Acceptable	Acceptable	Preferred option
B. Construct new airstrip on property	Acceptable	Acceptable	Acceptable	Preferred	Acceptable

An extension of Finlayson Airstrip was originally proposed in 2007, by the Yukon Department of Transport. The extension is currently proposed by BMC to accommodate an 18-person aircraft and allow for crew changes. The main scope of the upgrades will be to lengthen the airstrip to the southeast with an approximate area of new disturbance of 14,000 m^2.

4.15.4.5 Power Generation Options

The Project will require approximately 17 MW of electrical energy. The power demand will be required to be supplied continuously twenty-four hours per day, 365 days per year. The options to provide these energy requirements were assessed as follows:

- ***A. Build Renewable Energy Options:*** The provision of this magnitude of energy from renewable sources at the KZK site would likely involve development of some combination of

hydro, wind and solar together. This option was ranked 'acceptable' in the cost criteria (although there is variability in both capital and operating costs depending on the renewable method selected), 'preferred' in the environmental criteria owing to the renewable source(s), and 'acceptable' for socio-economics and reclamation. Base load requirements for the processing facility limit the degree to which wind and solar sources can be utilised without a backup power plant capable of generating the full capacity required. With respect to reclamation performance criteria, a major hydro facility involving the construction of a dam or dams and flooded land would have 'least preferred' amenability to reclamation, as returning drainage to original watercourses and reclamation of a dam or dams would not be an insignificant undertaking.

- ***B. Connect to Existing Grid:*** This option would involve construction of an overland connection to the exiting Whitehorse-Aishihik-Faro (the 'WAF' Grid) grid, which at its' closest point to the Project is approximately 120 km distant. Construction of this magnitude of power line would also carry its own environmental impact, while minor in magnitude, it would extend the footprint of the Project unnecessarily far off site. The Yukon Grid is nearing capacity and with the expected increase in the number of mines in the next four years it is unknown whether there will be adequate capacity without major infrastructure upgrades. This option was ranked 'least preferred' in cost due to the distance from the existing grid, and 'acceptable' in all other performance criteria.
- ***C. On Site Generation:*** This option would involve purchase and installation of generators at the KZK site. This was ranked 'preferred' in the cost criteria, as the used generators would be removed and resold at the end of the Project life. It was ranked 'acceptable' in the environmental criteria, and 'preferred' in the socio-economic and reclamation criteria. The entire power generation station and surrounding related infrastructure would be reclaimed during the implementation of active closure measures. Any energy required for post-closure monitoring and possible operation of the water treatment plant would be provided with a portable generator.

In consideration of the above, on site generation was ranked as the preferred alternative for this component. A summary of the assessment is presented in Table 4-41.

Table 4-41: Summary of Alternatives for Power Generation

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
Power Generation Options	***Cost Effectiveness***	***Minimizes effects on the natural environment***	***Maximizes socio-economic benefits***	***Amenability to reclamation***	
A. Build renewable energy options	Acceptable	Preferred	Acceptable	Acceptable	Acceptable
B. Connect to existing Yukon grid	Least preferred	Acceptable	Acceptable	Acceptable	Acceptable
C. Onsite generator	Preferred	Acceptable	Preferred	Preferred	Preferred option

The Project power supply will be a bi-fuel (natural gas and/or diesel) power plant, located adjacent to the processing plant. The power plant will consist of six 4.2 megawatt generators.

4.15.4.6 Concentrate Transport Route

Processing operations at KZK will result in the annual production of approximately 180,00 tonnes of zinc concentrate, approximately 60,000 tonnes of copper concentrate, and approximately 35,000 tonnes of lead concentrate. This will require approximately 19 trucks per day. Three routing/destination alternatives from the KZK Project mine site to a Pacific Ocean port for shipment to overseas smelters were assessed (Allnorth, 2016a) as follows:

- ***A. Through Whitehorse to Skagway, Alaska:*** This alternative would involve routing the concentrate trucks first westerly on the Robert Campbell Highway #4 to Carmacks, then south through Whitehorse to Skagway port on Highway #2, on both the North and South Klondike Highways. This alternative was ranked 'acceptable' for the cost and socio-economic performance criteria. It was ranked 'least preferred' for the natural environment criteria as this route overlaps with the Finlayson Caribou Herd (FCH) winter home range. Consultation with both YG biologists and RRDC citizens indicated that the preferred alternative would be through Watson Lake rather than Whitehorse to minimize potential FCH incidents related to increased use of this portion Robert Campbell Highway. The amenability to reclamation criterion is not applicable (N/A) to this alternative as it involves use of existing Highway infrastructure, which will remain in place after the Project closes. The Port of Skagway itself was considered to have some comparative limitations due to:
    - the tourism-related cruise ship focus for the utilization and management of the ship docking facilities;
    - passport and work visas required for hauling into the United States; and
    - border crossing hours limited to day time only.
- ***B. Through Watson Lake to Skagway, Alaska:*** This alternative would involve routing the concentrate haul trucks south-easterly on Robert Campbell Highway #4 to Watson Lake, then easterly on Alaska Highway #1 to the southern city limits of Whitehorse, then southerly on Klondike Highway #2 to Port of Skagway. This alternative was ranked 'acceptable' in all three applicable performance criteria. The amenability to reclamation criterion is not applicable (N/A) to this alternative as it involves use of existing Highway infrastructure, which will remain in place after the Project closes. The Port of Skagway itself was considered to have some comparative limitations due to:
    - the tourism-related cruise ship focus for the utilization and management of the ship docking facilities;
    - passport and work visas required for hauling into the United States; and
    - border crossing hours limited to day time only.
- ***C. Through Watson Lake to Stewart, British Columbia:*** This option would involve routing concentrate trucks south-easterly on Campbell Highway #4 to Watson Lake, then north on

Alaska Highway #1 to Junction 37, then south and west on BC Highway 37 to the Port of Stewart, BC. Budgetary quotes were obtained from a haulage contractor and the cost/tonne for this route was the lowest. This option was ranked 'preferred' in the cost effectiveness criteria 'preferred' in socio-economic benefits due to the contracting and employment opportunities this haul would involve, and 'acceptable' in environmental and reclamation criteria. The amenability to reclamation criterion is not applicable (N/A) to this alternative as it involves use of existing Highway infrastructure, which will remain in place after the Project closes. The World Port of Stewart is a newly constructed facility that is well suited to offloading trucks and loading concentrate into Handymax ships.

In consideration of the above, routing through Watson Lake to Stewart was ranked as the preferred alternative for this component. A summary of the assessment is presented in Table 4-42.

Table 4-42: Summary of Alternatives for Concentrate Transport Route

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
Concentrate Transport Route	***Cost Effectiveness***	***Minimizes effects on the natural environment***	***Maximizes socio-economic benefits***	***Amenability to reclamation***	
A. Through Whitehorse to Skagway, Alaska	Acceptable	Least preferred	Acceptable	N/A	Least preferred
B. Through Watson Lake to Skagway, Alaska	Acceptable	Acceptable	Acceptable	N/A	Acceptable
C. Through Watson Lake to Stewart, British Columbia	Preferred	Acceptable	Preferred	N/A	Preferred option

BMC proposes to transport concentrates approximately 911 km to Stewart Port. Copper and zinc concentrate will be transported in Convey-Ore Transportation Equipment, while lead concentrates will be transported using containerised bulk carriers to meet the handling requirements of the Stewart World Port facility. Convey-Ore Transportation Equipment will be Tridem (three axle) tractor matched with bulk carriers on Super B style trailer.

4.15.4.7 Mining Methods

The ABM Deposit contains an estimated Mineral Resource of 19.2 Mt in two ore zones, the ABM Zone and the Krakatoa Zone. The zones are moderately steeply dipping and structurally competent rock units. There are essentially two broad categories of developing access to orebodies in mining, along with a third being the combination of the two. The alternatives were assessed as follows:

- ***A. Open Pit Mining:*** This method would involve developing an open pit shell of sufficient size and depth to capture the entirety of both the ABM Zone and the Krakatoa Zone. Due to the safety and geotechnical design considerations of wall angle and bench height and width, a deep open pit design must be very wide at surface. Open pit sizing therefore has direct implications for the ore-to-waste stripping ratio and hence production of waste rock. An open pit sized to access the entire orebody would generate significantly more waste rock than

the other two alternatives. This alternative was ranked 'acceptable' in all four criteria used in this assessment.

- ***B. Underground Mining:*** This alternative would involve development of underground adits, drifts, crosscuts and stopes in several underground mining design configurations which are suited to different geometry and other characteristics of orebodies (methods such as cut and fill, shrinkage stoping, room and pillar, block caving, longwall mining, and others). These sub-alternatives have not been independently assessed for this section; rather, they are grouped in the general category of underground mining. Underground mining is recognized as the significantly more expensive of the three alternatives on a cost-per-tonne of ore produced, owing to the relatively more expensive development of necessary services such as fresh air ventilation, heating, ground support, water and electrical requirements. Waste rock volumes produced would be smaller; however, resulting in less surface deposition of waste rock storage facilities. Typically, underground mining methods result in lesser daily tonnage production during mining, requiring a longer period to extract the ore body which has implications for the economic viability of the Project. This option would present the opportunity to deposit some of the filtered tails as paste backfill in the mined-out portions of the underground development. This alternative was ranked 'least preferred' for cost criteria owing to the above-noted considerations, 'preferred' in the environmental criterion due to reduced waste rock production, 'acceptable' for socio-economic benefits, and 'preferred' for reclamation (again due to reduced volume of waste rock).
- ***C. Combination Open Pit with Underground:*** This method would involve developing the near surface portions of both the ABM and the Krakatoa Zones by open pit methods, and accessing the deeper portions of the Krakatoa Zone using underground methods which would commence from a decline within the ABM open pit. Due to the reduced depth of the open pit as compared to open pit exclusively (option A), the surface expression would also be reduced; thus creating superior ore to waste stripping ratios and lesser volume of waste rock produced. The combination option would preserve the ability to deposit some of the filtered tails as paste backfill in the mined-out portions of the underground development. This alternative was ranked 'preferred' in the cost criterion due to factors mentioned above, 'preferred' in socio-economic benefits due to the increased range of employee skills/opportunities required to undertake both mining methods, and 'acceptable' in both the environmental and reclamation criteria.

In consideration of the above, a combination of open pit and underground mining methods was ranked as the preferred alternative for this component. A summary of the assessment is presented in Table 4-43.

Table 4-43: Summary of Alternatives for Mining Methods

Mine Component Alternatives	Performance Criteria				Overall rating against performance criteria
Mining Methods	***Cost Effectiveness***	***Minimizes effects on the natural environment***	***Maximizes socio-economic benefits***	***Amenability to reclamation***	
A. Open pit	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable
B. Underground	Least preferred	Preferred	Acceptable	Preferred	Least preferred
C. Combination Open Pit with underground	Preferred	Acceptable	Preferred	Acceptable	Preferred option

Most of the ABM Deposit will be mined by Open Pit mining methods. The pit will be developed in two separate but connected lobes. The larger portion of the Open Pit will mine the ABM Zone while the smaller lobe will mine the upper portion of the Krakatoa Zone. Underground mining will be utilized for deeper parts of the Krakatoa Zone.

4.16 TECHNOLOGIES

The technologies proposed to be utilized for the Project, and the viability of these technologies in northern climates are described in this section.

4.16.1 Flotation Ore Processing

The Project will utilize flotation technology for the production of separate copper, lead, and zinc concentrates. Flotation is a well proven technology used in the minerals industry for over 100 years. Metallurgical testwork completed by Cominco and BMC has demonstrated that flotation technology can be successfully used to produce economic metal concentrates.

All flotation operations will be conducted within the enclosed processing plant building. The building will be heated by reclaimed heat from power generation during the winter months and therefore there will be no adverse impacts on this technology from operating in a cold northern climate.

Metallurgical testwork programs will be maintained during operations, seeking to optimize and improve metallurgical performance of the processing plant.

4.16.2 Filtered Tailings

BMC proposes to filter tailings to a nominal 15% moisture content for disposal in the Class A WSF or for use in producing paste backfill, as detailed in Section 4.8.3.5. Tailings will be co-disposed with Class A waste rock from the Open Pit and underground mining operations. The production of filtered tailings for disposal in a 'dry stack' facility is a relatively common method of tailings production, although not as common as wet tailings disposal behind an engineered dam structure. The production of filtered tailings in a northern environment has been successfully utilised by a number

of mining operations, including Minto (Yukon), Bellekeno (Yukon), Raglan (Quebec), Pogo (Alaska), and Green's Creek (Alaska). Of these operations, only Green's Creek disposes waste rock with tailings, and tailings and rock are placed in separate cells.

At Green's Creek (Golder, 2012), tailings are filter-pressed to 12% moisture content and 88% solids content. Approximately 50% of the tailings are transported underground for backfill and the remainder is transported to the filtered tailings disposal facility. The tailings disposal facility required less than 78% of the footprint area and 15% of the capital cost in comparison to the tailings slurry disposal facility at Greens Creek (Golder, 2012).

The tailings filters will be located within an enclosed building that is heated by reclaimed heat from power generation, and as such the production of filtered tailings will not be impacted by the northern climate. Tailings will be transported to the Class A WSF by truck and deposited for spreading and compaction. During the colder winter months, good operating practices will need to be maintained to ensure that spreading and compaction is completed in a timely manner to allow optimum compaction to be achieved. As this has been successfully implemented at a number of mines already, BMC does not believe that the required operational practices will be unreasonable to implement and maintain.

Access to deposit tailings may also become difficult during the time each year when the tailings will thaw. As BMC will be co-disposing waste rock with tailings it is not expected that the compacted tailings will be unable to support the equipment required for placement, spreading and compaction. However, should isolated areas of the Class A WSF prove to be inaccessible for the period of thawing, mitigation measures include isolating the affected area until thawing is complete and bearing strength of the tailings is re-established (the width of the Storage Facility being in excess of 1.5 km will allow this to be effectively managed) and the additional placement of dry materials such as Class A waste rock to provide an effective operating surface.

Due to the natural variability within the ore deposit, variations in the quality of the filtered tailings produced will occur, which could impact on the compaction performance achieved. The quality of tailings produced will be monitored regularly by the on site laboratory, with testwork used to guide the optimum placement of tailings within the Class A WSF footprint. Where less optimum quality tailings are produced, they will be directed for placement in areas that are not critical for structural integrity of the Storage Facility.

4.16.3 Filtered Tailings Reclamation

The use of filtered tailings allows for progressive reclamation of the Class A WSF, as detailed in Section 4.13. Progressive reclamation of storage facilities is a common goal for the mining industry, and is successfully applied at many northern operations. BMC does not expect that the northern climate will not have an adverse impact on the implementation of a reclamation program, currently planned to commence from Year Three of operations. Consideration will need to be given to prevailing climatic conditions when planning reclamation activities to ensure that compaction of the impermeable cover can be reliably achieved.

4.16.4 Paste Backfill

Paste backfill will be used for support of underground mine excavations. As described in Section 4.11.1, paste backfill is a mixture of tailings, cement and/or binder, and water that is pumped into the mined underground voids. Production of paste backfill is proven technology used for underground support requirements in mines, particularly where the geometry of mine excavations requires a support medium that can be pumped and/or flow to fill mine excavations.

Producing paste backfill in a northern climate is not expected to require any unusual operating practices for the Project. Paste backfill is already commonly used in northern mining operations, examples of which include Wolverine (Yukon), Pogo (Alaska) and Greens Creek (Alaska). The most critical aspect of the paste backfill system from a climatic perspective will be the surface pipeline delivering backfill from the backfill plant to the underground mine. Monitoring of the pipeline condition to ensure that paste backfill does not freeze in the pipeline will be regularly completed. It may also be necessary to implement heat tracing of the pipeline to ensure that freezing issues are adequately addressed.

4.16.5 Containerized Transportation of Lead Concentrates

BMC proposes to transport lead concentrates from the Project to Stewart in purpose built containers. The containers will minimize the potential for fugitive dust emissions from loading and unloading of concentrate, as well as reduce the number of loading and unloading operations. It is believed that the adoption of this technology will be new to Yukon and other northern climates, however it has been used successfully in a number of regions around the world in the past several years. Providers of this technology include Intermodal Solutions Group and Qube Ports & Bulk.

Concentrate will be loaded into the purpose built containers and transported to port on specialized super B flat deck trailers. The containers have a removable lid, to facilitate loading and unloading of concentrate, which is locked in place for transportation. The containers are designed to minimize hangup of concentrate through the adoption of curved gussets in all corners and tapered side and end walls.

The containers are unloaded at the port and stacked until sufficient stocks are available for a shipment. Ship loading is completed with a purpose built rotation system that removes the container lid, rotates the container emptying concentrate into the ships hold and re-securing the lid prior to removing the container form the ships hold, minimizing dust generation. Freezing of concentrate within the containers is not expected to be a regular concern due to the milder climatic conditions encountered at Stewart. Should this ultimately be determined to be a concern, it may be necessary to provide an indoor Storage Facility for the containers at the Stewart port.

4.16.6 Treated Wetlands

BMC has assessed the feasibility for passive water treatment by constructed wetlands or other passive and semi-passive treatment technologies (e.g., in pit treatment, bioreactors) at the Project.

Passive and semi-passive treatment has been successfully used for removal of metals and metalloids, and neutralization of acidic waters for many decades. There are many examples globally of copper, cadmium, and selenium treatment by constructed wetlands and other passive and semi-passive treatment technologies from which scientific principals can be borrowed for application in new systems along with more recent advances in technology and application (Ness, Janin, & Stewart, 2014). Regardless of the type of wetland treatment system or geographic location, fundamentals such as thermodynamic laws, Stokes' laws (settling), stoichiometry, and concepts of coupled biogeochemical reactions are globally applicable, crossing geographical and climatic boundaries. Moreover, there are standard calculations, such as Arrhenius' equation, that can be applied as necessary to adjust for temperature in chemical reactions.

Successful treatment of mine-influenced water in the north and/or cold climates has been achieved by integrating an understanding of the impacts of a cold climate in the system design phases. In cold climates, passive treatment systems are able to effectively treat mine impacted water with no impact of temperature fluctuation on treatment capacity during months when water is free flowing (Contango, 2016).

Reports and reviews have previously been compiled that summarize case studies for Northern climates where the use of bioremediation as a treatment option for active and abandoned mine drainage has been investigated (Nordin, 2010; Ness et al., 2014). Table 4-44 provides a sampling of a few examples of passive treatment technologies and constituents that have been applied to Northern mining environments. The case studies included in Table 4-44, along with on-going phased development in this area of technology in Yukon (Haakensen, Pittet, Spencer, Rodgers Jr., & Castle, 2015) indicate that there is sufficient evidence to suggest that a constructed treatment wetland system would efficiently remove the constituents of concern at the Project.

Table 4-44: Examples of Passive Treatment in Northern Environments

Location	Technology application	Constituents of concern	Reference
Minto Mine, YT	Demonstrations-scale on site passive wetland	Cadmium, copper, molybdenum, selenium and zinc	Contango, 2016
United Keno Hill Mines (UKHM), YT	Pilot-scale on site passive wetland, biochemical reactor, and natural wetland	Arsenic, cadmium, magnesium, nickel, zinc	Ness et al., 2014; Nordin, 2010
Faro Mine Complex, YT	In pit	Zinc	Nordin, 2010
Colomac, NT	Treatment in tailings ponds and Pit Lake	Cyanide, thiocyanate and ammonia	Nordin, 2010
Equity Silver, BC	In pit	Zinc, copper, cadmium	Nordin, 2010
Tulsequah Chief Mine, BC	Biochemical reactor	Aluminum, cadmium, copper, iron and zinc	Ness et al., 2014

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

5 EFFECTS ASSESSMENT METHODS 5-1

5.1 GENERAL APPROACH 5-1
5.2 TRADITIONAL KNOWLEDGE INTEGRATION 5-1
5.3 IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC VALUED COMPONENTS 5-3
5.3.1 Traditional Knowledge Integration 5-3
5.4 ASSESSMENT BOUNDARIES 5-6
5.4.1 Spatial Boundaries 5-6
5.4.2 Temporal Boundaries 5-6
5.4.3 Traditional Knowledge Integration 5-7
5.5 EXISTING CONDITIONS 5-7
5.5.1 Traditional Knowledge Integration 5-7
5.6 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS 5-8
5.6.1 Effects Characterization 5-8
5.6.2 Mitigation Measures 5-10
5.6.3 Residual Effects 5-11
5.6.4 Determination of Significance 5-13
5.7 CUMULATIVE EFFECTS ASSESSMENT 5-13
5.7.1 Cumulative Effects Assessment Scoping 5-13
5.7.2 Cumulative Effects Assessment Methods 5-29
5.8 EFFECTS MONITORING 5-29

LIST OF TABLES

Table 5-1: Environmental and Socio-economic Valued Components 5-4
Table 5-2: Interaction Matrix Used for Determining Potential Interactions for VCs 5-9
Table 5-3: Projects to be Considered in the Cumulative Effects Assessment for Environmental Valued Components 5-15
Table 5-4: Projects and Activities to be Considered in the Cumulative Effects Assessment for Socio-economic Valued Components 5-26

LIST OF FIGURES

Figure 5-1: Projects to be Considered in the Environmental Cumulative Effects Assessment 5-25
Figure 5-2: Projects to be Considered in the Socio-economic Cumulative Effects Assessment 5-28

5 EFFECTS ASSESSMENT METHODS

5.1 GENERAL APPROACH

The effects assessment approach for the Project will follow standard Effects Assessment (EA) guidance and address the requirements set out under *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*). The overall assessment steps are the same for each discipline; however, the detailed approach to effects characterization and assessment may differ. The discipline-specific approach is detailed in each of the corresponding discipline chapters and identifies any deviations from the standard approach.

The EA approach for the Project is consistent with the approach outlined in the Yukon Environmental and Socio-Economic Assessment Board (YESAB) guidance document for Executive Committee Project Proposal submissions (YESAB, 2005a). In general, the EA will follow these seven steps:

1. **Identify Valued Components (VCs)**: the VCs are identified based on likely Project interactions as well as consultation with First Nations, regulators, and other stakeholders and form the framework for the assessment of the potential effects of the Project on the environment;
2. **Define Assessment Scope/Boundaries**: the spatial and temporal boundaries are selected to define the scope or limits of the assessment for each VC. The selected boundaries encompass the areas within and times during which Project effects may occur;
3. **Describe Existing Conditions**: the existing conditions are described in enough detail to provide the benchmark against which the Project effects will be evaluated;
4. **Determine Interactions and Project Effects**: Project activities are first screened against each VC to identify potential Project-VC interactions and to focus the detailed effects assessment. The identified interactions are assessed further to identify potential effects;
5. **Describe Mitigations of Potential Project Effects**: for any identified potential effects, mitigation measures are proposed to eliminate, reduce or manage the effect on the VC;
6. **Characterize Residual Effects**: if the effect remains after application of the mitigation measures, the effect is considered residual and is characterized using effects criteria; and
7. **Determine Significance of Residual Effects**: the significance of the identified residual effects is determined using VC-specific definitions.

Each of the above steps is presented in further detail in the following sections. This chapter also provides an overview of how Traditional Knowledge (TK) has been integrated into each of the above assessment steps. Methods for assessment of cumulative effects are also provided in Section 5.7.

5.2 TRADITIONAL KNOWLEDGE INTEGRATION

This section provides an overview of the methods for incorporation of Kaska TK into the EA. This is an important part of relationship building efforts with the Ross River Dena Council (RRDC) and other Kaska groups and to fulfill the requirements for the Project assessment and planning under *YESAA*. YESAB provides guidance on which Aboriginal groups require consultation for proposed resource development projects. BMC has been consulting primarily with the RRDC (along with Liard First

Nation (LFN)) whose Traditional Territory overlaps the Project. The RRDC is part of the trans-boundary Kaska Dena Council. A Kaska TK study was undertaken over the Project area by RRDC in the 1990s for the Initiation Environmental Evaluation (IEE) (Rutherford, 1995). A desk-based TK study was also completed for the Project in 2016 (Appendix F-3). The desk-based study is a compilation of the TK information available in the Yukon Archives, EMR library, and academic institutions, such as Yukon College and University of British Columbia. In addition, RRDC is currently undertaking a supplemental TK study over the Project area. As such, further consideration and integration of Kaska TK into the Project will occur in an ongoing manner as more Kaska TK becomes available in partnership and collaboration with RRDC.

Section 33(a, b) of *YESAA* states:

> *The Board shall make rules with respect to a) the integration of scientific information, traditional knowledge and other information by designated offices, the executive committee and panels of the Board; (b) the determination of whether traditional knowledge is confidential for the purposes of paragraph 121(a)….*

Additionally, for context, the following TK definition is provided by the Canadian Environmental Assessment Agency (CEAA, 2015a):

> *Generally, [TK] is considered as a body of knowledge built up by a group of people through generations of living in close contact with nature. [TK] is cumulative and dynamic. It builds upon the historic experiences of a people and adapts to social, economic, environmental, spiritual and political change.*

It is also acknowledged that RRDC may have their own definition of TK, which is important context for understanding their relationship to the land and their distinct worldviews.

Kaska TK has been considered and integrated across the EA process, from biophysical baseline reports through to environmental effects and mitigation strategies. The principles guiding the process of incorporating Kaska TK are as follows:

- Kaska TK is considered on par with scientific knowledge;
- Kaska Dena citizens are recognized and referenced as key contributors to the EA; and
- Iterative communications are maintained between BMC and RRDC throughout the integration process.

The objective of the TK integration process is to complement and/or supplement scientific knowledge with regards to species of importance, characteristics, behaviours, populations, trends, abundance, habitat, migration, movements, and/or relationships with other species.

To support the specific integration efforts described in subsequent sections, there are several key procedural steps to integration. First, there is a Kaska Ethnographic Overview (provided as Appendix F-3), which summarizes publicly available Kaska TK for use and reference. The overview mirrors the chapters of the EA to facilitate ease of integration. Quotes or paraphrases from the overview are used

and introduced with sentences such as, "Kaska TK indicates…". Information used in the overview will be referenced both in-text and as part of the reference section. Chapters where Kaska TK was applied and/or used were reviewed to ensure culturally sensitive and appropriate integration with proper acknowledgement through references.

There are key integration destinations for Kaska TK within each chapter of the EA, including identification of Valued Components, determination of assessment boundaries, description of existing conditions, effects characterization, development of mitigation measures, and determination of residual effects and their significance. These are described in more detail in subsequent sections of this document.

5.3 IDENTIFICATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC VALUED COMPONENTS

VCs are defined by YESAB as elements of the environmental and/or socio-economic systems valued for environmental, scientific, social, aesthetic, or cultural reasons (YESAB, 2005a). VCs are aspects of biophysical and human environments that, if altered by the proposed Project, would be of concern to First Nations, regulators, stakeholders, and the general public. Although some VCs may be identified as biophysical, they may have value within the human environment as well. For example, wildlife is important ecologically, but is also a strong element of Yukon and First Nation culture.

The list of VCs and rationale for their inclusion in or exclusion from the EA are provided in Table 5-1. The list has been prepared through ongoing consultation with the Kaska First Nation, community members, regulators, and other stakeholders prior to submission of the Project Proposal (see Chapter 2 for further detail on consultation). Where appropriate, subcomponents may be identified (e.g., indicator species for wildlife VC) to focus the assessment and to better define potential effects. Subcomponents are identified in the corresponding VC chapters. Integration of TK into selection of the subcomponents is discussed below.

5.3.1 Traditional Knowledge Integration

Ann Garibaldi (2008) defines and describes the concept of the Cultural Keystone Species (CKS) as follows:

> *Throughout the world, people strongly identify with plants and animal species on which they depend for cultural and economic reasons. These species, CKS, comprise more than food or sources of raw materials. They permeate a culture's stories, spiritual practices, and language and daily practice. … Just as ecologists have long recognized that some species, by virtue of the key roles they play in the overall structure and functioning of an ecosystem are essential to its integrity, certain plants and animals feature prominently in language, ceremonies, and narratives of Indigenous peoples (Garibaldi, 2008:4).*

Where available, CKS (e.g., caribou, moose etc.) were identified and discussed in each chapter of the EA. They are used to inform, support, or add to the selection of VCs. It is clearly noted when CKSs are covered by another VC as an indicator species or proxy. It is also documented how CKS are included in current VCs, or where Kaska TK results in the addition or change to a VC.

Table 5-1: Environmental and Socio-economic Valued Components

Valued Component	Rationale for Inclusion/Exclusion
Air/Climate	
Air Quality	Included Air Quality was selected as a VC due to its fundamental importance to the health and well-being of humans, wildlife, vegetation, and other biota. Assessment of air quality also considers project greenhouse gas (GHG) emissions. Project activities will result in air emissions.
Noise Levels	Included Noise was selected as a VC because of its fundamental importance to the quality of life for humans and wildlife in the vicinity of the Project. Elevated noise levels may lead to negative health effects in humans. For wildlife, noise may lead to habitat avoidance as well as unfavourable physiological and behavioral responses, with concerns for potential effects of noise on wildlife raised through consultation (see Chapter 2). Project activities will generate noise.
Water Resources	
Surface Water	Included Surface water was selected as a VC because of its important role in maintaining functioning aquatic and biophysical environments. Furthermore, water quality and quantity is highly valued by Yukon residents, including First Nations, with concerns regarding changes to surface water quality and quantity (flow) raised through consultation (see Chapter 2). Project activities have the potential to affect surface water quality and quantity.
Groundwater	Included Groundwater was selected as a VC because of its importance in maintaining function of aquatic and biophysical environments. Furthermore, water quality and quantity has been identified as highly valued by Yukon residents, including First Nations, with concerns regarding changes to groundwater raised through consultation (see Chapter 2). Project activities have the potential to affect groundwater flow and quality.
Aquatic Ecosystems and Resources	Included Aquatic ecosystems and resources were selected as a VC because of their importance in maintaining function of aquatic and biophysical environments as well as the cultural and recreational importance of fish, with concerns regarding potential effects on fish and fish habitat raised through consultation (see Chapter 2). Aquatic resources may be affected by Project activities due to potential changes in water quality and flow.
Terrestrial Resources	
Terrain and Soils	Included Terrain and soils are closely interrelated, and are considered as a single VC for the Project as they are vital to landscape and ecosystems that support aquatic, biophysical, and human environments. Project facilities have potential to change local terrain and result in local soil loss. Project activities may also affect soil quality.

Valued Component	Rationale for Inclusion/Exclusion
Vegetation Cover and Composition (including rare or sensitive vegetation species/communities)	Included Vegetation cover and composition were selected as a VC due to their importance to the health and well-being of the biophysical and human environment, as well as having high cultural and First Nations' value. Project activities have the potential to affect vegetation through clearing activities.
Wildlife and Wildlife Habitat	Included Wildlife and wildlife habitat were selected as a VC due to their importance to the health and function of the biophysical and human environment, as well as wildlife's high cultural and First Nations' value, with concerns about potential effects on wildlife raised through consultation (see Chapter 2). Project activities may have direct and indirect effects on wildlife.
Socio-economic Resources	
Heritage Resources	Included Heritage resources were selected as a VC due to existing legislation and the high significance given them by the RRDC and LFN. Project activities may affect heritage resources present in the area.
Economy and Sustainable Livelihood	Included The affected communities and First Nations place a high value on a sustainable, diverse, and stable community economy that provides local employment and business opportunities, and helps to support local government. Promoting the self-sufficiency of community members and avoiding the excesses of a boom and bust economy are also valued. Project activities have potential to contribute to local economies through employment and business opportunities.
Human Health and Well-being	Included Human health and well-being are universally Valued Components. Project activities may affect the health of individuals and community health in the area.
Community Vitality	Included Community vitality includes a number of economic and social factors, such as population structure, health of local businesses, crime rates, and community events. Project activities may contribute to local community vitality through population changes, business opportunities and community events.
Infrastructure and Services	Included Infrastructure and related services make up the physical core of any community. Project activities may affect the availability of infrastructure and services (e.g., transportation infrastructure, municipal services).
Culture, History and Heritage	Included Culture, history and heritage form an important part of community identity. This VC considers language preservation and restoration, traditional knowledge and practice preservation and restoration, and heritage and historic sites.

Valued Component	Rationale for Inclusion/Exclusion
Excluded Components	
Climate/Climate Change	Excluded Climate and climate change were not selected as a VC because quantitative methods are not available to assess the Project's actual effects on climate change. Existing climate conditions are described in context of the air quality assessment as they are considered through air quality modelling, as well as in calculation of hydrologic conditions. The assessment also includes predictions of Project's GHG emissions (Chapter 6) and potential effects of climate change on the Project (Chapter 16).
Human Health Risk Assessment	Excluded Human health risk assessment has not been included as there are no permanent or semi-permanent residents in the immediate vicinity of the Project and access to the mine will be prohibited as per the requirements of the road lease. General community health and well-being is considered through the human health and well-being VC for residents of local communities.

5.4 ASSESSMENT BOUNDARIES

The assessment boundaries are the space (spatial) and time (temporal) within which potential effects on the VCs are characterized and assessed.

5.4.1 Spatial Boundaries

Spatial boundaries define the spatial extent within which potential effects are considered. These boundaries are defined for each VC and may include the following, as applicable:

- **Project Footprint**: refers to the area within which the Project infrastructure will be located and is the area of direct disturbance from the Project activities;
- **Local Study Area**: refers to the area within which most of the direct Project effects are expected to occur; and
- **Regional Study Area**: refers to the area within which indirect and cumulative effects may occur.

The study areas defined for each VC take into account ecological, technical, and social/political considerations. The selected spatial boundaries for each VC and respective subcomponents are described in the corresponding VC assessment chapters (Chapters 6 through 15).

5.4.2 Temporal Boundaries

Temporal boundaries are defined to include all Project phases within which effects are expected to occur. The Project phases considered in the EA include the following:

- **Construction Phase**: will last approximately two years and includes site preparation and clearing and establishment of Project infrastructure;

- **Operations Phase**: will last approximately 10 years and includes open pit and underground mining and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as Closure Phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished onsite and will continue until active monitoring is no longer required; the phase is split into two periods: a transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.

VC-specific temporal boundaries may also include seasonal considerations (i.e., winter/summer, breeding periods), if applicable. Where VC-specific temporal boundaries are used, they are identified in the corresponding VC chapter.

5.4.3 Traditional Knowledge Integration

Spatial and temporal boundaries for each VC are selected with consideration of the probable geographic extent and time span(s) in which environmental effects are likely to occur. Kaska TK is also reviewed to inform and/or support the extent of the spatial and/or temporal boundaries. Where applicable, changes to boundaries based on Kaska TK data are noted and documented. For example, some spatial boundaries may change to include a culturally important stream or species. There may also be instances in which temporal boundaries are increased (e.g., post-closure time to incorporate the regrowth or reintroduction of a plant species that is important to Kaska citizens). These changes are documented and attributed to Kaska TK within the discussion of boundaries.

5.5 EXISTING CONDITIONS

The existing conditions descriptions are presented for each VC and their subcomponents in the corresponding chapter, including discipline-specific methods used to gather the information. Existing conditions descriptions include considerations of "historic" environmental conditions (through previous studies conducted in the area), TK, available regional or case studies, and information gathered as part of the Project baseline field programs. The existing conditions are used to inform the effects assessment and to provide the benchmark against which the potential effects will be evaluated. The existing conditions may also inform mitigation measures selection and development of conceptual management plans.

5.5.1 Traditional Knowledge Integration

All relevant Kaska TK data are reviewed to ensure full reflection in the biophysical discussion of existing conditions related to each VC, where available and applicable. Kaska TK data are used to support or add to scientific understanding of existing conditions determined through field programs and/or desk-based research. Of particular value, Kaska TK may provide insights into important historical trends and site-specific or regional phenomena that scientific methods and results may not uncover or identify. When TK confirms, adds to, and/or revises scientific understanding of the

existing conditions, these are documented with references to the relevant TK documents and acknowledgement of Kaska as source of the knowledge.

5.6 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS

5.6.1 Effects Characterization

The effects characterization for each of the VCs is focused through identifying the following parameters:

- **Subcomponents**: are identified to facilitate and structure the assessment of a broadly defined VC (e.g., individual species or species groups for Wildlife VC), as applicable;
- **Measurable parameters**: are the metrics used to assess and quantify the effect on the VC from the Project activities. These represent how the change to the VC is identified and measured; and
- **Assessment endpoint/threshold criteria**: are the endpoints or criteria against which the measurable parameters will be assessed to identify potential effects on the VC or subcomponent (e.g., regulatory guidelines).

The VC-specific subcomponents, measurable parameters, and assessment endpoint/threshold criteria are identified in each VC chapter.

The potential effects are determined for each of the VCs and characterized through the following steps:

- **Determining potential interactions (effect pathways)**: The interaction between each VC and Project activities are ranked according to reasonably foreseeable effects and presented in a table format (Table 5-2). Ranking, 0, 1, or 2, is made in consideration of the Project activities and consultation efforts to indicate:

  0 – Nominal risk interactions;
  1 – Lower risk interactions- *the interaction will not result in potential effect due to the application of practices known to effectively mitigate predicted effects within Project design; and*
  2 – Higher risk interactions- *it is reasonably foreseeable that residual effects may result.*

- **Focusing on key interactions:** Those ranked as higher risk (2) are focused on in the EA. Those ranked as 0 or 1 are not discussed in detail as residual adverse effects will not result from these interactions; and
- **Describing the potential effects**: For those Project-VC interactions carried forward in the assessment, the potential effects, both adverse and beneficial, arising from those interactions are described in clear language and in enough detail to enable a non-technical reviewer to understand the cause, type, and nature of potential effects.

Table 5-2: Interaction Matrix Used for Determining Potential Interactions for VCs

Project Activity	Subcomponent/VC	Subcomponent/VC
Construction Phase		
Tote Road upgrade to Access Road		
Finlayson Lake airstrip upgrade		
Site preparation and clearing		
Site grading, including soil and overburden removal and stockpiling		
Off site traffic (construction equipment and materials delivery)		
On site traffic		
ABM open pit development (including dewatering and Fault Creek diversion)		
Infrastructure construction		
Waste handling		
Water use and management		
Power generation		
Worker transport		
Construction camp operation		
Workforce, procurement and hiring		
Operations Phase		
ABM open pit operations (including blasting and dewatering)		
Underground operations		
Ore processing		
On site traffic		
Off site traffic (highway)		
Finlayson Lake airstrip operations		
Storage facilities management (Class A, B, and C)		
Progressive reclamation of storage facilities		
Water use (potable and non-potable)		
Mine water management and treatment (including effluent discharge)		
Waste management		
Power generation		
Worker transport		
Camp operation		
Workforce, procurement and hiring		
Closure Phase		
Process plant decommissioning and site reclamation		
ABM lake filling		
Final storage facilities reclamation		
Support infrastructure removal and site reclamation		

Project Activity	Subcomponent/VC	Subcomponent/VC
Water management, treatment and discharge		
On site traffic		
Off site traffic		
Access road reclamation		
Workforce, procurement and hiring		

5.6.1.1 Traditional Knowledge Integration

Each effects assessment contains a discussion of how Kaska TK informed, shaped, or directed scientific understanding of effects on VCs, where available. In general, there are three possible integration scenarios related to effects:

- **Effect exclusively based on Kaska TK**: Effects identified entirely based on TK are clearly indicated and documented, including original understanding and shifts in understanding after reviewing Kaska TK. The process of arriving at the new understanding of Project-related effects is described in detail.
- **Effect confirmed by Kaska TK**: TK data confirmed understanding of the potential effect already known from scientific inquiry and/or analysis. In this scenario, both science and TK indicate the same understanding of the potential effect of the Project on the VC. It is recognized that many integration opportunities fall under this scenario.
- **Disagreement or Difference between Kaska TK and Science on Effect**: There may be a potential effect raised by Kaska TK that does not align with scientific understanding or is not considered relevant to the Project. In this scenario, descriptions and rationale of the effect from a scientific and TK perspective are presented side-by-side. Resolution of the difference is not required; however, transparency is considered important. This scenario is then raised with RRDC and LFN as part of the consultation process to seek clarification and understanding.

5.6.2 Mitigation Measures

Following the identification of the potential effects, mitigation measures are applied to eliminate or minimize the potential effects. Mitigation is the application of Project design, construction, operation, scheduling, and management principles and practices to minimize potentially adverse environmental and socio-economic impacts. The Project has inherent mitigation measures incorporated throughout Project planning and design which are described in Chapter 4. In addition, it is noted where the Project will adhere to conceptual management and protection plans, contingency plans, emergency response plans, or other plans or policies that may minimize or eliminate the potential adverse effects (these are described in Chapter 18).

Additional measures or restitution measures to compensate for or offset effects may be required to mitigate adverse effects on specific VCs. Practical mitigations are those that are both technically and

economically feasible for the Project. Proposed mitigation measures are one of the key inputs to the management plans which accompany the Project Proposal (Chapter 18).

5.6.2.1 Traditional Knowledge Integration

Recommendations, suggestions, and ideas (where available) from previous Kaska experiences with resource development and their interests in involvement in the Project's development are considered and included (e.g., Kaska involvement in monitoring efforts or reclamation of medicinal plant species). The source of the suggestion is provided and it is noted whether the course of action is proposed by science and TK or if the mitigation is exclusively based on TK. Some suggestions from Kaska TK may be modified and/or adapted to make them feasible. Where this is the case, they are documented and highlighted with recognition that the mitigation was TK-inspired with rationale for modification.

5.6.3 Residual Effects

Residual effects are those effects remaining after the implementation of mitigation measures. To characterize residual effects, six criteria are taken into consideration for all VCs that have a predicted residual effect. Beneficial residual effects are characterized but are not carried forward for determination of significance. Where practicable, criteria are described quantitatively and otherwise described qualitatively with sound rationale provided. The characterization of residual effects is used to support a determination of significance (outlined in the subsection below) and where practicable, assigns and rationalizes quantitative levels or values (i.e., threshold values). Examples of threshold values are included in parentheses following the description of the six criteria below:

- **Direction**: The residual effect may be adverse or beneficial.
- **Magnitude**: of the environmental effect, where magnitude refers to severity. Low or inconsequential effects may not be significant, but effects that are high may be significant. The magnitude descriptors are:
    - Low: differing from the average value for existing conditions to a small degree but within the range of natural variation and/or well below a guideline or threshold value;
    - Moderate: differing from average value for existing conditions and approaching the limits of natural variability and/or below a guideline/threshold value; or
    - High: differing from existing conditions and exceeding guideline or threshold value such that there will be detectable change beyond the range of natural variability (i.e., change of state from existing conditions).
- **Geographic**: spatial extent of the potential environmental effect. Localized effects may not be significant while widespread effects are more likely to be significant. The geographic descriptors are:
    - Site: an effect limited to the Project footprint;
    - Local: an effect extending beyond the Project footprint but within the local study area;

- Regional: an effect extending across the regional study area; or
- Beyond Regional: an effect that extends beyond the regional study area.

- **Duration:** the length of time the effect has the potential to last. The duration descriptors are:
  - Short term: an effect lasts through construction phase or closure phase only (less than one to five years);
  - Medium term: an effect lasting through operations phase only (approximately 10 years);
  - Long term: an effect lasting through any two concurrent Project phases or into post-closure phase (approximately 11 to 25 years); or
  - Far Future: an effect that lasts beyond 25 years.
- **Frequency:** How often the adverse effect occurs during any phase of the Project:
  - Once: an effect that occurs once during any phase of the Project;
  - Sporadic: an effect that occurs at sporadic or intermittent intervals during any phase of the Project;
  - Regular: an effect that occurs regularly during any phase of the Project; or
  - Continuous: an effect that occurs constantly during any phase of the Project.
- **Reversibility**: Degree to which the adverse effect is reversible or irreversible. Reversible adverse environmental effects may be less significant than effects that are irreversible. Reversibility descriptors are:
  - Reversible short term: an effect that can be reversed relatively quickly (i.e., in less than five years);
  - Reversible long term: an effect can be reversed after many years (i.e., more than five years); or
  - Irreversible: an effect cannot be reversed (i.e., is permanent).
- **Environmental and Socio-economic Context**: The adverse effects of projects may be significant if they occur in areas or regions that have not already been adversely affected by human activities and/or are ecologically or socially fragile and have little resilience to imposed stresses or changes. Context descriptors are:
  - Low: the VC is considered to have strong resilience to accommodate change;
  - Neutral: the VC is considered to have some resilience to accommodate change; or
  - High: the VC is considered to have low resilience to accommodate change.

Separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful; and

- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The consideration of uncertainty is VC-specific and may include quantitative (i.e., sensitivity analysis) or qualitative discussion. The uncertainty addresses any assumptions made through the assessment.

5.6.4 Determination of Significance

Significance is assigned to each identified adverse residual effect. The definition of the term 'significance' differs for each VC. This definition may comprise either a quantitative or qualitative threshold that describes the point beyond which a residual effect would be considered significant and relies on the criteria definitions provided above. For example, the residual effect may be considered significant if it is of high magnitude and has regional extent.

VC-specific significance definition factors may include items such as species population integrity, capacity limits of municipal services or infrastructure, resource management objectives, or other appropriate factors. The definition and assessment of significance identifies the relevant VC-specific factors and clearly articulates the definition of significance for each VC. This includes any quantitative or qualitative threshold(s) or other factors used, and provides a transparent and credible basis for the significance determination.

VC-specific significance definition is provided in each corresponding VC chapter.

5.7 CUMULATIVE EFFECTS ASSESSMENT

Although YESAA does not provide a definition of cumulative effects, the concept is understood to be the combined environmental or socio-economic effects that accumulate from a series of similar or related individual actions, contaminants, or projects (YESAB, 2005b). The Cumulative Effects Assessment (CEA) considers that although the Project effects may not be significant, the combined effects with other projects and activities may result in significant effect.

The CEA methods used for the project include scoping and assessment (including analysis, mitigation and significance determination) (CEAA, 2015b). The scoping step of the assessment is provided below. The assessment methods are described in Section 5.7.2, with the VC-specific CEA provided in each corresponding VC chapter.

5.7.1 Cumulative Effects Assessment Scoping

Identifying VCs for CEA is the first part of the scoping process. The CEA is conducted for those VCs for which residual effects are predicted after consideration of mitigation measures (including those that are predicted not to be significant) (CEAA, 2015c). The residual effects and whether CEA is completed are identified in each corresponding VC chapter.

The spatial and temporal boundaries considered for CEA are VC-specific and reflect the boundaries of the identified residual effects.

The final step in scoping is identifying other projects and activities to be considered in the CEA. The CEA defines the potential interaction of the Project's residual effects and the potential residual effects resulting from:

- Other past or present projects (where their effects may not be captured under the current conditions); and
- Reasonably foreseeable/known future projects.

In accordance with *YESAA*, reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB (as of December 2016). Potential futures projects that have not been submitted to YESAB for review could not be included in the CEA as their potential for temporal overlap, spatial overlap and residual effects were unknown at the time that this Project Proposal was prepared.

The projects for consideration in the CEA were identified through the review of the YESAB public registry for projects that may interact spatially with the Project. For potential interactions with environmental VCs, the projects within the Finlayson Caribou Herd range were considered, as that area represents the expected maximum extent of the environmental effects. Projects outside of Finlayson Caribou Herd range have been screened out for consideration of environmental cumulative effects (i.e., there is no anticipated spatial overlap). The list of the projects considered for the CEA for environmental VCs is included in Table 5-3. The activities listed for each project are based on the conditions of the respective permits that have been issued for the project. For most of the projects it is uncertain if the activities will overlap temporally with the Project as the permits are issued for several years, but that doesn't necessarily mean that activities will occur. Figure 5-1 shows the approximate locations of the projects considered in the CEA for environmental VCs.

For potential socio-economic cumulative effects, the CEA focuses on the major mining projects in Kaska Traditional Territory and Yukon, as these types of projects are expected to overlap in types of effects for socio-economic VCs and contribute to cumulative effects. The list of projects considered for the CEA for socio-economic VCs is included in Table 5-4. Figure 5-2 shows the approximate locations of the additional projects considered in the CEA for socio-economic VCs.

Table 5-3: Projects to be Considered in the Cumulative Effects Assessment for Environmental Valued Components

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Quartz Mining and Exploration					
Fyre Lake Property (*Pacific Ridge Exploration)*	2014-0204	30 km	Until 2020	The Fyre Lake copper-cobalt-gold exploration project is located approximately 30 km south of the Project, approximately 250 km east of Whitehorse in southeastern Yukon Territory. The project is a Class 3 mineral exploration program which consists of 169 claims over approximately 35.23 km^2. Access is via aircraft. Activities are scheduled to take place annually from March to October for 5 years, beginning March 2015. Source: http://www.pacificridgeexploration.com/s/fyre_lake.asp	Project activities include: • Exploration, geological mapping, soil sampling; • Re-establishment and use of existing camp: maximum 20 people; • Drill pad and heli-pad construction; • Clearings: up to 10 drill/heli-pads below tree line requiring clearing (between 10 m x 10 m to 30 m x 30 m each, depending on terrain aspects); • Drilling: up to 30 diamond drill holes (total 10,000 m); • Use of helicopter and float-plane; • Water use: 300 m^3/day for camp and drilling activities; • Waste management; • Fuel storage (maximum 30,000 l on site at any time); and • Progressive reclamation and final camp decommissioning. General exploration activities may include effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Grew Creek (*Golden Predator Corp.*)	2011-0168	135 km	Until 2016	The Grew Creek Project consists of 546 claims located along the Robert Campbell Highway, midway between Faro and Ross River, Yukon. Golden Predator has conducted exploration programs and drilled more than 19,000 m on these claims. Source: http://www.goldenpredator.com/grew-creek.html	Project activities include: • Use of heavy equipment; • Geological mapping and prospecting; • Geochemical sampling; • Airborne and ground geophysical surveying; • Upgrades to existing access; • New access development; • Site preparation; • Helicopter use; • Water use (up to 100 m^3 per day for all project activities on all claims); • Fuel storage (up to 10,000 l diesel; up to 1 ,000 l regular gas; up to 1 ,000 lb propane; up to 500 l oil per year) in a lined and bermed storage area if fuel volume exceeds 4000 l; • Drilling; and • On-going and final reclamation and decommissioning activities. General exploration activities may include effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Ketza River Mine *(Ketza Group/ Veris Group*)	2014-0096, 2011-0218, 2010-0196, 2010-0080, 2007-0148, 2007-0121, 2006-0021	92 km	Abandoned, in care and maintenance	The Ketza River gold mine, southwest of Ross River, operated at about 350 tonnes per day (tpd) from 1988 to 1991. Oxidized gold-bearing veins and mantos were mined until the oxide ore reserves were depleted. The mine was abandoned in 2015.	General care and maintenance activities include: • Water quality monitoring and treatment; • Maintenance of the tailings pond dam and emergency spillway; • Maintenance of existing diversion ditches; and • Maintenance of existing access roads. General care and maintenance activities may include effects on: • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	2016-0016	20 km	Until 2021	Pelly Exploration project is a Class 3 mineral exploration program at the Pelly Property which consists of 422 claims in southeast Yukon, located 130 km southeast from Ross River and 160 km northwest from Watson Lake. The project will be accessed via an existing access road and/or helicopter. Activities are scheduled to take place year round for five years.	Project activities include: • Establishment of a camp for up to 49 people; • Use of heavy equipment; • Prospecting, geological mapping; • Airborne and ground geophysics; • Rock, soil and silt sampling; • Line cutting (500 km x less than 1 m); • Clearing (up to approximately 151,000 m^2); • Trail construction (40 km x 4 m); • Diamond drilling (410 sites, 15 m x 15 m); • Hydrogeologic drilling (50 sites, 15 m x 15 m); • Sump construction; • Water use (up to 270 m^3 per day); • Helicopter use (2.5 to 4.5 hours per day); • Fuel use and management (up to 107,000 l); • Waste management; • Environmental monitoring and data collection; and • Progressive and final reclamation. General exploration activities may include effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Selwyn Project *(Selwyn Chihong Mining Ltd)*	2015-0098, 2015-0072, 2009-0207, 2008-0280, 2006-029, 2010-0072	135 km	Assessed until 2021	The Selwyn Project is a proposed zinc-lead mine, located in Howard's Pass in eastern Yukon. The Project is one of the largest undeveloped zinc-lead deposits in the world and is located 165 km east of Ross River and 280 km north of Watson Lake, straddling the border with the Northwest Territories. The Selwyn Project is in the advanced exploration phase and has been conducting the technical and environmental research and studies required to design the proposed mine and begin preparing to apply for the Project to enter the environmental and social economic assessment process. Source: http://selwynchihong.com/	Exploration activities include: • Geophysical surveys, material sampling; • Diamond drilling; • Establishment of sumps for drill cuttings; • Test pitting; • Water Use; • Clearings for drill pads and test pits; • Line Cutting; • Helicopter use; • Trail construction; • Watercourse crossings (approximately 7) by fording and/or snow/ice bridge construction; • Temporary fuel storage: diesel, up to 1,230 l; • Use of heavy equipment; • Waste management; and • Progressive reclamation. General exploration activities may include effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

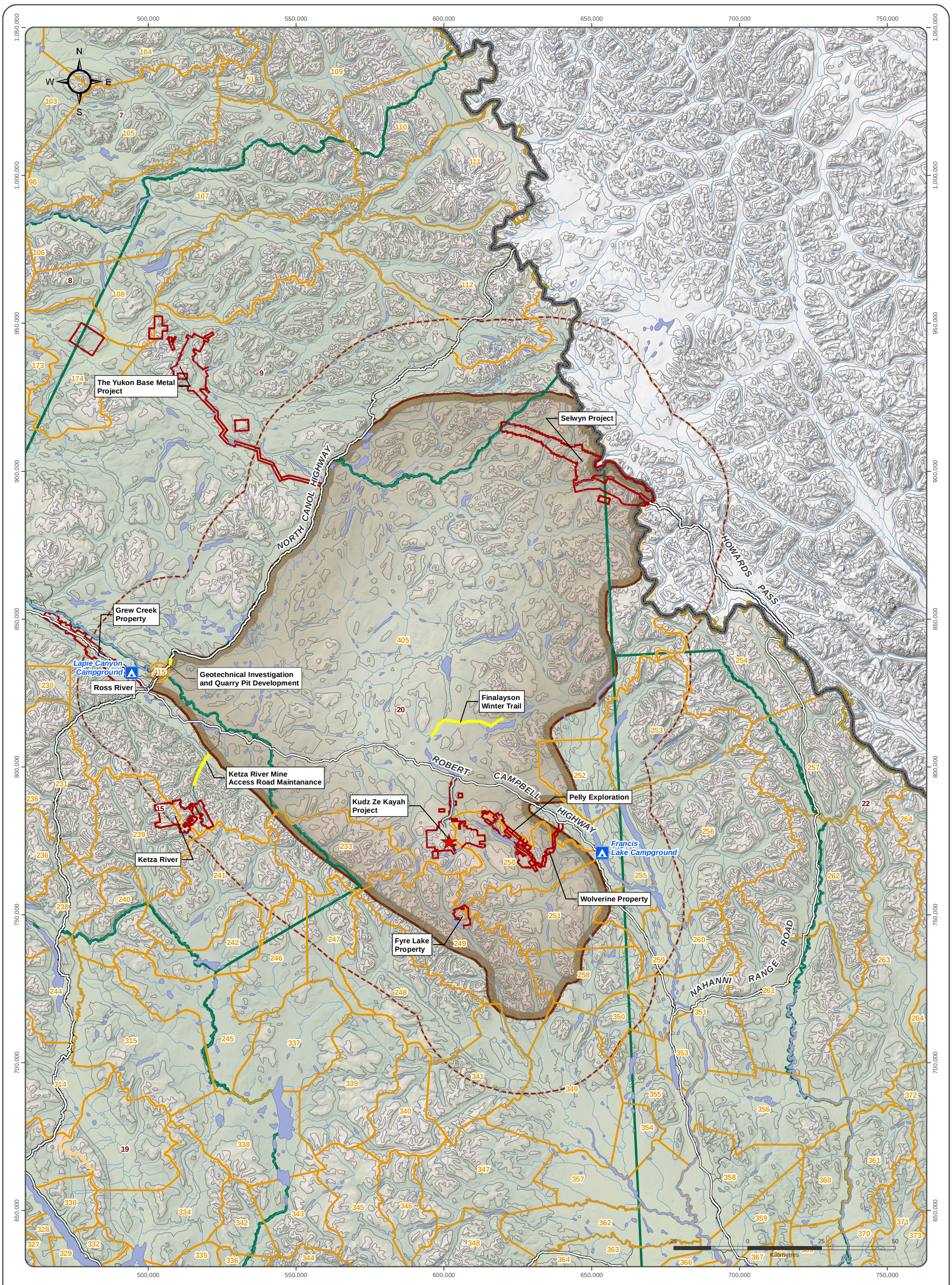
Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
The Yukon Base Metal Project *(Overland Resources Ltd.)*	2014-0048	180 km	Assessed until 2019	Overland Resources' Yukon Base Metal Project comprises in excess of 1,500 Mineral Claims covering approximately 300 km^2 within the highly prospective Selwyn Basin, Yukon Territory, Canada, approximately 125 km north of Ross River. Access is via the North Canol Road and existing winter trail (February to April), or aircraft. Included in this land package are the high grade Andrew Zinc Deposit, Darcy Zinc Deposit and Darin Zinc Deposits, and several other highly prospective target areas including the Myschka copper-gold target, Scott zinc-lead target, Riedell base metal target, and a large area of unexplored territory. The project is a Class 3 mineral exploration program. Activities are schedule to take place throughout the year. Source: http://www.overlandresources.com/content/index.php/projects/yukon-base-metal-project	Exploration activities include: • Use of heavy equipment; • Geophysical and geotechnical sampling, geological mapping, and soil sampling; • Environmental monitoring and data collection; • Heritage and socio-economic data collection; • Use of existing camp: maximum 50 people; • Use of existing winter trail (February to April); • Construction of new trails; • Clearing: up to 15 per claim (20 m^2 each), 210 m^2 total for up to 14 helipads • Drill pad construction; • Drilling: up to 50 reverse circulation drill holes and up to 15 diamond drill holes over a 5-year program; • Helicopter use; • Use of existing airstrip and use of fixed wing aircraft; • Water use (less than 3 m^3/day for camp activities and less than 5 m^3/day for drilling activities); • Waste management; • Fuel storage; and • Progressive reclamation and final camp decommissioning. General exploration activities may include effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Wolverine Mine (*Yukon Zinc Corp.)*	2016-0007 2009-0209	25 km	Currently in care and maintenance, approximate mine life is 9.5 years	The Wolverine Mine is located in southeast Yukon, 282 km northeast from Whitehorse, and 190 km (by road) north of Watson Lake and 180 km south of Ross River via the Robert Campbell Highway. The Wolverine property encompasses 107 square kilometres, and is accessible either via a 26 km access road west from the Robert Campbell Highway or a 1,200 m long all-season gravel airstrip. Yukon Zinc's Wolverine Mine is a high grade zinc-silver-copper-lead-gold underground mine, with on site milling capabilities of 1,700 tpd to produce zinc, copper and lead concentrates. The current mine life is 9.5 years based on a 5.2 million tonne deposit and there is potential to expand the reserve through drilling. Yukon Zinc completed major site construction at Wolverine throughout 2009 and 2010. Mill commissioning commenced in late 2010 and operations started in 2011. In March 2012, commercial production was achieved and in the first quarter of 2013, full design capacity was reached. The majority of the concentrate from Wolverine is trucked to the port at Stewart, British Columbia. The Wolverine Mine was put on care and maintenance in January 2015. Yukon Zinc is fully permitted to operate the Wolverine Mine. Yukon Zinc was issued a Quartz Mining License by the Yukon Government in December 2006 and a Type A Water Licence by the Yukon Water Board in October 2007.	General care and maintenance activities include: • Maintenance of site infrastructure; • Water treatment and monitoring; and • Waste management. General care and maintenance activities may include effects on: • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife. As the mine is licensed to operate, the operations of the mine may have potential effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Roads, Access Roads and Trails					
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	2014-0058	110 km	2014 to 2039	Government of Yukon, Highways and Public Works, Transportation Engineering Branch is proposing geotechnical testing and development of an aggregate pit on a 5 hectare (ha) parcel of land, located at km 237.5 of the North Canol Road, approximately 11 km northeast of Ross River. The purpose of the project is to develop a long-term source (25 to 50 years) of granular material for road reconstruction, watercourse crossings and annual road erosion control and slope stabilization for the Deep Creek watercourse crossing, and for erosion control at the Ross River Ferry Crossing. Pit development was to begin August 2014. Future geotechnical and pit development activities will occur between June and October, annually. The temporal scope for the assessment of the project is 25 years.	Project activities include: • Use of heavy equipment; • Access construction; • Clearing, grubbing, stripping and site preparation; • Burning of brush and slash; • Quarry pit development; • Blasting, granular extraction (total of approximately 150 000 m^3), and stockpiling on site; • Geotechnical investigations; • Establishment of a temporary camp at km 235.5 (8 to12 people) to support blasting, sorting and stockpiling activities every 4 to 5 years for approximately 2 weeks; • Establishment of fuel storage and equipment maintenance/storage areas at camp; • Waste management and disposal; and • Decommissioning and reclamation. The project activities include potential effects on: • Air quality; • Noise levels; • Surface water quality; • Aquatic resources; • Soil; • Vegetation; and • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Finlayson Winter Trail *(Inconnu Lodge Limited)*	2015-0175	40 km	2016-2017	Inconnu Lodge Limited is proposing to use an existing winter trail, approximately 35 km, from the Robert Campbell Highway (at approximately km 248) to the west side of McEvoy Lake in southeast Yukon. From McEvoy Lake, the existing route follows the lakeshore (on the lake side) for about 3 km. From this location, a 3 km diversion will be constructed/utilized from the lake to the Inconnu airstrip. In 2016, Inconnu Lodge Limited intends to utilize the portion of the winter trail from the airstrip to the lake, along the lakeshore and continue for approximately 100 m west of the lake to recover and transport a broken-down bulldozer and a fuel tank back to the airstrip. In 2017, Inconnu Lodge Limited plans to walk a D7 bulldozer out to the Robert Campbell Highway and possibly walk a small excavator back to the airstrip. The use of the winter trail is expected to occur over two years.	Project Activities: • Use of an existing winter trail to McEvoy Lake and along the shoreline of the lake crossing of two completely frozen creeks in 2017 (creeks less than 1 m wide and less than 0.5 m deep); • Diversion from the existing winter trail around a swampy area (less than 300 m), potentially need to remove a few small trees; no brushing; • Diversion from McEvoy Lake to airstrip (approximately 3 km x up to 4 m); some brushing and removal of small trees; • Transport of a broken bulldozer and 5,000 gallon fuel tank from the existing trail to the airstrip; and • Transport of a D7 bulldozer from the airstrip to the highway and potential transport of a small excavator from the highway to the airstrip. The project activities include potential effects on: • Air quality; • Noise levels; • Vegetation; and • Wildlife.
Other Activities					
Single/Group Trapline Concessions	N/A	N/A	Ongoing (generally, October to March trapping season)	The following single trapline concessions are present within Finlayson Caribou Herd range: 415; 252; 255; 233; 250; 251; 249; 258; 349; and 341. The following group trapline concessions are present within Finlayson Caribou Herd range: 405.	Potential effects of trapping activities include those on: • Wildlife.
Outfitting Concessions	N/A	N/A	Ongoing (generally, August to October season)	The following outfitting concessions are present within Finlayson Caribou Herd range: 9; 20; 22; and 15.	Potential effects of use of outfitting concessions include those on: • Wildlife.

Project (*Proponent*)	Associated YESAB Project #s	Approx. Distance to KZK Project	Timeline	General Description	Potential Activities/Effects
Campgrounds	N/A	N/A	Ongoing	The following campgrounds are present in the region: • Lapie Canyon Campground; and • Francis Lake Campground.	Potential effects of campground use include those on: • Wildlife.



Kudz Ze Kayah Project

Campground

Quartz Mining Activity

FCH Habitat Range 25km Buffer

FCH Habitat Range

Trapline Concession

Outfitting Concession

Transportation Projects

Tote Road/Proposed Access Road

Primary road

Secondary Road

Yukon Territory Border

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BMC MINERALS

ALEXCO ENVIRONMENTAL GROUP

KUDZ ZE KAYAH PROJECT

FIGURE 5-1

PROJECTS AND ACTIVITIES TO BE CONSIDERED IN THE ENVIRONMENTAL CUMULATIVE EFFECTS ASSESSMENT

JANUARY 2017

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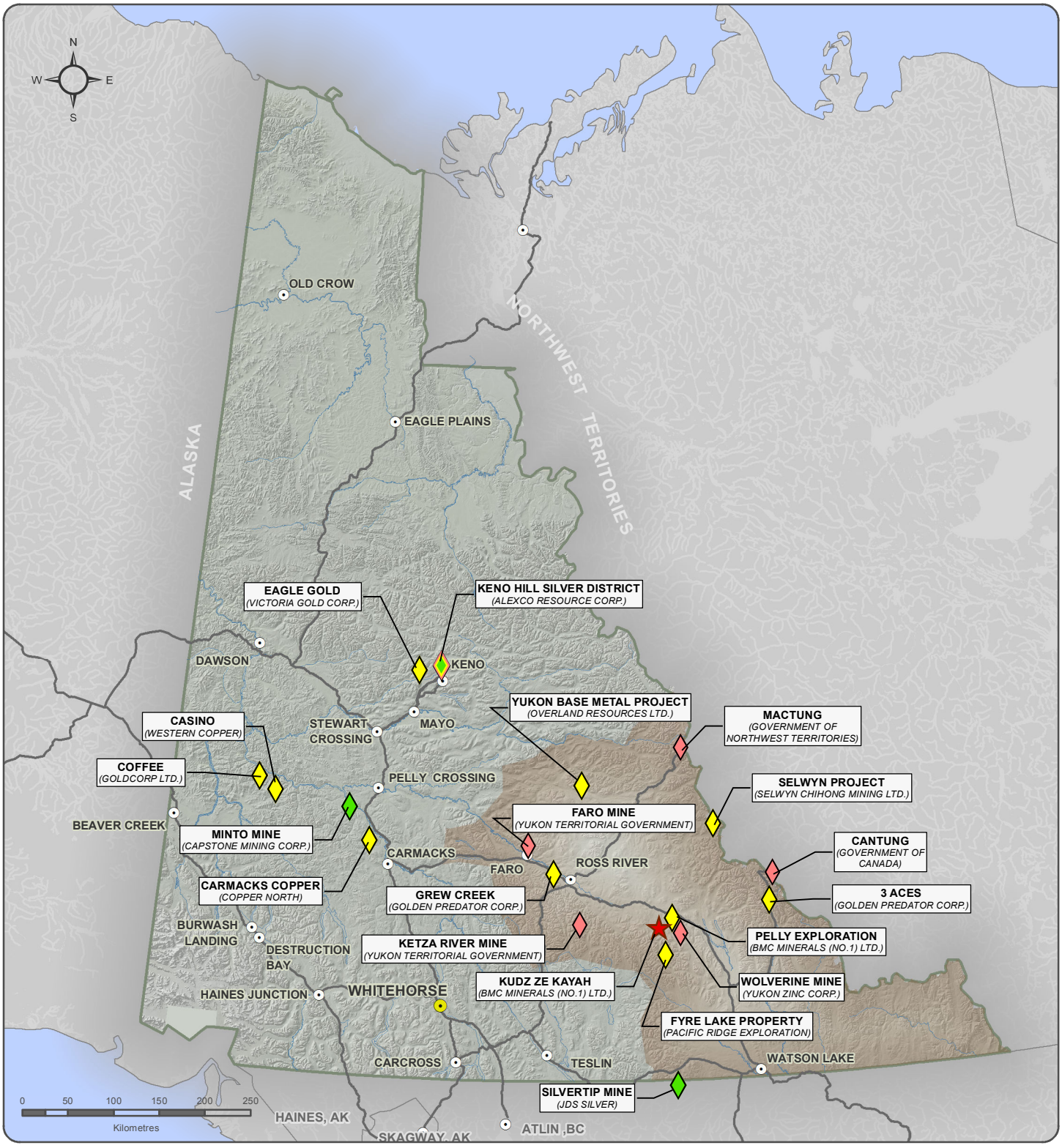
Table 5-4: Projects and Activities to be Considered in the Cumulative Effects Assessment for Socio-economic Valued Components

Project (*Proponent)*	Description
Kaska Traditional Territory	
3 Aces (*Golden Predator Corp.*)	An advanced exploration gold project located in the southeast Yukon approximately 40 km south of the Cantung mine and accessed off of the Nahanni Range Road.
Cantung Mine (*Abandoned*)	Tungsten mine located in the Northwest Territories near the Yukon border and accessed through the Yukon via the Nahanni Range Road. Began production in 1962 and operated till 1986. Intermittent operations from 2002 through 2015. Abandoned by North American Tungsten in 2015 and now under care and maintenance by the federal government.
Faro Mine (*Abandoned*)	Major lead-zinc producer through three periods beginning in 1969 and the late 1990s when the last owner went bankrupt and abandoned the site. Site is under Yukon government care and maintenance. Planning and engineering studies for reclamation underway since 2009 with some cleanup and remediation work completed but most still to do.
Fyre Lake Property (*Pacific Ridge Exploration)*	Copper-cobalt-gold exploration project located approximately 30 km south of the Project.
Grew Creek (*Golden Predator Corp*.)	Gold exploration project located along the Robert Campbell Highway between Ross River and Faro.
Ketza River Mine (*Abandoned*)	Gold mine in production from 1988 to 1991. Abandoned by owners in 2015 and currently under Yukon government care and maintenance.
Mactung (*Government of Northwest Territories*)	Tungsten deposit located on the Yukon-NWT border and accessed by the North Canol Road. Entered the permitting stage in 2009 as an underground mine with screening completed in 2014. Purchased by the Government of the Northwest Territories in November 2015 after North American Tungsten declared bankruptcy.
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	A Class 3 mineral exploration program at the Pelly Property located 130 km southeast from Ross River and 160 km northwest from Watson Lake. The project will be accessed via an existing access road and/or helicopter. Activities are scheduled to take place year round for five years.
Selwyn Project (*Selwyn Chihong Mining Ltd.)*	Proposed lead-zinc mine at Howard's Pass along Yukon-NWT border. A large-scale deposit with expected 11-year mine life and employment of 750. In the advanced exploration stage and some studies begun in preparation for entering permitting stage however the project was put on hold by the company in February 2016.
Silvertip Mine (*JDS Silver*)	Silver-lead-zinc mine under construction in BC 16 km south of the Yukon border approximately 90 km south west of Watson Lake, and was scheduled to begin production in Q4 2016.
Wolverine Mine (*Yukon Zinc Corp.*)	Underground zinc mine with 300 employees that went into full production in 2013. Mine life estimated at 9.5 years. Production stopped in January 2015 and company placed under court protection while going through bankruptcy reorganization. Creditors accepted repayment plan in 2015. Property is on care and maintenance but underground has been flooding.
Yukon Base Metal Project (*Overland Resources Ltd.*)	Lead-zinc exploration project located west of the North Canol Road approximately 125 km north of Ross River.
Yukon	
Carmacks Copper (*Copper North*)	Located west of Carmacks. Planned open pit copper-gold-silver mine with an expected life of 7 years with estimated 180 jobs at full production. Initially proposed to use sulphuric acid heap leach technique, which local First Nation and others protested. Conditionally approved by YESAB and issued mining licence by YG in 2008/09 but refused water licence by Water Board. Lost court proceedings against Water Board and has now re-engineered the project to address concerns.
Casino (*Western Copper*)	Proposed copper-gold mine located west of Pelly Crossing. In the permitting stage. Expected capital costs in the $2.5 billion range with a 22 year mine life.

Project (*Proponent*)	Description
Coffee (*Goldcorp Ltd*.)	Planned open pit gold mine in the White Gold district south of Dawson City, with 10 year mine life. Currently in exploration phase. Purchased by Goldcorp in May 2016.
Eagle Gold (*Victoria Gold Corp*.)	Fully permitted open pit gold mine awaiting production decision. Located approximately 80 km north of Mayo in the central Yukon. Planned 10 year mine life with expected employment of 350.
Keno Hill Silver District (*Alexco Resource Corp*.)	The Keno district produced silver from numerous mines from 1920 to 1989 with a temporary closure in the mid-1940s. Alexco resumed underground silver production at Bellekeno in late 2011 until shutting down in 2013. The company has other deposits in the district and is also responsible for overall site reclamation on behalf of government.
Minto Mine (*Capstone Mining Corp*.)	Copper mine located west of the Yukon River near Pelly Crossing in the central Yukon. Began production in 2007. Open pit mining ceased in October 2016. Underground mining and milling continue with a temporary closure planned for mid to late 2017.
Other activities	
Single/Group Trapline Concessions Outfitting Concessions (see Figure 5-1)	Trapline and outfitting concessions contribute to the economy of Yukon and are considered for potential cumulative effects with the Project.



PROJECT STATUS

- Construction/Active
- Exploration/Licencing
- Temporary Closure/Reclamation/Closed/Abandoned
- Exploration/Licencing/Temporary Closure/Reclamation/Closed/Abandoned
- Kaska Dena First Nation (Ross River Dena Council and Liard) Traditional Territory

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KUDZ ZE KAYAH PROJECT

FIGURE 5-2

PROJECTS AND ACTIVITIES TO BE CONSIDERED IN THE SOCIO-ECONOMIC CUMULATIVE EFFECTS ASSESSMENT

MARCH 2017

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5.7.2 Cumulative Effects Assessment Methods

The CEA for each VC is completed in each VC chapter. The overall CEA approach includes the following steps:

- Consider how residual effects associated with the Project may interact with effects of other projects in the area to cumulatively impact VCs. Cumulative effects are considered for each VC for which it is shown there are Project-specific residual effects; however, not all residual effects will contribute to measurable cumulative effects. In order to be considered in the CEA, the following conditions must be met:
  - There is information available to identify if the project or activity results in a demonstrable or measurable effect on the VC;
  - The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area); and
  - The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time).
- Characterize and analyze cumulative effects interactions identified from the previous step;
- Develop mitigation measures to reduce or eliminate potential cumulative effects so they are not significant. As required in the *Proponent's Guide to Executive Committee Screenings* (YESAB, 2005a), the rationale for the expected success of these mitigation measures will also be provided, including the results of any field studies and research;
- Identify and define residual cumulative effects after application of the mitigation measures. Where identified, the residual cumulative effects will be characterized by direction, magnitude, geographic extent, frequency and timing, duration, reversibility, and context using the same definitions as those used for Project-specific residual effects; and
- Determine the significance of residual cumulative effects. Similar to the Project-specific methods, a determination of significance will be made for each cumulative effect based on the definition developed for the VC.

5.8 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Guide the implementation of additional mitigation measures as per adaptive management plans.

The proposed effects monitoring programs are described for each VC in the corresponding chapter.

Management plans are the main mechanism for implementing environmental and socio-economic mitigation, effects monitoring and management measures and ensuring operations are carried out in a manner that minimizes adverse effects and enhances beneficial effects. The conceptual management plans are provided in Chapter 18.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

6 AIR QUALITY 6-1

6.1 ASSESSMENT APPROACH 6-1
6.1.1 Regional Setting 6-1
6.1.2 Selection of Subcomponents and Measurable Parameters 6-1
6.1.3 Criteria for Assessing Significance 6-3
6.2 ASSESSMENT BOUNDARIES 6-5
6.3 EXISTING CONDITIONS 6-8
6.3.1 Air Quality 6-8
6.3.2 Meteorology 6-11
6.4 PROJECT-SPECIFIC EFFECTS 6-15
6.4.1 Effects Characterization 6-15
6.4.2 Mitigation Measures 6-28
6.4.3 Residual Effects and Significance Determination 6-30
6.5 CUMULATIVE EFFECTS 6-33
6.5.1 Cumulative Effects Characterization 6-33
6.5.2 Cumulative Effects Mitigation Measures 6-36
6.5.3 Cumulative Effects Significance Assessment 6-36
6.6 EFFECTS MONITORING 6-38
6.6.1 Air Quality Monitoring 6-38
6.6.2 Meteorology Monitoring 6-38

LIST OF TABLES

Table 6-1: Air Quality Subcomponents and Measurable Parameters 6-2
Table 6-2: Yukon Ambient Air Quality Standards (YAAQS) [i] 6-3
Table 6-3: Air Quality Significance Criteria Definition 6-4
Table 6-4: Proposed Study Areas for Air Quality 6-5
Table 6-5: Air Pollutants Ambient Concentrations, Whitehorse NAPS station 2012-2015 6-9
Table 6-6: Hourly Particulate Matter Baseline Ambient Concentration, Casino Mine Project 6-9
Table 6-7: Assumed Air Contaminants Baseline Concentrations 6-10
Table 6-8: National and Territorial GHG Emissions (in kilotonnes of CO_2 equivalent/year) 6-10
Table 6-9: Monthly Meteorological Data Summary, KZK, September 2015 to August 2016 6-12
Table 6-10: Wind Rose Summary Statistics 6-15
Table 6-11: Interaction Matrix for Air Quality 6-15
Table 6-12: Predicted TSP Concentrations 6-17
Table 6-13: Predicted PM_{10} Concentrations 6-19
Table 6-14: Predicted $PM_{2.5}$ Concentrations 6-19
Table 6-15: Predicted CO Concentrations 6-22

Table 6-16: Predicted NO_2 Concentrations 6-22
Table 6-17: Predicted SO_2 Concentrations 6-25
Table 6-18: Average Annual Project GHG Emissions (tonnes of CO_2 equivalent) 6-27
Table 6-19: Identified Potential Project Effects for Air Quality 6-28
Table 6-20: Proposed Mitigation Measures for Air Quality 6-28
Table 6-21: Project Effects Significance Assessment for Air Quality 6-31
Table 6-22: Cumulative Effects Screening for Air Quality 6-34
Table 6-23: Proposed Cumulative Effects Mitigation Measures for Air Quality 6-36
Table 6-24: Cumulative Effects Significance Assessment for Air Quality 6-37

LIST OF FIGURES

Figure 6-1: Mine Site Layout, Assessment Boundaries and Receptor 6-7
Figure 6-2: Wind Rose, KZK, September 2015 to August 2016 6-14
Figure 6-3: Predicted Maximum 24-hr TSP Concentrations 6-18
Figure 6-4: Predicted Maximum 24-hr PM_{10} Concentrations 6-20
Figure 6-5: Predicted Maximum 24-hr $PM_{2.5}$ Concentrations 6-21
Figure 6-6: Predicted Maximum 1-hr CO Concentrations 6-23
Figure 6-7: Predicted Maximum 1-hr NO_2 Concentrations 6-24
Figure 6-8: Predicted Maximum 1-hr SO_2 Concentrations 6-26

6 AIR QUALITY

This chapter provides an overview of the existing air quality conditions and assessment of the potential Project effects on air quality. Air quality was selected as a VC due to its importance to the health and well-being of humans, wildlife, vegetation, and other biota. The atmosphere provides a pathway for the transport of contaminants to the biophysical environment.

6.1 ASSESSMENT APPROACH

The air quality effects assessment (EA) will generally follow the methods outlined in Chapter 5 and will rely on results of air dispersion modelling for criteria air contaminants (CACs). Air dispersion modelling was conducted using CALPUFF, a Gaussian puff model that can account for time- and space-varying meteorological conditions, different source configurations and contaminants, and chemical transformations. CALPUFF is recommended in the *Guidelines for Air Quality Dispersion Modelling* in British Columbia (BC MOE, 2008) and by the US Environmental Protection Agency (U.S. EPA, 2014).

Project related greenhouse gas (GHG) emissions were also assessed because of their known association with climate change. For GHGs, an inventory was carried out using published emission factors to estimate average annual emissions for each Project phase.

Details of the air dispersion modelling and greenhouse gas emissions inventory are provided in the Air Dispersion Model Report (Appendix E-1).

6.1.1 Regional Setting

The Project is located approximately 260 km northwest of Watson Lake and 115 km southeast of Ross River, Yukon Territory (Yukon). Access to the Project is via a 24 km long, all weather, single lane gravel Tote Road that connects the Project to the Robert Campbell Highway. The Project is located in the northern foothills of the Pelly Mountains of the Yukon Plateau and in the Finlayson Creek watershed, which includes the Geona Creek drainage. Regional climatic conditions are described in Section 6.3.2.

6.1.2 Selection of Subcomponents and Measurable Parameters

The following two valued subcomponents have been selected for the air quality VC:

- Criteria Air Contaminants (CACs); and
- Greenhouse Gases (GHGs).

The air quality subcomponents and measurable parameters are provided in Table 6-1.

Sulphur dioxide (SO_2), total suspended particulates (TSP), carbon monoxide (CO), fine particulate matter less than 2.5 microns ($PM_{2.5}$), coarse particulate matter less than 10 microns (PM_{10}), and nitrogen dioxide (NO_2) were identified as measurable parameters for the CACs valued

subcomponent. The measurable parameters were selected because they are CACs known to be associated with human health issues and/or because they are subject to ambient air quality standards in Yukon.

More specifically, both SO_2 and NO_2 can cause adverse effects on respiratory systems of humans and animals, as well as damage to vegetation (Environment and Climate Change Canada, 2013). Numerous studies have linked TSP to aggravated cardiac and respiratory diseases such as asthma, bronchitis, emphysema, and to various forms of heart disease. TSP can also have adverse effects on vegetation and structures, and contributes to visibility deterioration and regional haze (Environment and Climate Change Canada, 2013). PM_{10} and $PM_{2.5}$ represent the coarse and fine fractions of TSP, respectively. PM_{10} (aerodynamic diameter of less than 10 µm) is the fraction of TSP that is inhalable, and therefore, has the potential to cause adverse health effects. Fine particles (aerodynamic diameter of less than 2.5 µm) are able to penetrate deeper into the lungs and are generally considered a stronger risk factor than the coarse fraction of PM_{10} (particles in the 2.5 to 10 µm range) (WHO, 2013). Carbon monoxide (CO) can also have an effect on human health. It enters the bloodstream through the lungs and forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Persons with heart or respiratory diseases, infants, and elderly persons are especially sensitive to effects from CO. CO can also affect healthy individuals, impairing exercise capacity, visual perception, manual dexterity, learning functions, and the ability to perform complex tasks (Environment and Climate Change Canada, 2013).

Greenhouse gases (GHGs) were also identified as a subcomponent for the air quality valued component because of their known association with climate change. Measurable parameters for GHGs include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O); all of which are reported as CO_2 equivalent based on their global warming potential.

Table 6-1: Air Quality Subcomponents and Measurable Parameters

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Air Quality	Criteria Air Contaminants	Ambient concentrations of SO_2, TSP, CO, $PM_{2.5}$, PM_{10} and NO_2	Compliance with standards at receptor	Yukon Ambient Air Quality Standards (YAAQS)
	Greenhouse Gases	Project annual CO_2, CH_4 and N_2O emissions, expressed as CO_2 equivalent	Comparison with national, and territorial emissions	National Inventory Report (EC, 2016b) GHGRP (ECCC, 2016d)

Yukon Government (YG) implemented Ambient Air Quality Standards (YAAQS) for SO_2, TSP, CO, $PM_{2.5}$ and NO_2 in 2010, and more recently for PM_{10} (Yukon Government, 2014). The YAAQS and averaging periods are presented in Table 6-2.

Table 6-2: Yukon Ambient Air Quality Standards (YAAQS) [i]

Parameter	Standard (µg/m³)[ii]	Standard (ppm)[iii]	Standard (ppbv)[iv]
Sulphur Dioxide (SO_2)	—	—	
1-hour average			172
24-hour average			57
Annual arithmetic mean			11
Total Suspended Particulates (TSP)		—	—
24-hour average	120		
Annual geometric mean	60		
Carbon Monoxide (CO)	—		—
1-hour average		13	
8-hour average		5	
Fine Particulate Matter ($PM_{2.5}$)		—	—
24-hour average (calendar day)	28		
Annual mean (calendar year)	10		
Coarse Particulate Matter (PM_{10})		—	—
24-hour average	50		
Nitrogen Dioxide (NO_2)	—	—	
1-hour average			213
24-hour average			106
Annual arithmetic mean			32

[i] All ambient air quality measurements will be referenced to standard conditions of 25 degrees Celsius and 101.3 kilopascals.
[ii] µg/m³ – micrograms per cubic metre
[iii] ppm = parts per million
[iv] ppbv = parts per billion by volume

For GHGs, the Government of Canada requires that facilities across Canada that emit the equivalent of 50 000 tonnes (50 kilotonnes) or more of GHGs in carbon dioxide equivalent units (CO_2 eq) per year report their GHG emissions annually through the Greenhouse Gas Emissions Reporting Program (GHGRP). A national GHG inventory is produced annually and Project emissions can be compared to territorial and federal emissions. It should be noted that ECCC is considering changes to the GHGRP starting in 2017 (ECCC, 2016d).

6.1.3 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long-term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and

- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of the activity causing the effect to occur and the probability of mitigation being successful; and
- **Uncertainty**: The possible error or range of error that may exist in assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for air quality are presented in Table 6-3.

Table 6-3: Air Quality Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
	Adverse	VC would change for the worse
Magnitude	Low	Minor change (i.e., within natural variability) from baseline (air contaminants) Less than 25% contribution to Yukon's total GHG emissions
	Moderate	Measurable change from baseline but below standards (air contaminants) Greater than 25% contribution to Yukon's total GHG emissions but less than 1% contribution to Canadian total emissions
	High	Ambient air contaminant concentrations above YAAQS Greater than 1% contribution to Canadian total GHG emissions
Geographic Extent	Site	Effect limited to the Project Footprint
	Local	Effect extending beyond the Project Footprint but in the local study area
	Regional	Effect extending across the regional study area
	Beyond Regional	Effect extending beyond the regional study area
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long-term	Effect lasting through any two concurrent Project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project (for CACs, YAAQS exceedances less than 25% of the time)
	Regular	An effect that occurs regularly during any phase of the Project (for CACs, YAAQS exceedances more than 25% of the time but less that 100% of the time)

Criteria	Definition	
	Continuous	An effect that occurs constantly during any phase of the Project (for CACs, consistent YAAQS exceedances (100% of the time))
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long-term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Economic and Social Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

For CACs, a significant effect is considered to occur if it is of high magnitude and extends across the regional study area or is of high magnitude in the local study area and occurs at regular or continuous frequency. For GHGs, a significant effect is considered to occur if it is of high magnitude and extends across the regional study area or is of high magnitude in the local study area and occurs over the long-term.

6.2 ASSESSMENT BOUNDARIES

The local and regional study areas for air quality are described in the table below and are shown in Figure 6-1. The study area boundaries have been selected to include areas where measurable changes in ambient air quality might be caused by the Project, and include camp as a sensitive receptor. The camp was selected as a receptor because ambient air contaminant concentrations at the camp will be representative of exposure to off-duty workers. Modelling results are also presented graphically for the entire modelling domain, corresponding to the regional study area, to evaluate the extent of predicted changes in air contaminant concentrations associated with Project activities.

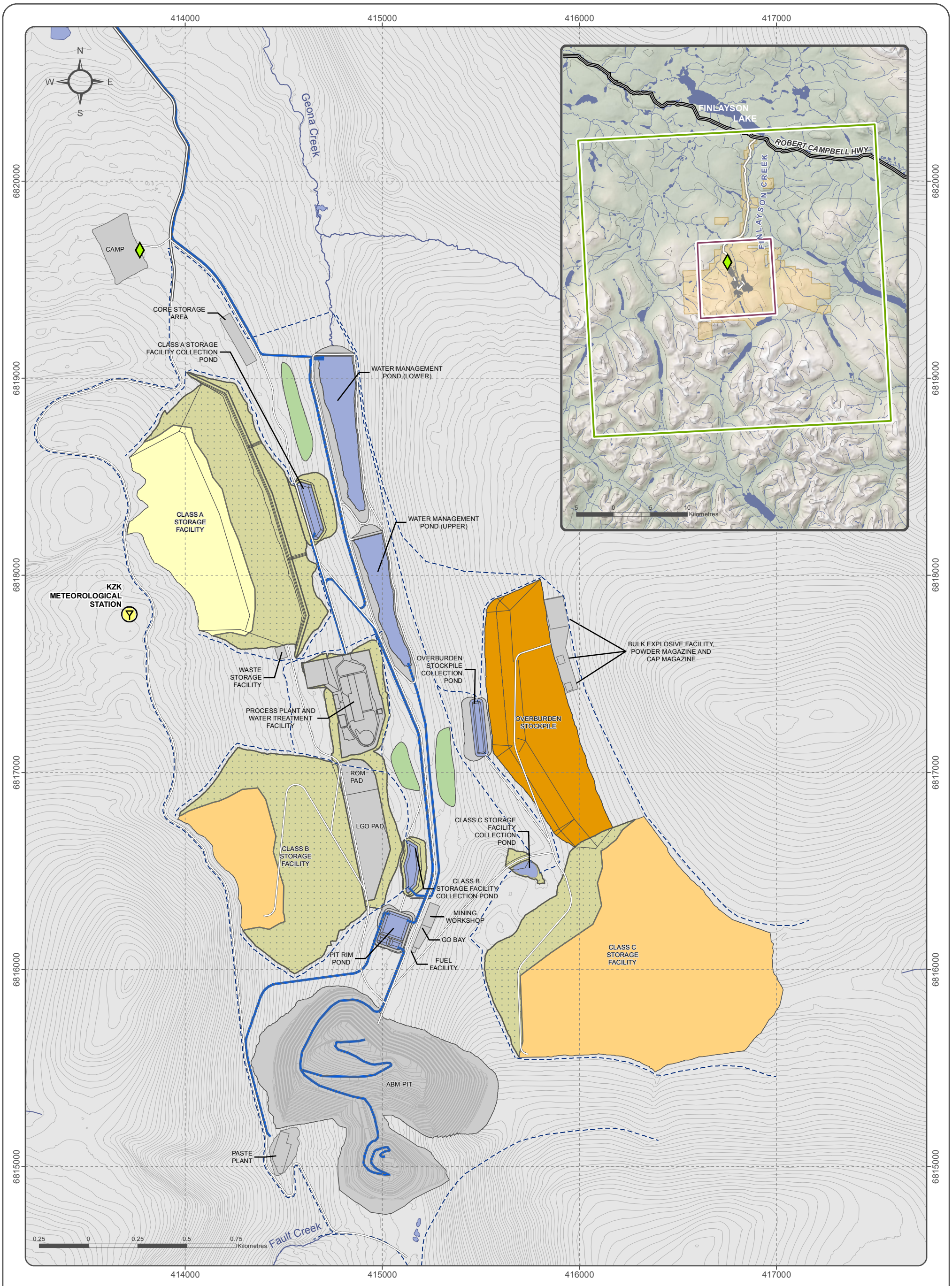
Table 6-4: Proposed Study Areas for Air Quality

Study Area	Air Quality Specific Study Area Description
Local Study Area	The local study area is 5 km by 5 km, centered on the mine footprint, and includes the camp as a receptor.
Regional Study Area	The regional study area is 40 km by 40 km and encompasses the mine footprint and the entire Tote Road/Proposed Access Road. Grid spacing is smaller in the local study area than in the regional study area.

Temporal boundaries are defined to include all Project phases in which effects are expected to occur. The Project phases considered in the air quality EA include the following:

- **Construction Phase**: will last approximately two years and includes Project site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground mining and ore processing; and
- **Decommissioning, Reclamation and Active Closure Phase** (referred to as Closure Phase): will last approximately three years.

As there are minimal or no physical activities during the transition closure period and the post-closure period, minimal air emissions are expected during these phases (i.e., less than those assessed for Closure Phase) and they have not been included in the assessment of air quality.



Receptor

Meteorological Station

Pipeline

Diversion Ditch

Class A Storage Facility

Class B and C Storage Facility

Overburden Stockpile

Topsoil Stockpile

Progressive Reclamation

Pond/Water

Local Study Area

Regional Study Area

Tote Road/Proposed Access Road

Proposed Mine Road

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FIGURE 6-1

MINE SITE LAYOUT, ASSESSMENT BOUNDARIES AND RECEPTOR

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6.3 EXISTING CONDITIONS

This section presents a summary of existing environmental conditions as they relate to air quality, including a description of meteorology. This characterization of the existing environment serves as the baseline against which the effects of the Project are assessed. The description of the existing environment has been focused on those components of the environment that may be affected by the Project.

The description of the existing environment for the air quality is based on the review of existing information, as no baseline data were collected in the Project area. The description of the meteorology and climate is based on regional data and on the monitoring conducted in the Project area, with the details provided in the Hydrometeorology Baseline Report, included as Appendix D-2. Desk-based research was conducted to identify Kaska First Nation (Kaska) knowledge, uses, interests, and values related to air quality and climate (Appendix F-3); however, none was available from publicly available secondary sources. Ongoing future traditional knowledge data collection efforts, as well as consultation and engagement activities with the RRDC as representatives of the Kaska, may result in additional information and understanding on this issue.

6.3.1 Air Quality

6.3.1.1 Criteria Air Contaminants

Due to the Project's remote location and the fact that there are no industrial or residential activities in the area, baseline air quality data were not collected. Gaseous air contaminants are expected to be minimal and any existing baseline air contaminants likely originate from natural sources (e.g., fugitive dust) or long range transport, and likely consist mainly of fine particulate matter ($PM_{2.5}$) able to survive long range transport.

The nearest air quality monitoring station for which data are available is operated by Environment Canada as part of the National Air Pollution Surveillance Network (NAPS) and is located in Whitehorse, Yukon, a distance of about 255 km. Because of the urban setting, ambient concentrations measured in Whitehorse are influenced by anthropogenic sources and are not deemed representative of ambient conditions in the Project area. For context, Table 6-5 presents Whitehorse air quality data over the past four years, and shows that even in a location where much more anthropogenic sources exist in comparison to the Project area, ambient levels of gaseous contaminants are well below their respective YAAQS. The only pollutant for which exceedances occasionally occur is $PM_{2.5}$, and elevated levels are generally associated in part with residential wood smoke in the winter time (Environment Canada, 2015a). A 2006 emission inventory for Whitehorse (SENES Consultants Ltd., 2008) estimated that, "…on an annual basis, heating contributes 84% to $PM_{2.5}$ emissions, followed by fugitive dust (approximately 9%), mobile (both on and off road) sources (approximately 4%) and industrial point sources (approximately 3%)" (Environment Canada, 2015a).

Table 6-5: Air Pollutants Ambient Concentrations, Whitehorse NAPS station 2012-2015

		CO		$PM_{2.5}$	NO_2	
	YAAQS	13 ppbv	5 ppbv	28 µg/m³	213 ppbv	106 ppbv
	Averaging Period	1 hr	8 hrs	24 hrs	1 hr	24 hrs
2012	Mean	0.3	0.3	6	6	6
	95th percentile	0.6	0.5	14	23	18
	Max	3.5	1.9	**31**	49	33
2013	Mean	N/A	N/A	6	5	5
	95th percentile	0.6	0.5	17	20	16
	Maximum	2	1.3	**41**	45	26
2014	Mean	N/A	N/A	N/A	N/A	N/A
	95th percentile	0.7	0.7	17	21	17
	Maximum	2.7	1.4	**39**	40	26
2015	Mean	N/A	N/A	N/A	5	5
	95th percentile	N/A	N/A	13	21	16
	Maximum	N/A	N/A	27	81	34

Source: Environment and Climate Change Canada, 2016

Notes: µg/m³ = micrograms per cubic metre; ppbv = parts per billion by volume; values in red exceed the YAAQS

Very limited ambient air quality data are available for remote Yukon locations; however, monitoring of SO_2, NO_2, and particulate matter was conducted during baseline conditions at the Casino Mine Project in 2013. SO_2 and NO_2 were sampled via passive samplers; however, the exposure period was not specified. Two samples were collected for each pollutant and all results were found to be below the detection limit of 0.1 ppb, except for one NO_2 sample that had a measured value of 0.2 ppb (Casino Mining Corporation, 2014a). Results for particulate matter are summarized in Table 6-6.

Table 6-6: Hourly Particulate Matter Baseline Ambient Concentration, Casino Mine Project

		Test 1	Test 2
	Date	23-May-2013	13-Jun-2013
	Duration (D:H:M)	20:00:51	12:00:50
$PM_{2.5}$	Average (µg/m³)	4	4
	Maximum (µg/m³)	11	13
PM_{10}	Average (µg/m³)	6	7
	Maximum (µg/m³)	11	13
TSP	Average (µg/m³)	6	7
	Maximum (µg/m³)	1	13

Source: Casino Mining Corporation, 2014a

PM_{10} sampling was also conducted by Yukon Government in 2013 in the Keno City area. One station was established to represent background levels and was located 8 km outside of Keno City, away from roads or other anthropogenic influences. Five-minute data averaged over the different sampling

periods (ranging from 14 to 53 hours) were reported. Results at this station indicated average levels of 2.8 µg/m^3, 10.2 µg/m^3 and 3.8 µg/m^3 in June, July and August, respectively (YG, 2014b).

Table 6-7 summarizes the baseline levels assumed for this study based on the limited information available. Gaseous contaminants were assumed to be minimal under baseline conditions, as supported by results of the passive sampling for SO_2 and NO_2 for the Casino Mine Project. Ambient baseline particulate levels for a 24-hr averaging period were taken to be the average of the Casino Mine data above and the Keno results for PM_{10}. It should be noted that the particulate data are representative of summer concentrations and that winter ambient concentrations are expected to be lower. Because no relevant data are available for longer averaging periods, a conversion factor was used to estimate annual averages, as recommended by the EPA (U.S. EPA, 1992).

Table 6-7: Assumed Air Contaminants Baseline Concentrations

Contaminant	Unit	Baseline Concentration	
		24-hour	Annual
TSP	µg/m^3	7	1
PM_{10}	µg/m^3	6	1
$PM_{2.5}$	µg/m^3	4	1
CO	ppm	0	0
SO_2	ppbv	0	0
NO_2	ppbv	0	0

6.3.1.2 Greenhouse Gases

Information on total Yukon and Canadian GHG emissions from 1990 to 2014 was obtained from the National Inventory Report (Environment Canada, 2016b), and is presented in Table 6-8.

Table 6-8: National and Territorial GHG Emissions (in kilotonnes of CO_2 equivalent/year)

Year	Canada Total Emissions	Canada Emissions - Mining Sector	Yukon Total Emissions
1990	613,000	6,000	531
2000	747,000	6,000	505
2005	696,000	7,000	459
2010	706,000	7,000	344
2011	710,000	8,000	384
2012	718,000	8,000	393
2013	731,000	8,000	351
2014	732,000	8,000	268

Source: National Inventory Report (Environment Canada, 2016b)

Emissions from the mining sector (excluding smelting and refining) represent an average of 1% of the total Canadian GHG emissions. Yukon emissions represent less than 0.1% of total Canadian

emissions. In 2014, total GHG emissions in Canada had increased by 19.5% compared to 1990 emissions, while in Yukon, they had decreased by 49.5% relative to 1990 emissions.

6.3.2 Meteorology

Climatic and meteorological conditions at the site were characterized using regional data available through Environment and Climate Change Canada (EC) and Environment Yukon, as well as meteorological data collected on site in 1995 (in support of the Initial Environmental Evaluation and Type A Water Use Licence Application), and at the new site meteorological station commissioned in late August 2015. Details are provided in the Hydrometeorology Baseline Report (Appendix D-2), while a summary is presented below.

Monthly site results are summarized for the period September 1, 2015 to August 31, 2016 in Table 6-9. The location of the meteorology station is presented in Figure 6-1.

6.3.2.1 Temperature

The mean annual temperatures at regional stations ranged from -4.7°C at Ross River to -2.2°C at Ketza River Mine for the periods of record (ranging from 10 to 63 years depending on station), and extreme annual temperatures ranged from -59.4°C at Ross River in December to 35.4°C at Watson Lake in July. Long-term records at the six regional stations studied indicate an increasing trend for average minimum, average maximum, and mean monthly temperatures.

The mean annual temperature recorded at the Project for the period September 2015 to August 2016 was -0.47°C, with extremes ranging from -26.28°C to 19.89°C. When compared to both long-term regional averages and to regional data for the same period, the 2015 to 2016 record in the Project area generally shows warmer winter temperatures (October to April), cooler summer temperatures (May to September), and a smaller diurnal range.

Table 6-9: Monthly Meteorological Data Summary, KZK, September 2015 to August 2016

Month	Extreme Minimum Temperature (°C)	Average Minimum Temperature (°C)	Average Temperature (°C)	Average Maximum Temperature (°C)	Extreme Maximum Temperature (°C)	Average Relative Humidity (%)	Maximum Relative Humidity (%)	Minimum Relative Humidity (%)	Total Precipitation (mm)	Corrected Total Precipitation (mm)	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Total Evapotranspiration (mm)	Average Solar Radiation (W/m^2)	Average Barometric Pressure (hPa) *	Total Pan Evaporation (mm)	Snow Water Equivalent (mm) **
Sep-15	-8.28	-0.66	1.42	3.65	8.94	76.4	96.6	57.7	23.25	29.1	5.78	25.42	34.0	105.85	1006.83		
Oct-15	-11.05	-3.08	-1.12	0.89	6.01	73.0	96.1	39.9	7.18	15.8	4.71	19.17	14.1	50.31	1006.81		
Nov-15	-26.28	-11.08	-8.57	-5.93	2.00	73.1	89.1	34.1	12.56	27.6	6.37	28.52	5.0	18.25	1000.62		
Dec-15	-21.89	-13.28	-11.08	-9.23	0.23	78.8	88.6	49.0	6.30	13.9	3.47	23.62	-1.0	5.59	997.90		
Jan-16	-17.04	-8.87	-6.97	-5.41	-0.94	72.4	88.3	31.7	2.88	6.3	4.91	25.99	2.2	12.82	1002.03		44.0
Feb-16	-21.58	-10.08	-8.02	-6.11	-0.75	75.5	90.1	53.1	3.84	8.4	4.97	20.93	7.4	44.84	1003.76		37.3
Mar-16	-16.21	-8.01	-6.14	-4.28	7.69	74.9	86.9	47.1	0.88	1.9	4.91	19.56	25.0	120.06	1003.95		49.3
Apr-16	-5.53	-2.61	-0.16	2.26	9.39	66.1	89.7	43.3	12.06	26.5	6.10	24.87	51.3	176.36	1008.63		
May-16	-3.05	1.94	5.12	8.31	17.48	61.7	87.4	26.3	39.38	49.2	4.87	21.09	84.5	225.47	1014.41		
Jun-16	1.45	6.39	9.81	13.29	19.42	57.2	78.2	36.1	18.26	22.8	4.84	16.9	106.2	256.27	1013.28	138.5	
Jul-16	1.52	7.71	10.75	13.91	19.89	69.9	86.7	49.9	113.46	141.8	4.44	18.93	76.5	196.60	1014.69	111.5	
Aug-16	0.33	6.71	9.29	12.31	18.93	71.0	93.2	45.6	103.22	129.0	4.70	17.29	59.52	153.18	1017.31	80.2	
Annual	**-26.28**	**-2.91**	**-0.47**	**1.97**	**19.89**	**70.84**	**96.60**	**26.30**	**343.25**	**472.5**	**5.01**	**28.52**	**464.67**	**113.80**	**1007.52**		

* Corrected to sea-level equivalent

** Averaged across the 3 baseline snow survey stations for January and February and the 3 baseline and 4 peak snow survey stations for March

6.3.2.2 Precipitation

Mean annual precipitation at regional stations (calculated for a period of record ranging from 10 to 63 years depending on station) varied between 210 mm at Ross River and 710 mm at Ketza River Mine; the proportion of total annual precipitation falling as rain ranged from 39% at Ketza River Mine to 70% at Ross River and Faro. The greatest amount of precipitation generally fell between June and September for all regional stations. Long-term records did not show clear trends when looking at total precipitation over time; however, the proportion of total precipitation falling as rain displayed an increasing trend at all stations, consistent with the rising trends observed in air temperature.

Total precipitation measured in the Project area for the period from September 1, 2015 to August 31, 2016 was 343 mm. Compared to regional data for the same period, the total precipitation measured at the Project was greater than the total precipitation at both Faro A (elevation of 716 masl) and Watson Lake A (elevation of 687 masl) EC meteorological stations. However, the difference is not as great as that expected in relation to the higher elevation of the Project meteorological station (elevation of 1542 masl). Given the high wind speeds observed at site and the known phenomenon of undercatch (lower than actual precipitation readings in the rain or snow gauge due to winds preventing all precipitation from falling in the gauge), the observed precipitation was corrected for undercatch by considering runoff, snowpack observations, and known ranges of expected evapotranspiration to a total value of 473 mm.

The total precipitation measured for the period September 2015 to August 2016 represented 70% of the long-term mean annual precipitation (MAP) for Watson Lake A, and 88% for Faro A, indicating that the 2015 to 2016 period was below average for precipitation. The MAP is estimated to be 612 mm for the upper Geona Creek catchment after applying the same correction factors to the Project total precipitation amount measured for that period. The estimated mean annual precipitation was set as 616 mm at the Project meteorological station (1,542 masl) with a change of 9 mm per 100 m change in elevation. This compares well to the previous estimate of 655 mm in the Initial Environmental Evaluation.

6.3.2.3 Snowpack

The 2016 snow survey data at five regional stations indicated that 2016 was a below average snowfall year. Snow Water Equivalent (SWE) values in April 2016 ranged from 62% to 93% of long-term average with a mean of 78%, whereas the May 2016 SWE values ranged from 0% to 91% of normal with a mean of 44%.

Snow surveys conducted at the Project in January, February, and March 2016 indicate lower SWE values than at regional stations; although, sampling was not carried out at the same time of year. The 2016 snow survey data at the Project also indicated a lower snowfall year when compared to the 1995 site snow survey results.

6.3.2.4 Wind Speed and Direction

Wind speed and direction are measured at a height of 10 m at the site Campbell Scientific meteorological station. Wind data collected between September 1, 2015 and August 31, 2016 are presented in Figure 6-2. The prevailing winds blew from the northwest to northeast and the highest average wind speeds originated from the northeast. Wind rose summary statistics are presented in Table 6-10. The strongest winds were observed during the month of November for the period of record (Table 6-9).

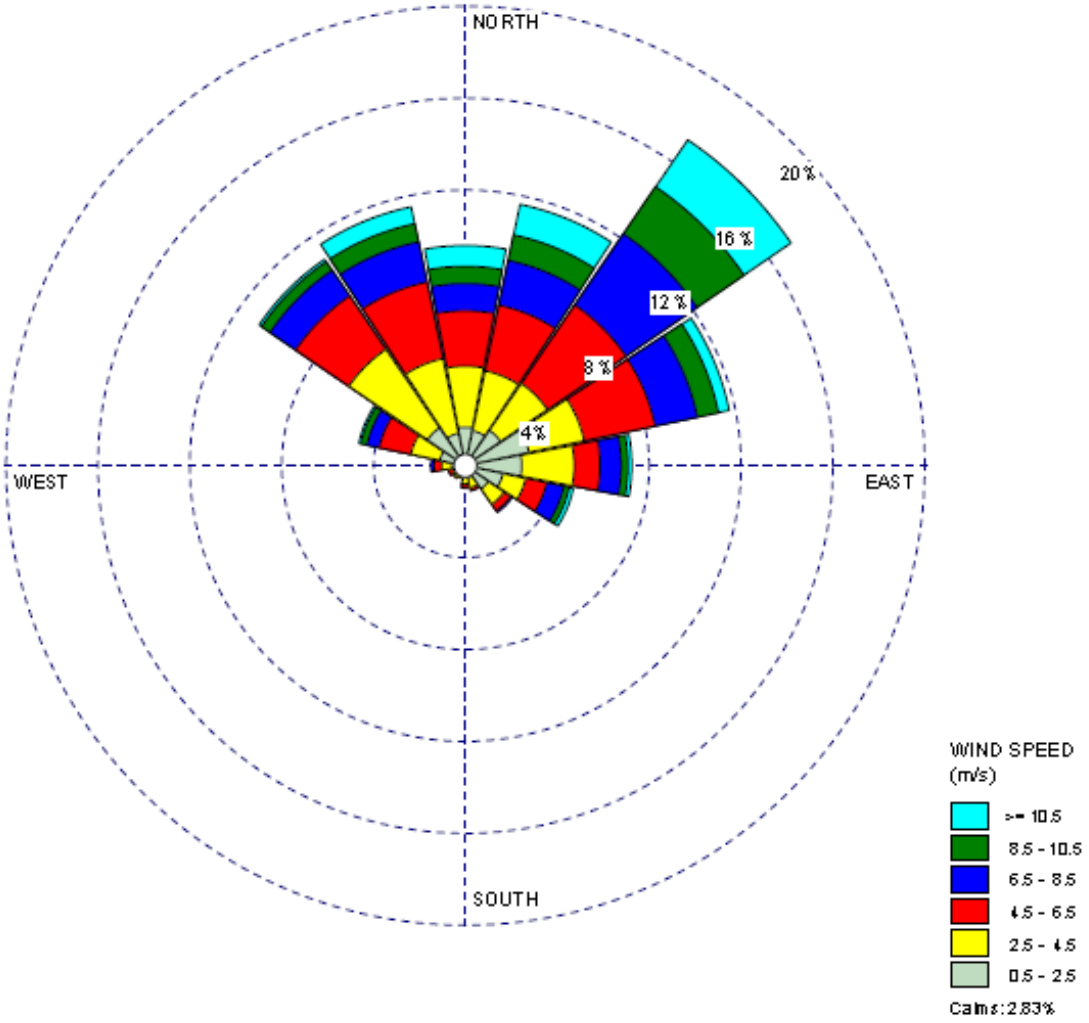


Figure 6-2: Wind Rose, KZK, September 2015 to August 2016

Table 6-10: Wind Rose Summary Statistics

Total Number of Hours	8,784
Average Wind Speed	5.01 m/s
Calm Records	249 (2.8%)
Calm Winds Frequency	2.83%
Data Availability	99.52%
Incomplete/Missing Records	42 (0.5%)
Total Records Used	8,742 (99.5%)

6.3.2.5 Other Meteorological Parameters

For the period of record (September 1, 2015 to August 31, 2016), relative humidity and barometric pressure at the Project meteorological station were generally consistent with regional patterns. Solar radiation peaked in June and was at a minimum in December. Pan evaporation measurements and evapotranspiration calculations at the Project for the 2015 to 2016 period were generally consistent with 1995 measurements and estimates.

6.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on air quality as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures, and determining significance of any identified residual effects.

6.4.1 Effects Characterization

In order to focus the EA, the first step is to identify any potential interactions between Project activities and air quality. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking 0, 1, or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects;* and
2 – Higher risk interactions- *it is reasonably foreseeable that residual effects may result.*

The results of the interactions screening are presented in Table 6-11.

Table 6-11: Interaction Matrix for Air Quality

Project Activity	Criteria Air Contaminants	Greenhouse Gases
Construction		
Tote Road upgrade to Access road	1	1
Finlayson Lake airstrip upgrade	0	1

Project Activity	Criteria Air Contaminants	Greenhouse Gases
Site preparation and clearing	2	1
Site grading, including soil and overburden removal and stockpiling	2	1
Off site traffic (construction equipment and materials delivery)	0	1
On site traffic	1	1
ABM open pit development (including dewatering and Fault Creek diversion)	2	1
Infrastructure construction	1	1
Waste handling	1	1
Water use and management	1	1
Power generation	2	2
Worker transport	1	1
Construction camp operation	1	1
Workforce, procurement and hiring	0	0
Operations		
ABM open pit operations (including blasting and dewatering)	2	1
Underground operations	0	1
Ore processing	2	1
On site traffic	1	1
Off site traffic (highway)	0	1
Finlayson Lake airstrip operations	0	1
Storage facilities management (Class A, B, and C)	1	1
Progressive reclamation of storage facilities	1	1
Water use (potable and non-potable)	1	1
Mine water management and treatment (including effluent discharge)	1	1
Waste management	1	1
Power generation	2	2
Worker transport	1	1
Camp operation	1	1
Workforce, procurement and hiring	0	0
Closure		
Processing plant decommissioning and reclamation	1	1
ABM lake filling	0	0
Final storage facilities reclamation	1	1
Support infrastructure removal and reclamation	2	1
Water management, treatment and discharge	1	1
On site traffic	1	1
Off site traffic	0	1
Access road reclamation	1	1
Workforce, procurement and hiring	0	0

In addition to the direct Project interactions identified above, the following indirect interactions are identified with air quality:

- Potential effect to soils and vegetation as a result of air contaminants deposition (Chapters 11 and 12, respectively).

6.4.1.1 Criteria Air Contaminants

Modelled ambient concentrations resulting from Project activities (e.g., pit blasting, power generation, material handling and transfer, unpaved roads, wind erosion of exposed surfaces) were added to baseline concentrations and results are presented in Table 6-12 to Table 6-17. Detail of the model inputs and assumptions are presented in Appendix E-1. Modelling results presented for each averaging period represent the maximum predicted value over the one-year period modelled (for each Project phase), except for the annual value which represents the single annual result for the modelling period. Conservative assumptions were made to produce reasonable worst-case scenarios and confidence is high that the model is not under-predicting ambient concentrations.

Total Suspended Particulates (TSP)

Predicted maximum 24-hour and mean annual ambient concentrations at the camp receptor location for all Project phases are presented in Table 6-12 below. Short duration (24-hour) exceedances could occur at camp during operations under the worst-case meteorological and operational conditions. The ranked model results (for maximum predicted 24-hour concentrations) indicate that only the top three 24-hour concentrations would be in exceedance of the YAAQS on an annual basis, with a predicted fourth ranked value in camp of 113 µg/m^3. Overall, TSP YAAQS exceedances in camp are predicted to occur less than 1% of the time.

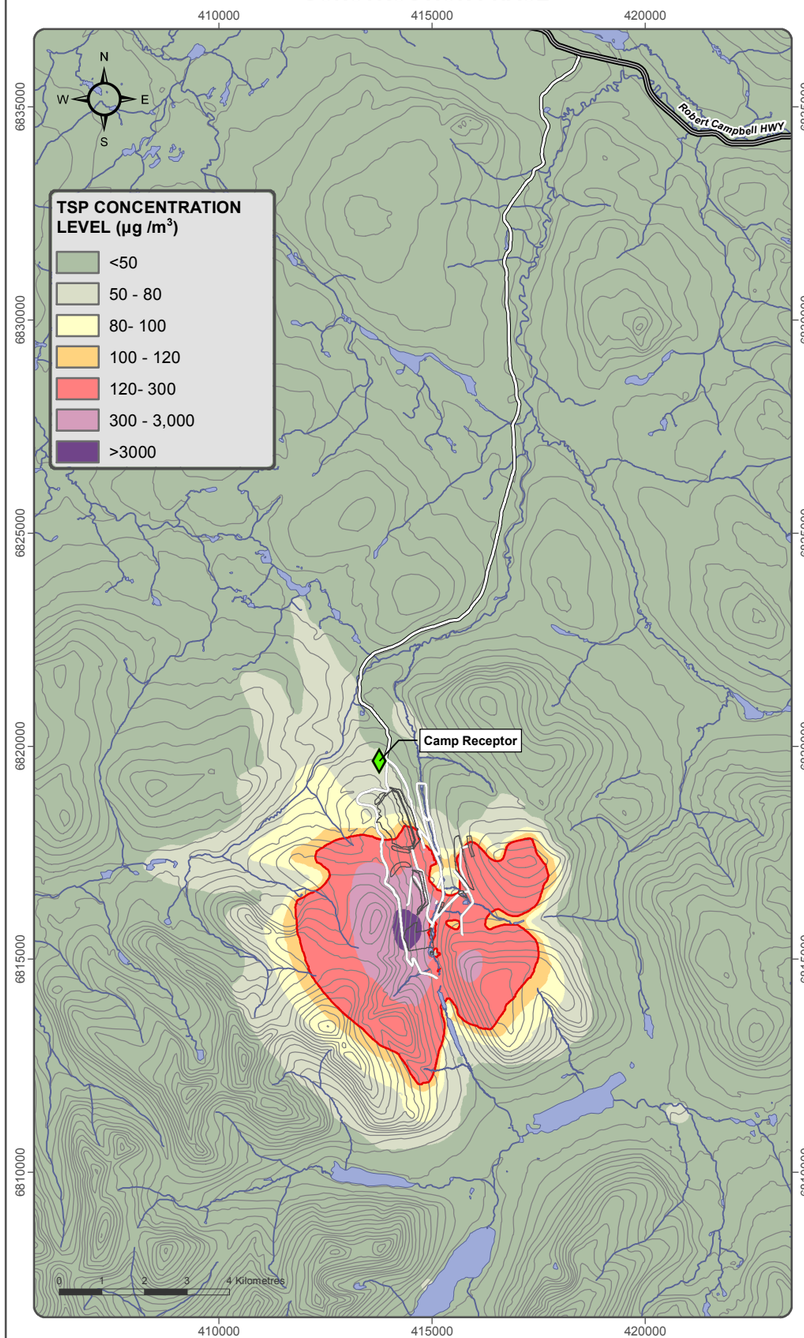
Table 6-12: Predicted TSP Concentrations

Receptor	Maximum 24-hr Concentration (µg/m^3)			Annual Concentration (µg/m^3)		
	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase
YAAQS	120			60		
Baseline	7			1		
Camp	43	148	8	2	15	1
Baseline + Camp	50	154	15	3	16	2

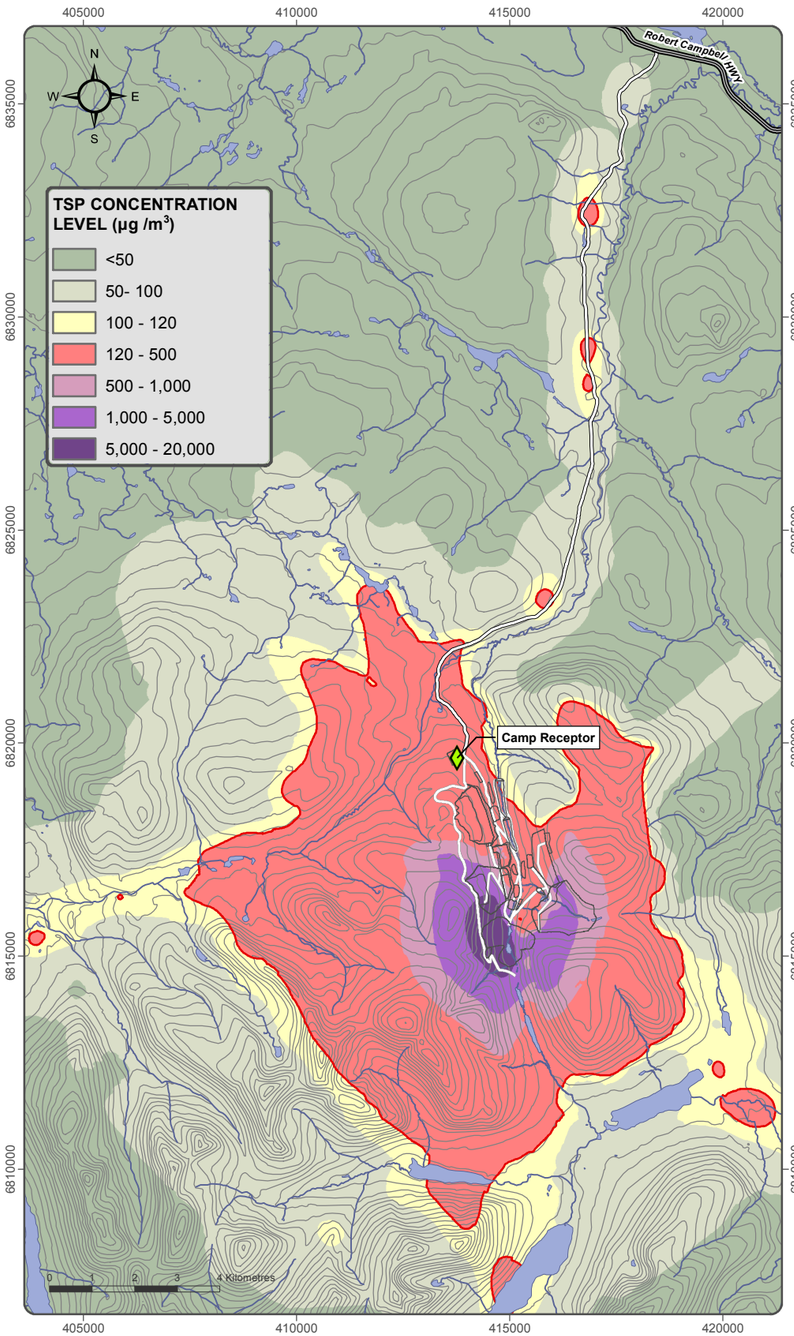
Values in red exceed the YAAQS

Figure 6-3 shows the maximum 24-hour predicted concentration contours for the construction, operations, and closure phases.

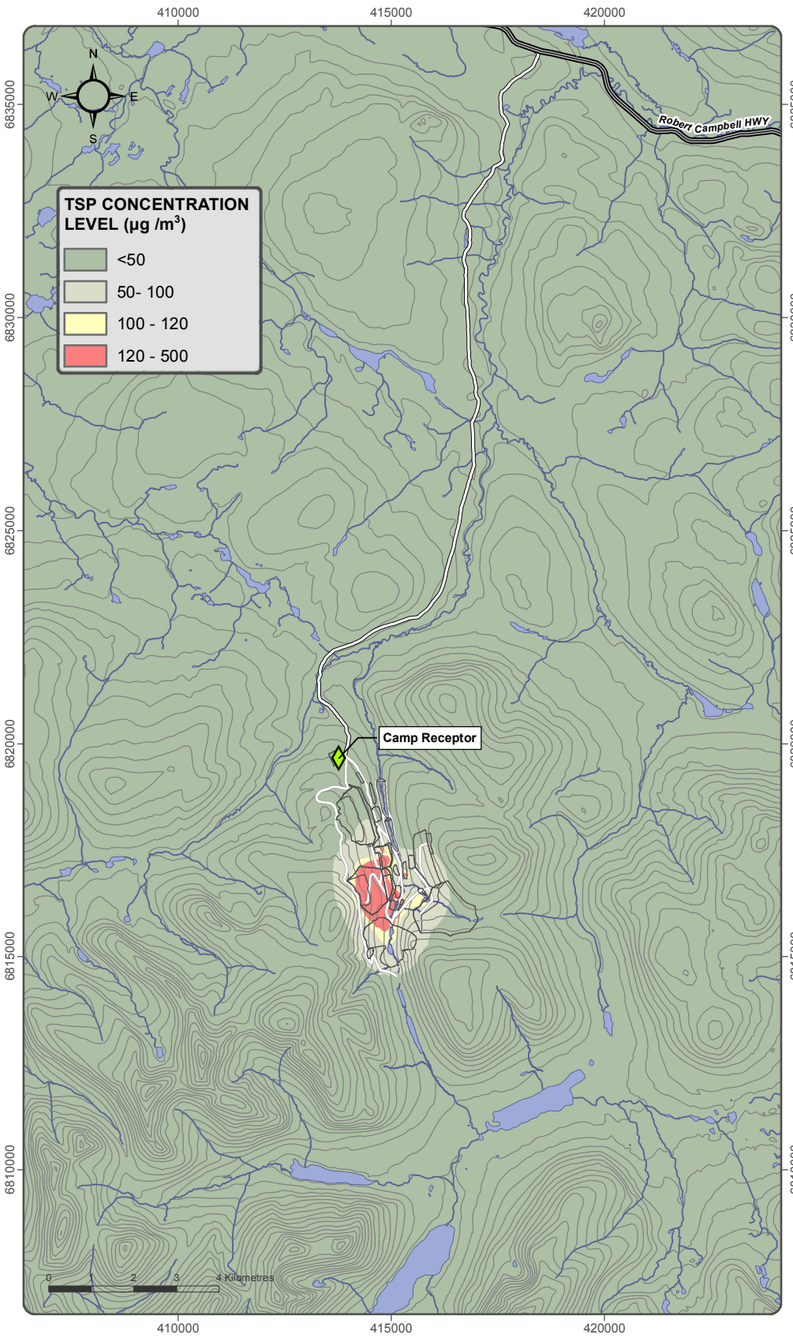
CONSTRUCTION PHASE



OPERATION PHASE



CLOSURE PHASE



Predicted ambient concentrations shown on this map were produced with CALPUFF Version 5.8.5

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Receptor
- Standard Boundary
- Contour at 120 µg /m3 (according to YAAQS)
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Waterbodies
- Watercourse
- Contour (40 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 6-3

PREDICTED MAXIMUM 24-HR TSP CONCENTRATION

NOVEMBER 2016

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Coarse Particulate Matter (PM_{10})

Predicted maximum 24-hour and mean annual ambient concentrations at the camp receptor location for all Project phases are presented in Table 6-13. While short duration (24-hour) exceedances could occur at camp during operations under the worst-case meteorological and operational conditions, ranked model results indicate that only the top four 24-hour concentrations would be in exceedance of the YAAQS on an annual basis, with a predicted fifth ranked value in camp of 47 µg/m^3. Overall, PM_{10} YAAQS exceedances in camp are predicted to occur approximately 1% of the time.

Table 6-13: Predicted PM_{10} Concentrations

Receptor	Maximum 24-hr Concentration (µg/m^3)			Annual Concentration (µg/m^3)		
	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase
YAAQS	50			N/A		
Baseline	6			1		
Camp	15	67	5	1	5	1
Baseline + Camp	21	73	11	2	6	2

Values in red exceed the YAAQS

Figure 6-4 shows the maximum 24-hour predicted concentration contours for the construction, operations, and closure phases.

Fine Particulate Matter ($PM_{2.5}$)

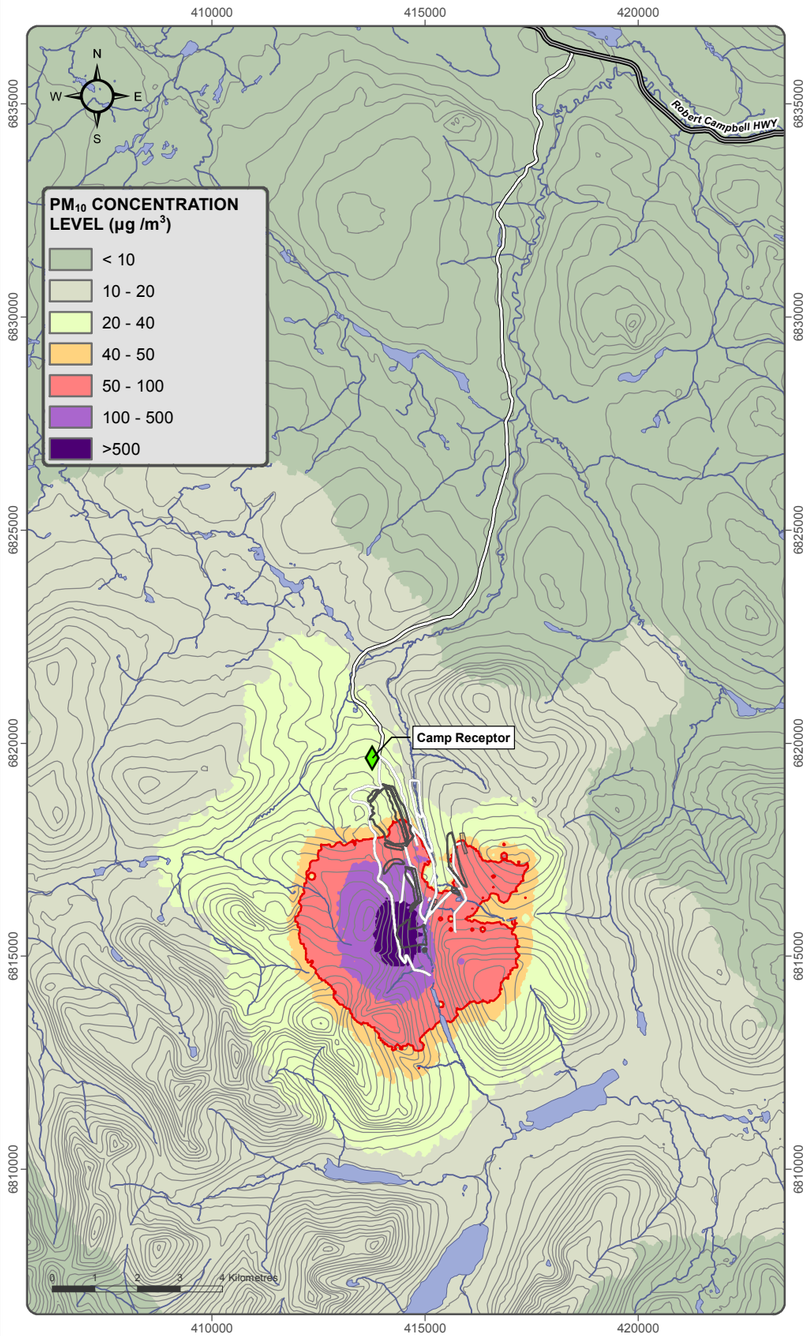
Predicted maximum 24-hour and mean annual ambient concentrations at the camp receptor for all Project phases are presented in Table 6-14. No exceedances of the YAAQS are predicted at the camp receptor location.

Table 6-14: Predicted $PM_{2.5}$ Concentrations

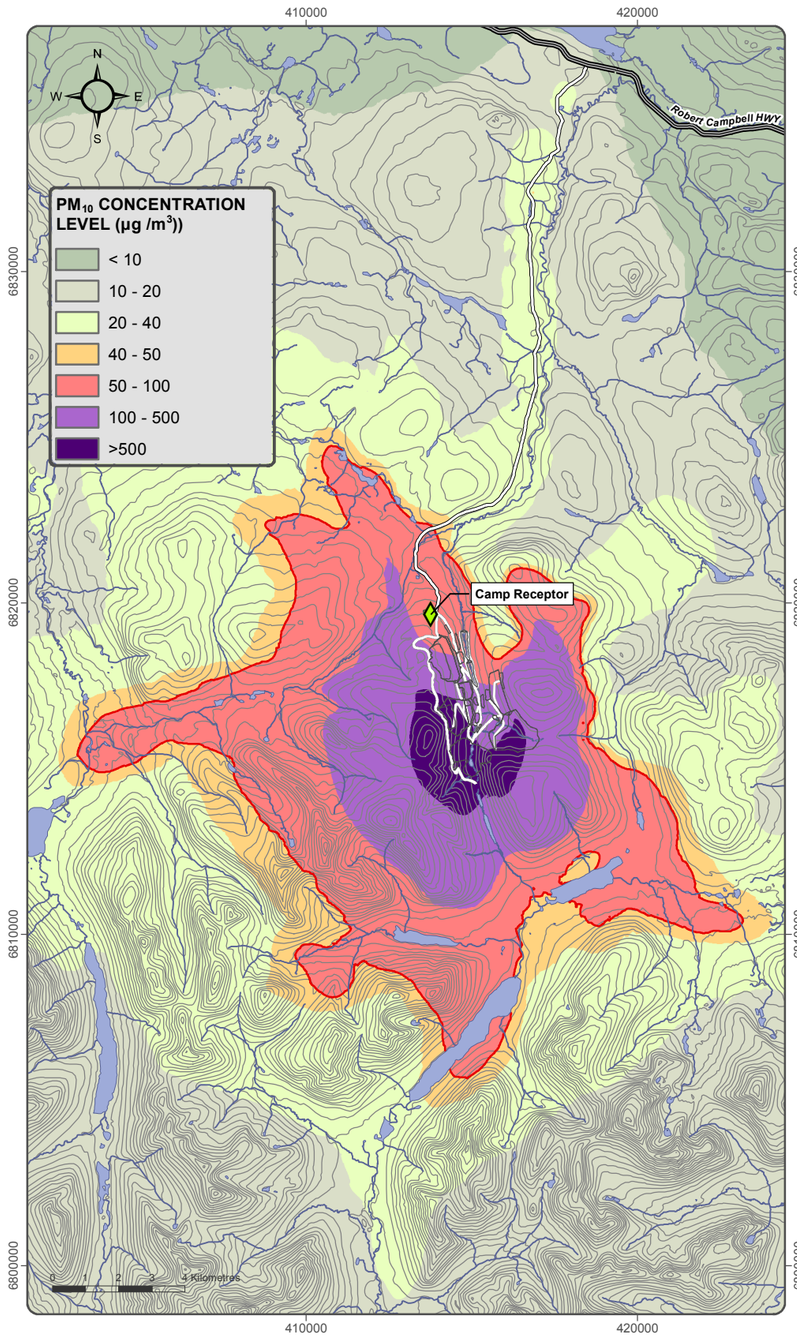
Receptor	Maximum 24-hr Concentration (µg/m^3)			Annual Concentration (µg/m^3)		
	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase
YAAQS	28			10		
Baseline	4			1		
Camp	4	6	4	<1	<1	<1
Baseline + Camp	8	10	8	1	1	1

Figure 6-5 shows the maximum 24-hour predicted concentration contours for the construction, operations, and closure phases.

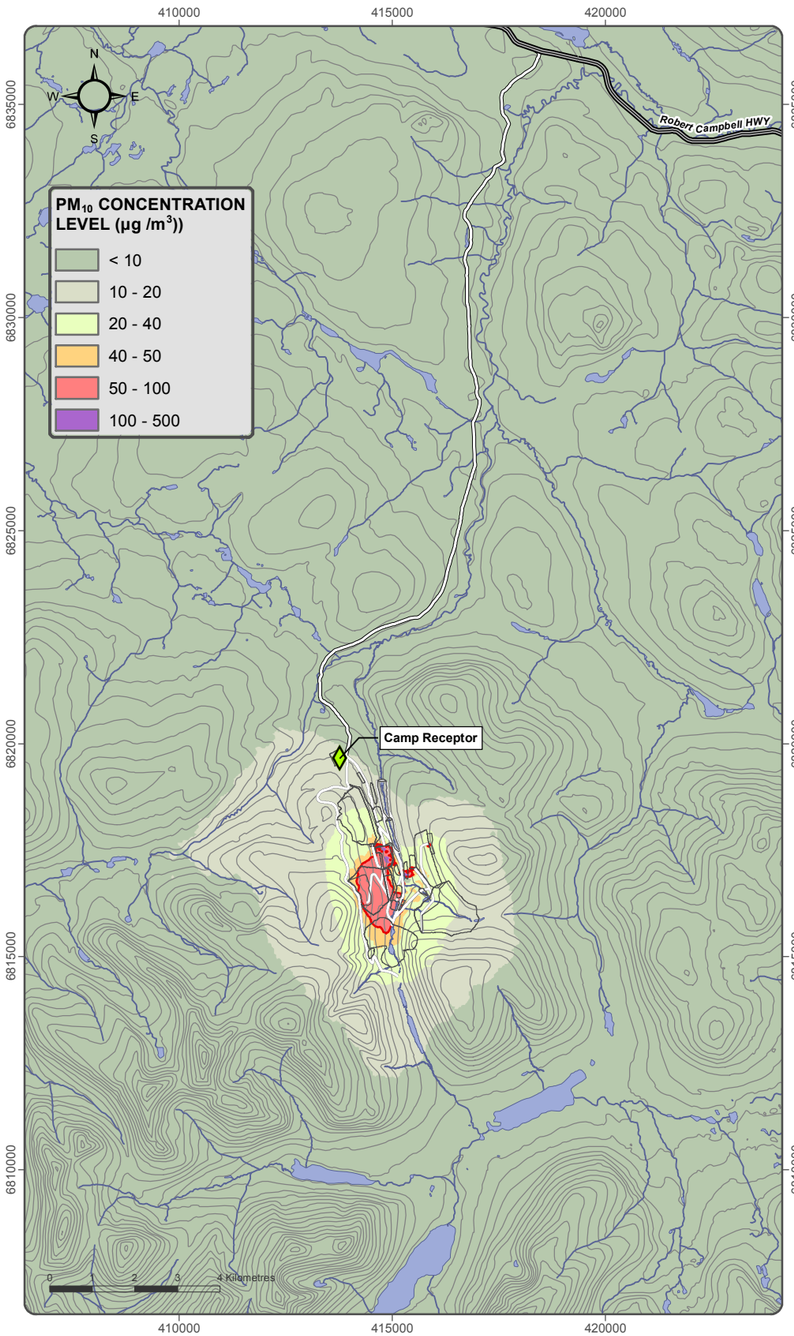
CONSTRUCTION PHASE



OPERATION PHASE



CLOSURE PHASE



Predicted ambient concentrations shown on this map were produced with CALPUFF Version 5.8.5

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Receptor
- Standard Boundary Contour at 50 µg /m3 (according to YAAQS)
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Waterbody
- Watercourse
- Contour (40 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 6-4

PREDICTED MAXIMUM 24-HR PM_{10} CONCENTRATIONS

NOVEMBER 2016

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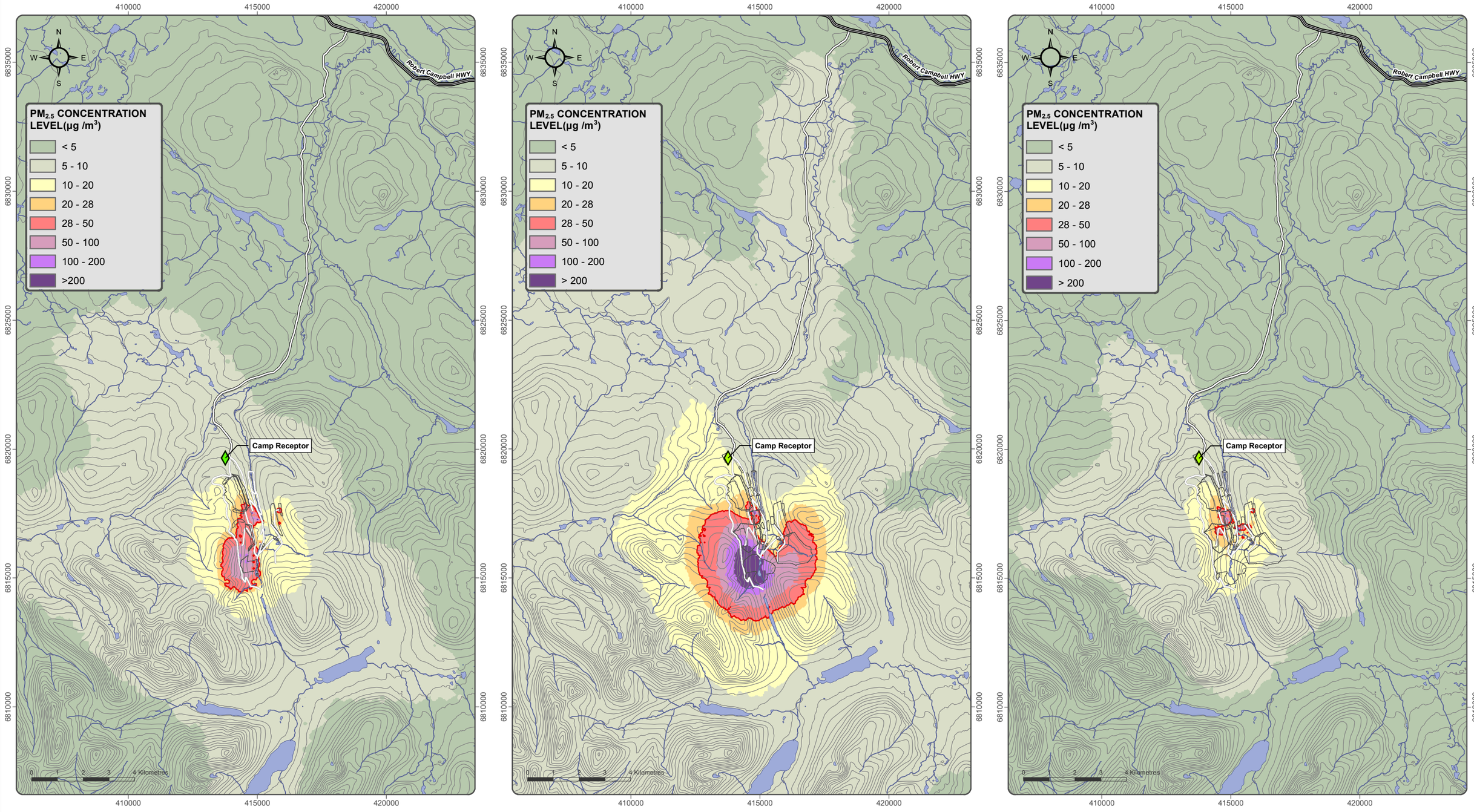
CONSTRUCTION PHASE

OPERATION PHASE

CLOSURE PHASE



Predicted ambient concentrations shown on this map were produced with CALPUFF Version 5.8.5

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Receptor
- Standard Boundary
- Contour at 28 µg /m3 (according to YAAQS)
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Waterbody
- Watercourse
- Contour (40 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 6-5

PREDICTED MAXIMUM 24-HR $PM_{2.5}$ CONCENTRATIONS

NOVEMBER 2016

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Carbon Monoxide (CO)

Predicted maximum 1-hour and 8-hour ambient concentrations at the camp receptor location for all Project phases are presented in Table 6-15. No exceedances of the YAAQS are predicted at the camp receptor location.

Table 6-15: Predicted CO Concentrations

Receptor	Maximum 1-hr Concentration(ppm)			Maximum 8-hr Concentration (ppm)		
	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase
YAAQS	13			5		
Baseline	0			0		
Camp	<1	<1	<1	<1	<1	<1

Figure 6-6 shows the maximum 1-hour predicted concentration contours for the construction, operations, and closure phases.

Nitrogen Oxides (NO_X)

To provide a conservative estimate and to enable comparison with the YAAQS, a 100% conversion ratio between from NO_X to NO_2 was assumed. Predicted maximum 1-hour, 24-hour, and mean annual ambient concentrations at the camp receptor location for all Project phases are presented in Table 6-16. No exceedances of the YAAQS are predicted at the receptor location; therefore, no further refinement of the NO_X to NO_2 conversion factor was carried out, as per the BC MOE recommendations (2008). Note, however, that actual NO_2 concentrations are expected to be well below concentrations shown in Table 6-16, and could range from 5% (within 1 km of the source) to 37% (at 7 km from the source) of NO_X concentrations (Janssen et al., 1988).

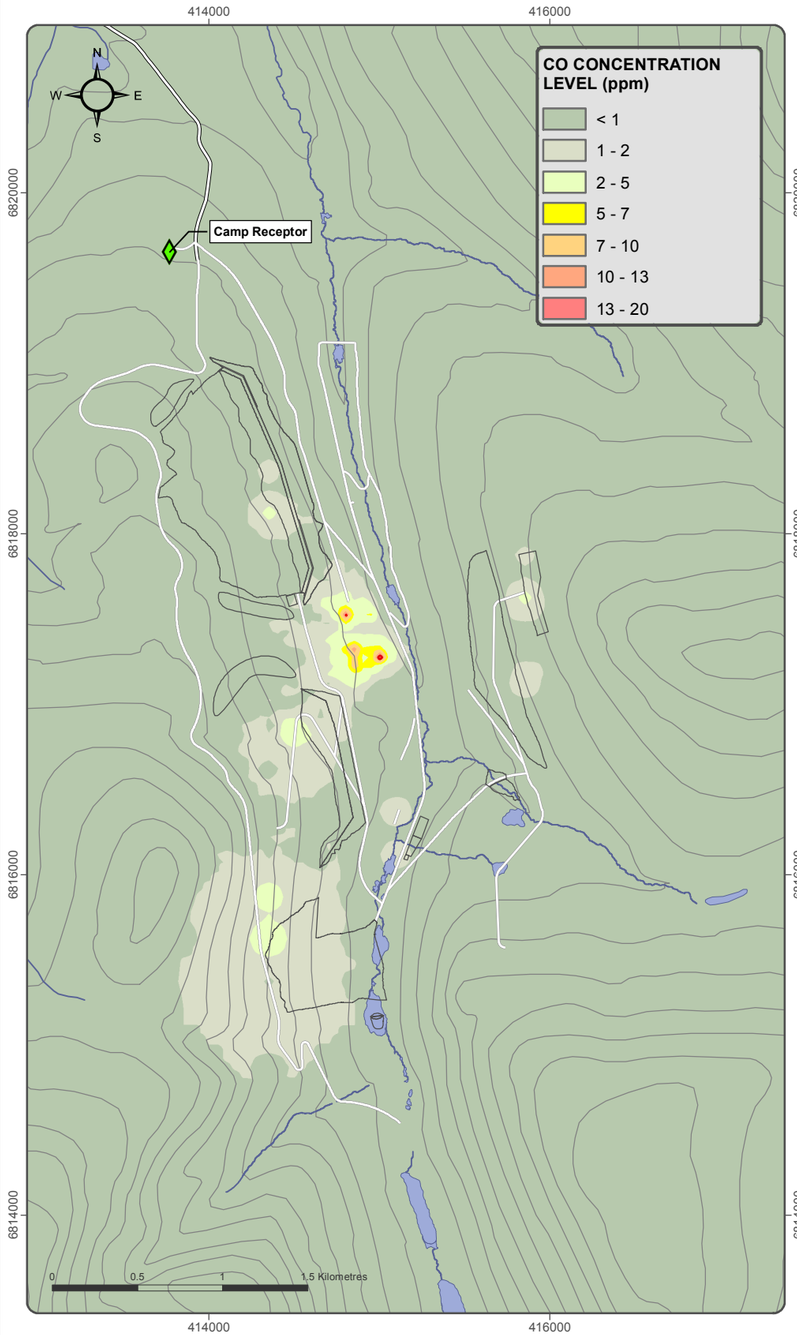
Table 6-16: Predicted NO_2 Concentrations

Receptor	Maximum 1-hour Concentration (ppbv)			Maximum 24-hour Concentration (ppbv)			Annual Concentration (ppbv)		
	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase
YAAQS	213			106			32		
Baseline	0			0			0		
Camp	161	120	149	56	14	56	5	1	2

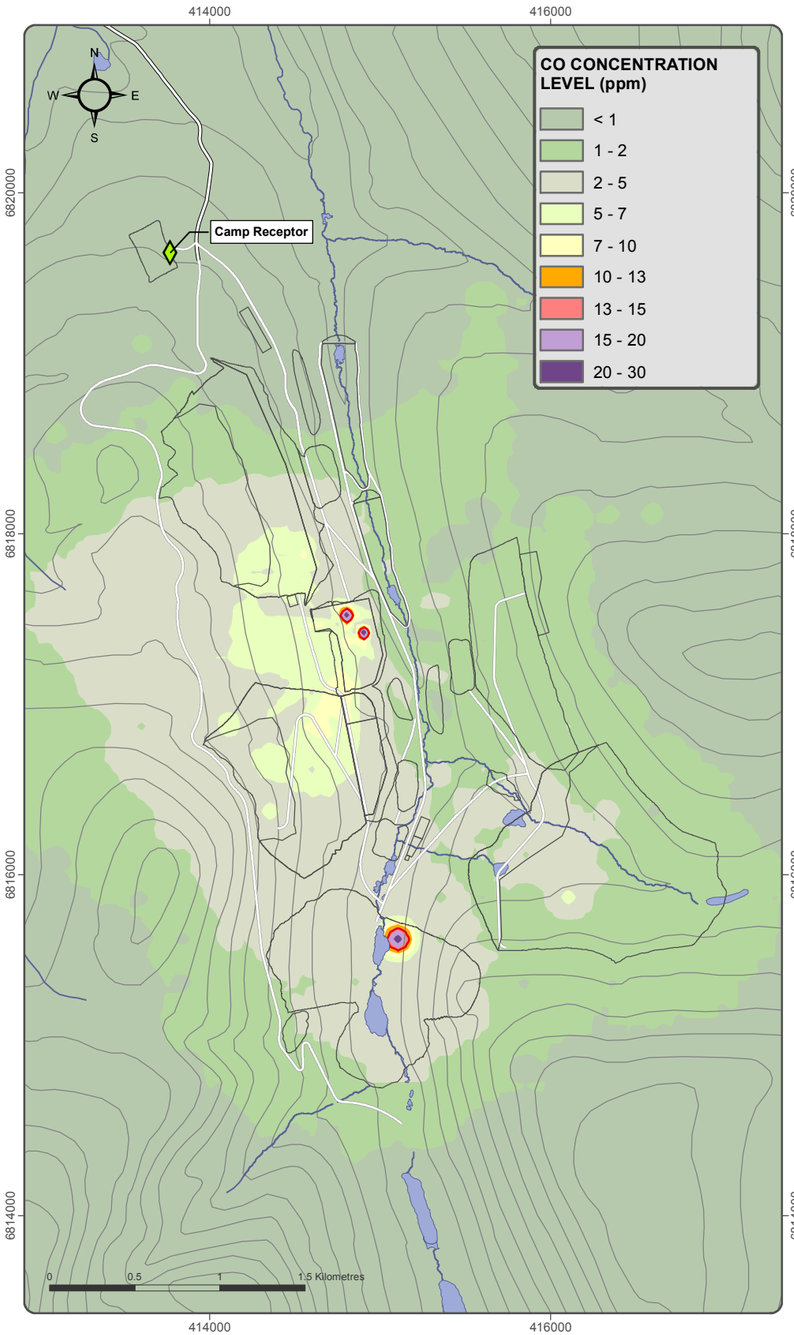
It should be noted that higher ambient concentrations at the camp receptor during construction and closure compared to operations are associated with the use of diesel generators in camp, which will be replaced with dual-fuel generators located at the process plant facility during the operations phase.

Figure 6-7 shows the maximum 1-hour predicted concentration contours for the construction, operations, and closure phases.

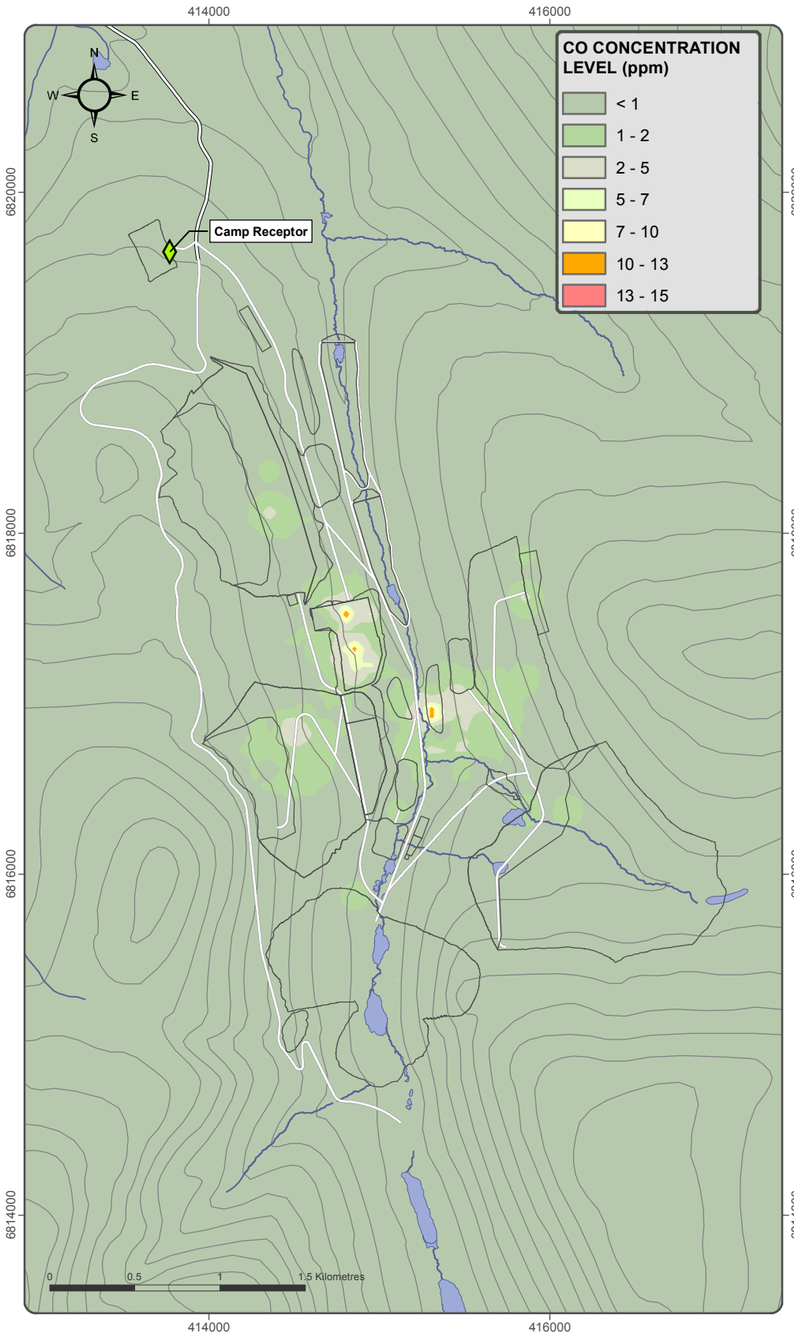
CONSTRUCTION PHASE



OPERATION PHASE



CLOSURE PHASE



Predicted ambient concentrations shown on this map were produced with CALPUFF Version 5.8.5

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Receptor
- Standard Boundary
- Contour at 13 ppm (according to YAAQS)
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Waterbody
- Watercourse
- Contour (40 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 6-6
PREDICTED MAXIMUM 1-HR CO CONCENTRATIONS

NOVEMBER 2016

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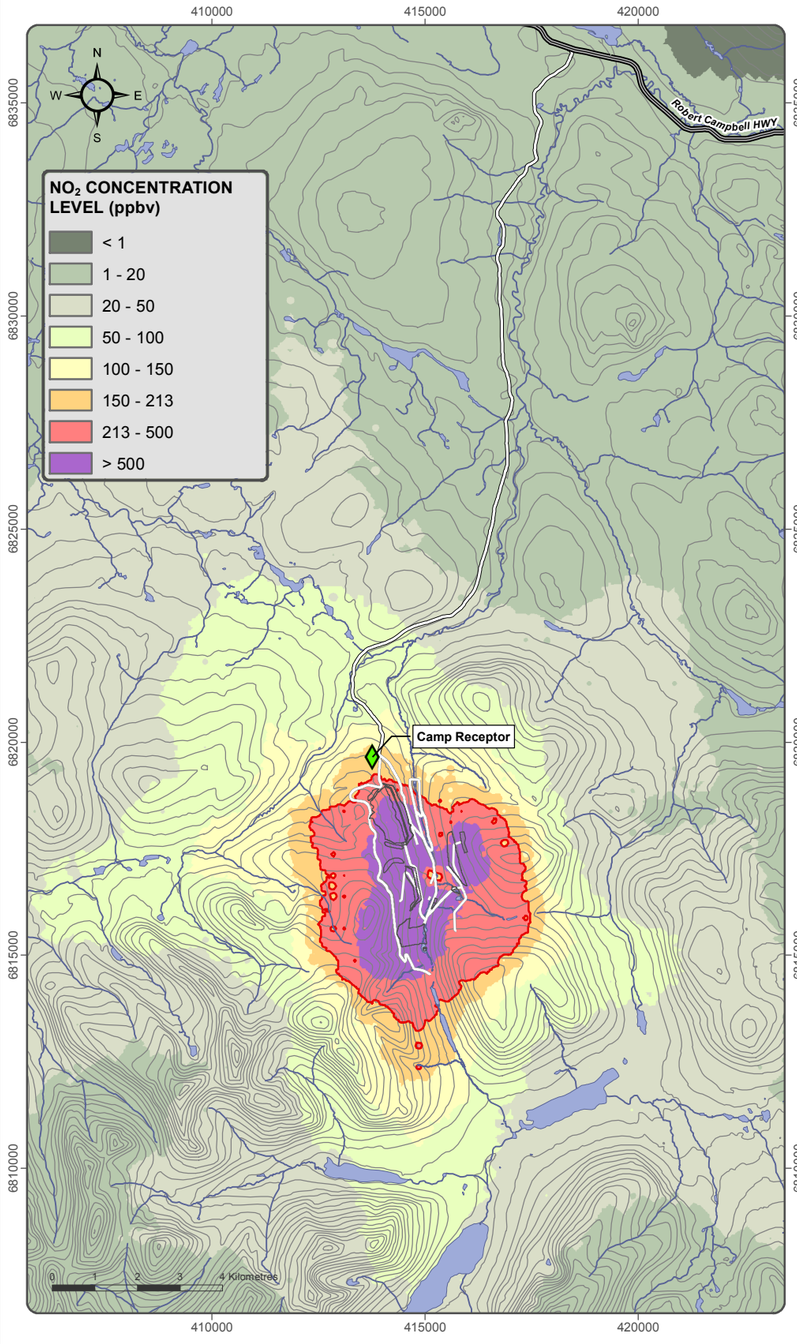
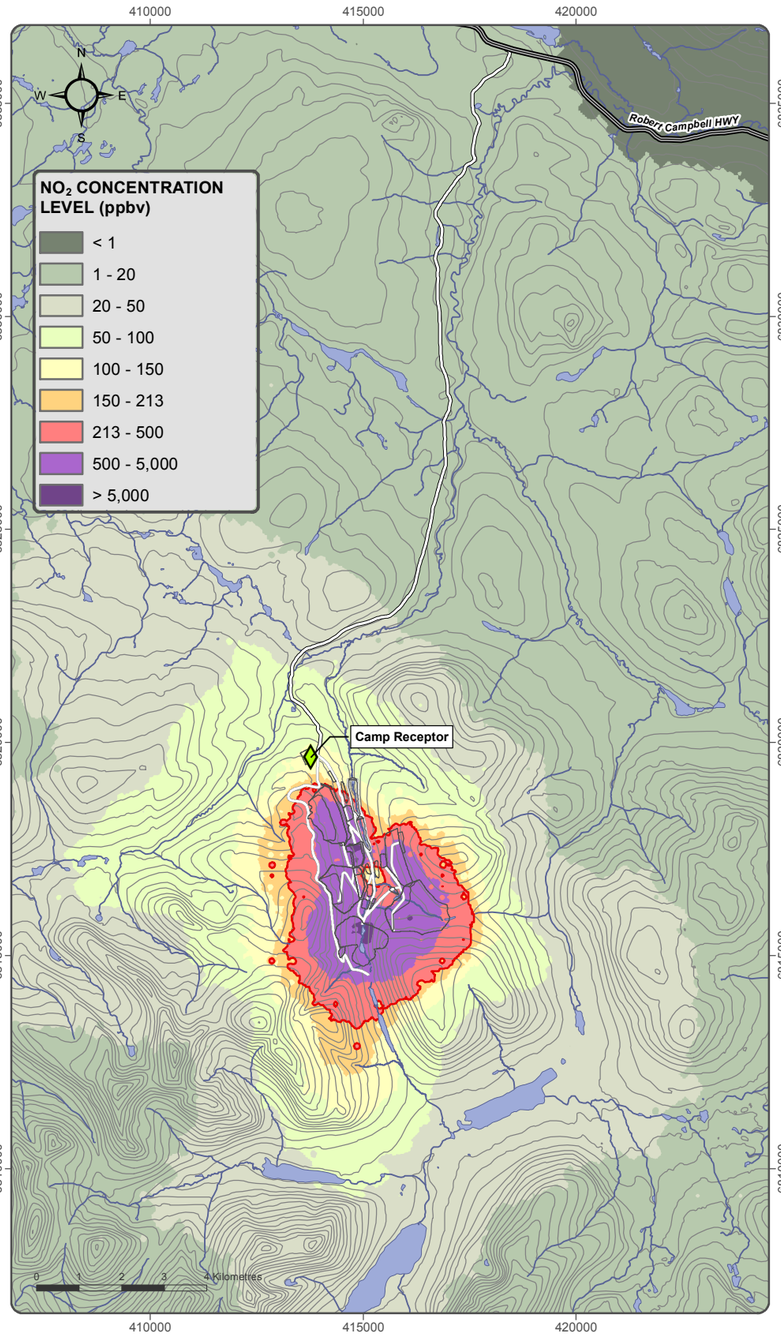
CONSTRUCTION PHASE



OPERATION PHASE



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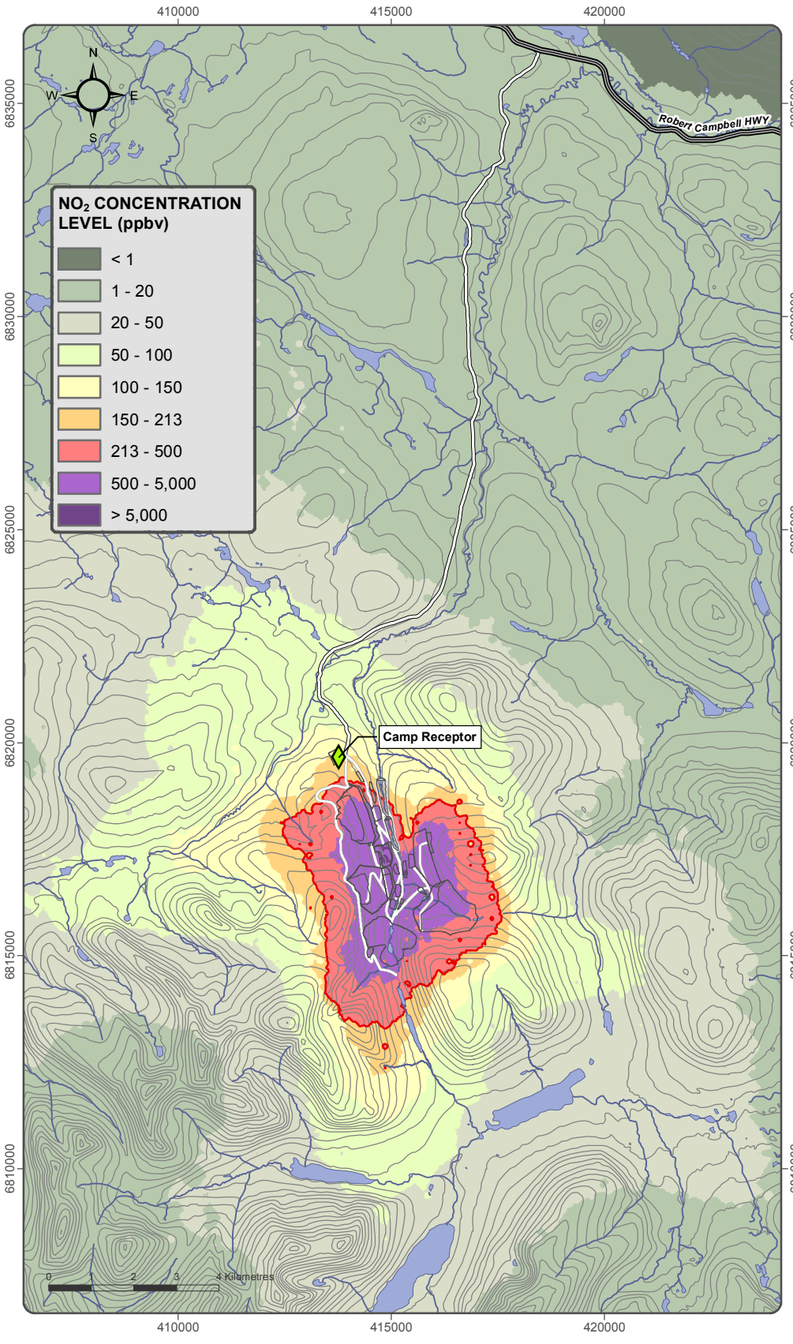

Predicted ambient concentrations shown on this map were produced with CALPUFF Version 5.8.5

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Receptor
- Standard Boundary Contour at 213 ppbv (according to YAAQS)
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Waterbody
- Watercourse
- Contour (40 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 6-7
PREDICTED MAXIMUM 1-HR NO_2 CONCENTRATIONS

NOVEMBER 2016

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Sulphur Oxides (SO_X)

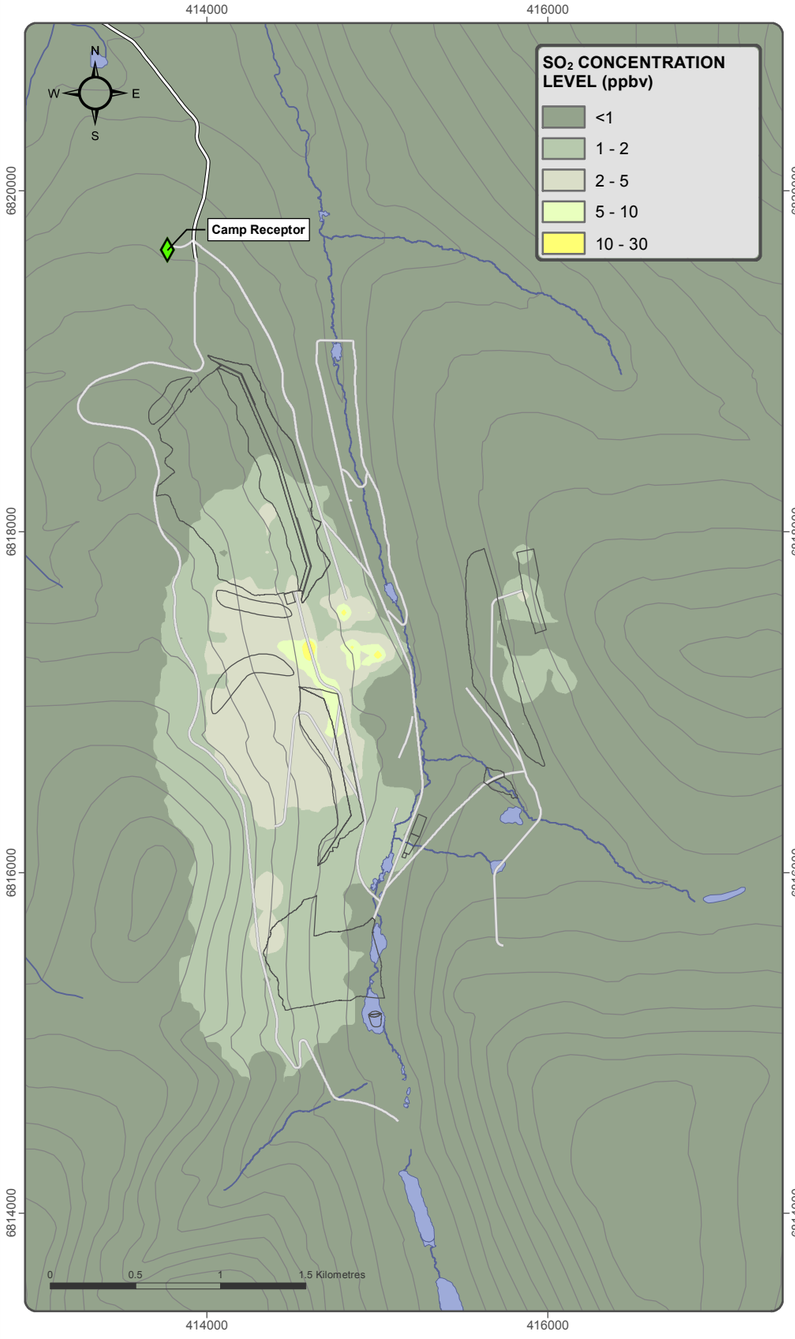
Assuming 100% conversion of SO_X to SO_2 as a conservative estimate, predicted maximum 1-hour, 24-hour, and mean annual ambient SO_2 concentrations at the camp location for all Project phases are presented in Table 6-17. No exceedances of the YAAQS are predicted at the receptor location.

Table 6-17: Predicted SO_2 Concentrations

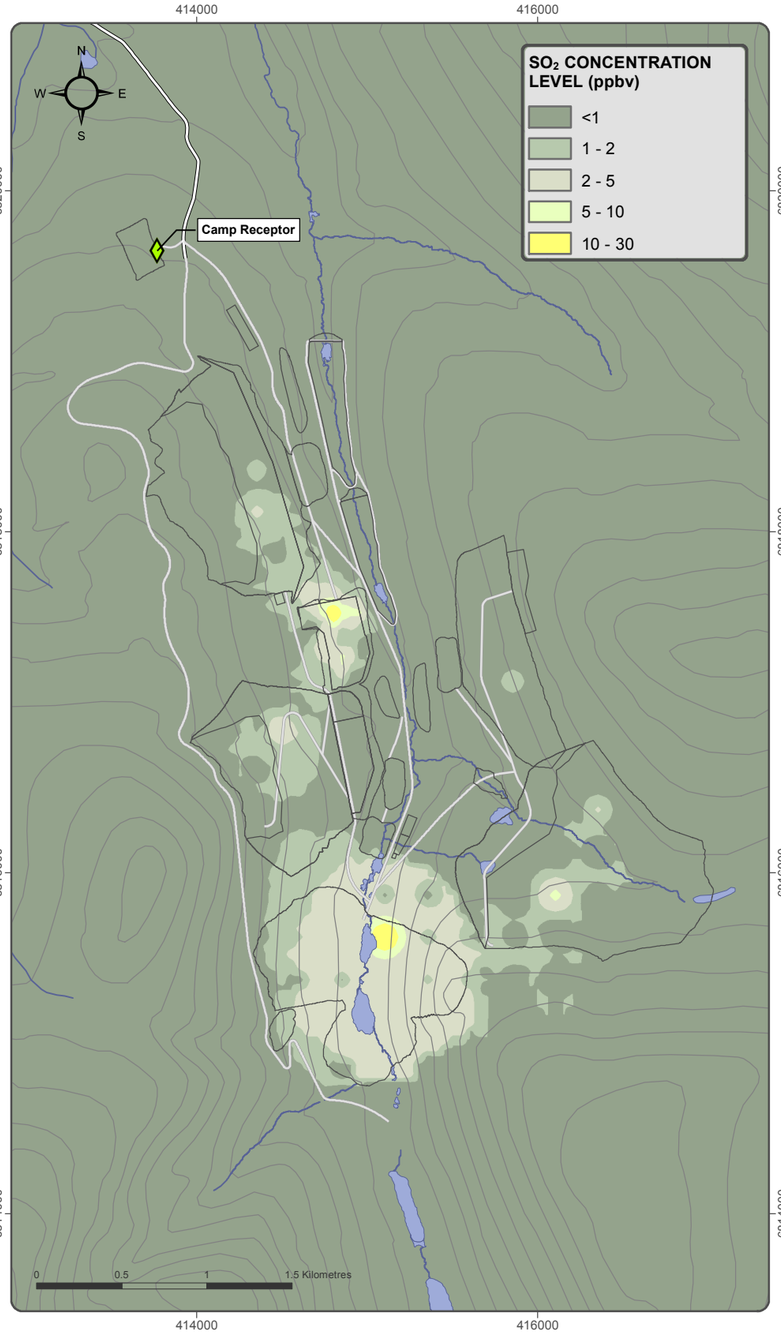
Receptor	Maximum 1-hour Concentration (ppbv)			Maximum 24-hour Concentration (ppbv)			Annual Concentration (ppbv)		
	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase	Construction Phase	Operations Phase	Closure Phase
YAAQS	172			57			11		
Baseline	0			0			0		
Camp	<1	<1	<1	<1	<1	<1	<1	<1	<1

Figure 6-8 show the maximum 1-hour predicted concentration contours for the construction, operations, and closure phases.

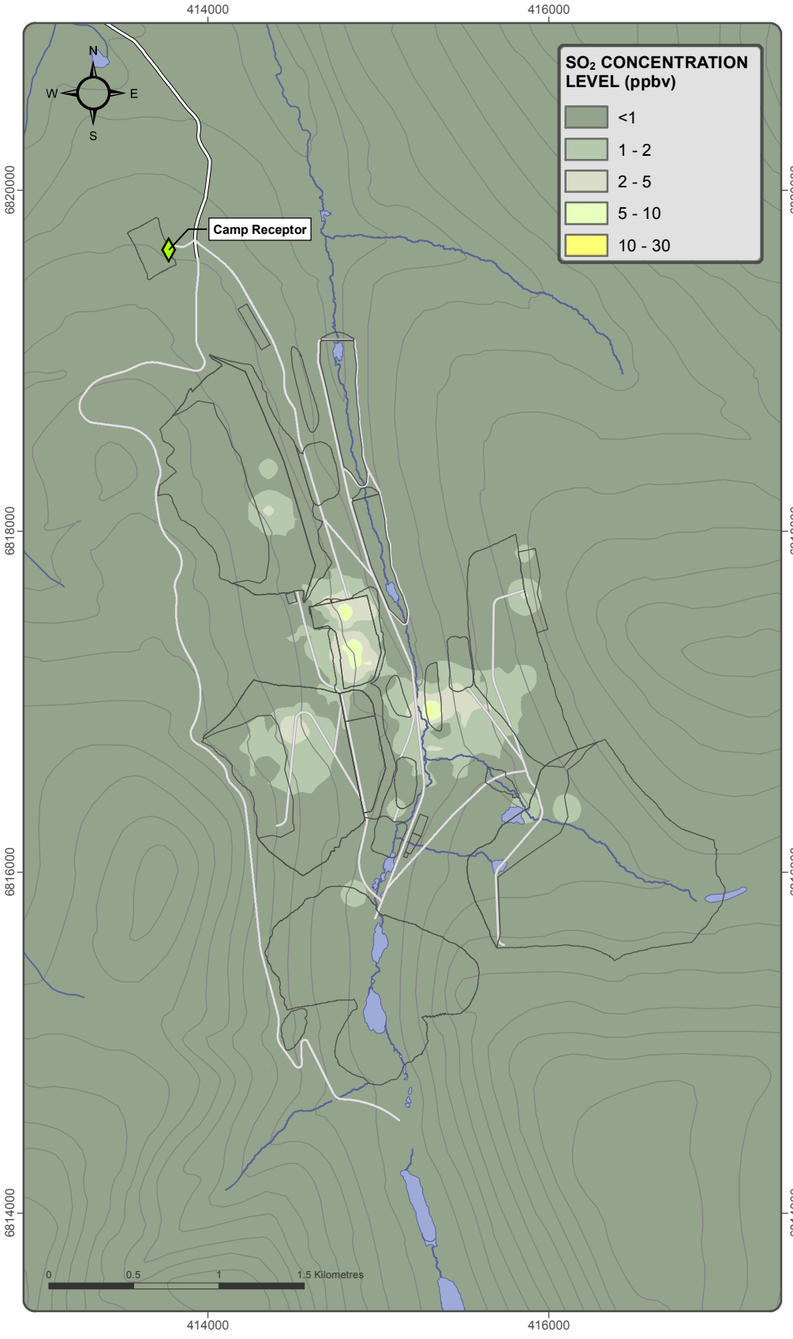
CONSTRUCTION PHASE



OPERATION PHASE



CLOSURE PHASE



Predicted ambient concentrations shown on this map were produced with CALPUFF Version 5.8.5

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Receptor
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Waterbody
- Watercourse
- Contour (40 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 6-8

PREDICTED MAXIMUM 1-HR SO_2 CONCENTRATIONS

NOVEMBER 2016

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6.4.1.2 Greenhouse Gases

Greenhouse gas emissions were estimated for each Project phase based on equipment and vehicle use. Average annual GHG emissions per source type and per Project phase are summarized in Table 6-18. Total emissions are reported in CO_2 equivalent, which is calculated based on a global warming potential of 25 for CH_4 and 298 for N_2O (EC, 2015b). The average fuel consumption of diesel engines (generators and other equipment) was estimated based on the power output (kW). For air travel, an average of four flights of five passengers per week was used for construction and closure phase, while seven flights of 18 passengers per week were estimated for the operations phase.

Table 6-18: Average Annual Project GHG Emissions (tonnes of CO_2 equivalent)

Source	Construction Phase	Operations Phase	Closure Phase
Diesel Generators	2,790	0	1,189
Dual-fuel Generators*	0	24,132	0
Boiler	1,582	1,582	1,582
Incinerator	1.4	1.4	1.4
Diesel Fired Equipment	7,388	26,457	7,334
Light Vehicles	10.5	20.4	65.0
Heavy Vehicles	126	6,814	877
Air Travel	0.4	6.4	0.4
TOTAL	**11,898**	**59,014**	**11,049**

*Assumes 99% natural gas and 1% diesel

When comparing to the 2014 Canada and Yukon GHG emissions (see Table 6-8), predicted Project emissions represent a very small fraction of the total Canadian emissions (less than 0.01% for all Project phases). When comparing to the 2014 Canadian emissions from the mining sector, the predicted Project emissions are below 1% for all Project phases. Predicted Project emissions represent about 4% of the 2014 total Yukon GHG emissions during the construction and closure phases and 22% during the operations phase.

6.4.1.3 Summary

Table 6-19 provides a summary of the identified potential effects from the above section that are carried forward for consideration of mitigation measures.

Table 6-19: Identified Potential Project Effects for Air Quality

Subcomponent	Potential Effect	Project Phase
Criteria Air Contaminants	Increase in Ambient Concentration of TSP at receptor	Construction, operations, closure
	Increase in Ambient Concentration of PM_{10} at receptor	
	Increase in Ambient Concentration of $PM_{2.5}$ at receptor	
	Increase in Ambient Concentration of CO at receptor	
	Increase in Ambient Concentration of NO_2 at receptor	
	Increase in Ambient Concentration of SO_2 at receptor	
Greenhouse Gases	Emission of Greenhouse Gases contributing to territorial and national inventories	Construction, operations, closure

6.4.2 Mitigation Measures

Potential effects on air quality and identified mitigation measures are summarized in Table 6-20 and discussed further below.

Table 6-20: Proposed Mitigation Measures for Air Quality

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Increase in Ambient Concentrations of Particulate Matter (TSP, PM_{10}, $PM_{2.5}$) at receptor	Operations	Crusher enclosure, and material handling and transfers at the process plant facility occurring indoors	High	**Yes**
		Cover over the coarse ore stockpile	High	
	Construction, operations, closure	Progressive reclamation of disturbed areas	High	
		Road and Exposed Surfaces Watering	High	
	Operations	Use of dust collectors and proper chute design to prevent air entrainment of dust	High	
		Dust extraction with conveyance to and processing in dust collectors	High	
		Covering or enclosure of conveyors or conveyor galleries	High	
		Installation of water sprays at conveyor transfers	High	
	Construction, operations, closure	Minimizing land clearing activities (i.e. waste storage facilities will be cleared progressively through the project construction and operations phase)	High	
		Construction of the Access Road and site roads with low silt content material	Medium	
		Low speed limits for all mobile equipment	Medium	
		Orientation of material stockpiles so that the length is parallel with prevailing winds where practicable	Medium	

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
		Re-vegetate waste rock storage area final surfaces early	Medium	
		Construction of wind breaks or stationary misters	High	
		Visual inspections to identify and address potential dust emissions	Medium	
Increase in Ambient Concentrations of Criteria Air Contaminants (TSP, PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2) at receptor Emission of Greenhouse Gases contributing to territorial and national inventories	Operations	Use filters, scrubbers, and other pollution control devices at processing facilities	High	Yes
	Construction, Operations, Closure	Avoid engine idling	Medium	
		Ensure vehicles and equipment are maintained according to manufacturers' guidelines	Medium	
		Use catalytic control systems on diesel engines	Medium	
		Waste reduction at source and recycling	Medium	
		Waste segregation	Medium	
		Incinerator operation for optimum combustion	Medium	
		Regular inspection and maintenance of incinerator	Medium	

The crusher enclosure, indoor material transfers, covering of the coarse ore stockpile, progressive reclamation, as well as road and exposed surfaces watering (first four mitigations in Table 6-20) were already incorporated into the air dispersion model.

For primary crushing and material transfers occurring indoors, a control efficiency of 75% was assumed. More realistically, a total enclosure would reduce dust emissions by close to 100% (Countess Environmental, 2006); however, a control efficiency of 75% was used in the model, for conservatism and to account for traffic in and out of the building. In addition, BMC will cover the coarse ore stockpile. The control efficiency for this mitigation measure was assumed to be 90% (Countess Environmental, 2006).

The control efficiency of road and exposed surfaces watering varies with the rate and frequency of application, traffic volume, and prevailing meteorological conditions. For PM_{10}, the estimated control efficiency of road watering ranges between 10% and 74% (Countess Environmental, 2006). The average value of 42% was used in the model, for all particle sizes.

The other mitigation measures listed in Table 6-20 were not modelled or quantified, but are expected to contribute to a further reduction in air contaminant ambient concentrations and greenhouse gases emissions. In addition, road and exposed surfaces watering frequency can be adjusted as necessary (as a function of meteorological conditions) to increase control efficiency, and ensure that YAAQS for TSP and PM_{10} are not exceeded in camp.

It should also be noted that blasting is a major contributor to fugitive dust emissions and ambient particulate matter concentrations, and that as the pit development progresses in a series of benches, the benches and rock face will act as a wind break and resulting dust dispersion outside the pit will be considerably attenuated. Therefore, the maximum fugitive dust will occur during the initial pit development, when blasts are located close to the original ground elevation, and this is the scenario that was modelled. Predicted ambient concentrations for particulate matter therefore represent the worst-case combination of meteorological and operational conditions.

6.4.3 Residual Effects and Significance Determination

The significance of residual effects as a result of the Project on air quality are summarized in Table 6-21.

6.4.3.1 Criteria Air Contaminants

Overall, short duration (24-hour) exceedances of the YAAQS are predicted at the camp location for TSP and PM_{10} during operations under the worst-case meteorological and operational conditions. However, mitigation measures such as road and surface watering can be adjusted in frequency and combined with additional measures described in the Conceptual Air Quality Management Plan (Chapter 18) to ensure that standards are not exceeded in camp. As shown on Figure 6-3 through Figure 6-8, higher ambient concentrations could occur in close proximity to the sources; however, these concentrations are not comparable to the YAAQS as they occur in an industrial area. Also, modelling results presented for each averaging period (except annual) represent the maximum predicted value over the one-year period modelled. Ambient concentrations will therefore be below values reported in Section 6.4.1.1 the rest of the year. The scenarios modelled are conservative as they assume the simultaneous operation of all non-continuous sources, blasting occurring at the original ground elevation, and only include the main operational mitigations.

For all measurable parameters, the direction of the effect is adverse and the duration is long-term as the effect will last through all Project phases. The effect is reversible in the short term and the probability of the effect occurring is very likely. The air contaminant subcomponent has some resilience to accommodate change.

Table 6-21: Project Effects Significance Assessment for Air Quality

Residual Effect	Direction	Magnitude *	Geographic Extent *	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Increase in Ambient Concentrations of TSP at receptor	Adverse	Moderate	Regional	Long-term	Sporadic	Reversible Short term	Neutral	Very Likely	Not significant
Increase in Ambient Concentration of PM_{10} at receptor	Adverse	Moderate	Regional	Long-term	Sporadic	Reversible Short term	Neutral	Very Likely	Not significant
Increase in Ambient Concentration of $PM_{2.5}$ at receptor	Adverse	Low	Regional	Long-term	Sporadic	Reversible Short term	Neutral	Very Likely	Not significant
Increase in Ambient Concentration of CO at receptor	Adverse	Low	Local	Long-term	Sporadic	Reversible Short term	Neutral	Very Likely	Not significant
Increase in Ambient Concentration of NO_2 at receptor	Adverse	Low	Local	Long-term	Sporadic	Reversible Short term	Neutral	Very Likely	Not significant
Increase in Ambient Concentration of SO_2 at receptor	Adverse	Low	Local	Long-term	Sporadic	Reversible Short term	Neutral	Very Likely	Not significant
Emission of Greenhouse Gases contributing to territorial and national inventories	Adverse	Low	Beyond Regional	Far future	Continuous	Reversible Long-term	Neutral	Very Likely	Not significant

Note: Criteria definitions are provided in Table 6-3.

* Magnitude and geographic extent assessment provided for Project phase with highest criteria value

For the increase in TSP ambient concentration at the receptor, the magnitude is moderate (measurable change from baseline) and the extent is regional (includes Access Road). The frequency is sporadic as YAAQS exceedances are predicted to occur less than 1% of the time and only during the operation phase. For criteria air contaminants, a significant effect is considered to occur if it is of high magnitude and extends across the regional study area or is of high magnitude within the local study area and occurs at regular or continuous frequency; the effect is therefore not significant.

For the increase in PM_{10} ambient concentration at the receptor, the magnitude is moderate (measurable change from baseline) and the extent is regional (includes Access road). The frequency is sporadic as YAAQS exceedances are predicted to occur approximately 1% of the time and only during the operation phase. The effect is therefore not significant.

For the increase in $PM^{2.5}$ ambient concentration at the receptor, the magnitude is low (minor change from baseline) and the extent is local. The frequency is sporadic as no YAAQS exceedances are predicted to occur. The effect is therefore not significant.

For the increase in CO ambient concentration at the receptor, the magnitude is low (minor change from baseline) and the extent is local. The frequency is sporadic as no YAAQS exceedances are predicted to occur. The effect is therefore not significant.

For the increase in NO_2 ambient concentration at the receptor, the magnitude is low (minor change from baseline, considering that modelling results presented in Table 6-16 are for NO_X of which NO_2 only represents a small fraction) and the extent is local. The frequency is sporadic as no YAAQS exceedances are predicted to occur. The effect is therefore not significant.

For the increase in SO_2 ambient concentration at the receptor, the magnitude is low (minor change from baseline) and the extent is local. The frequency is sporadic as no YAAQS exceedances are predicted to occur. The effect is therefore not significant.

6.4.3.2 Greenhouse Gases

Predicted Project GHG emissions represent a very small fraction of 2014 Canadian total and mining sector emissions. They represent 4% to 22% of the 2014 total territorial emissions depending on the Project phase. However, it should be noted that Yukon GHG emissions are generally very low (less than 0.1% of total Canadian emissions) due to limited industrial activity and low population and were particularly low in 2014. Canadian mining facilities that have reported their emissions to the National Pollutant Release Inventory (NPRI) in 2014 had GHG emissions ranging from 320 tonnes to 258,120 tonnes of CO_2 equivalent (EC, 2016c). The average for 21 facilities (excluding tar sands facilities) was 102,217 tonnes of CO_2 equivalent. Predicted GHGs emissions during the operation phase of the Project are well below the Canadian average for mining facilities. In comparison, the much larger Casino Mine project in Yukon, currently under YESAB review, has predicted average GHG emissions of 609,000 tonnes of CO_2 equivalent during the operation phase (Casino Mining Corporation, 2014b), which represent about 227% of the 2014 Yukon emissions. The Casino Mine production is expected to be 120,000 tpd with a main power plant of 150 MW (Casino Mining Corporation, 2014b), or about 10 times the capacity of KZK Project's power plant. Therefore,

predicted Project GHG emissions are in line (proportionally) with predicted emissions from other facilities in a similar setting.

The direction of the effect is adverse and the magnitude is low during all Project phases. The geographical extent is beyond regional as climate change is a global phenomenon and the duration is far future as greenhouse gases lifetime in the atmosphere range from 12 years for methane to 114 years for nitrous oxide (Forster et al., 2007). The frequency is continuous and the effect is reversible in the long-term (given GHG decay rates above). The greenhouse gases subcomponent has some resilience to accommodate change, with context considered neutral given the potential social and economic consequences of climate change, and the probability of the effect occurring is very likely. For GHGs, a significant effect is considered to occur if it is of high magnitude and extends across the regional study area or is of high magnitude within the local study area and occurs over the long-term; the effect is therefore not significant.

6.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for air quality follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. The following Project residual effects have been identified for air quality and are considered through the CEA:

- Increase in ambient concentrations of particulate matter (TSP, PM_{10}, $PM_{2.5}$) at receptors from fugitive dust;
- Increase in ambient concentrations of air contaminants (TSP, PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2) at receptors from stationary equipment and vehicle emissions; and
- Emission of Greenhouse Gases contributing to territorial and national inventories.

6.5.1 Cumulative Effects Characterization

For past, present, and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the Project or activity results in a demonstrable or measurable effect on the VC;
2. The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for air quality are identified through the screening in Table 6-22. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

Table 6-22: Cumulative Effects Screening for Air Quality

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Quartz Mining and Exploration				
Fyre Lake Property (*Pacific Ridge Exploration)*	Yes	Yes (Emission of Greenhouse Gases contributing to territorial and national inventories)	Yes	Yes
Grew Creek (*Golden Predator Corp.*)	Yes	Yes (Emission of Greenhouse Gases contributing to territorial and national inventories)	No	No
Ketza River Mine *(Ketza Group/ Veris Group*)	Yes	No	N/A	N/A
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	Yes	Yes (Emission of Greenhouse Gases contributing to territorial and national inventories)	Yes	Yes
Selwyn Project *(Selwyn Chihong Mining Ltd)*	Yes	Yes (Emission of Greenhouse Gases contributing to territorial and national inventories)	Yes	Yes
The Yukon Base Metal Project *(Overland Resources Ltd.)*	Yes	Yes (Emission of Greenhouse Gases contributing to territorial and national inventories)	No	No
Wolverine Mine (*Yukon Zinc Corp.)*	Yes	No	Yes	No
Roads, Access Roads and Trails				
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	Yes	Yes (Emission of Greenhouse Gases contributing to territorial and national inventories)	Yes	Yes
Finlayson Winter Trail *(Inconnu Lodge Limited)*	Yes	No	N/A	No
Other Activities				
Single/Group Trapline Concessions	Yes	No	N/A	No
Outfitting Concessions	Yes	No	N/A	No
Campgrounds	Yes	No	N/A	No

No overlap in space is identified with any of the projects listed in Table 6-22 for the air contaminants subcomponent of the air quality VC. However, greenhouse gases overlap both in time and space with most of the projects listed, because they have effects on the global scale and over the long-term.

The Fyre Lake Property project could overlap in time with the construction phase of the KZK Project as its timeline is until 2020. The Fyre Lake Property project activities that could result in emissions

of GHGs include exploration, re-establishment and use of existing camp, drill pad and heli-pad construction, clearing, drilling, use of helicopter and float plane, waste management, progressive reclamation, and final decommissioning. The magnitude of the residual effects of the Fyre Lake Property project on GHG emissions is not known, but are assumed to be less than that of the KZK Project.

The Grew Creek project is expected to be completed in 2016, therefore no overlap in time is expected with the Project. The Ketza River Mine is currently under care and maintenance and GHG emissions are expected to be minimal, so there is no overlap in type of effect.

The Pelly Exploration project could overlap in time with the construction phase of the KZK Project as its timeline is until 2021. The Pelly Construction project activities that could result in emissions of GHGs include the establishment of a camp, the use of heavy equipment, clearing, trail construction, drilling, helicopter use, fuel use, waste management, progressive and final reclamation. The magnitude of the residual effects of the Pelly Exploration project on GHG emissions is not known, but assumed to be less than that of the KZK Project.

The Selwyn project could overlap in time with the construction phase of the KZK Project as it is assessed until 2021. The Selwyn project activities that could result in emissions of GHGs include drilling, clearing, line cutting, helicopter use, trail construction, use of heavy equipment, waste management and progressive reclamation. The magnitude of the residual effects of the Selwyn project on GHG emissions is not known, but assumed to be less than that of the KZK Project.

The Yukon Base Metal project is only assessed until 2019 and should therefore not overlap in time with the KZK Project.

The Wolverine Mine is currently in care and maintenance and has a 9.5 year mine life should it return to operation. Under care and maintenance, the GHG emissions are expected to be minimal so there is no overlap in type of effect. Because it is unknown if or when Wolverine Mine will return to operation, it was not considered to have cumulative effects with the KZK Project.

Geotechnical investigation and quarry pit development are expected to overlap in time with all Project phases. Transportation Engineering Branch activities that could result in emissions of GHGs include the use of heavy equipment, access construction, clearing, grubbing, stripping and site preparation, burning of brush and slash, quarry pit development, blasting, granular extraction, establishment of a temporary camp, waste management, decommissioning, and reclamation. The magnitude of the residual effects of geotechnical investigation and quarry pit development on GHG emissions is not known, but assumed to be less than that of the KZK Project.

The Finlayson winter trail, trapline and outfitting concessions, and campgrounds are not expected to results in substantial emissions of GHGs and are not considered to have cumulative effects with the Project.

In summary, the following potential cumulative effects have been identified for air quality:

- Emission of Greenhouse Gases contributing to territorial and national inventories.

6.5.2 Cumulative Effects Mitigation Measures

Potential cumulative effects on air quality and identified mitigation measures are summarized in Table 6-23 and discussed further below.

Table 6-23: Proposed Cumulative Effects Mitigation Measures for Air Quality

Potential Cumulative Effect	Mitigation Measures Identified for Project Effects	Additional Mitigation Measures (if practicable)	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual cumulative effect identified? (Yes/No)
Greenhouse Gas Emissions	Use filters, scrubbers, and other pollution control devices at processing facilities	No additional mitigation measures are identified	High	Yes
	Avoid engine idling		Medium	
	Ensure vehicles and equipment are maintained according to manufacturers' guidelines		Medium	
	Waste reduction at source and recycling		Medium	
	Waste segregation		Medium	
	Incinerator operation for optimum combustion		Medium	
	Regular inspection and maintenance of incinerator		Medium	

6.5.3 Cumulative Effects Significance Assessment

The significance of cumulative residual effects on air quality is summarized in Table 6-24.

Overall the significance criteria for greenhouse gas emissions cumulative effects are the same as for the Project effects. However, little information is available on the GHG emissions of other projects, resulting in high uncertainty. It is expected that the overall contribution to Canadian GHG inventory will remain small, and therefore magnitude is anticipated to be low and an overall rating of not significant.

Table 6-24: Cumulative Effects Significance Assessment for Air Quality

Residual Cumulative Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Cumulative Effect Significance (Significant/ Not significant)
Greenhouse Gas Emissions	Adverse	Low	Beyond Regional	Far future	Continuous	Reversible Long-term	Neutral	Very Likely	Not significant

Note: Criteria definitions are provided in Table 6-3.

6.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

6.6.1 Air Quality Monitoring

The EA for air quality identified no significant effects. Furthermore, the Air Quality Management Plan (Section 18.11) will be in place and will aim to eliminate all exceedances identified through modelling as those are predicted during worst meteorological and operational conditions. Therefore, no monitoring is proposed.

6.6.2 Meteorology Monitoring

A Campbell Scientific meteorological station for the Project was commissioned on 25 August 2015 at 1542 Meters Above Sea Level (masl) at the following UTM coordinates: NAD83 09V 413,710 E 6,817,805 N (see location on Figure 6-1). The station consists of a 10 m tower, datalogger, and sensors to collect the following ongoing measurements:

- Air temperature (°C);
- Relative humidity (%);
- Wind speed (m/s) and direction (degrees);
- Barometric pressure (hPa);
- Solar radiation (W/m^2); and
- Total precipitation (mm).

The station is programmed to take readings at 10 second intervals and to log hourly values of the above parameters, including average and maximum wind speed. The station is equipped with satellite communication and is set up for weekly data transfers. The station's program also incorporates an evapotranspiration (ET) instruction that provides an estimate of ET values based on measured meteorological parameters, using the American Society of Civil Engineers (ASCE) Penman-Monteith Standardized reference evapotranspiration equation.

Each year a Class A evaporation pan is installed at the weather station during the summer months and manual readings are taken daily. These measurements will continue through Project construction, operations and closure. Additionally, snow surveys will be completed every year in February, March and April within the Geona Creek watershed.

Data collected at the Campbell Scientific meteorological station are validated weekly, by searching for outliers or any unrealistic values, and comparing with data from regional stations as required. Diagnostic values can also be consulted to help determine whether or not data needed to be invalidated and, as the case may be, determine the cause. When suspicious values are noted during the weekly validation, appropriate maintenance or troubleshooting actions are incorporated into the next site visit. In addition, the station is visually inspected and maintained monthly, including the following steps:

- Ensuring that the solar panel is free of frost, snow or debris;
- Ensuring that the solar radiation sensor is free of frost, snow or debris. The sensor is wiped free of dust, using a soft cloth dampened with water or alcohol. Condensation within the dome is also checked for;
- Ensuring that the precipitation gauge opening is not obstructed by debris or snow. If clearing is necessary, note the date and time clearing is completed;
- Ensuring that all the wires are properly connected to the datalogger inside the enclosure;
- Replacing desiccant in enclosure; and
- Observing any sign of damage to the station by animals, wind, etc. paying particular attention to sensor cables and guy wires; guy wires are tightened if necessary.

Meteorological data will be presented in the annual report to the Yukon Water Board. Meteorological data will be used in conjunction with hydrology data to further refine the hydrometeorology character of the Project area and update the site water balance. The refined water balance will be used to inform operational decisions.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

7 NOISE LEVELS 7-1

7.1 ASSESSMENT APPROACH 7-1
7.1.1 Regional Setting 7-1
7.1.2 Selection of Subcomponents and Measurable Parameters 7-1
7.1.3 Criteria for Assessing Significance 7-2
7.2 ASSESSMENT BOUNDARIES 7-4
7.3 EXISTING CONDITIONS 7-6
7.4 PROJECT-SPECIFIC EFFECTS 7-7
7.4.1 Effects Characterization 7-7
7.4.2 Mitigation Measures 7-16
7.4.3 Residual Effects and Significance Determination 7-18
7.5 CUMULATIVE EFFECTS 7-21
7.5.1 Cumulative Effects Characterization 7-21
7.6 EFFECTS MONITORING 7-22

LIST OF TABLES

Table 7-1: Noise Subcomponents and Measurable Parameters 7-1
Table 7-2: Noise Standards and Guidelines (Leq) 7-2
Table 7-3: Noise Significance Criteria Definition 7-3
Table 7-4: Proposed Study Areas for Noise 7-4
Table 7-5: Interaction Matrix for Noise 7-7
Table 7-6: Predicted Blasting Noise Levels 7-15
Table 7-7: Identified Potential Project Effects for Noise 7-16
Table 7-8: Proposed Mitigation Measures for Noise 7-16
Table 7-9: Summary of Predicted Cumulative Noise Levels at the Camp Receptor (dBA) 7-17
Table 7-10: Summary of Predicted Increase in Noise Levels at the Camp Receptor (dBA) 7-17
Table 7-11: Project Effects Significance Assessment for Noise 7-20
Table 7-12: Cumulative Effects Screening for Noise 7-21

LIST OF FIGURES

Figure 7-1: Noise Local and Regional Study Areas 7-5
Figure 7-2: Construction Phase Predicted Noise Levels (with Design Mitigations) 7-10
Figure 7-3: Operation Phase Predicted Noise Levels (with Design Mitigations) 7-12
Figure 7-4: Operation Phase Predicted Daytime Noise Levels (with Design Mitigations) – Extended Domain 7-13
Figure 7-5: Closure Phase Predicted Daytime Noise Levels (with Design Mitigations) 7-14

7 NOISE LEVELS

This chapter provides an overview of the existing noise conditions and assessment of the potential effects from the Project on noise levels. Noise was selected as a VC because of its fundamental importance to the quality of life for humans and wildlife in the vicinity of the Project. Elevated noise levels may lead to annoyance, stress, sleep disruption, decreased ability to concentrate, lowered learning performance, and other adverse health effects in humans (enHealth Council, 2004). For wildlife, noise may lead to habitat avoidance as well as unfavourable physiological and behavioral responses (Turina and Barber, 2011). The assessment in this chapter will focus on potential effects to humans, while potential effects to wildlife will be assessed in Chapter 13.

7.1 ASSESSMENT APPROACH

The noise effects assessment (EA) will generally follow the methods outlined in Chapter 5 and will rely on results of noise prediction modelling. Noise modelling was conducted using SoundPLAN Essential; a standard software for predicting noise from roads, railroads, parking lots, and industrial point, line and area sources, using international ISO 9613:1996 (Acoustics - Attenuation of sound during propagation outdoors) standards. The Noise Prediction Model Report is provided in Appendix E-2.

7.1.1 Regional Setting

The Project is located in a remote wilderness area. As such, noise levels are assumed to be quiet and dominated by sounds of nature (e.g., wind, rustling of vegetation, creeks, chirping birds). There are no permanent or temporary residences in the vicinity of the Project. The only people that will be in the Project area during construction, operations, and closure are BMC employees and contractors.

7.1.2 Selection of Subcomponents and Measurable Parameters

The noise level subcomponents and measurable parameters are provided in Table 7-1.

Table 7-1: Noise Subcomponents and Measurable Parameters

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Noise Levels	Daytime Noise Level	Noise levels at sensitive receptor in dBA Leq	Compliance with standards	BC OGC, 2009; ERCB, 2007
	Night-time Noise Level	Noise Levels at sensitive receptor in dBA Leq	Compliance with standards	BC OGC, 2009; ERCB, 2007
	Blasting Noise	Sound Pressure Level (SPL) at sensitive receptor in dB	Compliance with limits/ guidelines	Ontario MOE, 1978; EC, 2009

Noise levels are measured on a logarithmic scale, of which the unit is the decibel (dB). The A-weighting scale (dBA) is based on the sensitivity of human hearing at moderate levels. Equivalent continuous level (Leq) is a common method of describing sound levels that vary over time, resulting in a single decibel value which takes into account the total sound energy over the period of time of interest. Noise standards are generally expressed in dBA Leq.

Although there are no applicable standards for noise in Yukon, predicted noise levels were compared with relevant standards from other jurisdictions (i.e., the BC Oil and Gas Commission standards (2009), and the Alberta Energy Resources Conservation Board Directive 038 (2007)). Environment Canada's (EC) Environmental Code of Practice for Metal Mines (Environment Canada, 2009) also provides guidance on maximum noise levels in residential areas adjacent to mine sites, and specifies that since ambient noise can also affect wildlife, sites in remote locations should also work to meet these objectives for off site ambient noise levels. Table 7-2 summarizes relevant noise standards and guidelines; noise modelling results are compared to BC OGC and ERCB standards, which are the most stringent.

Table 7-2: Noise Standards and Guidelines (Leq)

Standard	Daytime (7:00 – 22:00)	Night-time (22:00 – 7:00)
EC (2009)	55 dBA	45 dBA
BC OGC (2009) *	50 dBA	40 dBA
ERCB (2007) Directive 38 *	50 dBA	40 dBA

* Standards presented for Category 1 dwellings (more than 500 m from heavily travelled roads, rail line and not subject to frequent aircraft flyover), with 0 Class A adjustment (for seasonal or ambient monitoring) and 0 Class B adjustment (for short duration).

In addition to the standards above, the Project noise from blasting was evaluated against Ontario Ministry of the Environment (MOE) (Ontario MOE, 1978) Noise Pollution Control (NPC) NPC-119 Blasting, which specifies a cautionary limit of 120 dB. Environment Canada's *Environmental Code of Practice for Metal Mines* (2009) suggests that mines should design their blasts so that concussion noise of a maximum of 128 dB is not exceeded at or beyond the boundaries of the mine property.

7.1.3 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and

- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of the activity causing the effect to occur and the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for noise is presented in Table 7-3.

Table 7-3: Noise Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
	Adverse	VC would change for the worse
Magnitude	Low	Noise level at camp receptor differs from average baseline conditions by < 3 dBA and is below applicable standards, limits or guidelines (50 dBA during daytime and 40 dBA during night-time) For blasting noise, low magnitude is defined as SPL below 120 dB (Ontario MOE, Noise Pollution Control (NPC) NPC-119 Blasting limit)
	Moderate	Noise level at camp receptor differs from average baseline conditions by > 3 dBA and is below applicable standards, limits or guidelines (50 dBA during daytime and 40 dBA during night-time) For blasting noise, moderate magnitude is defined as SPL below 128 dB (Environment Canada's Environmental Code of Practice for Metal Mines guideline)
	High	Noise level at camp receptor is above applicable standards, limits or guidelines (50 dBA during daytime and 40 dBA during night-time) For blasting noise, high magnitude is defined as SPL exceeding 128 dB
Geographic Extent	Site	Effect limited to the Project Footprint
	Local	Effect extending beyond the Project Footprint but in the local study area
	Regional	Effect extending across the regional study area
	Beyond Regional	Effect extending beyond the regional study area
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent phases of the Project or beyond transitional closure phase (11 to 26 years) into the post-closure phase
	Far future	Effect lasting beyond 26 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project

Criteria	Definition	
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Economic and Social Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

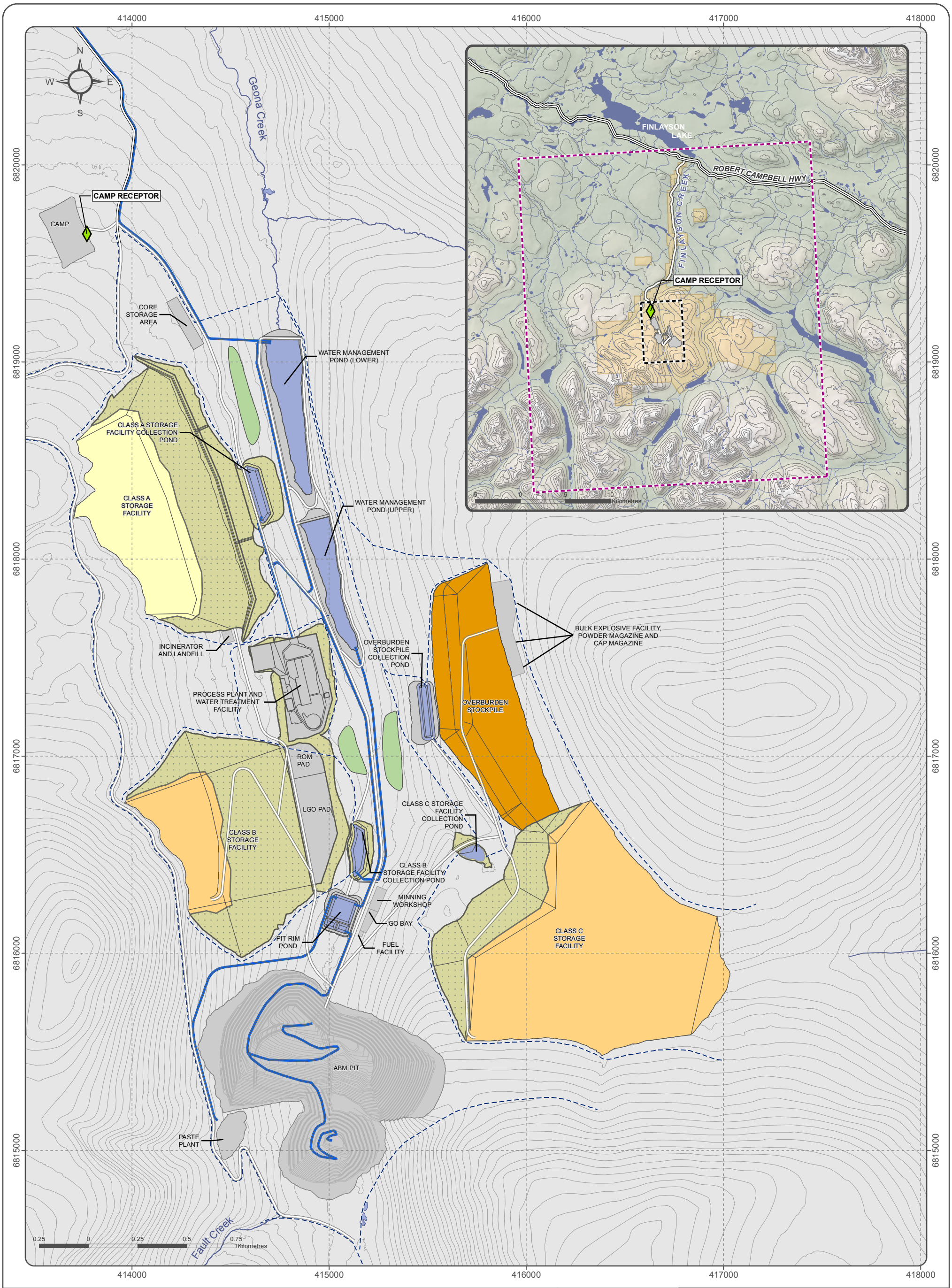
A significant effect is considered to occur if it is of high magnitude and extends across the regional study area (RSA) or is of high magnitude in the local study area (LSA) and occurs over the long-term.

7.2 ASSESSMENT BOUNDARIES

The local and regional study areas for noise levels are described in the table below and are shown in Figure 7-1. The study area boundaries have been selected to include areas where measurable changes in sound levels might be caused by the Project, and include the camp as a sensitive receptor. The camp was selected as a receptor because the noise level at camp will be representative of exposure to off-shift workers. The regional study area was selected to evaluate the potential effects of increased traffic on the Access Road, and the extent of predicted changes in baseline noise levels associated with the Project activities.

Table 7-4: Proposed Study Areas for Noise

Study Area	Noise Specific Study Area Description
Local Study Area	The local study area is 4.6 km by 6.0 km, centered on the Project Footprint, and includes camp as a sensitive receptor.
Regional Study Area	The regional study area is 32 km by 36 km and encompasses the Project Footprint and the entire Tote Road/proposed Access Road.



Noise Receptor
Pipeline
Diversion Ditch
Class A Storage Facility
Class B and C Storage Facility
Overburden Stockpile
Topsoil Stockpile
Progressive Reclamation, Footprint
Pond/Water
Footprints
Regional Study Area
Local Study Area
Tote Road/Proposed Access Road
Proposed Project Site Road
Contours (10 m)

National topographic Data Base (NTDB) compiled by Natural resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Projection: UTM Zone 9N

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ALEXCO ENVIRONMENTAL GROUP

KUDZ ZE KAYAH PROJECT

FIGURE 7-1

PROJECT SITE LAYOUT AND ASSESSMENT BOUNDARIES

NOVEMBER 2016

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(Last edited by: amatlashevska; 11/23/2016 11:07 AM)

For the assessment of noise levels, temporal boundaries are defined to include all Project phases in which effects are expected to occur. The Project phases considered in the noise levels EA include the following:

- **Construction Phase**: will last approximately two years and includes Project site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground mining and ore processing; and
- **Decommissioning, Reclamation and Closure Phase** (referred to as Closure Phase): will last approximately three years.

As there are minimal or no physical activities during the transition closure period and the post-closure period, minimal noise levels are expected during these phases (i.e., effects will be less than those during Closure Phase) and they have not been included in the assessment of noise.

7.3 EXISTING CONDITIONS

This section presents a summary of existing environmental conditions as they relate to noise. Characterization of the existing environment serves as the baseline against which the effects of the Project are assessed. The description of the existing environment has been focused on those components of the environment that may be affected by the Project. The description of the existing noise levels presents a compilation and review of existing information. Desk-based research was conducted to identify Kaska First Nation (Kaska) knowledge, uses, interests, and values related to noise (Appendix F-3); however, none was available from publicly available secondary sources. Ongoing future traditional knowledge data collection efforts, as well as consultation and engagement activities with the RRDC as representatives of the Kaska may result in additional information and understanding on this issue.

The Project is located in a remote area in central Yukon, where noise levels are expected to be low and dominated by natural sounds (wind, wildlife, and creeks). As such, no baseline sound level data were collected at or in the vicinity of the Project. However, based on the remote location of the Project, the existing acoustic ambient conditions are expected to be similar to the average ambient sound level for rural areas as established by the Energy Resources Conservation Board (ERCB, 2007) and the BC Oil & Gas Commission (BC OGC, 2009).

The baseline night-time (22:00 to 07:00) ambient sound level for rural areas was established at 35 dBA Leq by both the ERCB and the BC OGC. Daytime adjustment recognizes that daytime ambient sound levels are commonly 10 dBA Leq higher than night-time levels and that night-time noise disturbances are generally considered less acceptable (ERCB, 2007). In the case of a rural area, the average daytime (07:00 to 22:00) ambient sound level would therefore be 45 dBA Leq, according to both the ERCB and the BC OGC.

No similar daytime or night-time average ambient sound levels exist for Yukon; however, comparisons can be made with baseline noise data collected for other Yukon Projects located in a remote setting comparable to the Project. Noise monitoring carried out in August 2011 for the Casino

Project found an average daytime Leq of 40.3 dBA and an average night-time Leq of 33.9 dBA (RWDI AIR Inc., 2012). Although noise levels are variable and hourly values ranged between 30.3 dBA to 43.4 dBA during the course of this 22-hour study (RWDI AIR Inc., 2012), the average ambient sounds levels indicated above were found to be slightly below the values of 45 dBA and 35 dBA established by the ERCB and the BC OGC for daytime and night-time respectively. Therefore, use of the ERBC/BC OGC recommended values as baseline sound levels was deemed an appropriate approach for this assessment.

7.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on noise levels as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

7.4.1 Effects Characterization

In order to focus the effects assessment, the first step is to identify any potential interactions between Project activities and noise levels. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1, or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects; and*
2 – Higher risk interactions- *it is reasonably foreseeable that residual effects may result.*

The results of the interactions screening are presented in Table 7-5.

Table 7-5: Interaction Matrix for Noise

Project Activity	Daytime Noise Level	Night-time Noise Level	Blasting Noise
Construction			
Tote Road upgrade to Access Road	1	0	1 *
Finlayson Lake airstrip upgrade	1	0	0
Site preparation and clearing	1	1	0
Site grading, including soil and overburden removal and stockpiling	2	2	0
Off site traffic (construction equipment and materials delivery)	0	0	0
On site traffic	1	1	0
ABM open pit development (including dewatering and Fault Creek diversion)	2	2	2
Infrastructure construction	2	2	0
Waste handling	1	1	0
Water use and management	1	1	0

Project Activity	Daytime Noise Level	Night-time Noise Level	Blasting Noise
Power generation	2	2	0
Worker transport	1	0	0
Construction camp operation	1	1	0
Workforce, procurement and hiring	0	0	0
Operations			
ABM open pit operations (including blasting and dewatering)	2	2	2
Underground operations	1	1	0
Ore processing	2	2	0
On site traffic	1	1	0
Off site traffic (highway)	0	0	0
Finlayson Lake airstrip operations	1	0	0
Storage facilities management (Class A, B, and C)	2	2	0
Progressive reclamation of storage facilities	2	2	0
Water use (potable and non-potable)	1	1	0
Mine water management and treatment (including effluent discharge)	1	1	0
Waste management	1	1	0
Power generation	2	2	0
Worker transport	1	0	0
Camp operation	1	1	0
Workforce, procurement and hiring	0	0	0
Closure			
Processing plant decommissioning and Project reclamation	2	0	0
ABM lake filling	0	0	0
Final storage facilities reclamation	2	0	0
Support infrastructure removal and Project reclamation	2	0	0
Water management and treatment (including effluent discharge)	1	0	0
On site traffic	1	0	0
Off site traffic (highway)	0	0	0
Access road reclamation	1	0	0
Workforce, procurement and hiring	0	0	0

* There may be occasional blasting for road levelling during the construction phase. Exact location to be determined.

In addition to the direct Project interactions identified above, the following indirect interactions are identified for noise:

- Potential effect to wildlife as a result of changes to noise levels (assessed in Chapter 13).

Noise prediction modelling was conducted for each of the Project phases (construction, operations, and closure), assuming a reasonable worst case scenario (i.e., all non-continuous noise sources in operation at the same time, weather condition favourable to sound propagation) for each model run. Design mitigations such as noise dampening enclosures for the boiler, generators, and compressor as well as crusher, grinding mills, conveyor shielding (enclosed building) were incorporated into the model. Results are discussed in the following sections.

7.4.1.1 Construction Phase

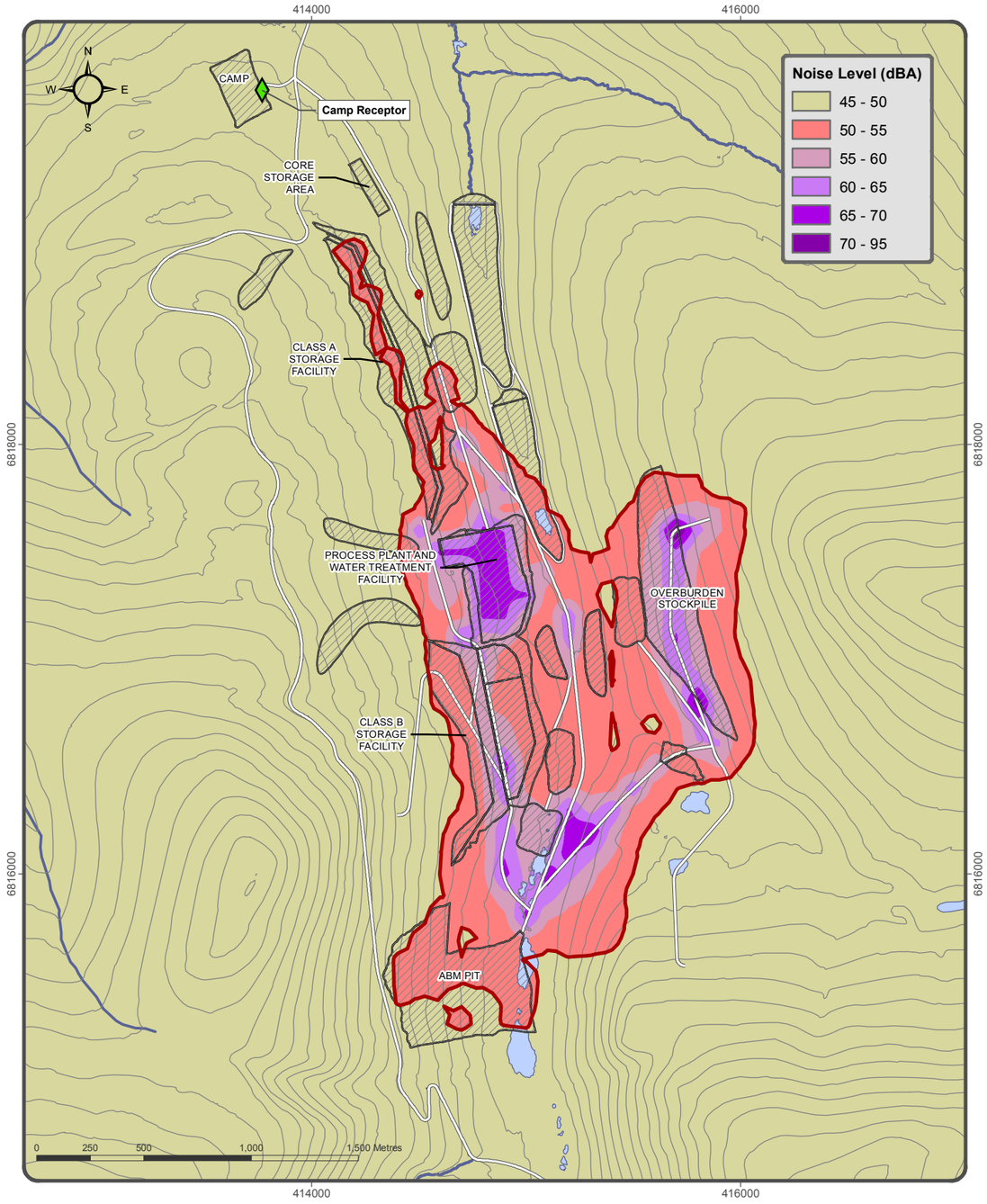
Results of noise prediction modelling for the local study area during the Project construction phase are shown in Figure 7-2 (the noise model is described in detail in Appendix E-2). The predicted cumulative outdoor noise level (baseline level plus Project related noise) at the camp receptor is 45.4 dBA and 37.5 dBA for daytime and night-time respectively, prior to the application of any additional mitigation measures. Noise levels could be higher in the immediate area around the Process Plant Facility; however, these noise levels are not comparable to the BC OGC or ERBC standards as they occur in an industrial area. Workers will be equipped with adequate PPE, where required.

In terms of potential effects of predicted noise levels on sleep disturbance, indoor annoyance or speech comprehension, a building attenuation factor is applied to predicted outdoor noise levels.

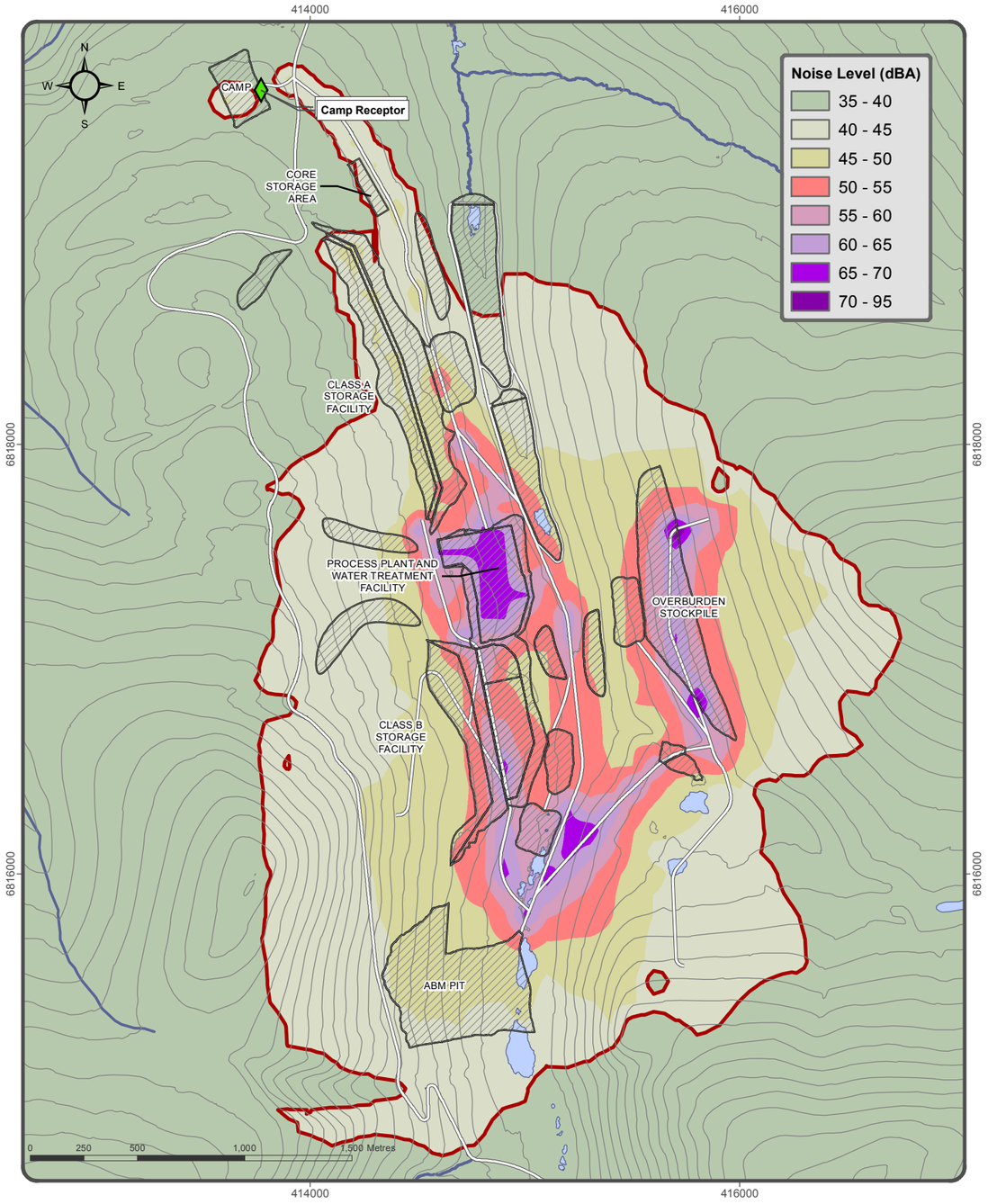
> *The [World Health Organization's] WHO's Guidelines for Community Noise (1999) report a threshold for sleep disturbance of an indoor night-time sound level (Ln) of no more than 30 dBA for continuous noise. […] Unless specified otherwise, it is assumed by Health Canada that an outdoor-to-indoor transmission loss with windows at least partially open is 15 dBA (EPA 1974, WHO 1999). Fully closed windows are assumed to reduce outdoor sound levels by approximately 27 dBA (EPA 1974). (Health Canada, 2011)*

The predicted outdoor night-time noise level of 37.5 dBA indicated above, when adjusted to indoor level using the value of 15 dBA (for windows partially open), falls below the recommended threshold of 30 dBA. For night shift workers sleeping during daytime, the maximum indoor noise level would be 30.4 dBA; however, a 0.4 dBA change in noise level is not perceptible by the human ear (Health Canada, 2011).

DAYTIME



NIGHT-TIME



Noise Levels Predictions shown on this map were produced with SoundPLAN Essential 3.0

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Noise Receptor
- Standard Noise Level Boundary
- Location of Proposed Mine Footprint (Year One)
- Tote Road/Proposed Access Road and Project Site Roads
- Contour (20 m)
- Watercourse
- Waterbody

Standard Noise Levels:
Daytime - 50 dBA; Night-Time - 40 dBA

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KUDZ ZE KAYAH PROJECT

FIGURE 7-2

CONSTRUCTION PHASE PREDICTED NOISE LEVELS (WITH DESIGN MITIGATIONS)

NOVEMBER 2016

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7.4.1.2 Operations Phase

Results of noise prediction modelling for the LSA during the Project operations phase are shown in Figure 7-3. Predicted cumulative outdoor noise level (baseline level plus Project related noise) at the camp receptor is 45.6 dBA and 37.6 dBA for daytime and night-time respectively, prior to the application of any additional mitigation measures. As was the case during the construction phase, noise levels could be higher in the immediate area around the Process Plant Facility; however, these noise levels are not comparable to the BC OGC or ERBC standards as they occur in an industrial area. Workers will be equipped with adequate PPE, where required.

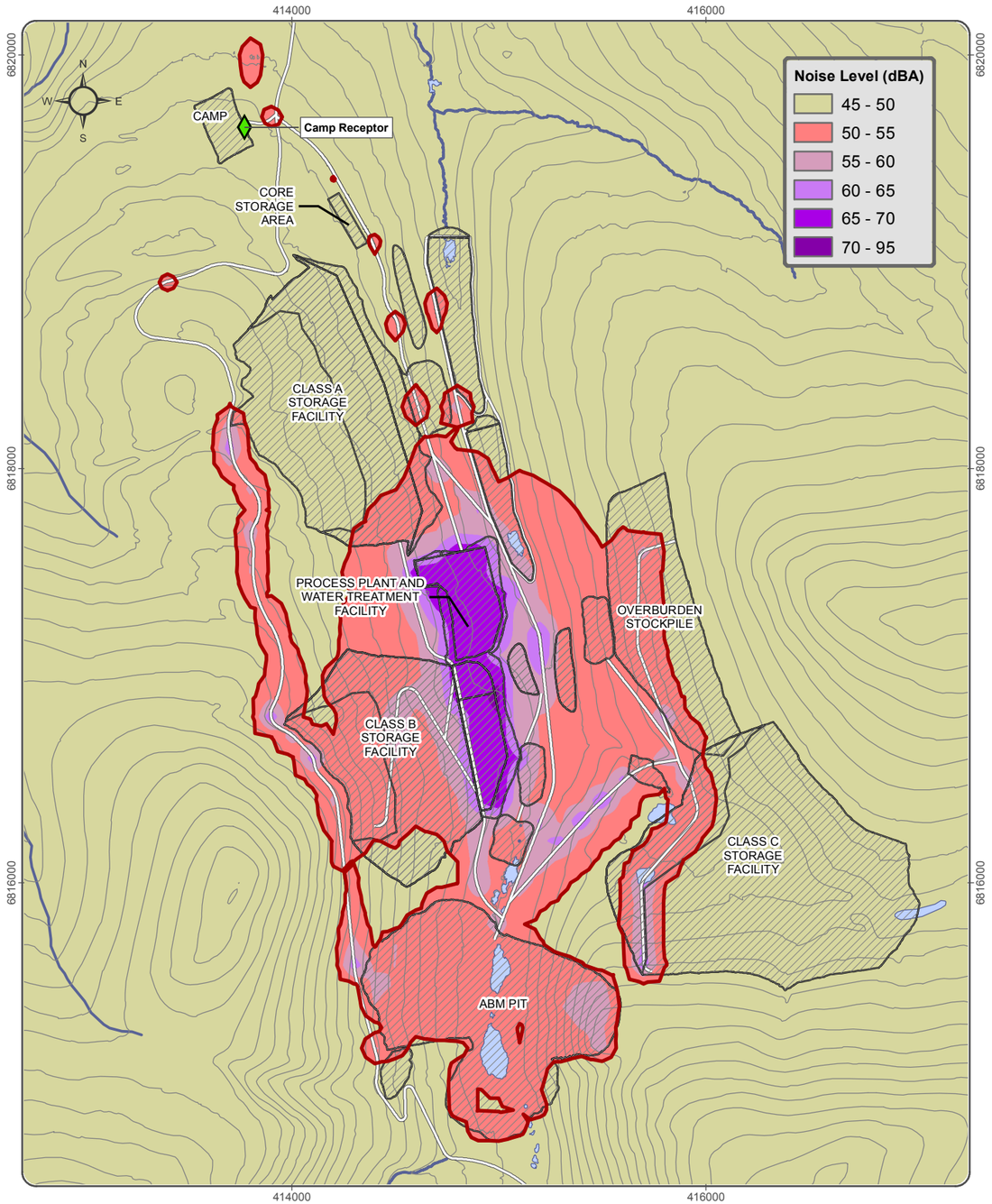
The predicted outdoor night-time noise level of 37.6 dBA indicated above, when adjusted to indoor level using the value of 15 dBA (for windows partially open), falls below the recommended sleep disturbance threshold of 30 dBA. For night shift workers sleeping during daytime, the maximum indoor noise level would be 30.6 dBA, which is slightly above the recommended threshold of 30 dBA, however, a 0.6 dBA change in noise level is not perceptible by the human ear (Health Canada, 2011).

Because it is expected that the maximum amount of traffic on the proposed Access Road will occur in the daytime during the operations phase, the noise prediction model was also run for the regional study area under this scenario (see results on Figure 7-4). These results were used to assess potential wildlife effects along the road during operations (Chapter 13).

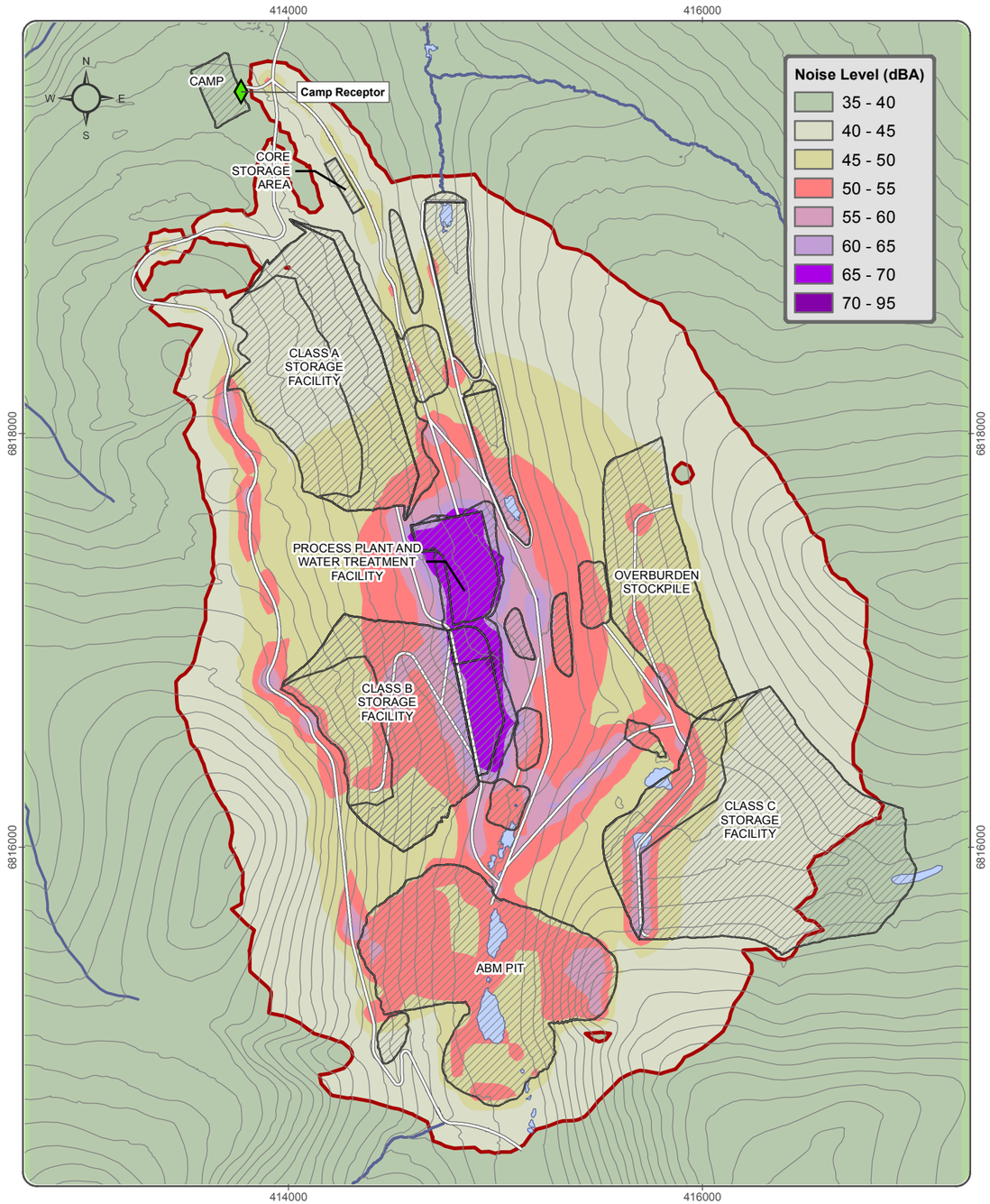
7.4.1.3 Closure Phase

Because the closure activities are only anticipated to occur during daytime, the model was not run for night-time for this phase of the Project. There is no anticipated night shift work during this Project phase and effects on sleep disturbance are therefore non-existent. In addition to all the conservative assumptions common to all scenarios, the closure scenario also assumed that all reclamation activities occur concurrently rather than progressively (consistent with a reasonable worst case scenario). Results of noise prediction modelling for the LSA during the Project closure phase are shown in Figure 7-5. Predicted cumulative noise level (baseline level plus the Project related noise) at the camp receptor is 46.5 dBA (daytime), prior to the application of any additional mitigation measures. Noise levels could be higher in the immediate area around the sources; however, these noise levels are not comparable to the BC OGC or ERBC standards as they occur in an industrial area. Workers will be equipped with adequate PPE, where required.

DAYTIME



NIGHT-TIME



Noise Levels Predictions shown on this map were produced with SoundPLAN Essential 3.0

Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

- Noise Receptor
- Standard Noise Level Boundary
- Location of Proposed Mine Footprint (Year Ten)
- Tote Road/Proposed Access Road and Project Site Roads
- Contour (20 m)
- Watercourse
- Waterbody

Standard Noise Levels:
Daytime - 50 dBA; Night-Time - 40 dBA

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 7-3

OPERATION PHASE PREDICTED NOISE LEVELS (WITH DESIGN MITIGATIONS)

NOVEMBER 2016

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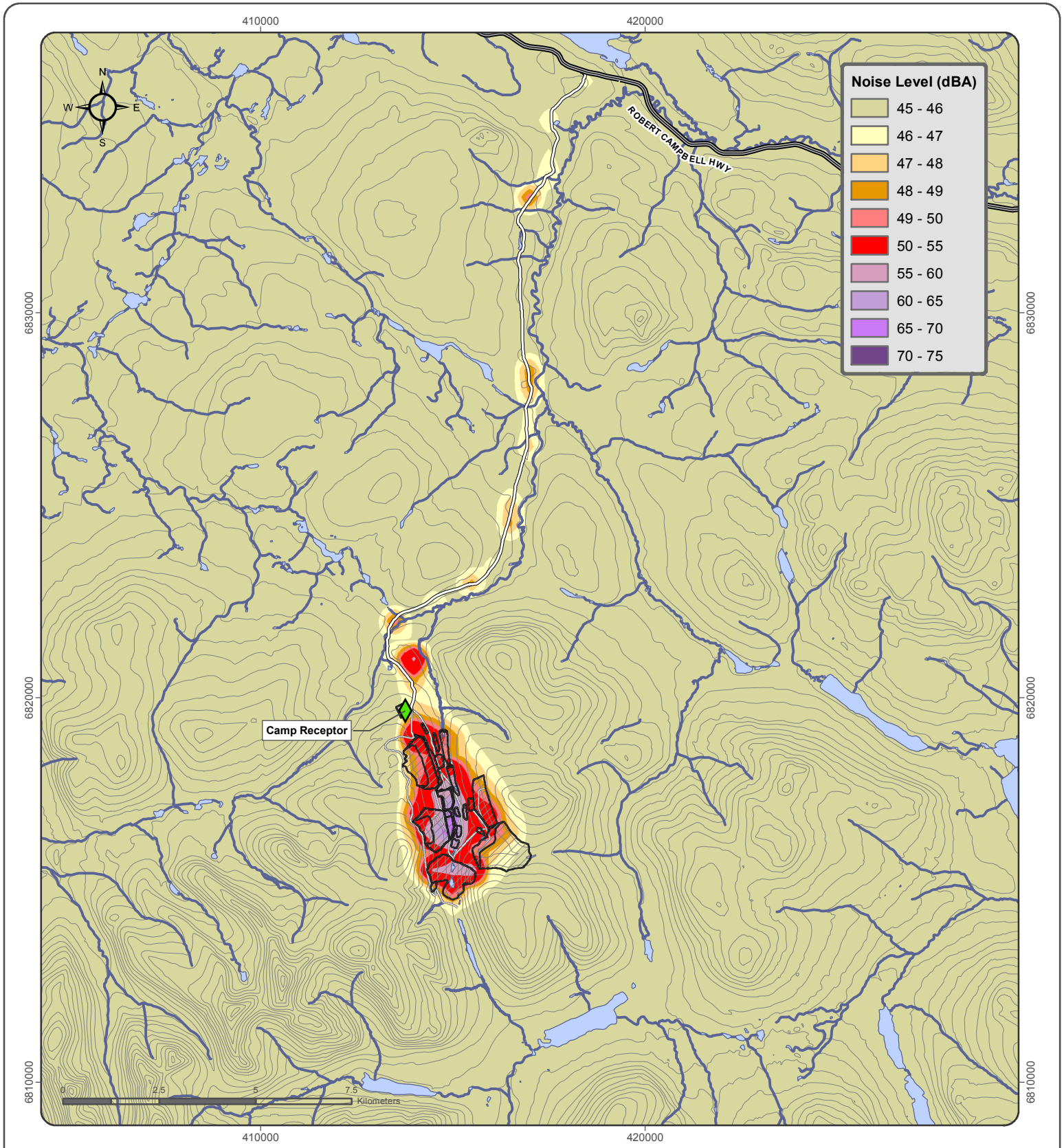

Noise Receptor

Location of Proposed Mine Footprint (Year 10)

Tote Road/Proposed Access Road

Project Site Roads

Contours (40 m)

Watercourse

Waterbody

Standard Noise Levels:
Daytime - 50 dBA

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KUDZ ZE KAYAH PROJECT

FIGURE 7-4

OPERATION PHASE PREDICTED DAYTIME NOISE LEVEL (WITH DESIGN MITIGATIONS) – EXTENDED DOMAIN

NOVEMBER 2016

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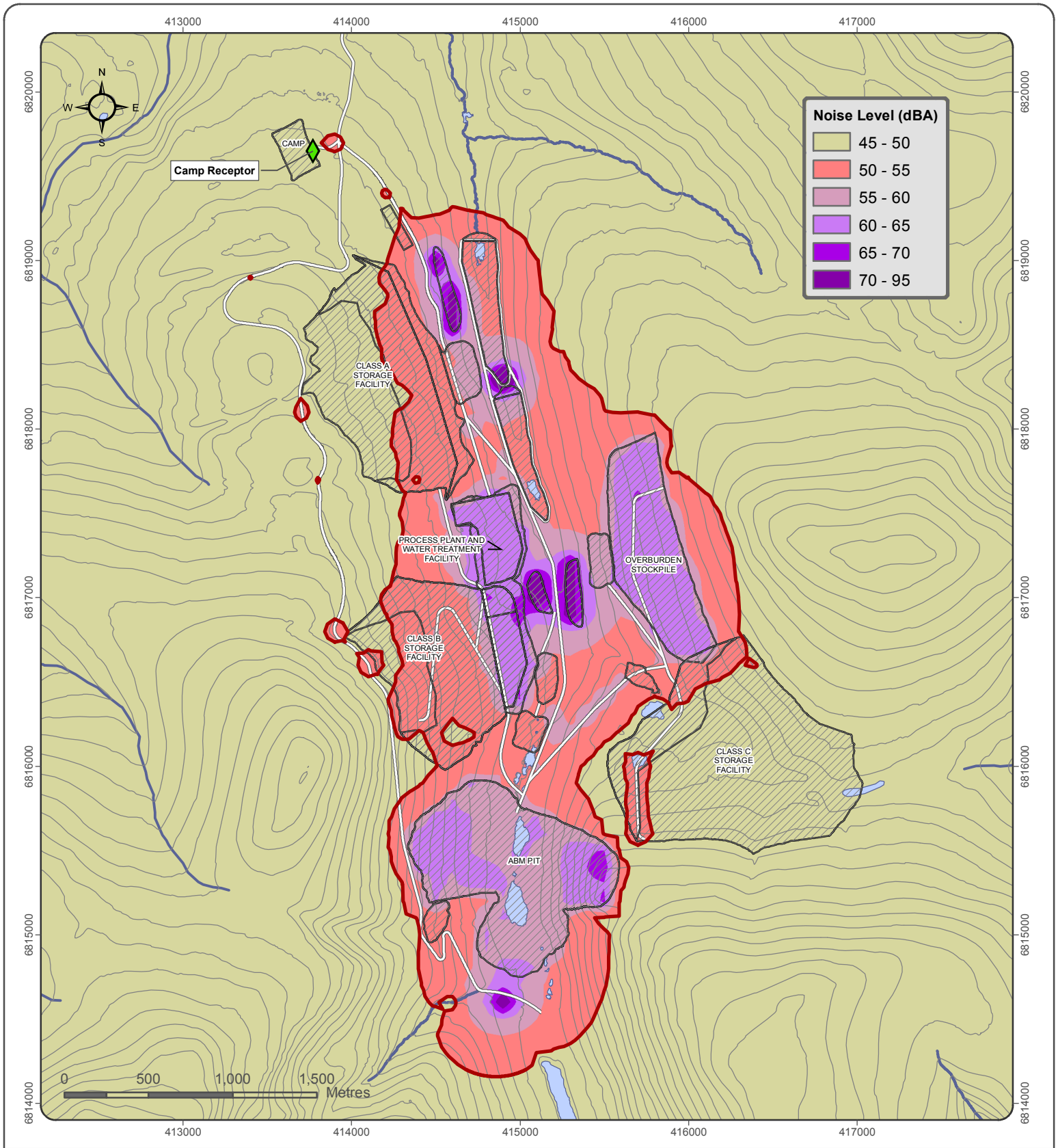

Noise Receptor

Location of Proposed Mine Footprint (Year 10)

Standard Noise Level Boundary

Tote/Proposed Access Road and Project Site Roads

Contour (20 m)

Watercourse

Waterbody

Standard Noise Levels:
Daytime - 50 dBA

Noise Levels Predictions shown on this map were produced with SoundPLAN Essential 3.0

Datum: NAD 83; Map Projection: UTM Zone 9N

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KUDZ ZE KAYAH PROJECT

FIGURE 7-5

CLOSURE PHASE PREDICTED DAYTIME NOISE LEVELS (WITH DESIGN MITIGATIONS)

NOVEMBER 2016

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(Last edited by: amatlashevska; 11/23/2016/11:11 AM)

7.4.1.4 Blasting

Sound pressure levels (SPL) resulting from blasting were estimated with an empirical formula, based on the maximum anticipated explosive use, which is during the operations phase for the open pit development. To produce a reasonable worst case scenario, the equation constants (which can vary between sites) were chosen such that they result in the highest predicted noise levels. Details are available in the Noise Model Report (Appendix E-2). Resulting unweighted SPL as a function of distance from the source are presented in Table 7-6.

Table 7-6: Predicted Blasting Noise Levels

Distance (m)	50	100	250	500	1,000	2,000	3,000	4,000	5,000
SPL (dB)	153	146	136	129	122	116	111	109	106

The camp is located between 4,000 m and 5,000 m from the open pit, depending on the exact location of the blast in the pit. Noise at camp resulting from blasting is therefore expected to reach a maximum of 106 dB to 109 dB, which falls below both the Ontario Ministry of the Environment (MOE) (Ontario MOE, 1978) Noise Pollution Control (NPC) NPC-119 Blasting and Environment Canada's *Environmental Code of Practice for Metal Mines* (2009) guidelines. However, it should be noted that the propagation of the air blast is highly dependent on atmospheric conditions.

As noted in AMEC, 2011:

> *[Unweighted SPLs] are not judged by humans, and presumably most animals, to be as loud as A-weighted continuous sound levels, particularly in the case of very low frequency noise such as blast noise. For example, blast noise with an unweighted peak sound level of 90 dB would likely be judged to be as quiet, or quieter, than a continuous noise source with an A-weighted level of 45 dBA. In some cases, a blast with an unweighted peak level of 90 dB would be barely discernible above the background noise. […] Airborne pressure waves can cause annoyance because of hearing and feeling (particularly the low frequency component) the noise at levels above peak linear values of around 115 dB.*

It is also important to note that this annoyance is of short duration (one or two seconds), and blasting will occur on a regular schedule, which could result in habituation and overall less disturbance.

7.4.1.5 Summary

Table 7-7 provides a summary of the identified potential effects from the above section that are carried forward for consideration of mitigation measures.

Table 7-7: Identified Potential Project Effects for Noise

Subcomponent	Potential Effect	Project Phase
Daytime Noise Level	Increase in Daytime Noise Level at Camp Receptor	Construction, Operation, Closure
Night-time Noise Level	Increase in Night-time Noise Level at Camp Receptor	Construction, Operation
Blasting Noise	Blasting Noise Perceptible at Camp Receptor	Operation

Under the loudest scenarios, daytime and night-time noise levels differ from baseline by more than 1 dBA over a maximum extent of approximately 4 km in the east-west direction and 8 km in the north-south direction centered on the Project Footprint. One dBA is the lower end of the typical threshold for an increase in sound level that is considered to be "barely perceptible" by the human ear (Health Canada, 2011). The range is 1 to 5 dBA. A similar threshold is assumed for animals.

7.4.2 Mitigation Measures

Potential effects on noise and identified mitigation measures are summarized in Table 7-8 and discussed further below.

Table 7-8: Proposed Mitigation Measures for Noise

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Increase in Daytime and Night-time Noise Level at Camp Receptor	**Construction, operations, closure**	**Noise dampening enclosures for boiler, generators, and compressor**	**High**	Yes
	Operations	**Crusher, grinding mills, conveyor shielding (enclosed building)**	**High**	
	Construction, operations, closure	Equipping all vehicles and internal combustion engine with appropriate muffler systems	Moderate	
		Ensuring regular equipment maintenance including lubrication	Moderate	
		Keeping noisy equipment inside buildings or sheds and/or near ground level whenever possible	High	
		Imposing speed limits for all vehicles	Moderate	
		Avoiding engine idling	Moderate	
		Maintaining natural cover (vegetation) between noise sources and sensitive receptor	High	
		Maintaining the Project roads regularly to minimize vehicle noise associated with vibration	Moderate	
		Maintaining a noise control standard when procuring equipment	Moderate	

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Blasting Noise Perceptible at Camp Receptor	Operations	Adhering to BMC's blasting plan that implements controlled blasting procedures, optimizes blasting operations, and minimizes non-productive noise	Moderate	Yes

7.4.2.1 Daytime and Night-time Noise Levels

Noise dampening enclosures for the boiler, generators, and compressor as well as crusher, grinding mills and conveyor shielding (first two mitigation measures – in bold in Table 7-8) were already incorporated into the model. A completely closed enclosure located close to the source has an estimated shielding factor of 10 dBA (U.S. Department of Transportation, 2006). To evaluate the effectiveness of these design mitigations, noise levels were also predicted at the camp receptor assuming no enclosures or shielding, with all other model input kept the same. Table 7-9 below summarizes predicted cumulative (baseline plus the Project related) noise levels without and with these mitigations.

Table 7-9: Summary of Predicted Cumulative Noise Levels at the Camp Receptor (dBA)

Project Phase	Daytime		Night-time	
	No Mitigations	With Design Mitigations	No Mitigations	With Design Mitigations
BC OGC / ERCB Standards	***50.0***		***40.0***	
Construction	46.8	45.4	42.6	37.5
Operations	46.9	45.6	42.6	37.6
Closure	49.7	46.2	N/A	N/A

Note: Results in red indicate exceedances of the applicable BC OCG / ERCB standard

Results indicate that shielding and enclosures are very effective in controlling noise levels. The implementation of these mitigations will reduce the predicted night-time noise levels at the camp receptor below the applicable BC OGC and ERCB standards. Table 7-10 below presents the predicted increase in noise levels compared to baseline.

Table 7-10: Summary of Predicted Increase in Noise Levels at the Camp Receptor (dBA)

Project Phase	Daytime		Night-time	
	Predicted Noise Levels (with design mitigations)	Difference with baseline	Predicted Noise Levels (with design mitigations)	Difference with baseline
Baseline Levels	***45.0***		***35.0***	
Construction	45.4	0.4	37.5	2.5
Operations	45.6	0.6	37.6	2.6
Closure	46.2	1.2	N/A	N/A

Although changes in the sound characteristics such as frequency, modulation, or impulsiveness may affect perceptibility, *the typical threshold for an increase in sound level that is considered to be "barely perceptible" by the human ear in a controlled laboratory setting varies from 1 to 5 dBA, depending on the sound pressure level and frequency of the sound. In community noise applications, a 5 dBA reduction in highway noise by a barrier is accepted as the minimum that will be clearly noticeable.* (Health Canada, 2011).

In that context, predicted increases in daytime noise levels for all of the Project phases will likely not be perceptible at camp, while night-time predicted noise levels may or may not be perceptible at the camp receptor. When considering the additional mitigation measures that were not modelled but that will also contribute to sound attenuation, it is expected that the change in daytime and night-time noise levels compared to baseline will be even lower than predicted by the model and therefore less likely to be perceptible by the human ear.

7.4.2.2 Blasting Noise

The predicted SPLs resulting from blasting activities are below the Ontario MOE NPC-119 limit of 120 dB at the camp receptor and below EC's Environmental Code of Practice for Metal Mines guideline of 128 dB outside the mine property. In addition, it is expected that the mitigation measures outlined in BMC's blasting plan will further reduce SPLs.

Also, as the pit development progresses in a series of benches, the benches and rock face will act as a sound barrier and resulting noise outside the pit will be attenuated. Therefore, the loudest stage will occur during the initial pit development, when blasts are located close to the original ground elevation. *According to Griffiths and Oates (1978), the additional attenuation to be expected for blast noise originating on the first and second benches below original ground level would be about 2 dBA and 6 dBA, respectively. Although additional shielding can be expected for blasts on lower benches, it is unlikely that the additional attenuation would ever exceed 15 dBA, even for very deep pits, because of reflection of sound off the opposing faces of the pit* (AMEC, 2011).

7.4.3 Residual Effects and Significance Determination

The significance of residual effects as a result of the Project on noise levels are summarized in Table 7-11. For all effects, direction is adverse (there will be an increase in noise at the camp receptor), geographic extent is local (effect is in the LSA), the effect is reversible in the short-term (as soon as the noise sources stop, the effect stops), the VC is considered to have strong resilience to accommodate change, and the probability of the effect occurring is very likely. This results in ratings of no significant effects.

For the increase in daytime noise level, the magnitude is low (predicted increase is less than 3 dBA for all of the Project phases), the duration is long-term (the effect will last through all of the Project phases), and the frequency is continuous. For the increase in night-time noise level, the magnitude is low (predicted increase is less than 3 dBA for all of the Project phases), the duration is long-term as the effect will extend over the construction and the operations phases, and the frequency is continuous. For blasting noise, the magnitude is low (predicted sound pressure level at camp is

below Ontario MOE 120 dB limit), the duration is medium term as it will only occur during operations phase, and the frequency is regular (blasting is planned to occur four times a week).

Table 7-11: Project Effects Significance Assessment for Noise

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Increase in daytime noise level at camp receptor	Adverse	Low	Local	Long-term	Continuous	Reversible short term	Low	Very likely	Not significant
Increase in night-time noise level at camp receptor	Adverse	Low	Local	Long-term	Continuous	Reversible short term	Low	Very likely	Not significant
Blasting noise perceptible at camp receptor	Adverse	Low	Local	Medium-term	Regular	Reversible short term	Low	Very likely	Not significant

Note: Criteria definitions are provided in Table 7-3.

7.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for noise follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. The following residual effects for the Project have been identified for noise and are considered through the CEA:

- Increase in daytime noise levels at camp receptor;
- Increase in night-time noise level at camp receptor; and
- Blasting noise perceptible at camp receptor.

7.5.1 Cumulative Effects Characterization

For past, present and future projects/activities to be considered all of the following conditions must be met:

1. There is information available to identify if the Project or activity results in a demonstrable or measurable effect on the VC;
2. The Project-specific residual effect on the VC overlaps in time with the effects from other projects or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on the VC overlaps spatially with the effects from other projects or activity (i.e., effects occur in the same area).

The potential cumulative effects for noise are identified through the screening in Table 7-12. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

Table 7-12: Cumulative Effects Screening for Noise

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Quartz Mining and Exploration				
Fyre Lake Property (*Pacific Ridge Exploration)*	No	N/A	N/A	No
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/ Veris Group*)	No	N/A	N/A	No

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	No	N/A	N/A	No
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	N/A	N/A	No
mYukon Base Metal Project *(Overland Resources Ltd.)*	No	N/A	N/A	No
Wolverine Mine (*Yukon Zinc Corp.)*	No	N/A	N/A	No
Roads, Access Roads and Trails				
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	N/A	N/A	No
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	N/A	N/A	No
Other Activities				
Single/Group Trapline Concessions	No	N/A	N/A	No
Outfitting Concessions	No	N/A	N/A	No
Campgrounds	No	N/A	N/A	No

Note: If "No" is indicated for a condition the remaining conditions are indicated as N/A (not applicable) as all conditions must be met for potential cumulative effect to be identified.

As indicated in the table above, no projects or activities have been identified to overlap with the Project's residual effects in type of effect, in time, and in space simultaneously. Therefore, no potential cumulative effects have been identified for noise. No further assessment is required.

7.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

The management plans for the Project are described further in Chapter 18. No noise specific monitoring has been proposed.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

8 SURFACE WATER QUALITY AND QUANTITY 8-1

8.1 ASSESSMENT APPROACH 8-1
8.1.1 Selection of Subcomponents and Measurable Parameters 8-2
8.1.2 Criteria for Assessing Significance 8-3
8.2 ASSESSMENT BOUNDARIES 8-5
8.3 EXISTING CONDITIONS 8-8
8.3.1 Surface Water Quantity 8-8
8.3.2 Surface Water Quality 8-12
8.4 PROJECT-SPECIFIC EFFECTS 8-20
8.4.1 Effects Characterization 8-21
8.4.2 Mitigation Measures 8-104
8.4.3 Residual Effects, Consequence and Significance Determination 8-108
8.5 CUMULATIVE EFFECTS 8-118
8.5.1 Cumulative Effects Characterization 8-118
8.6 EFFECTS MONITORING 8-120
8.6.1 Historic and Current Surface Water Monitoring Program 8-120
8.6.2 Surface Water Monitoring Program during Construction and Operations 8-121
8.6.3 Surface Water Monitoring at Closure 8-121
8.6.4 Geochemistry Field Barrels 8-122
8.6.5 Quality Assurance/Quality Control 8-122
8.6.6 Reporting 8-122

LIST OF TABLES

Table 8-1: Surface Water Quality and Quantity Subcomponents, – Measurable Parameters and Threshold Criteria 8-2
Table 8-2: Surface Water Significance Criteria Definition 8-4
Table 8-3: Study Areas for Surface Water Quality and Quantity 8-6
Table 8-4: Hydrological Statistics for Various Catchments within the Project Area 8-10
Table 8-5: Surface Water Quality and Hydrology Monitoring Locations 8-13
Table 8-6: Summary of Water Quality Guideline Exceedances at each Sampling Site 8-18
Table 8-7: Summary of Water Quality at Select Sampling Stations (mg/L) 8-19
Table 8-8: Interaction Matrix for Surface Water 8-21
Table 8-9: KZK Preliminary Water Quality Objectives Based on CCME and BCMoE Guidelines 8-25
Table 8-10: KZK Site Specific Water Quality Objectives 8-26
Table 8-11: Dewatering Rates for ABM Open Pit Overburden during Construction 8-55
Table 8-12: Percent Change in Discharge during 18-Month Construction Period for Mean Scenario 8-55

Table 8-13: Percent Change in Discharge during 18-Month Construction Period for 1/50 Wet Scenario....8-56
Table 8-14: Percent Change in Discharge during 18-Month Construction Period for 1/10 Dry Scenario....8-56
Table 8-15: Groundwater Wells and Average Dissolved Groundwater Quality Data used in Water Quality Model (mg/L) 8-60
Table 8-16: South Diversion and South Creek Flows 8-62
Table 8-17: Northwest and Northeast Diversion Flows....8-63
Table 8-18: South Diversion Monthly Median Concentrations of Select Parameters (mg/L) 8-65
Table 8-19: ABM Open Pit and Underground Working Pumping Rates during Operations (year 10)....8-68
Table 8-20: Percent Change in Discharge during Year 10 of Operations for Mean Scenario 8-69
Table 8-21: Percent Change in Discharge during Year 10 of Operations for 1/50 Wet Scenario 8-69
Table 8-22: Percent Change in Discharge during Year 10 of Operations for 1/10 Dry Scenario 8-69
Table 8-23: Anticipated Explosives Use and Estimated Waste Production by Year 8-70
Table 8-24: Annual Nitrogen Loading to Storage Facilities, Nitrogen Load Stored in Storage Facility at Year's end and Nitrogen Load Released 8-71
Table 8-25: Pond Design Specifications 8-73
Table 8-26: Estimated Median Class A Storage Facility Drainage Chemistry (mg/L)....8-74
Table 8-27: Estimated Median Class B Storage Facility Drainage Chemistry (mg/L) 8-74
Table 8-28: Estimated Median Class C Storage Facility Drainage Chemistry (mg/L) 8-78
Table 8-29: Overburden Stockpile Concentrations used in Model....8-78
Table 8-30: Lower Water Management Pond Discharge Volumes to Geona and Finlayson Creeks (year 10) (m^3) 8-79
Table 8-31: Average and Maximum Total Concentrations of Modelled Parameters in the Lower Water Management Pond throughout Operations in each of the Precipitation Scenarios 8-82
Table 8-32: Percent Change in Discharge from Baseline during Active and Transition Closure for Mean Scenario....8-88
Table 8-33: Percent Change in Discharge from Baseline during Active and Transition Closure for 1/50 Wet Scenario....8-88
Table 8-34: Percent Change in Discharge from Baseline during Active and Transition Closure* for 1/10 Dry Scenario 8-89
Table 8-35: ABM Lake Formation and Water Budget 8-91
Table 8-36: ABM Lake Water Quality Results 8-92
Table 8-37: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for Mean Scenario 8-95
Table 8-38: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for 1/50 Wet Scenario 8-95
Table 8-39: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for 1/10 Dry Scenario....8-99
Table 8-40: Reduction Factors used in Modelling for the North Constructed Wetland during Transition Phase....8-101
Table 8-41 Reduction Factors Used in Modelling for the South Constructed Wetland in Post-Closure Phase....8-102

Table 8-42 Reduction Factors Used in Modelling for the North Constructed Wetland in Post-Closure Phase 8-102
Table 8-43: Identified Potential Project Effects for Surface Water 8-104
Table 8-44: Proposed Mitigation Measures for Surface Water 8-105
Table 8-45: Project Effects Significance Assessment for Surface Water Quantity 8-112
Table 8-46: Project Effects Significance Assessment for Surface Water Quality 8-115
Table 8-47: Cumulative Effects Screening for Surface Water Quantity 8-119
Table 8-48: Cumulative Effects Screening for Surface Water Quality 8-119
Table 8-49: Kudz Ze Kayah Surface Water Quality Monitoring Program Summary 8-124

LIST OF FIGURES

Figure 8-1: Local and Regional Study Area for Surface Water 8-7
Figure 8-2: Surface Water Quality and Hydrometric Monitoring Catchments 8-9
Figure 8-3: Surface Water Quality and Hydrology Monitoring Locations 8-11
Figure 8-4: Mean Monthly Runoff Distribution Measured at Kudz Ze Kayah Versus the Regional Distribution Versus the Combined Distribution 8-12
Figure 8-5: Monitoring Locations at Geona Creek (KZ-9) and South Creek (KZ-13) 8-14
Figure 8-6: Monitoring Locations at Upper Finlayson Creek (KZ-15) and Lower Finlayson Creek (KZ-26) 8-15
Figure 8-7: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-37 in Geona Creek in the Mean Precipitation Scenario 8-30
Figure 8-8: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-37 in Geona Creek in the Mean Precipitation Scenario 8-31
Figure 8-9: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-37 in Geona Creek in the Mean Precipitation Scenario 8-32
Figure 8-10: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario 8-33
Figure 8-11: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario 8-34
Figure 8-12: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario 8-35
Figure 8-13: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario 8-36
Figure 8-14: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario 8-37
Figure 8-15: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario 8-38
Figure 8-16: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario 8-39
Figure 8-17: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario 8-40

Figure 8-18: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario 8-41
Figure 8-19: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario 8-42
Figure 8-20: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario 8-43
Figure 8-21: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario 8-44
Figure 8-22: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario 8-45
Figure 8-23: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario 8-46
Figure 8-24: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario 8-47
Figure 8-25: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-13 in South Creek in the Mean Precipitation Scenario 8-48
Figure 8-26: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-13 in South Creek in the Mean Precipitation Scenario 8-49
Figure 8-27: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-13 in South Creek in the Mean Precipitation Scenario 8-50
Figure 8-28: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-13 in South Creek in the 1/10 Dry Year Scenario 8-51
Figure 8-29: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-13 in South Creek in the 1/10 Dry Year Scenario 8-52
Figure 8-30: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-13 in South Creek in the 1/10 Dry Year Scenario 8-53
Figure 8-31: Modelled Baseline and Construction Phase Discharge Rates in Geona Creek (KZ-37) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-57
Figure 8-32: Modelled Baseline and Construction Phase Discharge Rates in Upper Finlayson Creek (KZ-15) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-58
Figure 8-33: Modelled Baseline and Construction Phase Discharge Rates in Lower Finlayson Creek (KZ-26) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-58
Figure 8-34: Modelled Baseline and Construction Phase Discharge Rates in South Creek (KZ-13) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-59
Figure 8-35: Groundwater Monitoring Wells in ABM Open Pit Vicinity 8-61
Figure 8-36: Construction Water Management Schematic 8-66
Figure 8-37: Operations Water Management Schematic 8-77
Figure 8-38: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the Mean Precipitation Scenario 8-83
Figure 8-39: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the 1/10 Dry Year Precipitation Scenario 8-84

Figure 8-40: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the 1/10 Wet Year Precipitation Scenario 8-85
Figure 8-41: ABM Lake Mass Transfer Flowpaths during Closure Phases 8-86
Figure 8-42: ABM lake Storage-Elevation and Area-Elevation Curves.....8-87
Figure 8-43: Active Closure Water Management Schematic.....8-96
Figure 8-44: Transition Closure Water Management Schematic.....8-97
Figure 8-45: Post-Closure Water Management Schematic 8-98
Figure 8-46: Modelled Post Closure and Baseline Discharge Rates in Geona Creek (at KZ-37) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios.....8-99
Figure 8-47: Modelled Post Closure and Baseline Discharge Rates in Upper Finlayson Creek (KZ-15) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-100
Figure 8-48: Modelled Post Closure and Baseline Discharge Rates in Lower Finlayson Creek (KZ-26) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios 8-100
Figure 8-49: Modelled Post Closure and Baseline Discharge Rates in South Creek (KZ-13) Under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios.....8-101
Figure 8-50: Existing and Proposed Surface Water Quality Monitoring Locations.....8-125
Figure 8-51: Existing and Proposed Surface Water Quality Monitoring Locations within Mine Site 8-126

8 SURFACE WATER QUALITY AND QUANTITY

This chapter provides an overview of the existing surface water conditions in the Project area (Section 8.3) and an assessment of the Project's potential effects on both quality and quantity of surface water (Section 8.4). Preceding these, for those wanting insight into the methodology, is a detailed description of the approach used for the surface water effects assessment (Section 8.1).

Surface water quality and quantity was identified and selected as a Valued Component (VC) for two reasons. Firstly, surface water is essential to maintain aquatic and biophysical environments, and secondly, surface water quality is of high value to Yukon residents, including the Kaska First Nation (Kaska) as represented by Ross River Dena Council (RRDC) and Liard First Nation (LFN).

Discussions with local Kaska citizens indicated that surface water at Fault Creek is used as a drinking source and that headwater streams, including Geona Creek, hold an important value within their Traditional Territory (Chapter 2). Headwater values are documented in the Kaska Dena Management Practices: Kaska Dena Land Use Framework as follows:

> *Headwater and source watersheds are important to maintain water quality and support the flow, storage, and hydrology of the adjacent watersheds. In addition, these watersheds tend to have a higher density of Kaska sites, hunting areas, traditional uses, and Kaska values. The watersheds also generally have high ecological values (Dena Kayeh Institute, 2010).*

8.1 ASSESSMENT APPROACH

The effects assessment methods as outlined in Chapter 5, follow standard Effects Assessment (EA) guidance and address the requirements set out under the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) which is consistent with the guidance document outlined by the Yukon Environmental and Socio-Economic Board (YESAB, 2005a).

As a key VC within the Project, the surface water quality and quantity effects assessment defines the scope and boundaries of this VC, and describes existing surface water conditions to provide a benchmark for evaluation. Project activities are screened to identify potential Project-VC interactions and to focus the detailed effects assessment. Mitigation measures are proposed to eliminate, reduce, or manage the potential effect on the VC and if the effect remains after application of the mitigation measures, the effect is considered residual and is characterized using effects criteria. Traditional knowledge integration is an important part of the VC assessment to inform findings throughout each stage.

A water quality prediction model and water balance (Appendices D-7 and D-8) were used to predict water quality and quantity based on the anticipated sources associated with the Project during the construction, operations, and closure phases. Additional information used to support the surface water EA includes the Project-specific effects outlined in Section 9.4 for groundwater quantity and quality, and Section 10.4 for aquatic resources and ecosystems.

Desk-based research was conducted to identify Kaska knowledge, uses, interests, and values related to surface water (Appendix F-3); however, limited information was available from public secondary

sources. Traditional Knowledge (TK) data collection efforts as well as consultation and engagement activities with RRDC have helped provide additional information and understanding of the importance of water quality and quantity in the Project area.

8.1.1 Selection of Subcomponents and Measurable Parameters

The surface water subcomponents and measurable parameters are provided in Table 8-1. Surface water was considered as two subcomponents comprising:

- Surface water quantity; and
- Surface water quality.

The surface water quantity has been selected as a subcomponent as it determines the type and amount of aquatic habitat available in the waterbodies. Change in surface water quantity (i.e., change in volumetric stream flow) has been selected as the measurable parameter for surface water quantity subcomponent as changes in flow may alter quantity and quality of aquatic habitat.

The surface water quality subcomponent refers to the chemical composition of the surface water in the regional study area (RSA; defined in Section 8.2). Changes to surface water quality can affect aquatic life and wildlife. The measurable parameters for surface water quality have been defined as the constituents of potential interest (COPIs), which were selected based on their presence at elevated concentrations under baseline conditions at some receiving environment locations (Appendix D-1), their tendency to leach at elevated concentrations from site materials in laboratory and field testwork (Appendix D-5), and their association with either local mineralization or reagents used as part of the Project.

Table 8-1: Surface Water Quality and Quantity Subcomponents, – Measurable Parameters and Threshold Criteria

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Surface Water	Surface Water Quantity	Change in volumetric stream flow from baseline conditions.	Low = 0-10%; Moderate = 10-20%; High = greater than 20%.	No substantial alteration of surface water quantity within RSA to protect quantity and quality of aquatic habitat.

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
	Surface Water Quality	Total aluminum, arsenic, antimony, cadmium, copper, iron, nickel, lead, manganese, phosphorus, selenium, silver, uranium and zinc. Cyanide (total and weak acid dissociable (WAD)), sulfate, chloride, fluoride, ammonia-N (NH_3-N), nitrate-N (NO_3-N) and nitrite-N (NO_2-N) at stations KZ-15 and KZ-26 in Finlayson Creek, KZ-9 in Geona Creek and KZ-13 in South Creek.	Modelled results in comparison with the parameter specific preliminary water quality objectives (pWQO). Low = results less than pWQO. Moderate = results greater than pWQO but less than 10 times pWQO. High = results greater than 10 times pWQO.	Changes in water quality may result in potential effect to aquatic life due to changes in stream water quality for the Project area. pWQO have been (in part) developed using Canadian Council of Ministers of the Environment (CCME) (CCME, 2016) and British Columbia Ministry of Environment (BCMoE) (BCMoE, 2016) guidelines for protection of aquatic life. Additional site specific water quality objectives (SSWQO) have been developed (Appendix D-8) for selenium at all receiving environment sites, and for aluminum, iron, fluoride, copper, cadmium, and zinc at those sites where the baseline 95th percentile concentrations exceeded the pWQO, necessitating a SSWQO.

8.1.2 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and
- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, in addition to the above criteria is likelihood determination. The likelihood determination provides additional context to the assessment of identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for surface water are presented in Table 8-2.

Table 8-2: Surface Water Significance Criteria Definition

Criteria	Definition	
Direction	Adverse	VC would change for the worse
	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
Magnitude	Low	***Surface water quantity*** A detectable effect that is a measurable change of less than 10% from existing mean conditions, and the change is within the range of natural variation ***Surface water quality*** A detectable effect for a measurable parameter that is a change from existing conditions, and the parameter is within the range of natural variation and/or below the pWQO
	Moderate	***Surface water quantity*** An effect differing from the natural variation where it comprises a change of between 10% and 20% from the mean value for existing conditions ***Surface water quality*** An l effect where predicted concentrations are above the pWQO and are less than ten times the pWQO
	High	***Surface water quantity*** An effect that is greater than a 20% change from the mean value for existing conditions ***Surface water quality*** An effect where predicted concentrations are greater than ten times the pWQO
Geographic Extent	Site	Effects are restricted to the stream within the Project activity area (i.e., Upper Geona Creek and Fault Creek)
	Local	Effects extend beyond the Project activity area but remain within the assessment area (i.e., Lower Geona Creek, upper Finlayson Creek and South Creek)
	Regional	Effects extend beyond the assessment area (i.e., Lower Finlayson Creek, and North River)
	Beyond Regional	Effects extend to watershed/regional level (i.e., Liard River)
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and active closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)

Criteria	Definition	
	Long term	Effect lasting through any two concurrent Project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any year of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

Ratings for the magnitude of surface water quality effect were defined based on the preliminary water quality objectives for the Project (Section 8.4.1.1 and Appendix D-8) that were developed mainly from CCME and BC MoE water quality guidelines for protection of aquatic life. These guidelines were developed from extensive research and incorporate factors of safety in the order of 10 to 100.

Ratings for direction, geographic extent, duration, frequency, reversibility, and environmental and socio-economic context were based on standardized significance rating criteria for the Project.

Based on the significance criteria summarized in Table 8-2, a water quality or quantity effect is considered significant if it meets all three of the following criteria:

- The effect is of regional extent;
- The effect is of high magnitude; and
- The effect occurs over the long-term.

8.2 ASSESSMENT BOUNDARIES

The local and regional study areas for surface water quality and quantity are described in Table 8-3 and shown in Figure 8-1 and Figure 8-2.

The local study area (LSA) is defined as the Geona Creek catchment, including the footprint of the proposed mine infrastructure, and Geona Creek downstream to the confluence with Finlayson Creek (KZ-15). These areas are where surface water quantity and/or quality may be affected by the Project activities including the final effluent discharge locations.

The regional study area (RSA) is defined as the LSA (Geona Creek) and the Finlayson Creek catchment downstream of the LSA to the Robert Campbell Highway (KZ-26), and includes South Creek at monitoring location KZ-13 (due to the planned diversion of Fault Creek (KZ-2) into the South Creek catchment). This definition is based on the surface water quality and quantity for the Project area and the location of the discharge points (Geona Creek at KZ-9 and Finlayson Creek at KZ-15).

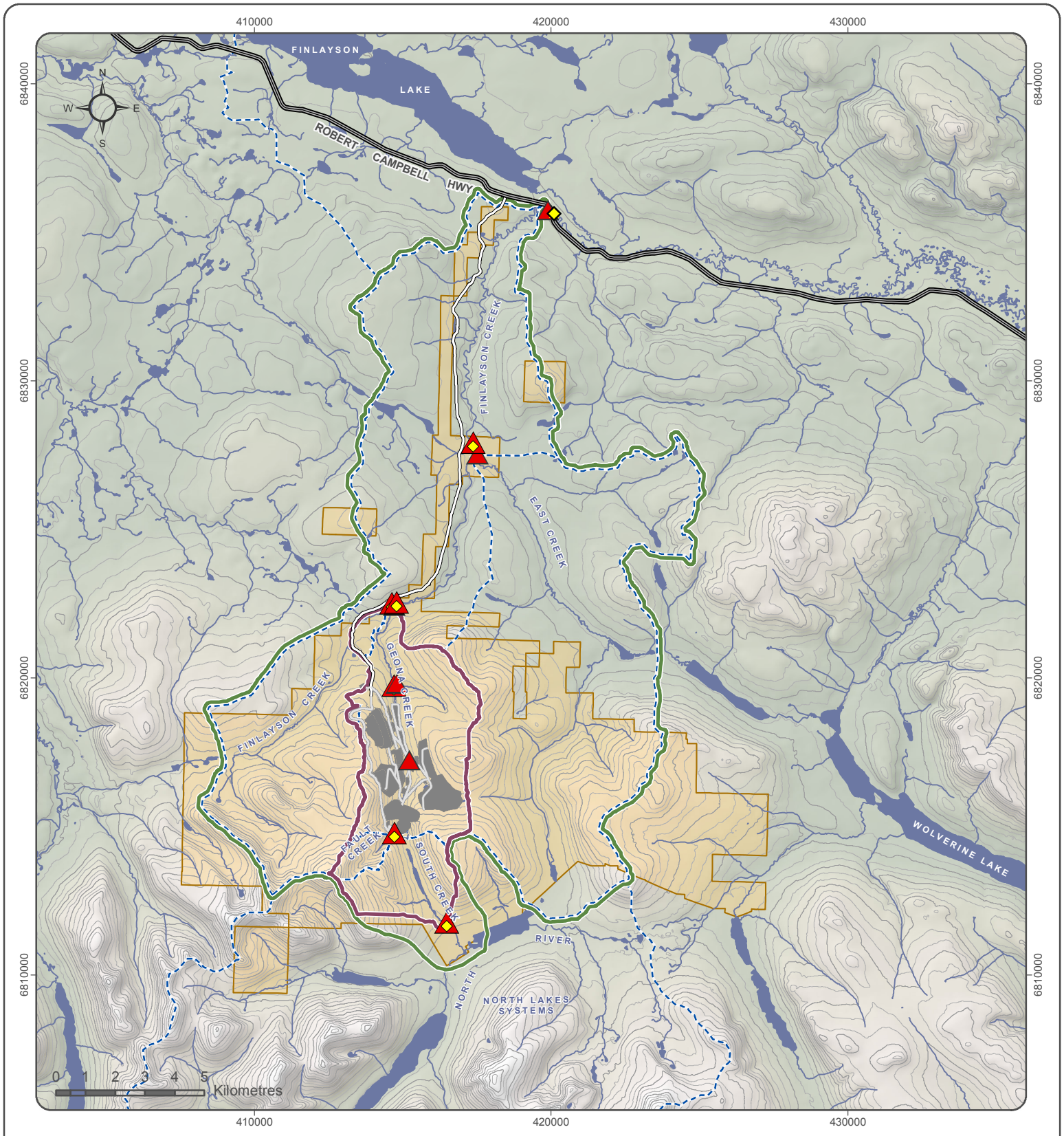
Based on the predicted changes to surface water quality and quantity, assessment of potential effects of the Project on surface water will be restricted to the LSA and RSA, as defined here.

Table 8-3: Study Areas for Surface Water Quality and Quantity

Study Area	Surface Water Specific Study Area Description
Local Study Area	Geona Creek (KZ-37), South Creek (KZ-13), and upper Finlayson Creek (KZ-15)
Regional Study Area	Lower Finlayson Creek (KZ-26), and North River

Temporal boundaries are defined to include all Project phases within which effects are expected to occur. The Project phases considered in the surface water EA include the following:

- **Construction Phase**: will last approximately two years and includes site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground development and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as closure phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required; the phase is split into two periods: transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.



- Hydrometric Station
- Water Quality and Hydrometric Station
- Water Quality Sampling Location
- Local Srudy Area for Surface Water
- Regoinal Study Area for Surface Water
- Location of Proposed Mine Infrastructure
- Drainages/Catchments
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road

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FIGURE 8-1

LOCAL AND REGIONAL STUDY AREA FOR SURFACE WATER

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8.3 EXISTING CONDITIONS

This section presents a summary description of existing environmental conditions as they relate to the surface water quantity and quality. This characterization of the existing environment serves as the baseline against which the potential effects of the Project are assessed. The description of the existing environment has focused on those components of the environment that may be affected by the Project.

The description of the existing environment presents a compilation and review of existing historical information and the results of the field programs (2015-2016). The following sections provide the summary descriptions of the field programs, with further details provided in the Surface Water Quality Baseline Report and Hydrometeorology Baseline Report, included as Appendices D-1 and D-2, respectively.

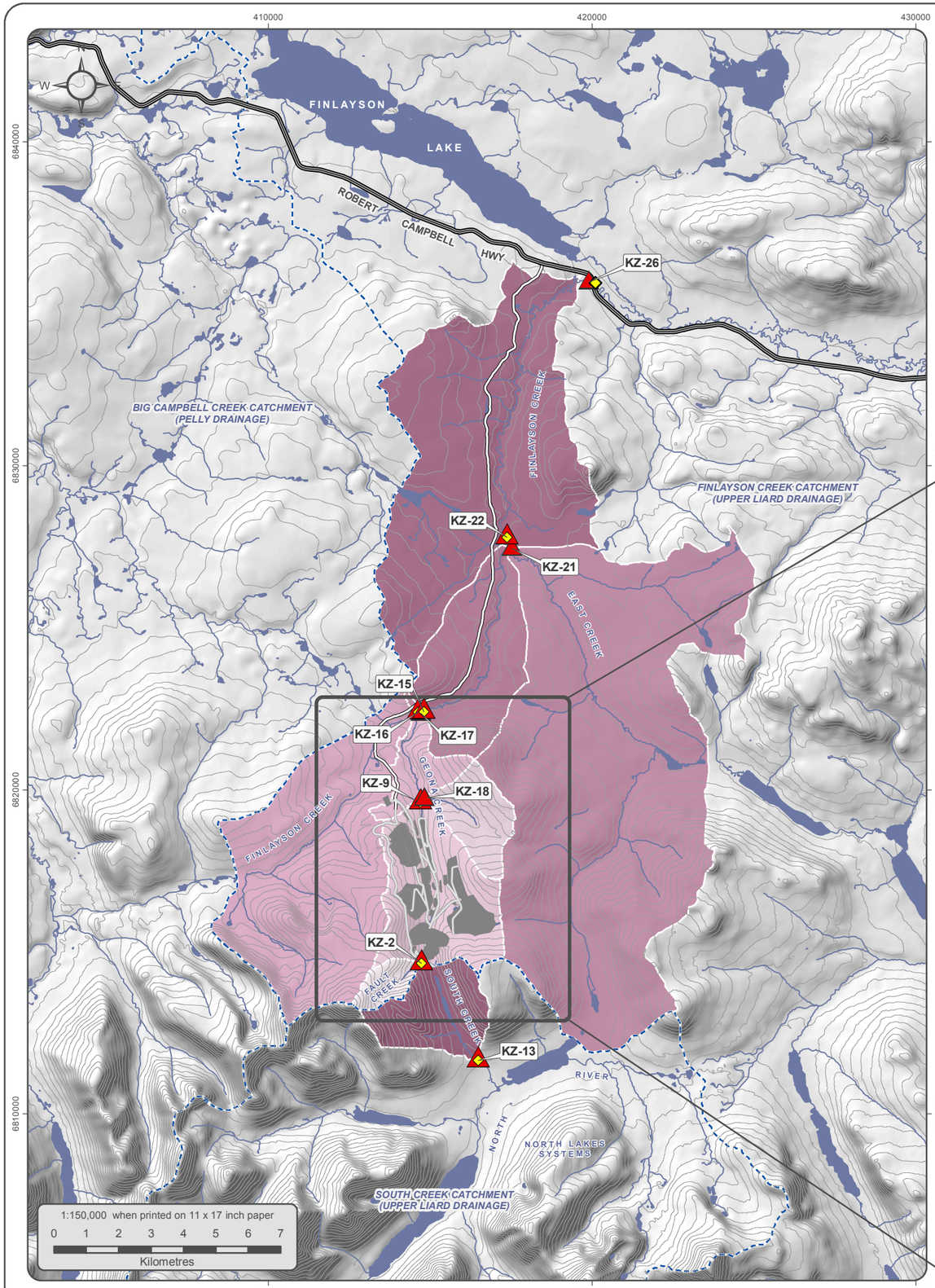
8.3.1 Surface Water Quantity

The Project lies in a small (approximately) 26 km^2 watershed called Geona Creek, which is a north flowing tributary of Finlayson Creek. Finlayson Creek meets the outflow of Finlayson Lake north of the Robert Campbell Highway and flows east to eventually join the Frances River, and ultimately, the Mackenzie River. One of the highest elevation tributaries within Geona Creek is Fault Creek, which has a median elevation of 1,708 metres above sea level (masl) and an area of approximately 2 km^2. Fault Creek is characterized by steep slopes and small trees and shrubs in the creek valley, but otherwise is an alpine environment. Geona Creek has a median elevation of 1,497 masl and spans from the alpine to sparsely forested areas at lower elevations. The Finlayson Creek catchment area is approximately 35 km^2 above the confluence with Geona Creek, and grows to 211 km^2 where it flows under the Robert Campbell Highway shortly before it joins the outflow of Finlayson Lake. The watershed divide of Geona Creek is characterized by several small lakes. The local catchment areas in the vicinity of the Project are shown in Figure 8-2.

CATCHMENT INFORMATION

Station	Location	Area (sq. m)
KZ-26	Finlayson Creek at Robert Campbell Highway	210,834,202
KZ-13	South Creek near mouth	7,917,319
KZ-22	Finlayson Creek 100 m downstream East Creek	162,485,967
KZ-21	East Creek at mouth	83,842,250
KZ-15	Finlayson Creek 100 m downstream confluence with Geona Creek	60,905,680
KZ-16	Finlayson Creek upstream confluence with Geona Creek	35,022,286
KZ-17	Geona Creek at mouth	25,714,949
KZ-18	East Tributaty to Geona Creek	5,309,542
KZ-9	Lower Geona Creek	16,465,305
KZ-2	Fault Creek	1,925,859

KZ-26 KZ-22 KZ-15 KZ-17 KZ-2
KZ-13 KZ-21 KZ-16 KZ-9 KZ-18



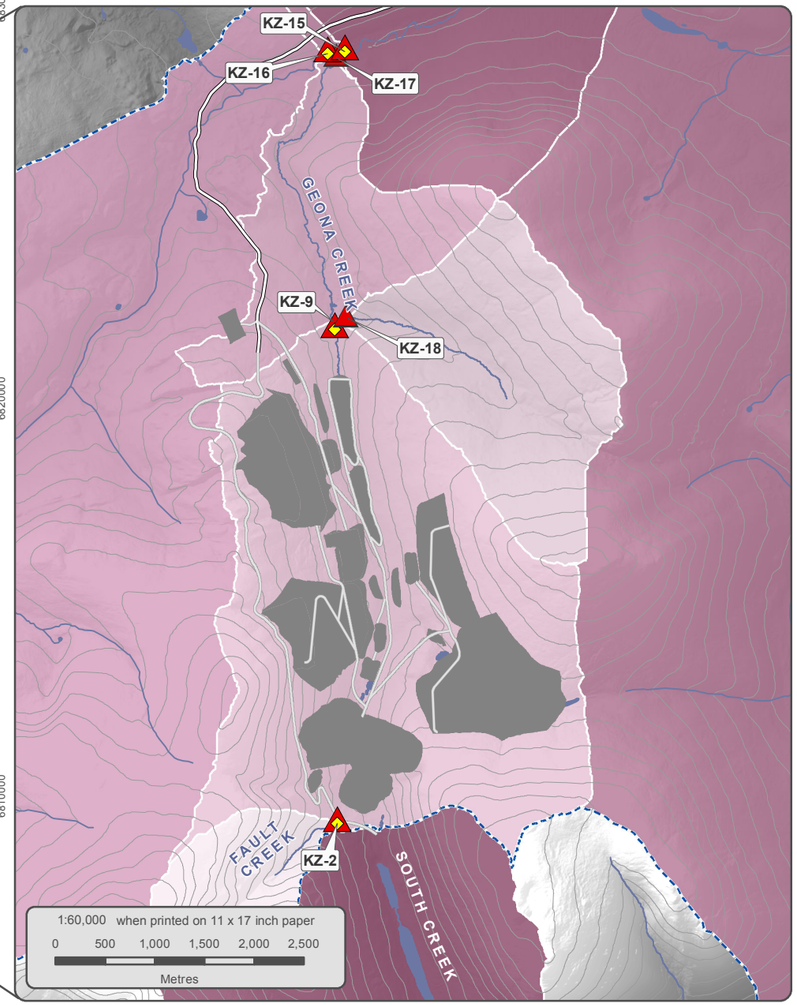


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FIGURE 8-2

SURFACE WATER QUALITY AND HYDROMETRIC MONITORING CATCHMENTS

JANUARY 2017

- Hydrometric Station
- Water Quality and Hydrometric Station
- Water Quality Sampling Location
- Location of Proposed Mine Infrastructure
- Major Drainages
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse
- Waterbody

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Catchments delineated using ArcGIS Spatial Analyst Watershed Tools, using 2014 LiDAR data and/or 2005 orthorectified aerial imagery and/or 16m DEM data obtained from geogratis.gc.ca, depending on extent.

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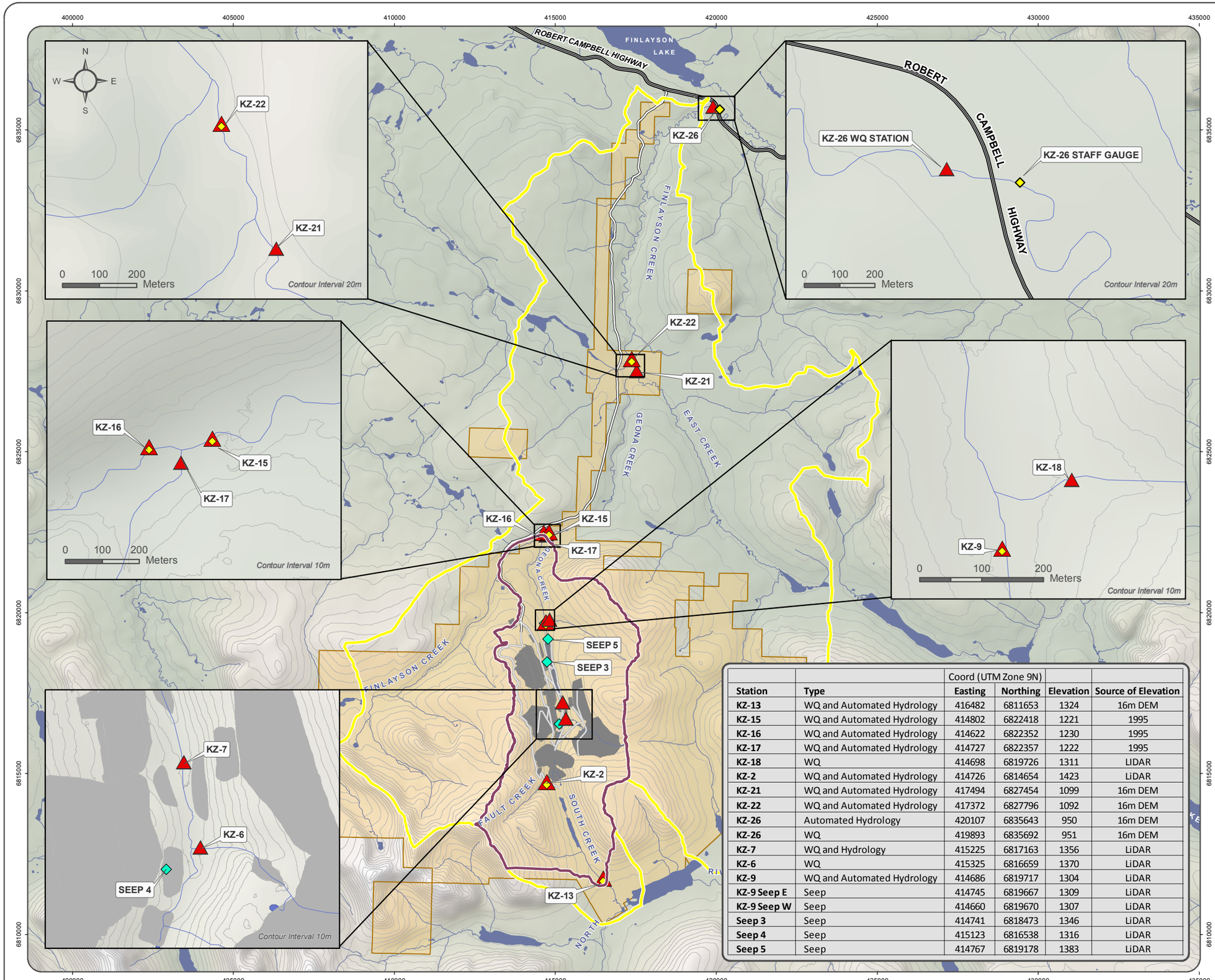
Previous local hydrometric data collection occurred in 1995 as part of the Initial Environmental Evaluation and Water Use Licencing processes and was re-initiated in May 2015. The current monitoring network included seven continuous monitoring stations (Figure 8-3). These data are presented in the 2015 Hydrometeorology Baseline Report (Appendix D-2) and considered alongside regional analyses to provide estimates of various hydrometric parameters. Table 8-4 provides estimates for various hydrological parameters at South Creek (KZ-13), Fault Creek (KZ-2), Geona Creek below the project infrastructure (KZ-9), Geona Creek below the confluence with the tributary below KZ-9 (KZ-37), Geona Creek above the confluence (KZ-17), Finlayson Creek below the confluence with Geona Creek (KZ-15), and Finlayson Creek at the Robert Campbell Highway (KZ-26).

Table 8-4: Hydrological Statistics for Various Catchments within the Project Area

	Site/Catchment						
	KZ-13	***KZ-2***	***KZ-9***	***KZ-37***	***KZ-17***	***KZ-15***	***KZ-26***
Catchment Area (km^2)	7.92	1.93	16.5	21.8	25.7	60.9	211
Mean annual runoff (mm)	425	610	388	388	373	386	249
Mean annual flow (m^3/s)	0.107	0.037	0.202	0.268	0.304	0.745	1.664
Mean summer flow (m^3/s)	0.179	0.063	0.340	0.450	0.511	1.252	2.796
Mean annual low flow (monthly) (m^3/s)	0.022	0.008	0.041	0.054	0.061	0.150	0.335
Mean annual low flow (daily) (m^3/s)	0.013	0.003	0.028	0.037	0.044	0.104	0.358
Mean summer low flow (monthly) (m^3/s)	0.161	0.056	0.306	0.404	0.459	1.126	2.514
Mean summer low flow (daily) (m^3/s)	0.086	0.029	0.161	0.213	0.241	0.594	0.997
Mean annual flood (daily) (m^3/s)	0.526	0.339	1.063	1.406	1.63	3.731	12.288
Mean summer flood (daily) (m^3/s)	0.52	0.367	1.004	1.328	1.496	3.244	9.879

Mean monthly flows are estimated by multiplying the monthly percent of annual runoff distribution adopted in the Hydrometeorology Baseline Report by the estimated mean annual runoff (MAR), while the mean annual daily low flow is estimated based on the regional analysis, which gives a value of 1.7 $L/s/km^2$ (Appendix D-2).

Peak flows typically occur in May due to snowmelt or in summer months in years when snowmelt generated peak flows are less significant and large summer rainstorms occur. Low flows occur in late winter in March, April, or early May depending on the melt cycles and snowpack in any given year. None of the creeks were observed to freeze completely and some flow was observed in all months of the 2015-2016 monitoring program.



Station	Type	Coord (UTM Zone 9N) Easting	Northing	Elevation	Source of Elevation
KZ-13	WQ and Automated Hydrology	416482	6811653	1324	16m DEM
KZ-15	WQ and Automated Hydrology	414802	6822418	1221	1995
KZ-16	WQ and Automated Hydrology	414622	6822352	1230	1995
KZ-17	WQ and Automated Hydrology	414727	6822357	1222	1995
KZ-18	WQ	414698	6819726	1311	LIDAR
KZ-2	WQ and Automated Hydrology	414726	6814654	1423	LiDAR
KZ-21	WQ and Automated Hydrology	417494	6827454	1099	16m DEM
KZ-22	WQ and Automated Hydrology	417372	6827796	1092	16m DEM
KZ-26	Automated Hydrology	420107	6835643	950	16m DEM
KZ-26	WQ	419893	6835692	951	16m DEM
KZ-7	WQ and Hydrology	415225	6817163	1356	LiDAR
KZ-6	WQ	415325	6816659	1370	LiDAR
KZ-9	WQ and Automated Hydrology	414686	6819717	1304	LiDAR
KZ-9 Seep E	Seep	414745	6819667	1309	LiDAR
KZ-9 Seep W	Seep	414660	6819670	1307	LiDAR
Seep 3	Seep	414741	6818473	1346	LiDAR
Seep 4	Seep	415123	6816538	1316	LiDAR
Seep 5	Seep	414767	6819178	1383	LiDAR

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FIGURE 8-3

SURFACE WATER QUALITY AND HYDROLOGY MONITORING LOCATIONS

FEBRUARY 2017

- Hydrometric Station
- Water Quality and Hydrometric Station
- Water Quality Sampling Location
- Seep
- Local Study Area
- Regional Study Area
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse
- Waterbody
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

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Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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The mean hydrograph observed in 2015-2016 was combined with the regional hydrograph to predict mean monthly discharge in the regional analysis (Figure 8-4). Smaller catchments tend to peak earlier than large regional rivers and higher flows in September are likely driven by precipitation, which has a greater relative effect in small creeks than larger rivers as the large regional sites tend to dampen the effect of more localized rain events. The two distributions were combined to capture the long term regional trend while maintaining some of the typical behaviour of smaller streams.

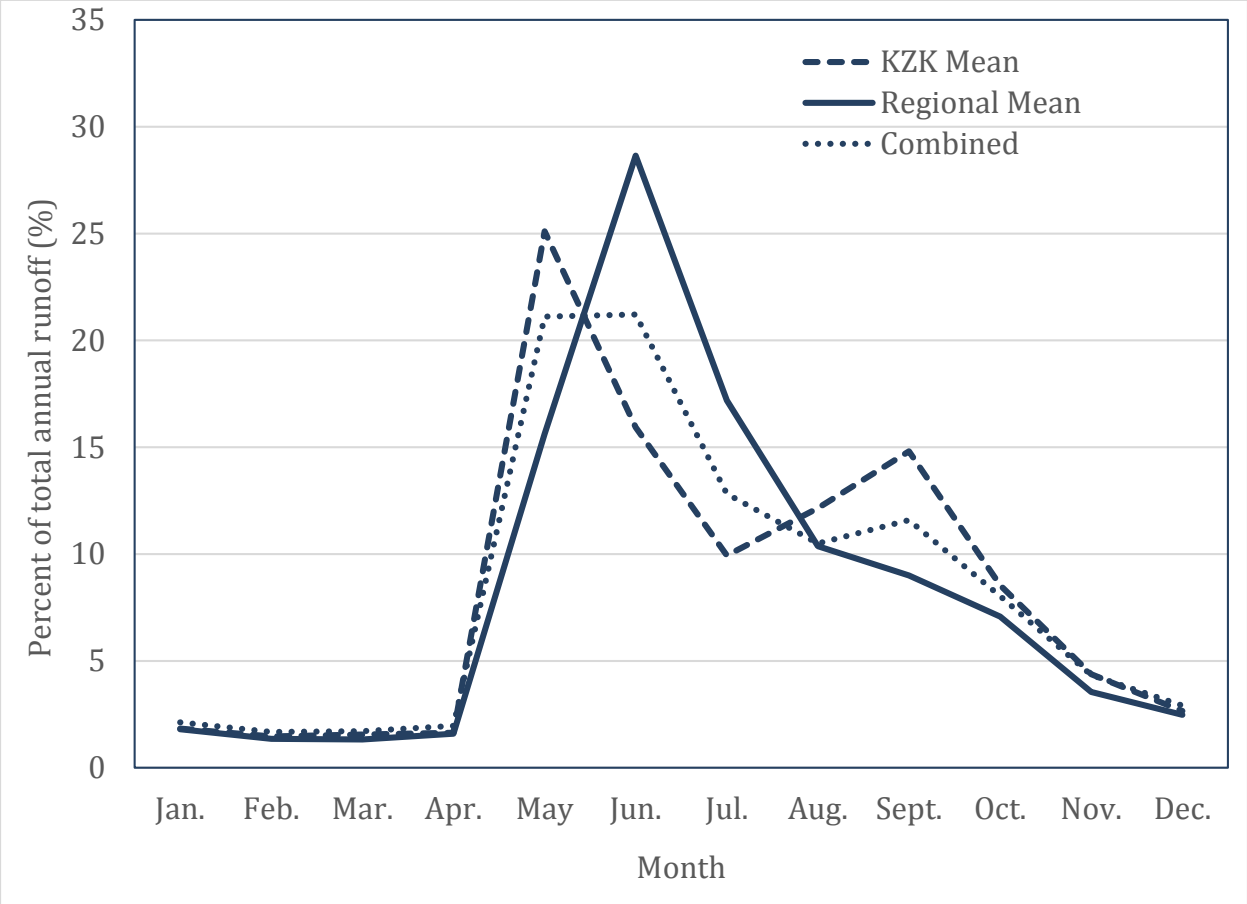


Figure 8-4: Mean Monthly Runoff Distribution Measured at Kudz Ze Kayah Versus the Regional Distribution Versus the Combined Distribution

8.3.2 Surface Water Quality

Baseline studies for surface water quality were undertaken in 1994 and 1995 under the previous property ownership, followed by biennial water quality monitoring conducted as part of Water Licence QZ97-026-01 between 2002 and 2014. The surface water quality monitoring program was re-evaluated and re-initiated in April 2015, comprising 12 stations sampled on a monthly basis (Table 8-5 and Figure 8-3). Artesian seeps were also sampled to evaluate their effect on stream water chemistry (Table 8-5). Photos of monitoring locations at Geona Creek (KZ-9), Finlayson Creek (KZ-15 and KZ-26), and South Creek (KZ-13) have been presented in Figure 8-5 and Figure 8-6. A summary of median annual water quality at select stations is presented in Table 8-7.

Table 8-5: Surface Water Quality and Hydrology Monitoring Locations

Station	Description
KZ-26	Finlayson Creek at Robert Campbell Highway
KZ-22	Finlayson Creek 100 m downstream of East Creek
KZ-21	East Creek at mouth
KZ-16	Finlayson Creek immediately upstream of confluence with Geona Creek
KZ-15	Finlayson Creek 100 m downstream of confluence with Geona Creek
KZ-17	Geona Creek at mouth. Site currently flooded due to beaver dam constructed since 2008. A new sampling station will be re-established as close as possible to the original KZ-17 site
KZ-6	Tributary of Geona Creek where proposed Class C Storage Facility will be located
KZ-7	Upper Geona Creek near ABM open pit
KZ-9	Geona Creek downstream of Lower Water Management Pond discharge location
KZ-18	East tributary to Geona Creek
KZ-2	Fault Creek
KZ-13	South Creek near mouth
Seeps	
KZ-9 Seep East	Seep approximately 50 m east of Geona Creek at KZ-9
KZ-9 Seep West	Seep approximately 50 m west of Geona Creek at KZ-9
Seep 3	20 m wide seep located on west side of Geona Creek downstream of KZ-7
Seep 4	Wide seep network located on west side of Geona Creek upstream of KZ-7
Seep 5	Seep coming inside side channel of Geona Creek upstream of KZ-9

Surface water samples were analyzed for general chemical parameters, as well as total and dissolved metals, and nutrients in accordance with "Standard Methods for Examination of Water and Wastewater" (Rice et al., 2012) and AEG Protocols. The method detection limits were typically an order of magnitude or more below CCME (CCME, 2016) or BCMoE (BCMoE, 2016) water quality guidelines. A detailed discussion of the baseline surface water quality is contained in the Surface Water Quality Baseline Report (Appendix D-1). Water quality was compared against the most recently revised water quality guidelines for protection of aquatic life established by the CCME (CCME, 2016) or BCMoE (BCMoE, 2016). If guidelines presented by the CCME and BCMoE differed for a given constituent, the most recent of the two was used as the derivation of this guideline reflects the most recent science.

KZ-9 looking downstream, July 2015

KZ-9 looking upstream, March 2016

KZ-13 looking downstream, July 2015

KZ-13 looking downstream, February 2016

Figure 8-5: Monitoring Locations at Geona Creek (KZ-9) and South Creek (KZ-13)

KZ-15 looking upstream, July 2015

Photo 35: KZ-15 looking downstream, March 2016

Photo 36: KZ-26 looking upstream from Robert Campbell Highway, July 2015

KZ-26 looking downstream approximately 200 metres upstream of Robert Campbell Highway, February 2016

Figure 8-6: Monitoring Locations at Upper Finlayson Creek (KZ-15) and Lower Finlayson Creek (KZ-26)

8.3.2.1 General Chemistry

Creeks that drain the Project area were circumneutral to alkaline (pH 6.8 to 8.7; median 7.8) and had hardness ranging from moderately hard (Fault Creek and South Creek) to hard (Geona Creek) in the upper watershed, and very hard in the lower watershed (Finlayson Creek and East Creek). The KZ-9 East Seep had lower pH (pH 5.8 to 6.0), which likely contributes to the slightly lower pH observed at the nearby KZ-9 (median pH 7.5) station on Geona Creek compared to sites KZ-6 (median pH 8.1) and KZ-7 (median pH 7.8) located farther upstream. The other seeps had a more circumneutral pH.

East Creek had the highest median conductivity (471 µS/cm) in the Project area, whereas South Creek had the lowest median conductivity (152 µS/cm). Similar to conductivity, hardness was lowest in South Creek (median 69 mg/L), and highest in East Creek (median 257 mg/L). Hardness in Finlayson Creek increased progressively downstream due to contributions from the harder waters of Geona Creek, East Creek, and likely other tributaries.

8.3.2.2 Nutrients and Anions

Dissolved organic carbon (DOC) ranged from <0.5 mg/L to 17.2 mg/L. Similar to hardness, DOC concentrations in Finlayson Creek increased downstream due to contributions from Geona and East Creek; the latter had the highest median DOC level (5.6 mg/L) of all monitoring sites. DOC concentrations peaked during freshet as snowmelt rinsed surrounding organic soils and flushed organic carbon into the streams.

At all surface water stations, nitrogen species (nitrate, nitrite, cyanide, ammonia) were all typically below or marginally above the detection limit, with the exception of nitrate-N, which ranged from median concentrations of <0.02 mg/L in East Creek to 0.12 mg/L in Fault Creek. Nitrate concentrations were highest over winter due to the limited primary productivity over these months, which would otherwise limit dissolved nitrate levels. No nitrate-N concentrations exceeded the CCME threshold of 3 mg/L.

Fluoride commonly exceeded the CCME guideline (0.12 mg/L) in East Creek with a median fluoride concentration of 0.17 mg/L, suggesting that East Creek drains an area of fluoride-bearing rocks. Fluoride concentrations in Finlayson Creek increased downstream with the input of high fluoride waters from East Creek. All seeps had relatively low fluoride levels (0.032 mg/L to 0.17 mg/L) except for KZ-9 East Seep (0.86 mg/L to 0.97 mg/L), which had higher fluoride concentrations than any of the creek monitoring stations. Only one fluoride exceedance was measured in Geona Creek (0.14 mg/L) and no exceedances occurred in South Creek or Fault Creek.

Total phosphorus exceeded the CCME eutrophic guideline of 0.035 mg/L in at least one sample at many of the stations. These peaks typically occurred during freshet and were accompanied by high concentrations of total suspended solids (TSS) and total iron. Due to the affinity phosphorous has for iron oxyhydroxides, it was likely that phosphorus was associated with iron particulates and mobilized during freshet or precipitation events that caused high TSS. Dissolved phosphorous was often below detection.

8.3.2.3 Metals

Water quality guideline exceedances were observed sporadically for a number of constituents (Table 8-6) in the baseline study of current site conditions including total concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, lead, selenium, and zinc occurring naturally above their respective guidelines. The majority of these exceedances coincided with freshet, when TSS concentrations were highest and metal(loid)s were largely transported as particulates.

Total metal(loid) concentrations were observed to be greater downstream in Geona Creek from KZ-6 to KZ-9 with water quality guideline exceedances of total aluminum, arsenic, cadmium, chromium, copper, lead, selenium, and zinc. These exceedances were largely associated with freshet or high precipitation sampling events, consistent with the observation of far fewer exceedances of the dissolved component of these elements. Total concentrations of cadmium and zinc were highest in the headwaters of Geona Creek at site KZ-7, and in Fault Creek (KZ-2), which flows into Geona Creek, likely related to the mineralized nature of this location. Indeed, concentrations of these elements linked to the local mineralization were elevated in the upper watershed (primarily Geona Creek) relative to the lower watershed waters (Finlayson Creek). Monitoring of seeps in the upper watershed indicated they may play a small role in slightly lowering the pH and raising the total iron content of waters in Geona Creek at KZ-9, due to inputs from the mildly acidic, ferruginous waters of the KZ-9 East Seep.

Fault Creek, which flows into the headwaters of Geona Creek, exhibited sporadic CCME water quality guideline exceedances for total chromium, copper, selenium, and zinc, as well as frequent exceedances for cadmium. The chromium, copper, and zinc exceedances were associated with high levels of particulates; however, dissolved cadmium comprised the majority of total cadmium and higher concentrations of selenium were measured in the winter when TSS and total concentrations of other metals were lower.

Sporadic water quality guideline exceedances for total aluminum, zinc, and chromium were observed in Finlayson Creek waters upstream of Geona Creek (KZ-16) and generally occurred during spring freshet. More elements (total aluminum, copper, iron, cadmium, zinc, and chromium) exhibited at least one water quality guideline exceedance in Finlayson Creek immediately downstream of the confluence with Geona Creek (KZ-15). These largely occurred during freshet and comparison with their dissolved counterpart concentrations indicated the total metal exceedances were primarily particulate related. Further downstream, site KZ-22 on Finlayson Creek displayed occasional water quality guideline exceedances for total aluminum, arsenic, cadmium, and iron, which were all dominated by a particulate component and typically occurred during high flow conditions of spring freshet. At the mouth of Finlayson Creek (KZ-26), sporadic water quality guideline exceedances were noted for total zinc and chromium, with more regular excursions observed for total aluminum. All of the aluminum exceedances occurred during periods of high flow (spring freshet or following rainstorm events) and were dominated by particle-associated aluminum as indicated by the much lower dissolved aluminum content.

Table 8-6: Summary of Water Quality Guideline Exceedances at each Sampling Site

Watercourse	Monitoring Site	Number of Samples [a]	Percentage of Samples with Water Quality Guideline Exceedances [b]
South Creek	KZ-13	28 to 30	Total P (n=2; 7%), Al (n=5; 17%), As (n=1; 3%), Cd (n=1; 4%), Cr (n=7; 24%), Cu (n=4; 14%), Fe (n=2; 7%), Pb (n=1; 4%), Zn (n=3; 10%)
Geona Creek	KZ-7	28 to 36	Total P (n=1; 4%), Al (n=2; 6%), Cd (n=10; 30%), Cr (n=4; 12%), Cu (n=3; 9%), Fe (n=2; 9%), Zn (n=13; 36%)
	KZ-9	25 to 32	Total P (n=1; 4%), Al (n=3; 9%), Cd (n=2; 7%), Cr (n=2; 7%), Cu (n=2; 6%), Fe (n=5; 16%), Pb (n=1; 3%), Se (n=1; 3%), Zn (n=2; 6%)
	KZ-17	20 to 28	F (n=1; 5%), NH3 (n=1; 3%), Total P (n=1; 4%), Al (n=1; 4%), As (n=1; 4%), Cd (n=2; 7%), Cr (n=3; 11%), Cu (n=1; 4%), Fe (n=1; 4%), Zn (n=1; 4%)
Unnamed Tributary to Geona Creek	KZ-6	16 to 17	Total Al (n=1; 6%), Cr (n=1; 6%), Cu (n=1; 6%), Zn (n=1; 6%)
Unnamed Tributary to Geona Creek	KZ-18	7	Total P (n=2; 29%), Cr (n=1; 14%)
Fault Creek	KZ-2	25 to 27	Total Al (n=1; 4%), Cd (n=20; 80%), Cr (n=1; 4%), Cu (n=3; 11%), Se (n=6; 22%), Zn (n=19; 70%)
Finlayson Creek	KZ-16	36 to 37	Total Al (n=1; 3%), Cr (n=4; 11%), Zn (n=1; 3%)
	KZ-15	31 to 37	Total P (n=1; 3%), Al (n=1; 3%), Cd (n=2; 6%), Cr (n=3; 8%), Cu (n=1; 3%), Fe (n=1; 3%), Zn (n=2; 5%)
	KZ-22	20 to 24	F (n=8; 40%), NH3 (n=1; 4%), Total P (n=2; 8%), Al (n=2; 8%), As (n=2; 8%), Cd (n=1; 4%), Fe (n=4; 17%)
	KZ-26	19 to 35	F (n=2; 11%), Total P (n=2; 7%), Al (n=8; 23%), Cr (n=2; 6%), Zn (n=1; 3%)
East Creek	KZ-21	20 to 36	F (n=19; 95%), Total P (n=5; 17%), Al (n=3; 8%), As (n=4; 11%), Cd (n=1; 3%), Cr (n=4; 11%), Fe (n=7; 19%), Pb (n=1; 3%), Zn (n=1; 3%)

[a] Number of samples varies depending on removal of some historic samples due to poor detection limit or suspected contamination. Some analytes (e.g., F) were also not analysed in the pre-2015 dataset.

[b] Number in parentheses indicates number of samples that exceeded the water quality guideline and associated percentage of the total number of samples analysed for that constituent.

Table 8-7: Summary of Water Quality at Select Sampling Stations (mg/L)

	Geona Creek	Finlayson Creek		South Creek
	KZ-9	KZ-15	KZ-26	KZ-13
	Median ± Standard Deviation			
Fluoride	0.065 ± 0.014	0.074 ± 0.020	0.11 ± 0.018	0.044 ± 0.0060
Sulphate	26.2 ± 7.3	23.7 ± 7.45	31.1 ± 7.5	11.9 ± 6.6
Ammonia-N	0.018 ± 0.026	0.0060 ± 0.023	0.0086 ± 0.031	0.0070 ± 0.010
Nitrate-N	0.039 ± 0.10	0.036 ± 0.074	0.028 ± 0.077	0.045 ± 0.045
Nitrite-N	0.0010 ± 0.00070	0.0010 ± 0.00080	0.0022 ± 0.00080	0.0010 ± 0.00070
Aluminum, Total	0.023 ± 0.025	0.010 ± 0.059	0.020 ± 0.056	0.028 ± 0.61
Antimony, Total	0.000051 ± 0.000021	0.000030 ± 0.0000050	0.000077 ± 0.000031	0.000025 ± 0.000010
Arsenic, Total	0.00038 ± 0.00037	0.00042 ± 0.00049	0.00077 ± 0.00061	0.00021 ± 0.0013
Cadmium, Total	0.000073 ± 0.00018	0.000024 ± 0.00014	0.000013 ± 0.000017	0.000029 ± 0.0013
Copper, Total	0.00061 ± 0.00088	0.00047 ± 0.00061	0.00077 ± 0.00052	0.00078 ± 0.0041
Iron, Total	0.47 ± 0.97	0.076 ± 0.33	0.16 ± 0.25	0.10 ± 1.7
Lead, Total	0.00017 ± 0.00065	0.000053 ± 0.00040	0.00010 ± 0.00019	0.000067 ± 0.00020
Selenium, Total	0.00066 ± 0.00056	0.00050 ± 0.00045	0.00050 ± 0.00031	0.00015 ± 0.00017
Uranium, Total	0.0012 ± 0.00058	0.0017 ± 0.0014	0.0023 ± 0.00069	0.00061 ± 0.00052
Zinc, Total	0.017 ± 0.010	0.0038 ± 0.0090	0.0020 ± 0.0088	0.0040 ± 0.013

East Creek, a tributary of Finlayson Creek, showed exceedances for total iron, aluminum, arsenic, cadmium, lead, and zinc. In all cases, the elevated metal(loid) concentrations were related to freshet-induced, high TSS events and the dissolved metal fractions were often an order of magnitude lower than the total concentrations.

Substantially more water quality guideline exceedances were noted for total metal concentrations than their dissolved counterparts, suggesting that a significant portion of the metals were particulate-bound, especially during freshet and/or other periods (e.g., heavy rainfall events) characterized by high flow and associated elevated TSS levels. It is important that dissolved metal concentrations exhibited much less frequent water quality guideline exceedances, since it is the dissolved fraction that is the most bioavailable (Prothro, 1993).

8.3.2.4 Seasonal Variability

The highest total metal concentrations and DOC were typically observed during spring freshet or following high precipitation events in late summer. The high runoff created from snowmelt or long periods of precipitation flushed organic soils, causing the spring peaks in DOC. The enhanced runoff and associated higher flow rates during such periods also result in erosive transport of particulate material, leading to the high total metal concentrations observed at these times. More limited seasonal variation was observed for iron and aluminum at KZ-9 on Geona Creek, likely because it is impacted by KZ-9 East Seep groundwater discharge, which contains perennially high dissolved iron and aluminum concentrations.

Unlike the majority of total metal(loid) concentrations, levels of other parameters such as fluoride, hardness, total selenium, and total uranium were lowest during freshet, as snowmelt diluted the concentration of these parameters, which were largely transported in their dissolved form in the Project watershed. Selenium, uranium, and hardness concentrations subsequently rose throughout the year, with highest levels reported during winter months. This suggests that groundwater may be an important contributor to the surface water concentrations of these constituents, since groundwater contribution to surface waters is highest during winter baseflow conditions.

Nitrate-N concentrations also exhibited seasonality in that they showed a marked maximum during the winter months across the watershed. Primary producers are significant consumers of nitrate in aquatic systems; therefore, lower primary productivity during winter conditions is likely responsible for the higher nitrate-N levels observed in winter.

8.3.2.5 Comparison of 2015-16 Data versus Historical Data

A comparison of the 1994-1995 water quality dataset with the more recent baseline water quality monitoring indicated that the majority of constituents shared a similar concentration range, suggesting there were no obvious differences between the two datasets.

Two exceptions were total selenium and total chromium. Total chromium concentrations were typically lower in the 2015-2016 dataset compared to the historic sampling, perhaps due to a preponderance of higher flow sampling events in the historic samples, which may have resulted in higher particulate chromium concentrations. Conversely, total selenium concentrations were generally higher in the recently collected samples compared to the 1994-1995 survey possibly because fewer samples were taken during low flows in the 1994-1995 when selenium concentrations are higher. The differences could also have been a result of differences in laboratory analytical techniques. Selenium concentrations appear to be sensitive to flow conditions, exhibiting minima during periods of high flow (i.e., dilution during freshet and following extended precipitation events) and elevated levels during baseflow winter conditions. The paucity of winter sampling in the 1994-1995 dataset allied with likely high precipitation events in the August 1995 samples, may have low-biased the historic dataset.

Although the detection limits for total chromium and selenium were similar for the 1994-1995 and 2015-2016 datasets, the historic analytical technique included a pre-concentration process to achieve the reported detection limits, albeit with commensurate reduction in analytical precision. As such, this reduced analytical precision may partly explain the observed differences between the 1994-1995 and 2015-2016 chromium and selenium datasets.

8.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on surface water as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects. The water quantity and quality models are introduced in Section 8.4.1.2 and the results (i.e., modelled changes to surface water quantity and quality as a result of the Project) are discussed by Project phase in Sections 8.4.1.3, 8.4.1.4, 8.4.1.5,

and 8.4.1.6. Mitigation measures to minimize effects from the Project are discussed, by Project phase, in Section 8.4.2. Finally, potential residual effects on surface water quantity and quality following mitigation measures are presented, by Project phase, in Section 8.4.3.

8.4.1 Effects Characterization

In order to focus the effects assessment, the first step is to identify any potential interactions between Project activities and surface water. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1 or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will be effectively mitigated so as to not result in a residual effect; and*
2 – Higher risk interactions- *it is reasonably foreseeable that residual adverse effects may result.*

The results of the interactions screening are presented in Table 8-8.

Table 8-8: Interaction Matrix for Surface Water

Project Activity	Surface Water Quality	Surface Water Quantity
Construction		
Tote Road upgrade to Access Road	1	0
Finlayson Lake airstrip upgrade	0	0
Site preparation and clearing	1	1
Site grading, including soil and overburden removal and stockpiling	1	1
Off site traffic (construction equipment and materials delivery)	1	0
On site traffic	1	0
ABM open pit development (including dewatering and Fault Creek diversion)	2	2
Infrastructure construction	1	0
Waste handling	1	0
Water use and management	2	2
Power generation	0	0
Worker transport	1	0
Construction camp operation	1	0
Workforce, Procurement and Hiring	0	0
Operations		
ABM open pit operations (including blasting and dewatering)	2	2
Underground operations	2	2
Ore processing	1	1
On site traffic	1	0

Project Activity	Surface Water Quality	Surface Water Quantity
Off site traffic (highway)	1	0
Finlayson Lake airstrip operations	0	0
Storage facilities management (Class A, B, and C)	2	1
Progressing reclamation of storage facilities	1	1
Water use (potable and non-potable)	2	2
Mine water management and treatment (including effluent discharge)	2	2
Waste management	1	0
Power generation	0	0
Worker transport	1	0
Camp operation	1	0
Workforce, Procurement and Hiring	0	0
Closure		
Process Plant decommissioning and site reclamation	1	0
ABM lake filling	2	2
Final storage facilities reclamation	2	1
Support infrastructure removal and site reclamation	1	1
Water management, treatment and discharge	2	2
On site traffic	1	0
Off site traffic	1	0
Access road reclamation	1	0
Workforce, Procurement and Hiring	0	0

In addition to the direct Project interactions identified above, the following indirect interactions are identified for surface water:

- Potential effect to aquatic species and habitat as a result of changes to surface water quality and quantity (e.g., potential effect to artic grayling as a result of changes to water quality); and

- Potential effect to wildlife as a result of changes to surface water quality and quantity (e.g., potential effect to waterfowl as a result of changes to water quality and quantity).

These indirect effects are assessed in Chapters 10 and 13, respectively.

Based on the screening of anticipated interactions between proposed Project activities and surface water quality and/or quantity, the activities and potential effects can be grouped as follows:

1. Changes in surface water quality and quantity from ABM open pit dewatering activities and diversions during construction phase;

2. Changes in surface water quality and quantity from water management and discharge during operations;

3. Changes in surface water quality and quantity from flooding of ABM open pit at active closure and ABM lake formation including residual drawdown and indirect effects on flow in Geona Creek and South Creek during Transition; and

4. Changes in surface water quality and quantity from water management and site discharge at post closure.

8.4.1.1 Water Quality Objectives

Preliminary water quality objectives (pWQO) have been developed for a range of COPI associated with the Project. These are summarized here with further details provided in Appendix D-8. The derivation of these pWQO has been performed following the methods outlined by the CCME (2003) and is consistent with methods used for other permitted mining projects in the Yukon.

The background concentration procedure (BCP) was used to develop site specific water quality objectives (SSWQO) for those COPIs for which the 95th percentile concentration at each receiving environment monitoring stations (Geona Creek, Finlayson Creek and South Creek) within the Project study area exceeded the CCME or BCMoE water quality guidelines for protection of aquatic life. This resulted in SSWQOs for aluminum, cadmium, copper, fluoride, and zinc (Table 8-10). Where the 95th percentile was lower than the generic CCME (CCME, 2016) or BCMoE (BCMoE, 2016) water quality guidelines for the protection of aquatic life, the most recent of the two guidelines was used (Table 8-9).

A different approach was used to develop the pWQO for selenium. Selenium uptake by primary producers is a critical step in the accumulation of selenium in higher trophic levels of the freshwater food chain. Sulphate is documented to compete with selenium for uptake by primary producers. Laboratory testing using Finlayson Creek water demonstrated that selenium uptake by two primary producers was diminished in the presence of increasing sulphate concentrations. Therefore, a sulphate-dependent selenium SSWQO was developed. At baseline sulphate concentrations of 60 mg/L or less, the SSWQO was set equivalent to the BCMoE guideline (0.002 mg/L), but at higher sulphate concentrations, the selenium SSWQO is calculated using an equation based on the sulphate concentration.

Alternative approaches to the derivation of SSWQO for copper, lead, and zinc were also considered since they are primary COPIs for the Project. Biotic ligand modelling indicated that the time- and resource- intensive water effects ratio procedure (WERP) would be unlikely to produce higher SSWQO for these elements; however, elevated concentrations of dissolved organic carbon (DOC) are present year-round in the downstream reach of Finlayson Creek (site KZ-26) and throughout the watershed during spring freshet and may provide some protective effect against these three elements. This may allow the development of a seasonal (i.e., spring), or DOC-threshold based SSWQO using the WERP. A review of the aquatic species that are resident in the Project receiving environment identified several organisms (or surrogate species) that are particularly sensitive to copper, lead, and zinc chronic exposure. As such, the recalculation procedure, which reviews the resident species and compares them with the species used in toxicity test databases that underpin

the development of CCME and BCMoE water quality guidelines, is unlikely to produce SSWQO that are substantially different from the generic water quality thresholds for these three metals.

In summary, SSWQO were developed for selenium at all receiving environment monitoring locations due to the well documented ameliorating effect that sulphate concentrations have on selenium toxicity. For those sites where the 95th percentile of baseline COPI concentrations exceeded the pWQO, a SSWQO was set based on the 95th percentile COPI concentration. As such, SSWQO were also developed for aluminum at sites KZ-13, KZ-9, and KZ-26, cadmium at site KZ-9, copper at site KZ-13, iron at site KZ-9, fluoride at site KZ-26, and zinc at site KZ-13 (Table 8-10).

Table 8-9: KZK Preliminary Water Quality Objectives Based on CCME and BCMoE Guidelines

Constituent	CCME Guideline Date	BCMoE Guideline Date	Long Term Water Quality Guideline
Aluminum, Total	1987 [a]	Not available	0.005 mg/L if pH < 6.5; 0.1 mg/L if pH ≥ 6.5
Ammonia-N	2001	2009	Temperature and pH dependent
Antimony, Total	Not available	No final guideline	0.009 mg/L (British Columbia working water quality guideline for antimony (III)]
Arsenic, Total	1997	2002	0.005 mg/L
Cadmium, Total	2014	No guideline for total cadmium	0.00004 mg/L if hardness (as $CaCO_3$) < 17 mg/L 10^{0.83(log[hardness]) – 2.46}/1000 (mg/L) if hardness ≥ 17 mg/L and ≤ 280 mg/L 0.00037 mg/L if hardness > 280 mg/L
Copper, Total	1987	1987	0.002 mg/L if hardness ≤ 50 mg/L; (0.04*(hardness))/1000 (mg/L) if hardness > 50 mg/L and < 187 mg/L
Cyanide, Total	1987	Not available	0.005 mg/L (as free CN)
Cyanide, Weak Acid Dissociable	Not available	1986	0.005 mg/L
Fluoride	1987	No long term guideline	0.12 mg/L
Iron, Total	1987	No long term guideline	0.3 mg/L
Lead, Total	1987	1987	(3.31 + e^[1.273 ln (hardness+D3) - 4.704])/1000 (mg/L) if hardness > 8 mg/L and <360 mg/L
Manganese, Total	Not available	2001	0.0044*hardness + 0.605 mg/L if hardness ≥ 37 mg/L and ≤ 450 mg/L
Mercury, Total	2003	2001	0.000026 mg/L
Molybdenum, Total	1999	1986	0.073 mg/L
Nickel, Total	1987	Same as CCME	0.025 mg/L if hardness (as CaCO3) ≤ 60 mg/L or unknown, (e^{0.76[ln(hardness)]+1.06})/1000 mg/L if hardness > 60 mg/L and ≤ 180 mg/L, 0.15 mg/L if hardness > 180 mg/L
Nitrate-N	2012	2009	3 mg/L
Nitrite-N	1987	2009	0.02 mg/L if chloride <2 mg/L; Guideline increases by 0.02 mg/L increments for every 2 mg/L chloride increase between 2 and 10 mg/L; 0.2 mg/L if chloride >10 mg/L
Selenium, Total	1987	2014	0.002 mg/L
Silver, Total	2015	1996	0.00025 mg/L
Sulphate	Not available	2013	128 mg/L if hardness ≤ 30 mg/L; 218 mg/L if hardness > 30 mg/L and ≤ 75 mg/L; 309 mg/L if hardness > 75 mg/L and ≤ 180 mg/L; 429 mg/L if hardness > 180 mg/L and ≤ 250 mg/L
Thallium, Total	1999	No final guideline	0.0008 mg/L
Uranium, Total	2011	No final guideline	0.015 mg/L
Zinc, Total	1987	1999	0.0075 mg/L if hardness ≤ 90 mg/L; (7.5 + 0.75*(hardness – 90))/1000 mg/L if hardness > 90 mg/L and <330 mg/L

[a] Green shading indicates guideline used for pWQO

Table 8-10: KZK Site Specific Water Quality Objectives

Constituent	Site Specific Water Quality Objectives (mg/L)			
Location	**KZ-13**	**KZ-9**	**KZ-15**	**KZ-26**
Aluminum, Total	0.58	0.19	-	0.15
Cadmium, Total	-	0.00029	-	-
Copper, Total	0.0048	-	-	-
Iron, Total	-	2.1	-	-
Fluoride	-	-	-	0.13
Selenium, Total	when sulphate >60 mg/L Total Selenium SSWQO (mg/L) = (0.1736*[sulphate]0.597)/1,000			
Zinc, Total	0.016	-	-	-

8.4.1.2 Modelling of Water Quantity and Water Quality

A receiving environment water balance was developed using a watershed model in conjunction with the operational water balance developed by Knight Piésold Ltd. (KP) to predict surface water quantity throughout the Project from construction to post closure. Details on the operational water balance can be found in the Mine Site Water Balance Report (Appendix C-7). The operational water balance and watershed model were also informed by Hydrogeological Model developed by Tetra Tech EBA Inc. (EBA) (Appendix D-4).

While baseline conditions including predicted mean annual runoff were quantified in the Baseline Hydrometeorology Report (Appendix D-2), they were also predicted using the watershed model to allow direct comparison of the modelled changes in runoff for the effects assessment. The watershed model was developed in Microsoft® Excel as a changeable tool based on physical parameters and processes which can be measured, estimated, or determined through calibration to predict runoff at various nodes corresponding to monitoring points within the watershed. The model was calibrated using one year of existing precipitation, temperature, and runoff data.

The receiving environment water balance model (Appendix D-6) was developed for both the LSA and the RSA (Geona Creek, Finlayson Creek, and South Creek) and includes the site components water balance (Appendix C-7) to reflect Project activities.

A mass load balance model (Appendix D-7) was prepared for surface water within the Project area and in the receiving environment downstream of the Project. The Water Quality Model, described in detail in Appendix D-7, was developed using Excel and combines estimated loads in predicted water flows at various evaluation points to predict concentrations over time. The model integrated the following loading and flow components:

- Baseline surface water quality (Appendix D-1);
- Geochemical source terms to predict the rate of mass loading from sources to the Project water management systems and the receiving environment (Appendix D-5); and

- Water balances for the operational mine components (Mine Site Water Balance; Appendix C-7), the ABM open pit (Hydrogeology Model Report; Appendix D-4) and the receiving environment (Appendix D-6).

Water quality modelling was performed on a monthly time step through the construction, operations, and closure phases of the Project under three different precipitation scenarios:

- Mean Annual precipitation (i.e., an "average" year);
- One in 50 (1/50) wet year; and
- One in ten (1/10) dry year.

Modelled constituents include hardness, sulphate, nitrate, nitrite, ammonia, phosphorus, fluoride, chloride, cyanide, aluminum, antimony, arsenic, cadmium, copper, iron, lead, manganese, nickel, silver, selenium, uranium, zinc, and DOC as they are common COPIs for base metal mining projects. Those constituents that water quality modelling indicated would approach or exceed their pWQO during any phase of the Project constitute the focus of the water quality discussion.

TSS have not been modelled, as they will be managed through the Sediment and Erosion Control Plan (Section 18.6), and water discharge will require TSS to meet regulatory standards (Water Use Licence (WUL) and *Metal Mining Effluent Regulations* (MMER)). The pH was also not modelled, as pH of water leaving the mine site will be adjusted, as required to be between 6.5 and 9.0, through lime addition and will be of circumneutral pH throughout the Project life.

Modelling predictions were produced at key monitoring locations located on site and in the downstream receiving environment:

- Water management ponds;
- The ABM lake that will form during closure;
- Geona Creek (receiving environment monitoring station KZ-37);
- Upper and lower Finlayson Creek (sites KZ-15 and KZ-26, respectively); and
- South Creek (KZ-13).

Mine loading sources to the receiving environment included the following:

- ABM pit dewatering (groundwater);
- Discharge water from the Lower Water Management Pond;
- Class A, Class B, and Class C Storage Facilities;
- Overburden Stockpile;
- ABM lake; and
- Diversion ditches.

Background loads were calculated using baseline data and assuming monthly median concentrations (Appendix D-1). The receiving water quality predictions were evaluated at the following sites:

- KZ-37 (Geona Creek downstream of Lower Water Management Pond discharge location);
- KZ-15 (Finlayson Creek downstream of confluence with Geona Creek and second Lower Water Management Pond discharge location);
- KZ-26 (Finlayson Creek at Robert Campbell Highway); and
- KZ-13 (South Creek).

In order to evaluate changes in water quality with respect to the Project activities, the modelled water quality results were compared with the pWQO and SSWQO and provided in Table 8-9 and Table 8-10, respectively. Where the pWQO for a parameter is dependent on another constituent (e.g., hardness, sulphate, or chloride), the modelled concentrations for the dependent parameters were used to calculate the pWQO for that given month's prediction.

It must be emphasized that this predictive water quality modelling can only predict a range of concentrations and, in some cases, relative changes in concentrations or loadings. The water quality modelling is attempting to simulate a range of complex natural processes that have inherent variability. This modelling is used to understand the potential range of controls that are needed to safely meet the closure objectives and, in addition, to identify the monitoring program during operations and after closure that will provide information to update this modelling and the required environmental controls. Additionally, the results of the model do not represent an impact assessment for the receiving environment. An aquatic impact assessment has been completed by AEG and is presented in Chapter 10 of the Project Proposal.

Additionally, given the limitations of field and laboratory datasets that attempt to capture the range of conditions that may be expected during the period of time over which predictions are made, numerous assumptions are required for the water quality model. In the interest of caution, relatively conservative estimates are preferred, and the result is a water quality model that generates COPI concentrations which will likely be higher than the actual levels in the receiving environment.

The conservative assumptions built into the water quality model include:

- Relative conservative conversion factors for particle size and contact water used to scale the laboratory ARD/ML data to field conditions;
- The use of average release rates from laboratory kinetic experiments to develop source terms for constituent release from waste rock and tailings during the operations and active closure phases of the Project;
- The use of 75th percentile release rates from laboratory waste rock kinetic experiments to develop source terms for constituent release from the ABM Pit wall rock;
- Wet and dry scenarios (i.e., 1/50 year wet and 1/10 year dry, in addition to the mean) modelled to assess the sensitivity of COPI concentrations to hydrologic variations and the

most conservative of these scenarios (i.e., that returned the highest COPI concentrations) were evaluated against the pWQOs; and

- Retaining moderate estimate of COPI removal from in situ treatment of the ABM lake also lends conservatism to the post-closure water quality forecasts (Section 8.4.2.3).

The model estimated concentrations for a range of COPIs at monitoring locations in Geona Creek (KZ-37), Finlayson Creek (KZ-15 and KZ-26), and South Creek (KZ-13) over the construction, operations, and closure phases of the Project are displayed in Figure 8-7 to Figure 8-30. The estimated concentrations under both the mean and 1/10 dry year precipitation scenarios are presented. The 1/50 wet year scenario is not presented here; however, the COPI trends are the same as those observed for the mean precipitation scenario, but the wet year concentrations are lower due to dilution from the higher flow conditions. The discussion of the modelled surface water quality of the receiving environment is presented in the subsequent sections and is focussed on those COPIs that were estimate to exceed their respective pWQO or SSWQO at each Project phase. Given the value of drinking water identified by the RRDC through consultation and confirmed through desk-based research results (Appendix F-3), comparisons of model estimated water quality with drinking water maximum acceptable concentration guidelines (Health Canada, 2014) were also made, although such comparisons were restricted to those monitoring points that are accessible to the general public:

- South Creek (KZ-13) and lower Finlayson Creek (KZ-26) at all phases of the Project; and
- Geona Creek (KZ-37) and upper Finlayson Creek (KZ-15) at post-closure only since the Access Road is gated such that only site workers will have access to these locations during construction through transition closure.

It should be noted that Fault Creek where drinking water has been collected by the Kaska is upstream of proposed Project disturbances

These locations are relevant and important to Kaska for a variety of social, sustenance, cultural, and ecological reasons, in particular:

- Finlayson Creek flows into the Finlayson River and Frances Lake, which are important fishing locations for Kaska citizens; and
- South Creek flows into North Lakes, which is a destination for Kaska hunting of caribou, moose, and sheep.

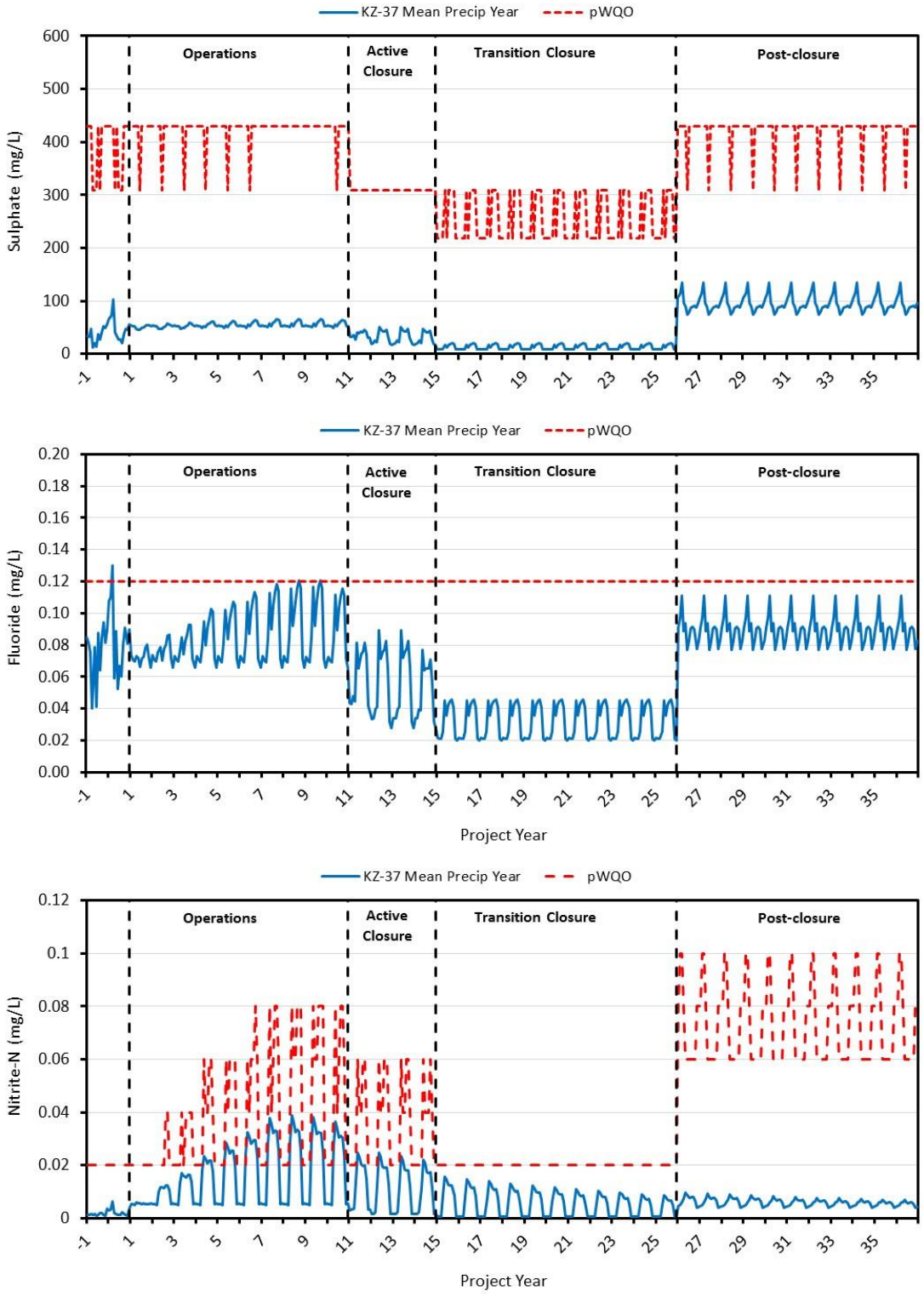


Figure 8-7: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-37 in Geona Creek in the Mean Precipitation Scenario

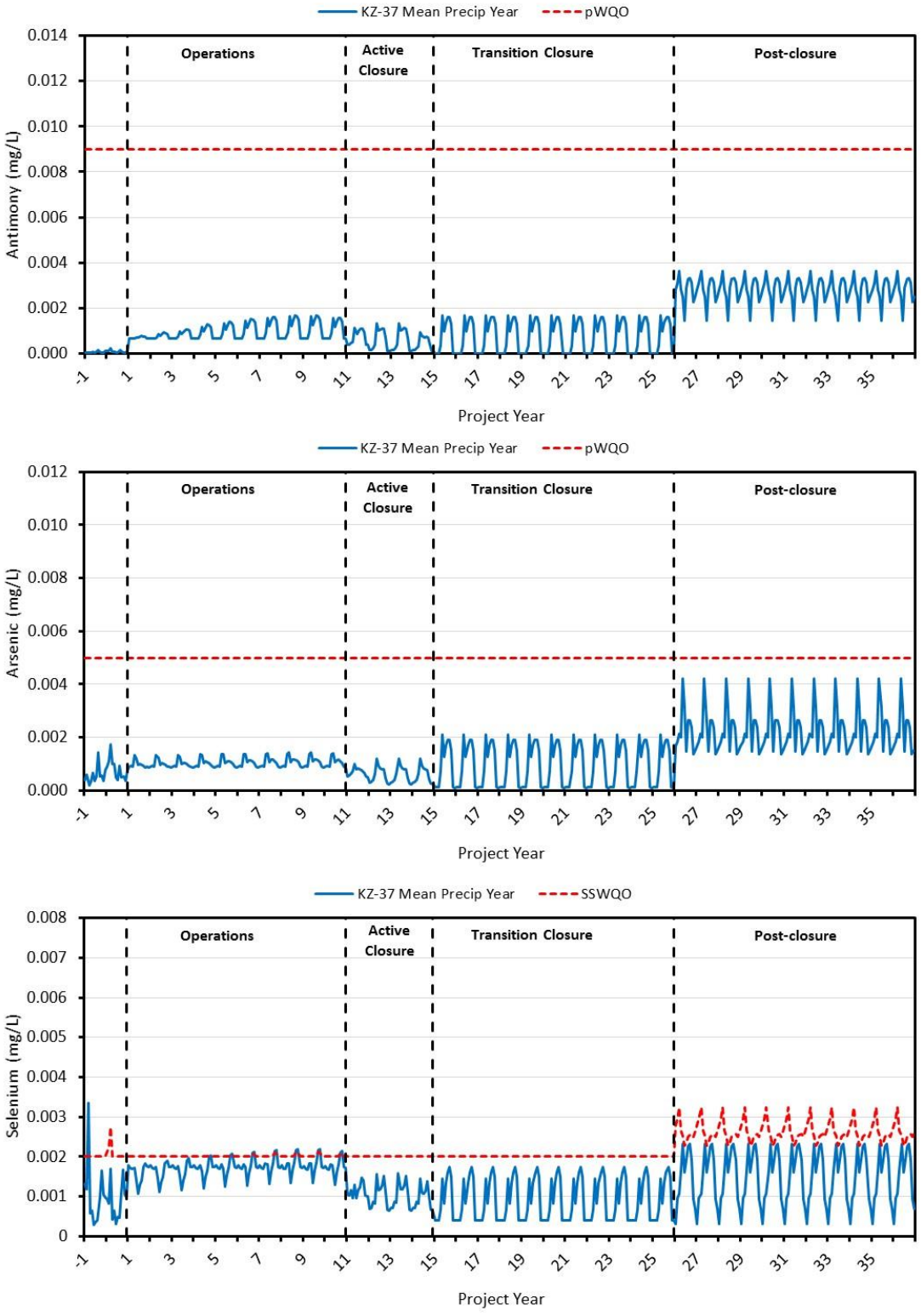


Figure 8-8: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-37 in Geona Creek in the Mean Precipitation Scenario

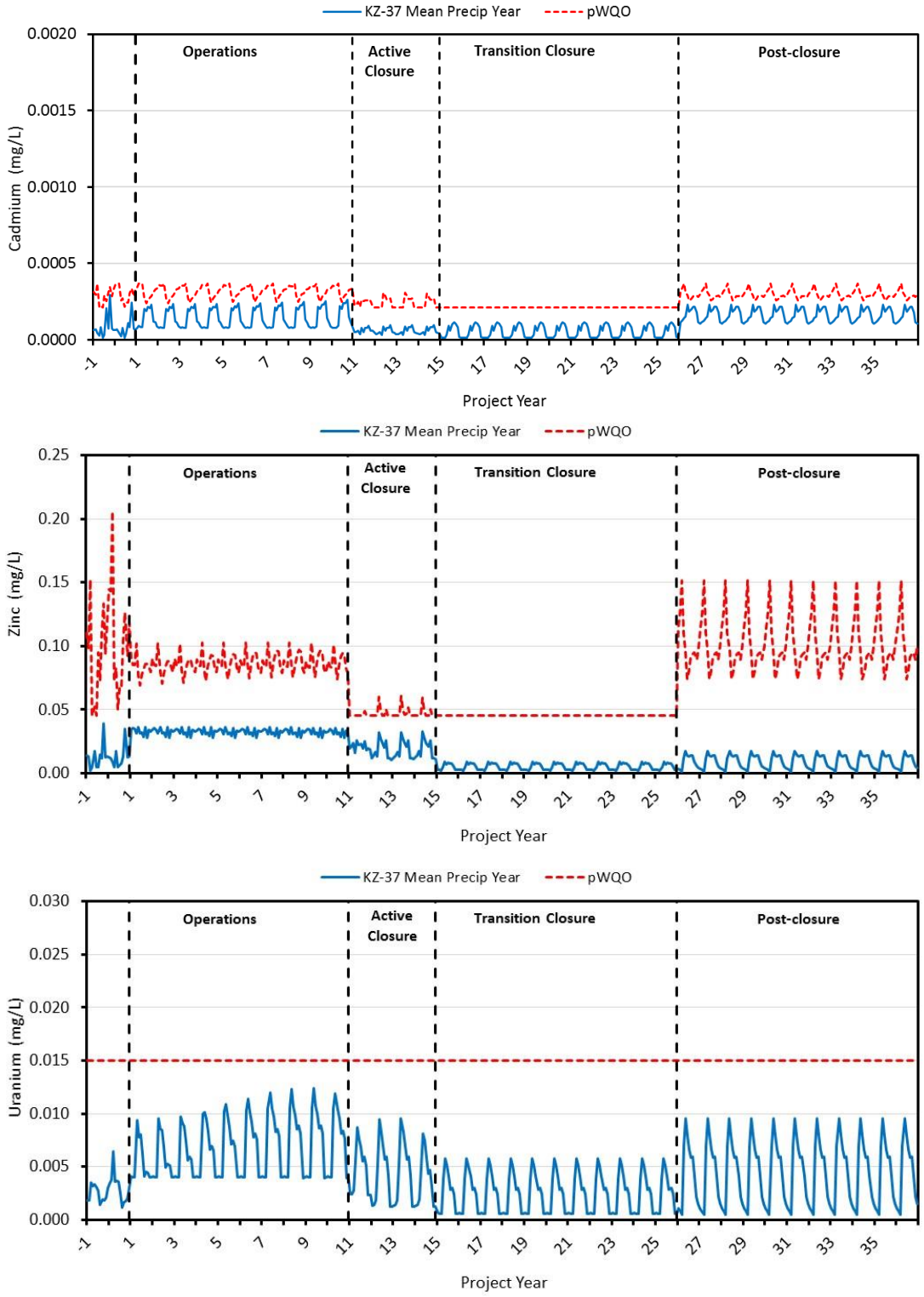


Figure 8-9: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-37 in Geona Creek in the Mean Precipitation Scenario

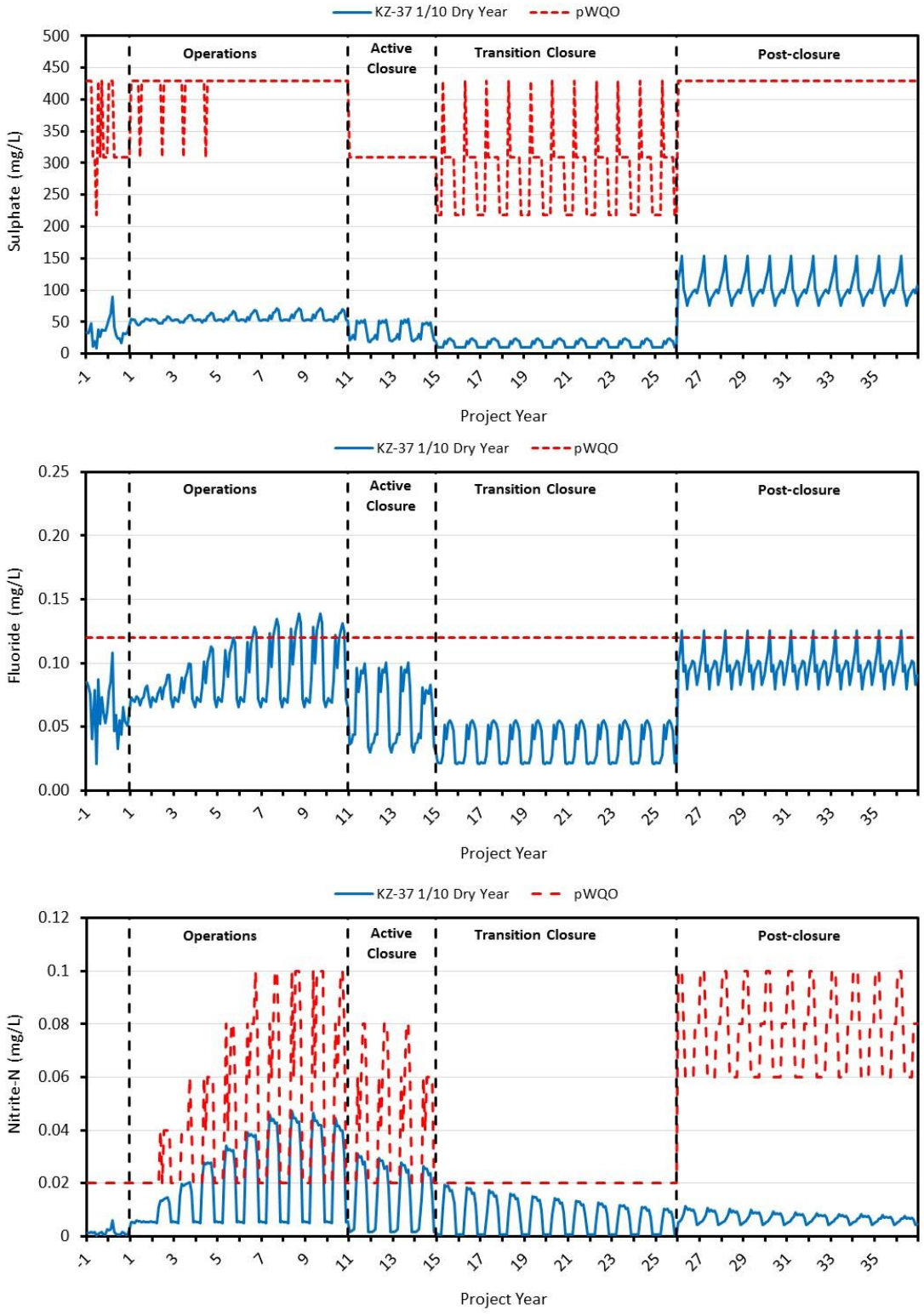


Figure 8-10: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario

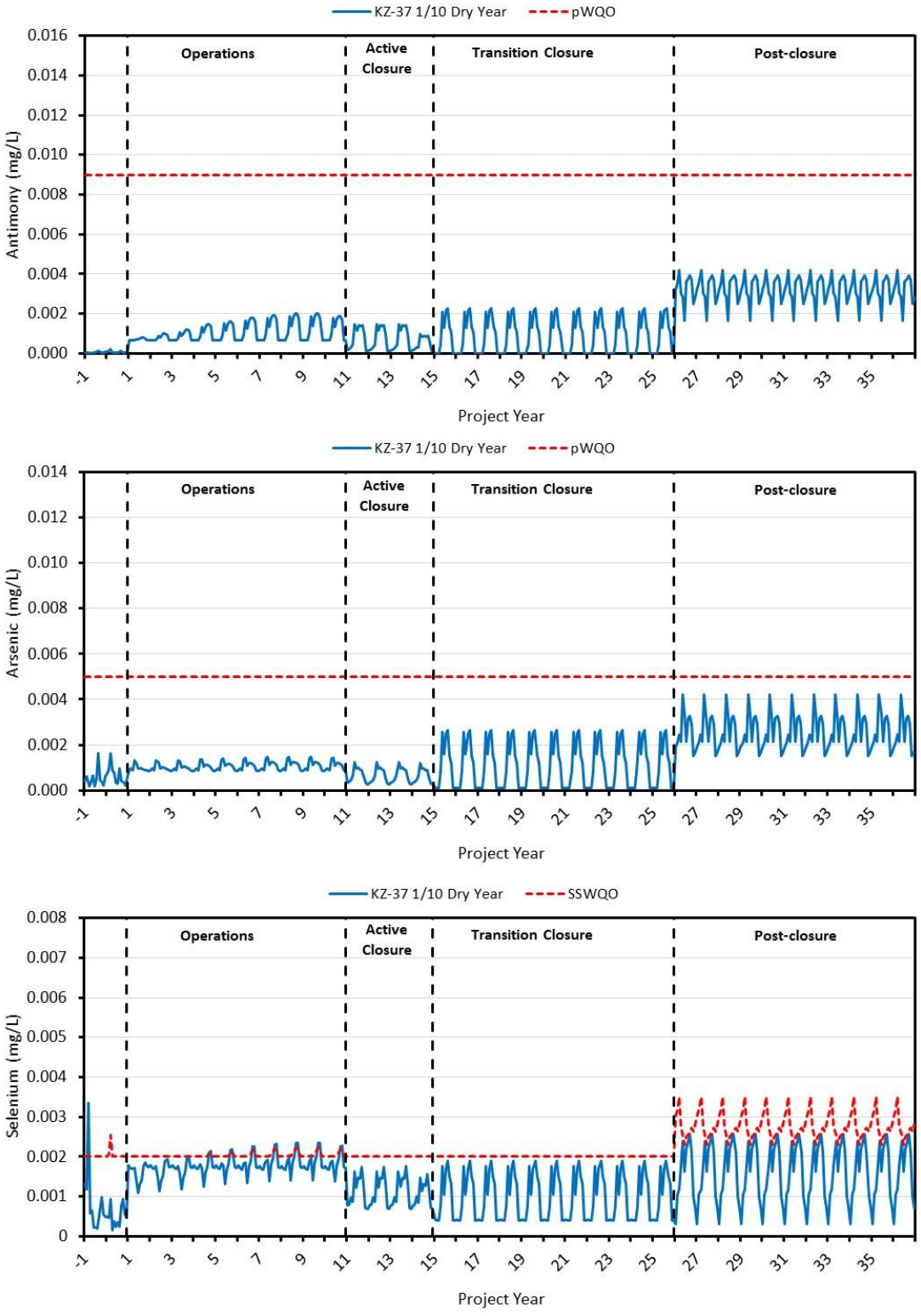


Figure 8-11: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario

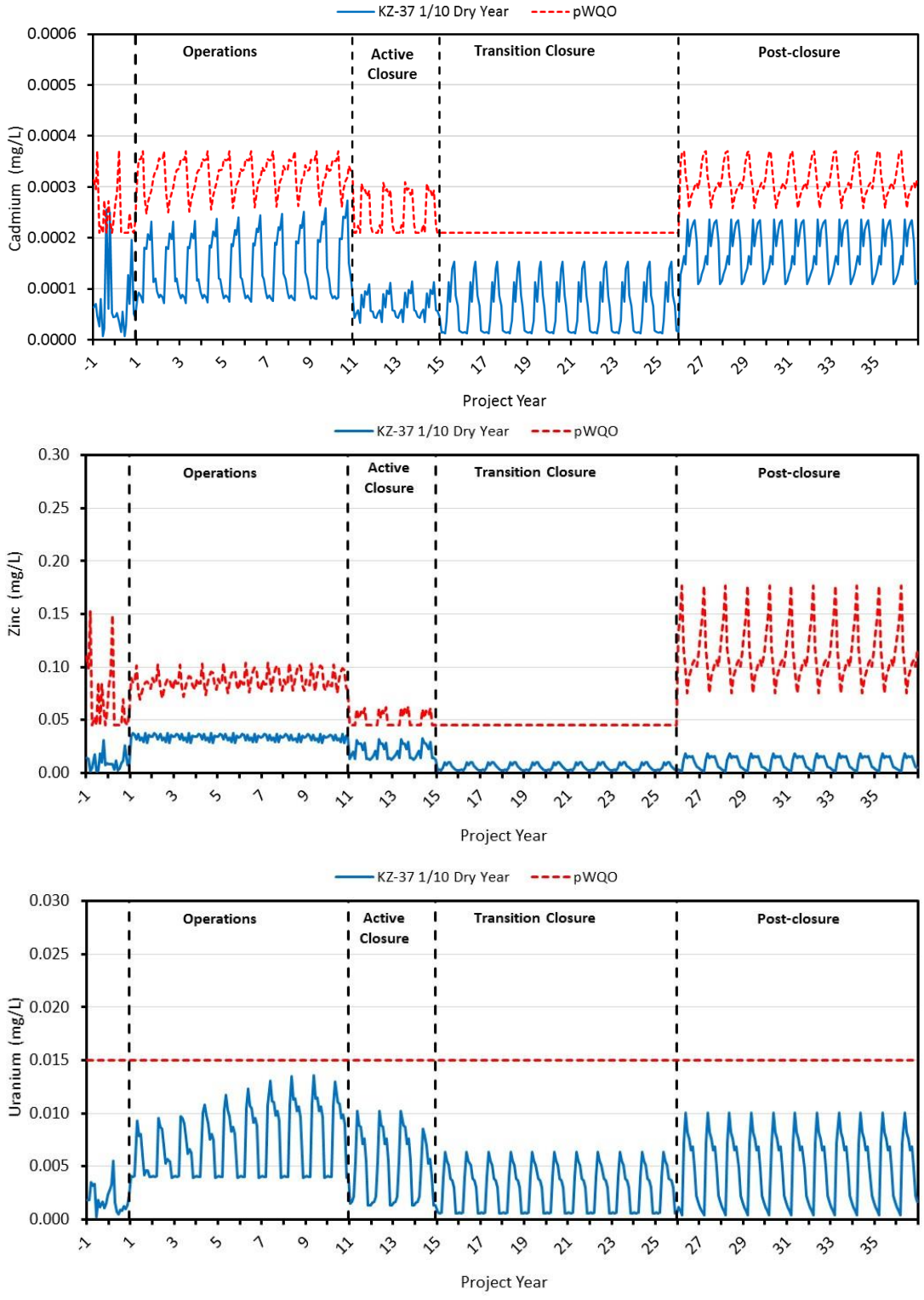


Figure 8-12: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-37 in Geona Creek in the 1/10 Dry Year Scenario

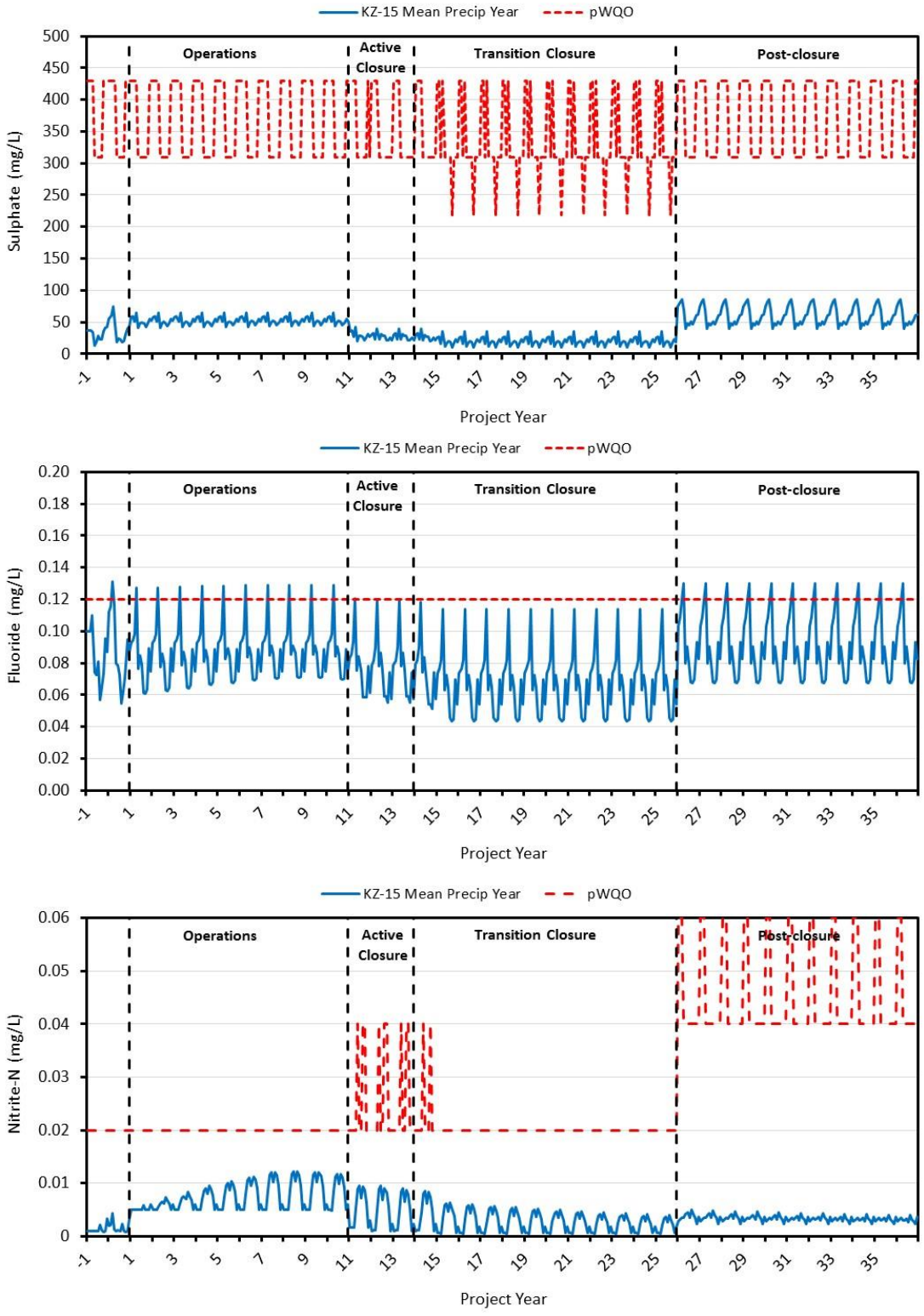


Figure 8-13: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario

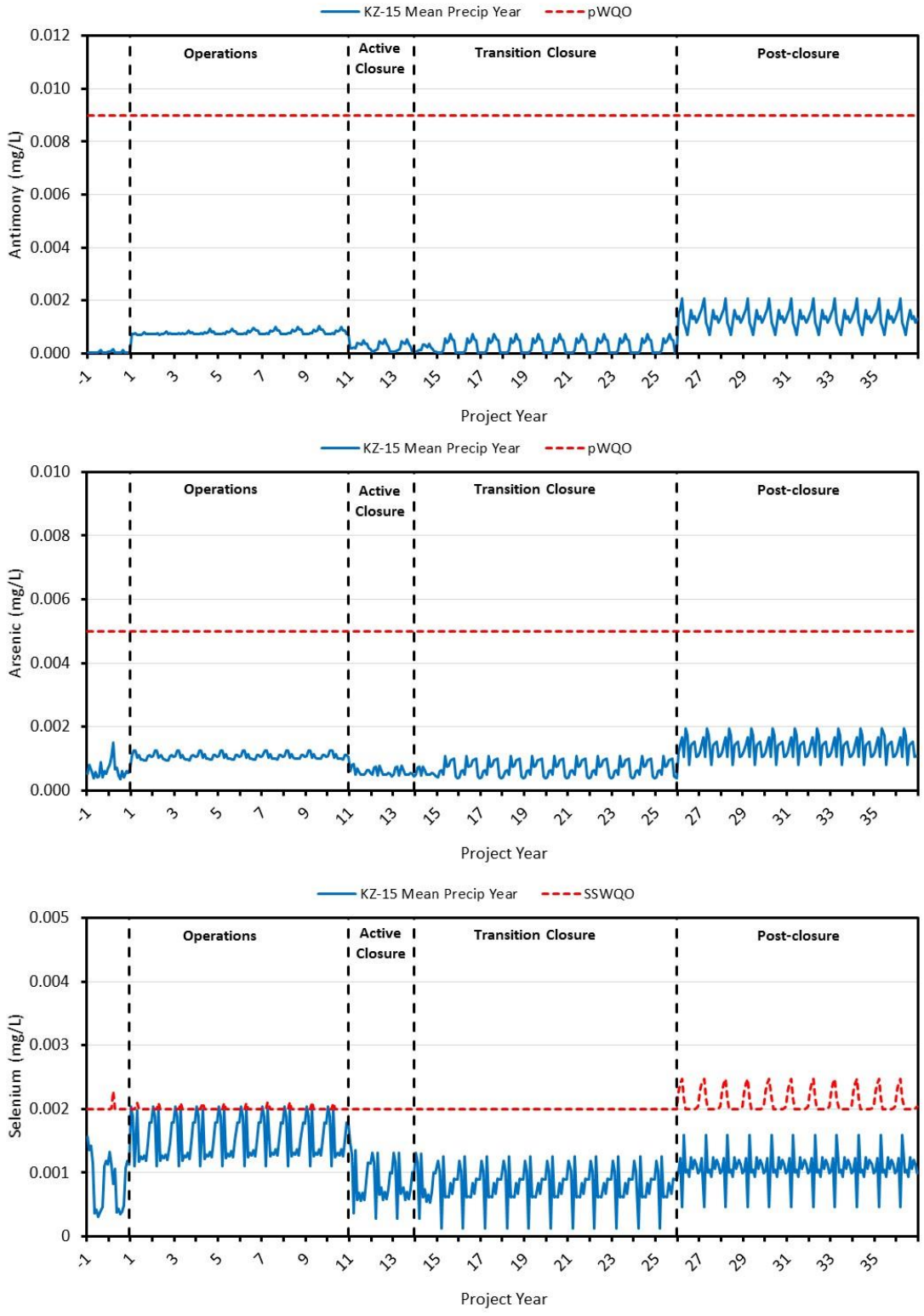


Figure 8-14: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario

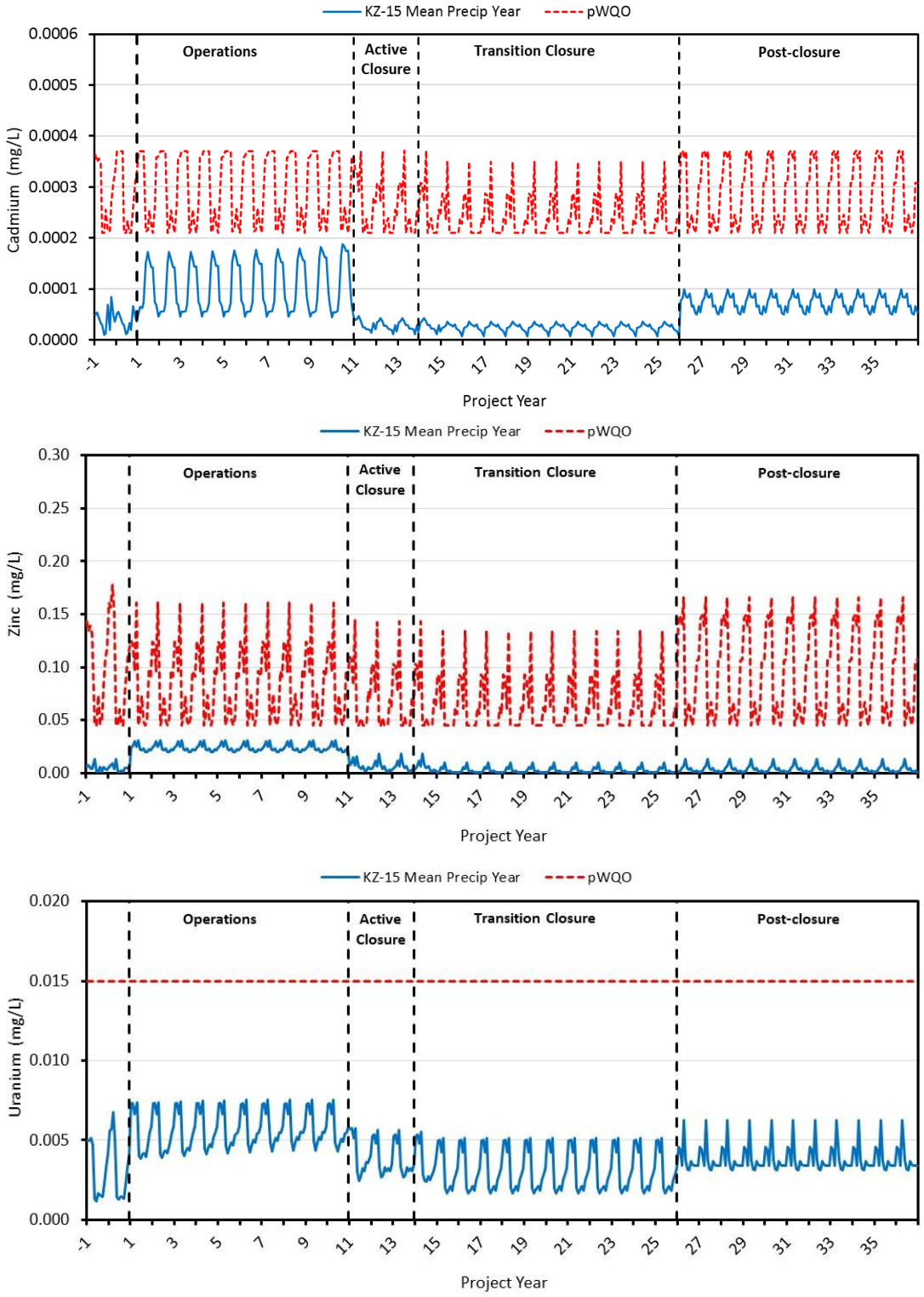


Figure 8-15: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-15 in Upper Finlayson Creek in the Mean Precipitation Scenario

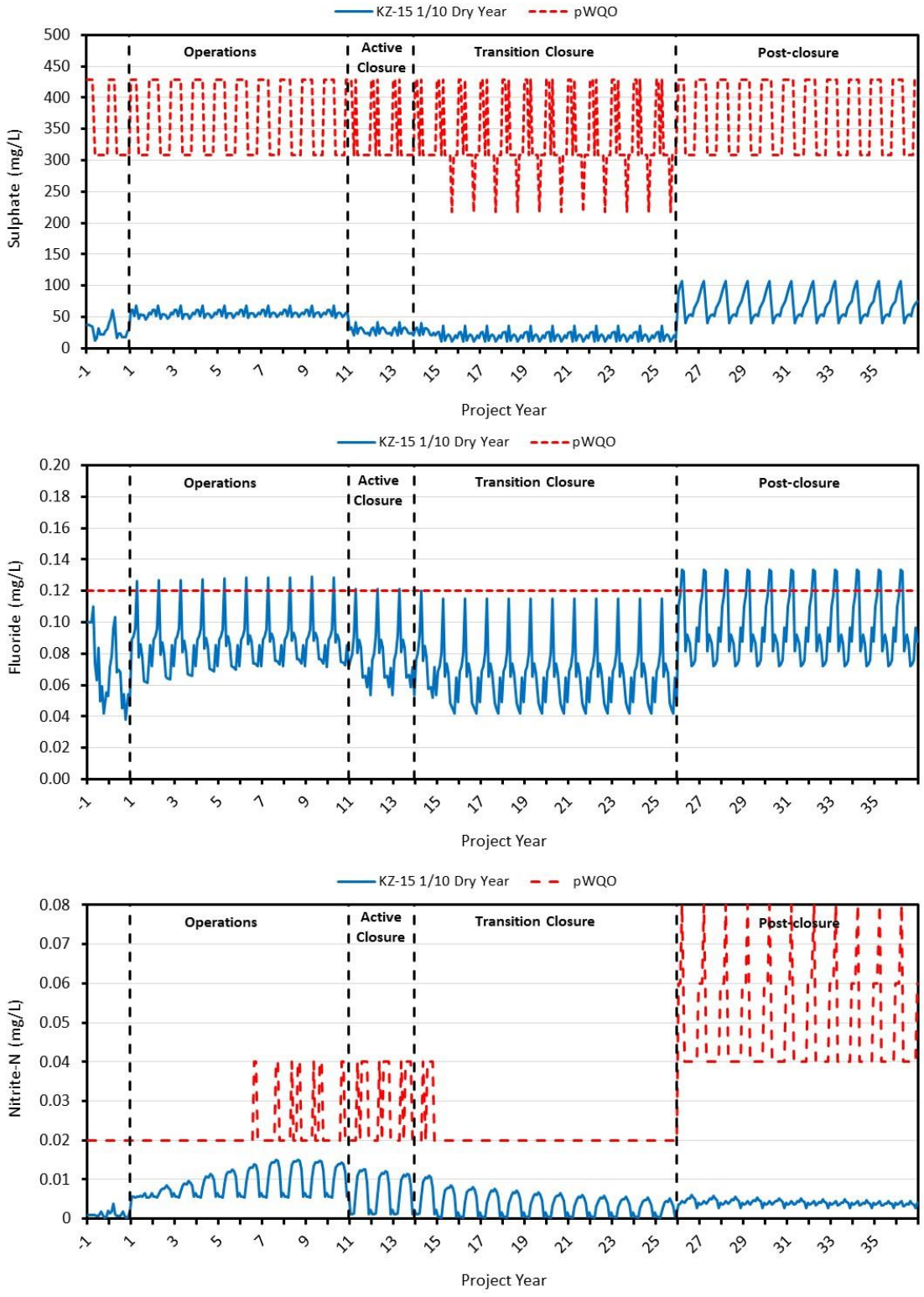


Figure 8-16: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario

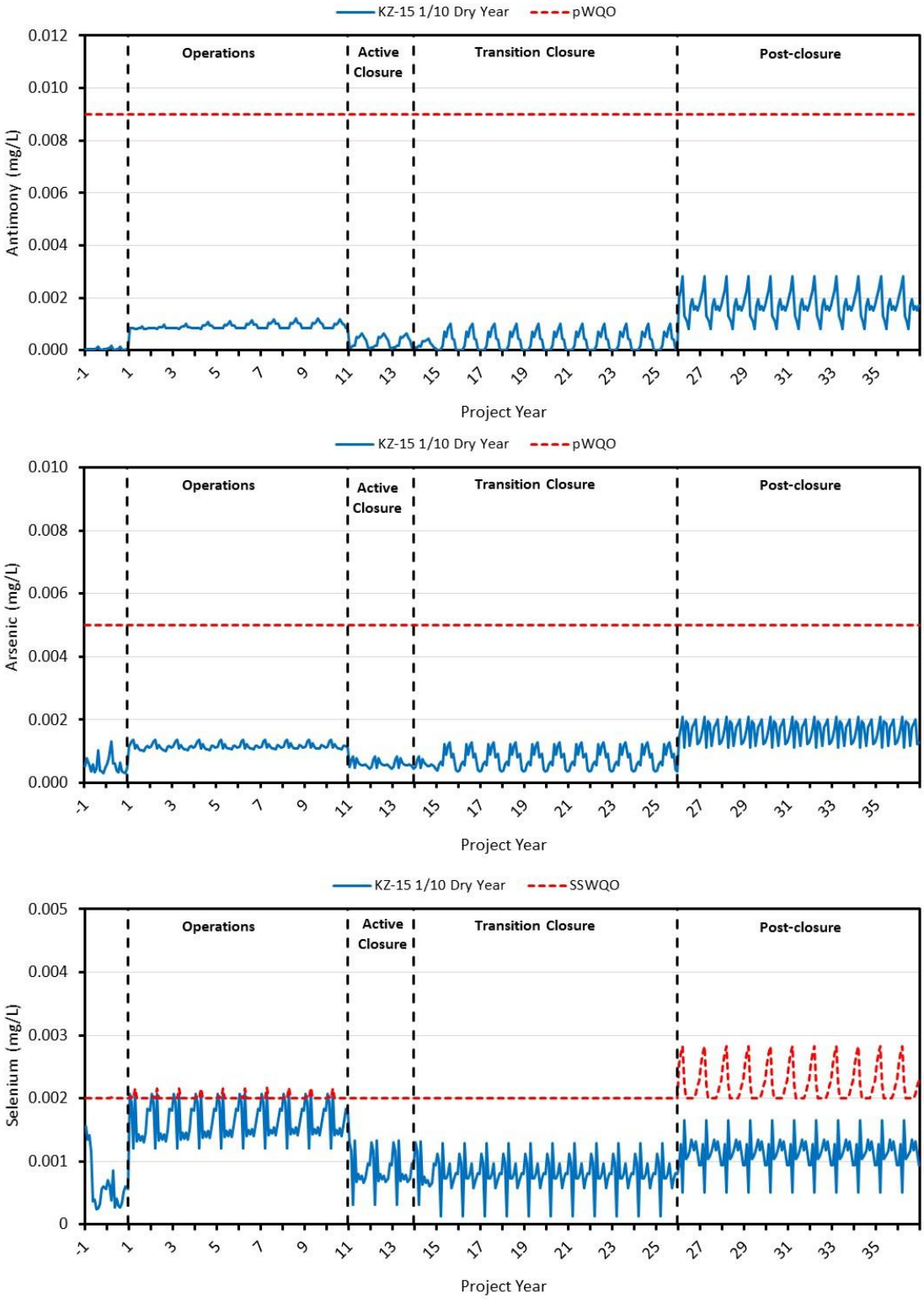


Figure 8-17: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario

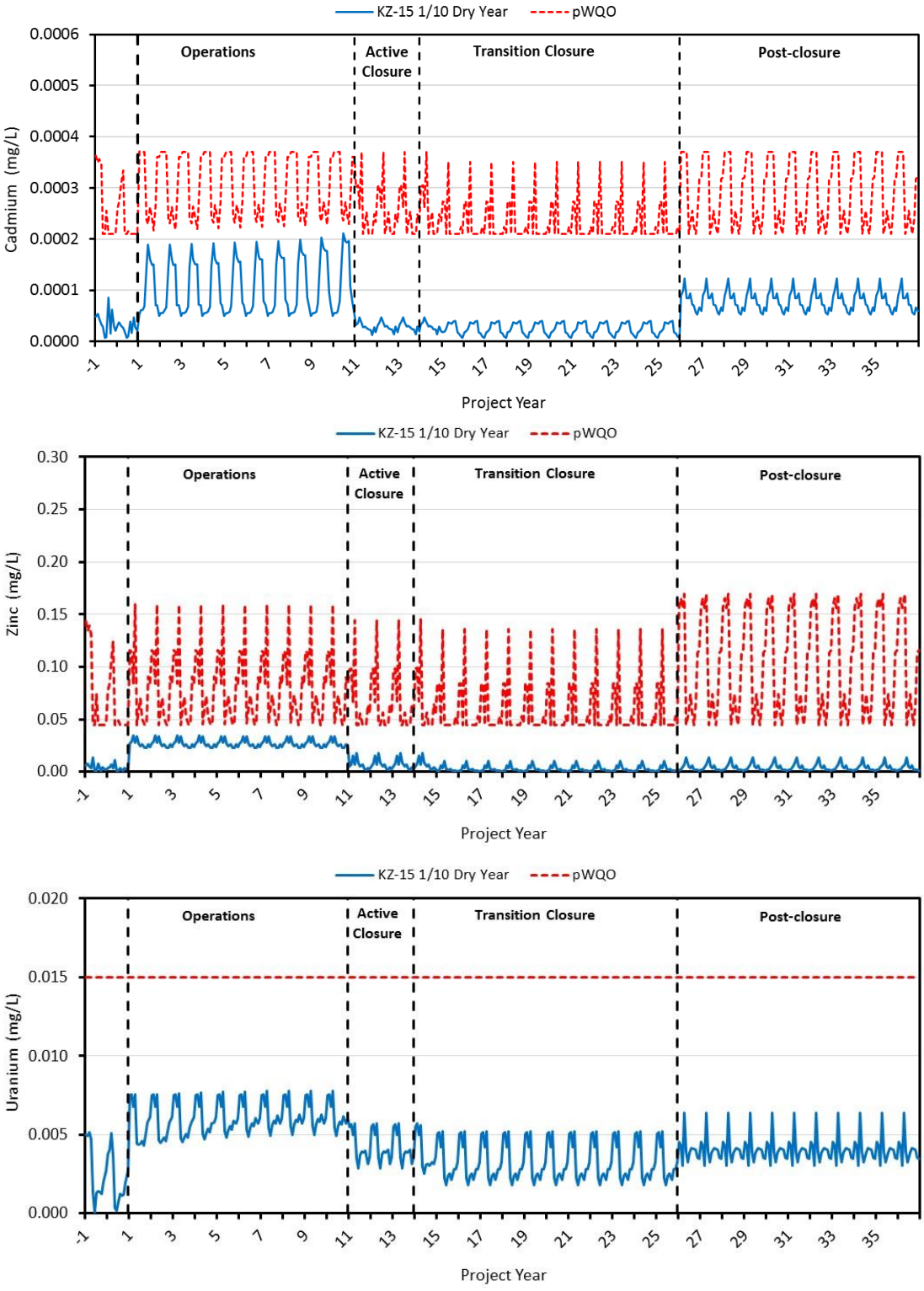


Figure 8-18: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-15 in Upper Finlayson Creek in the 1/10 Dry Year Scenario

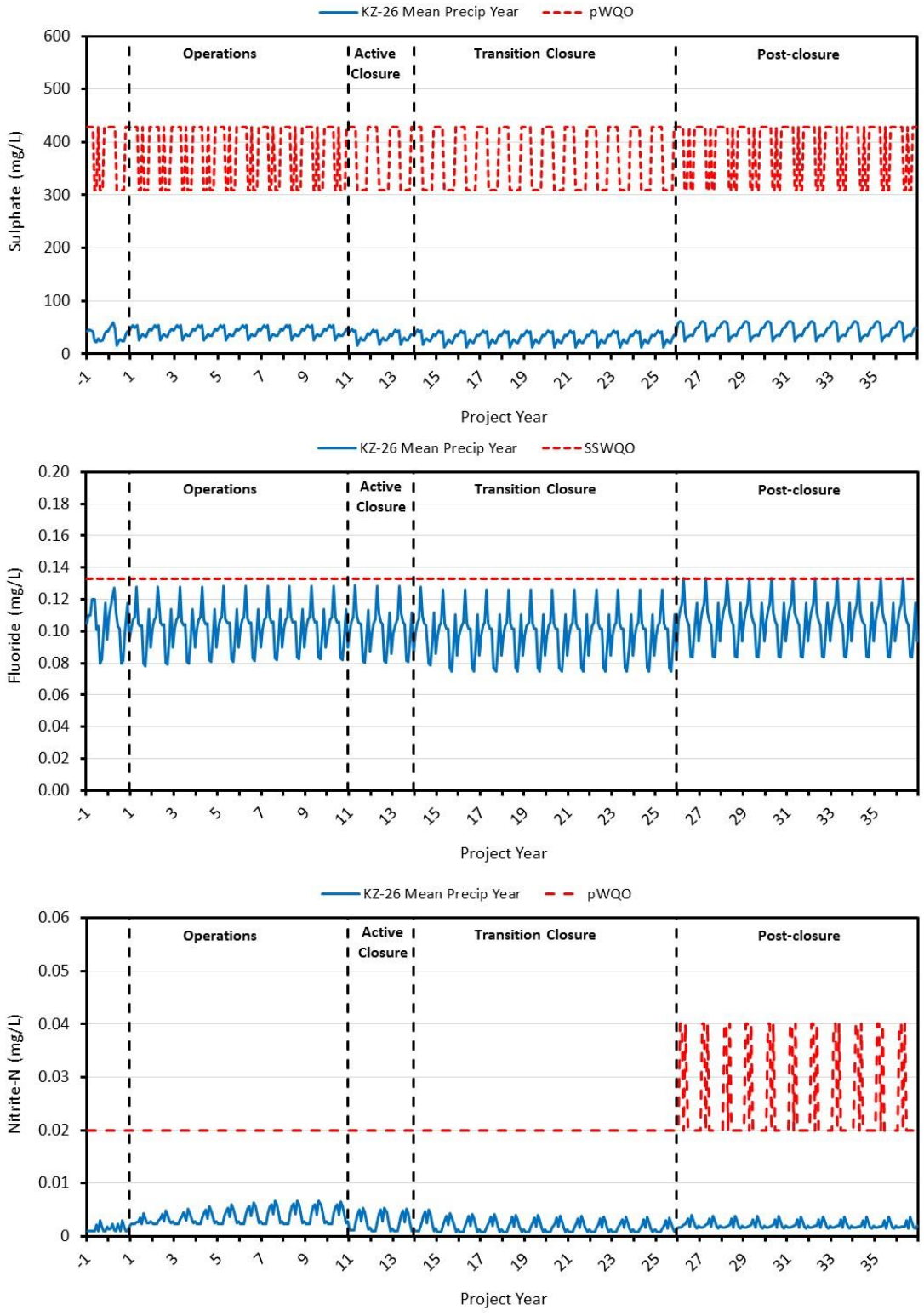


Figure 8-19: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario

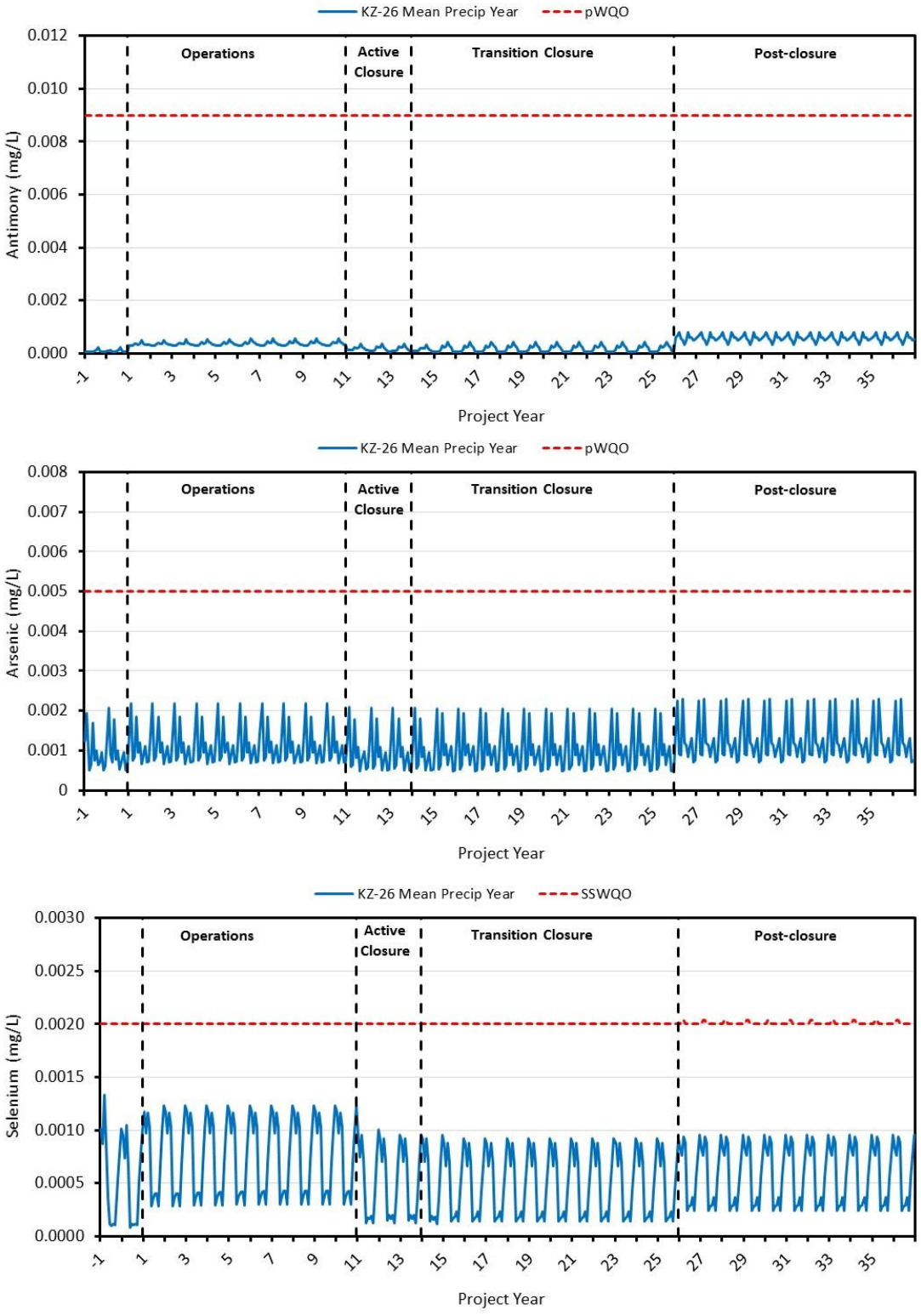


Figure 8-20: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario

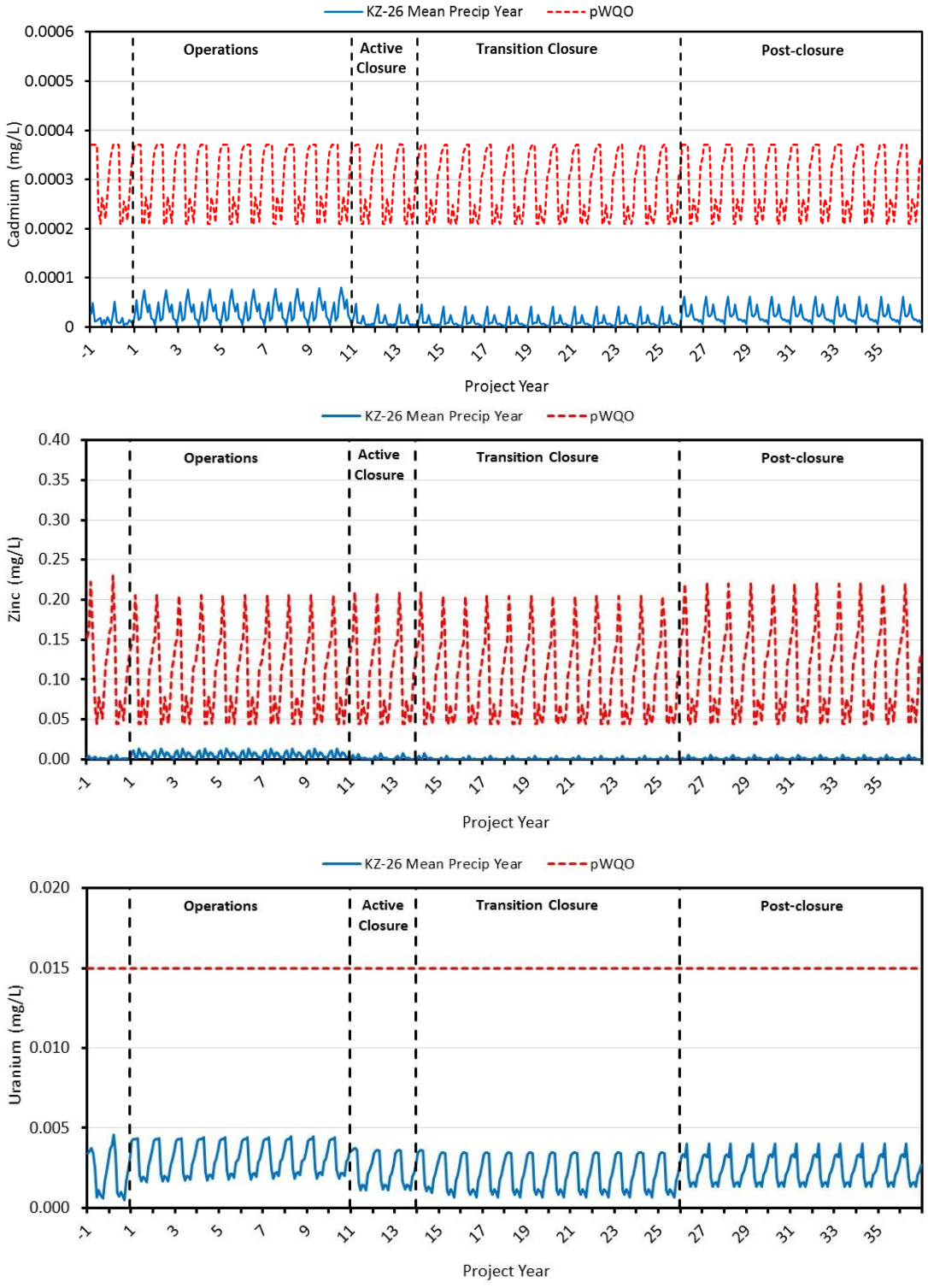


Figure 8-21: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-26 in Lower Finlayson Creek in the Mean Precipitation Scenario

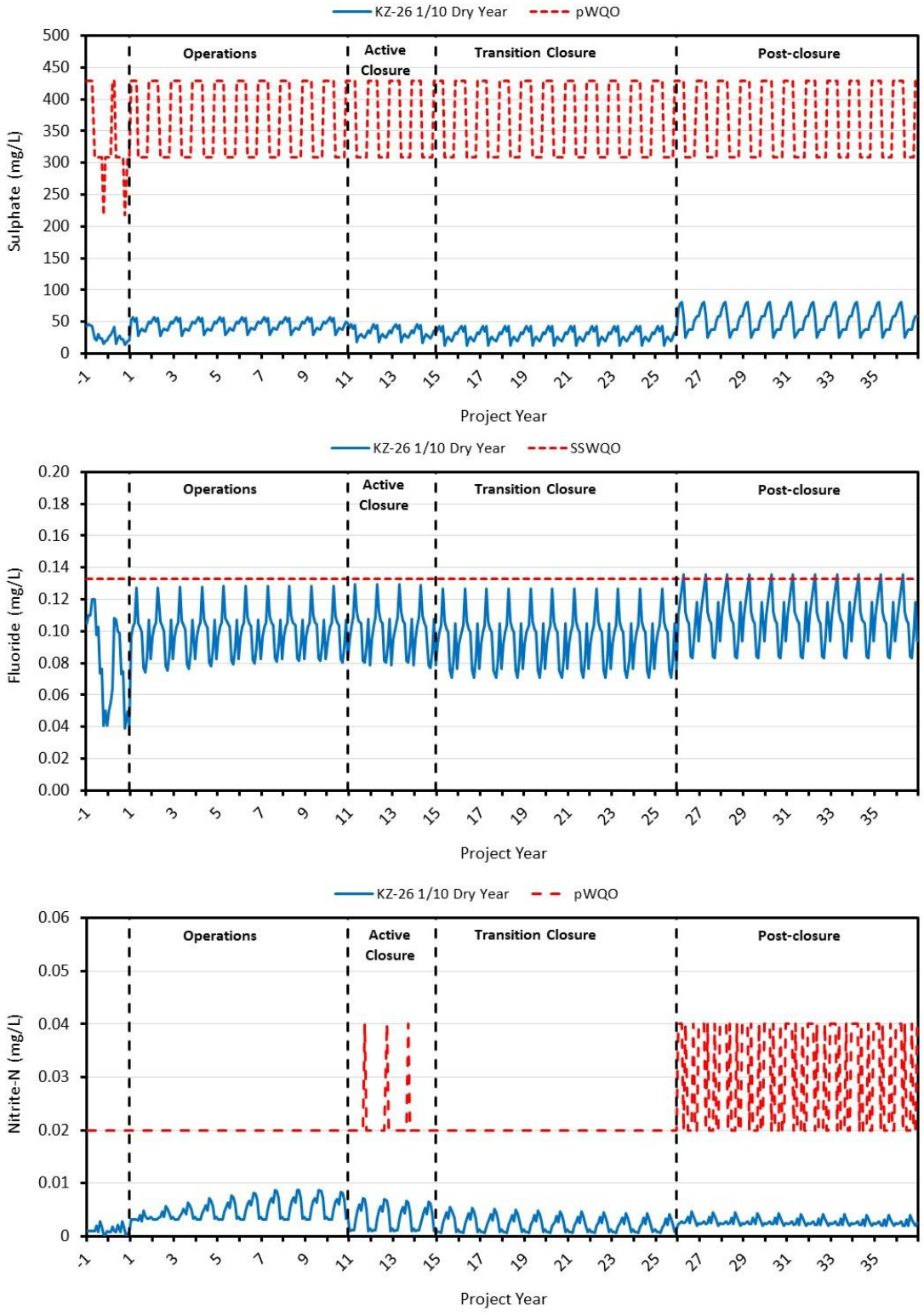


Figure 8-22: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario

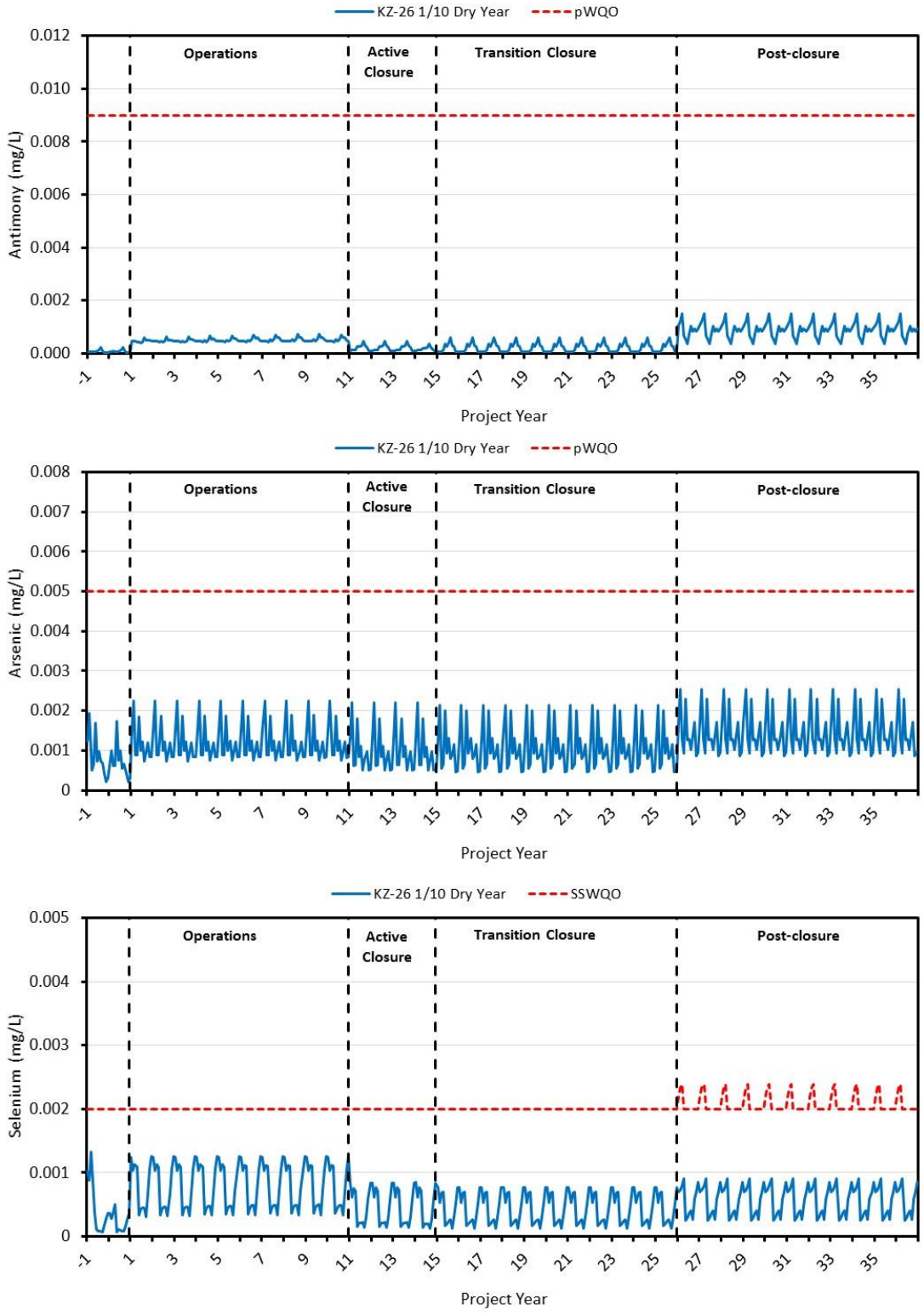


Figure 8-23: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario

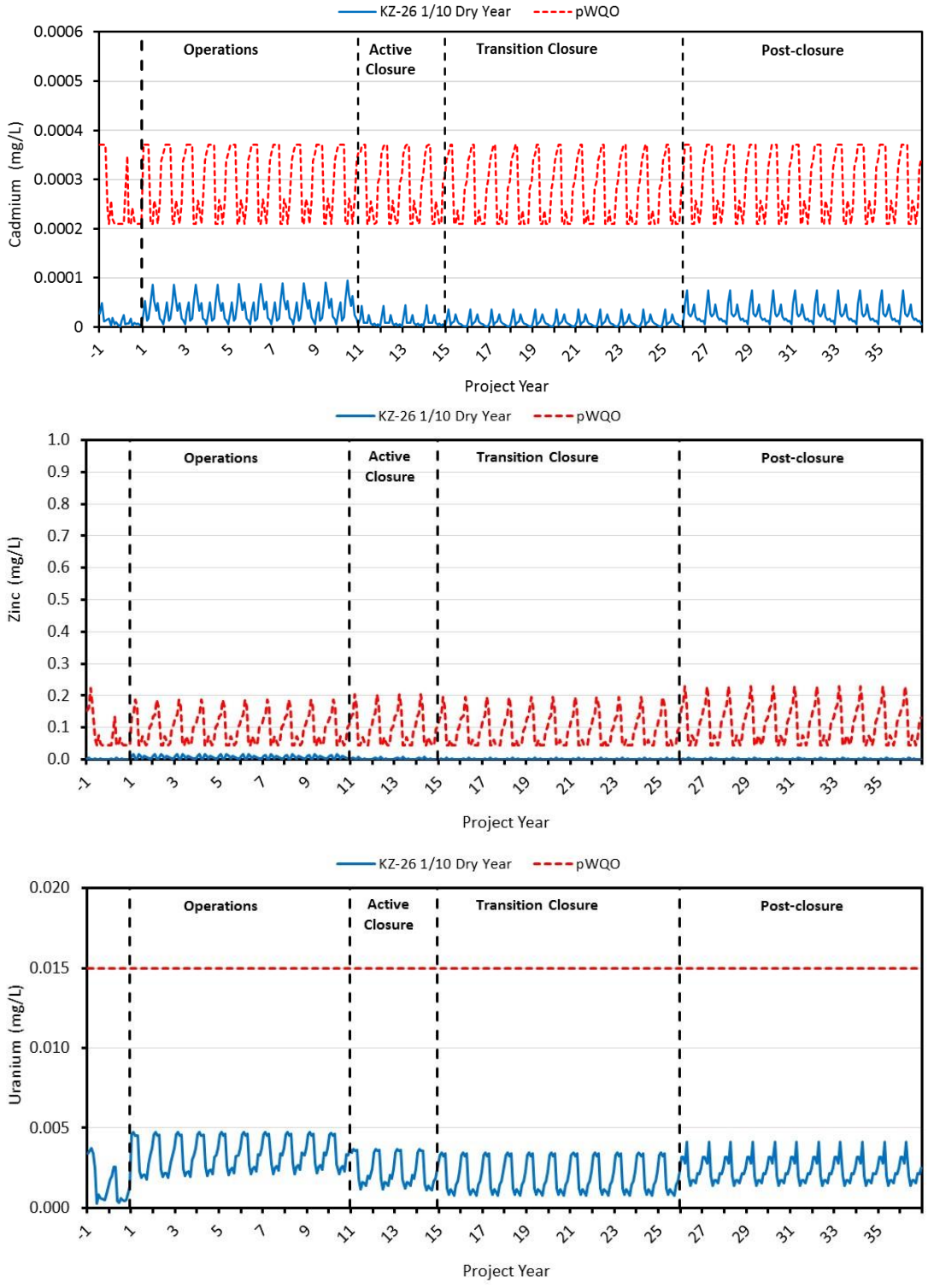


Figure 8-24: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-26 in Lower Finlayson Creek in the 1/10 Dry Year Scenario

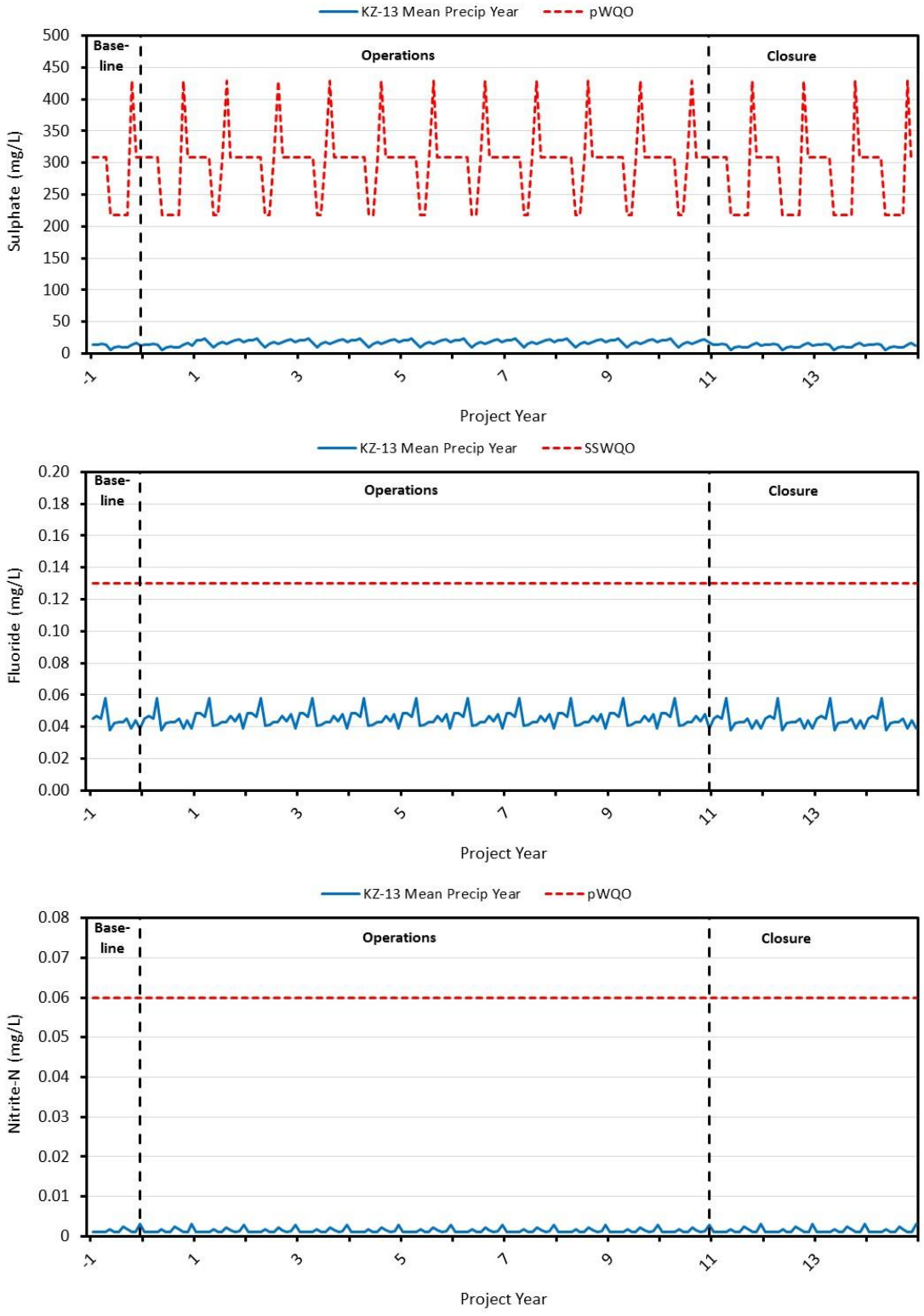


Figure 8-25: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-13 in South Creek in the Mean Precipitation Scenario

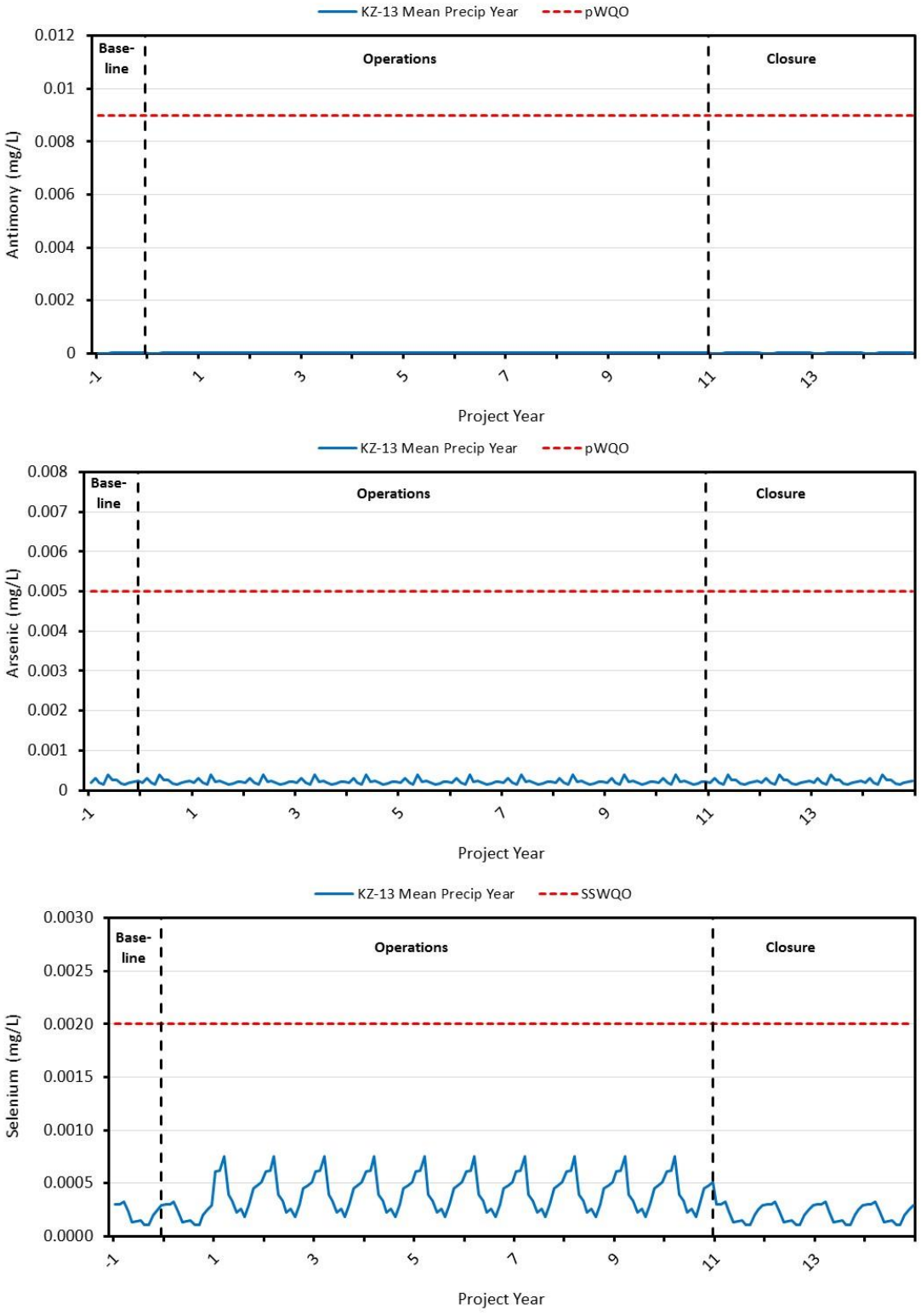


Figure 8-26: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-13 in South Creek in the Mean Precipitation Scenario

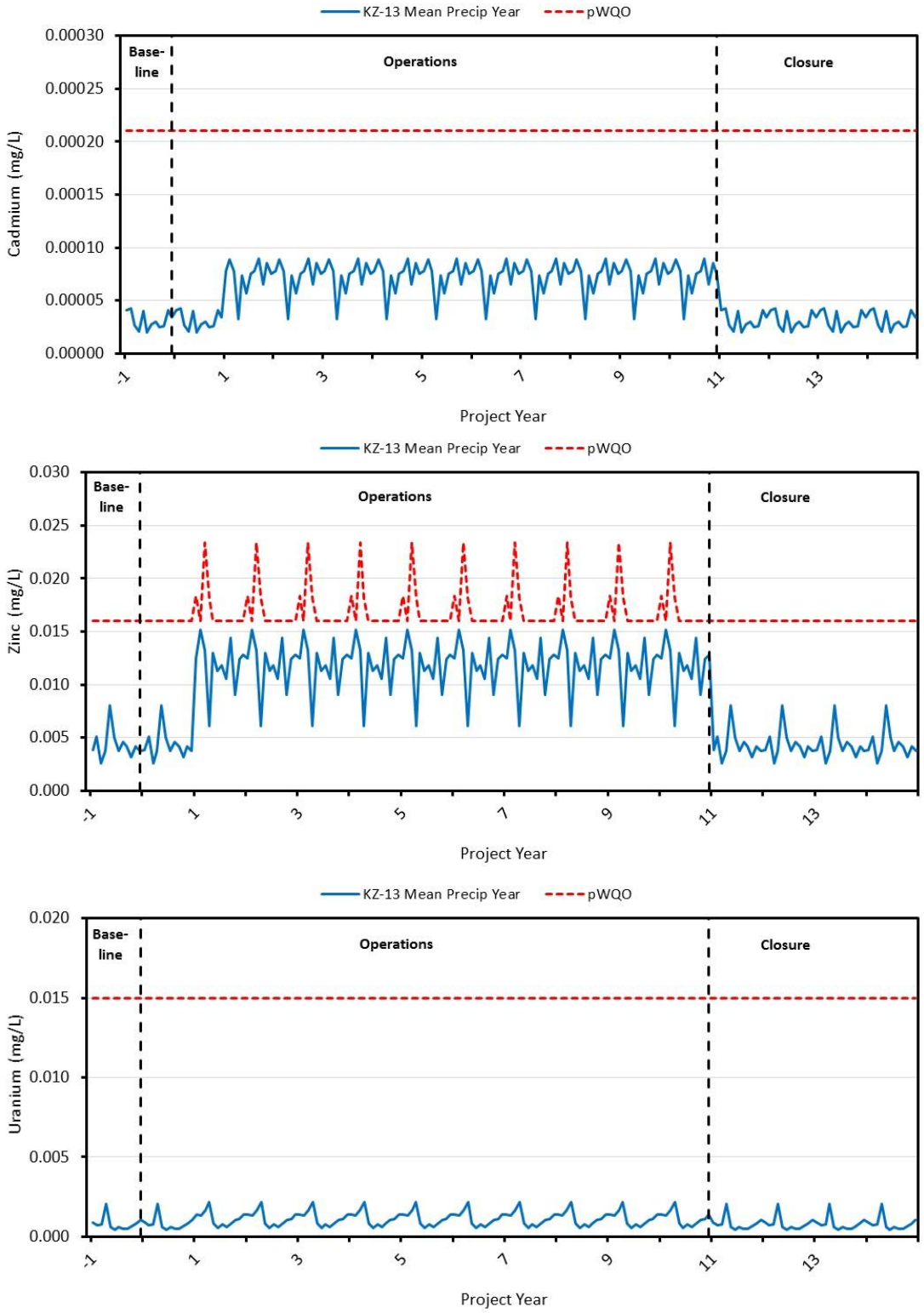


Figure 8-27: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-13 in South Creek in the Mean Precipitation Scenario

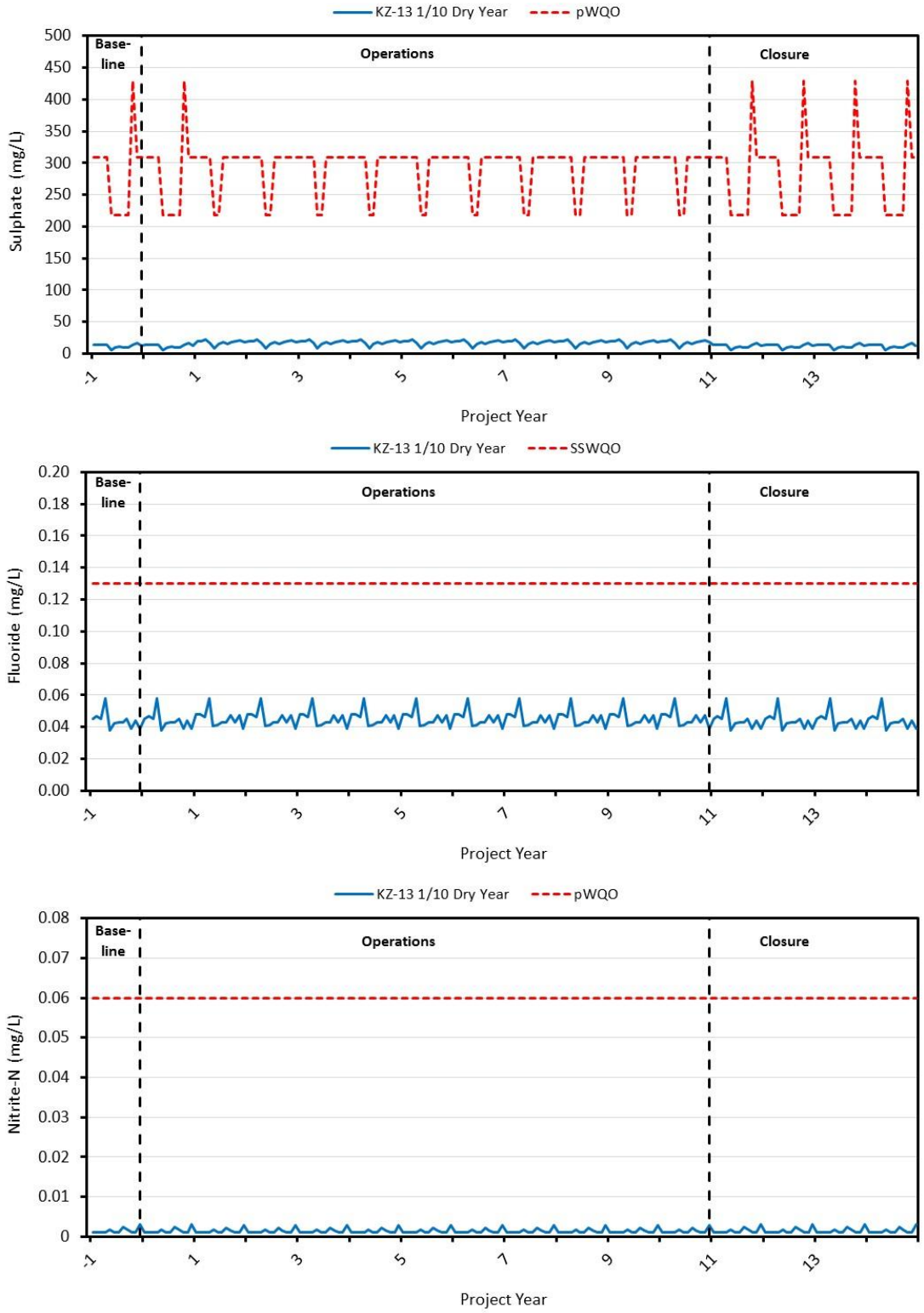


Figure 8-28: Model Estimated Concentrations of Sulphate, Fluoride, and Nitrite-N at site KZ-13 in South Creek in the 1/10 Dry Year Scenario

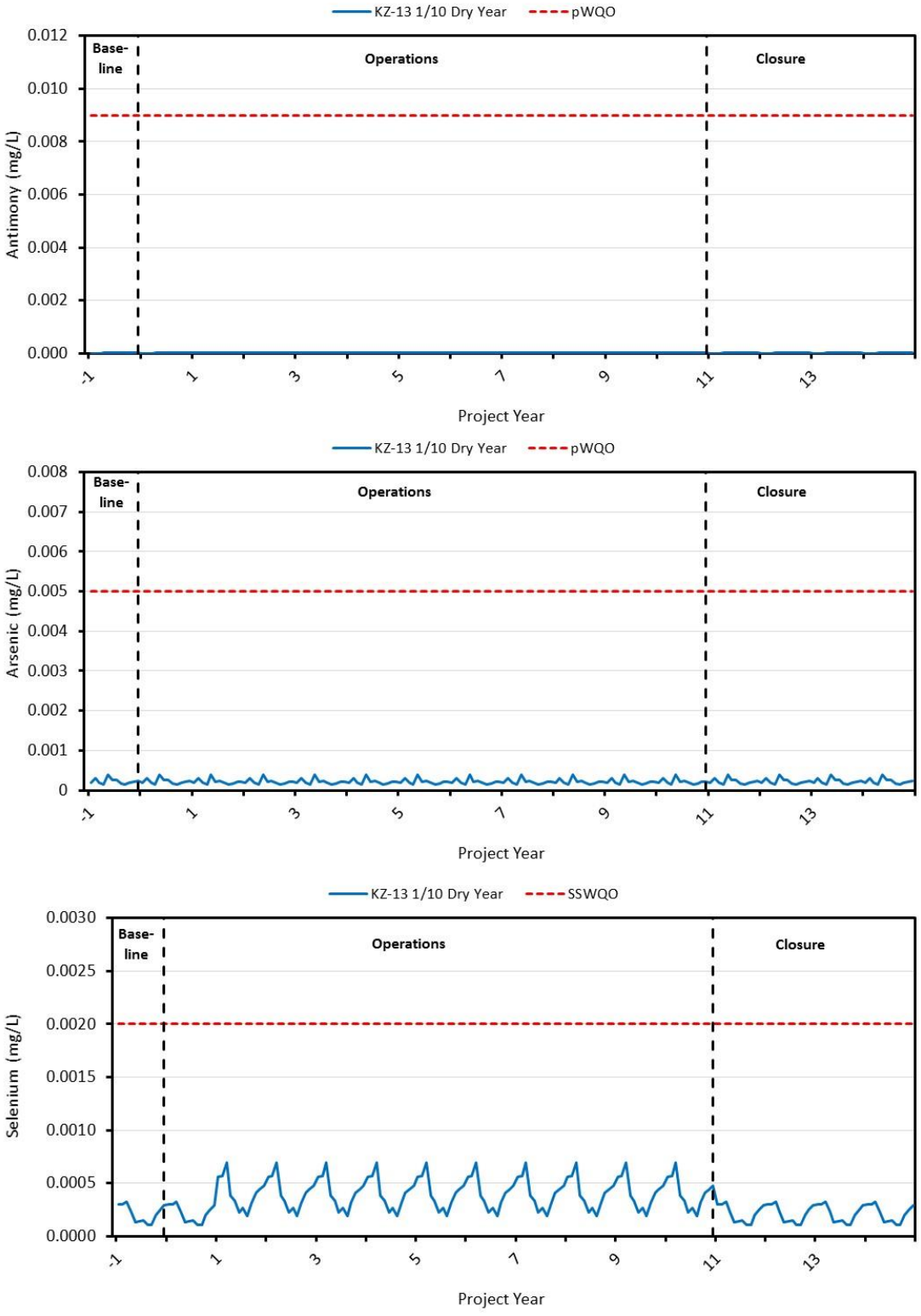


Figure 8-29: Model Estimated Total Concentrations of Antimony, Arsenic, and Selenium at site KZ-13 in South Creek in the 1/10 Dry Year Scenario

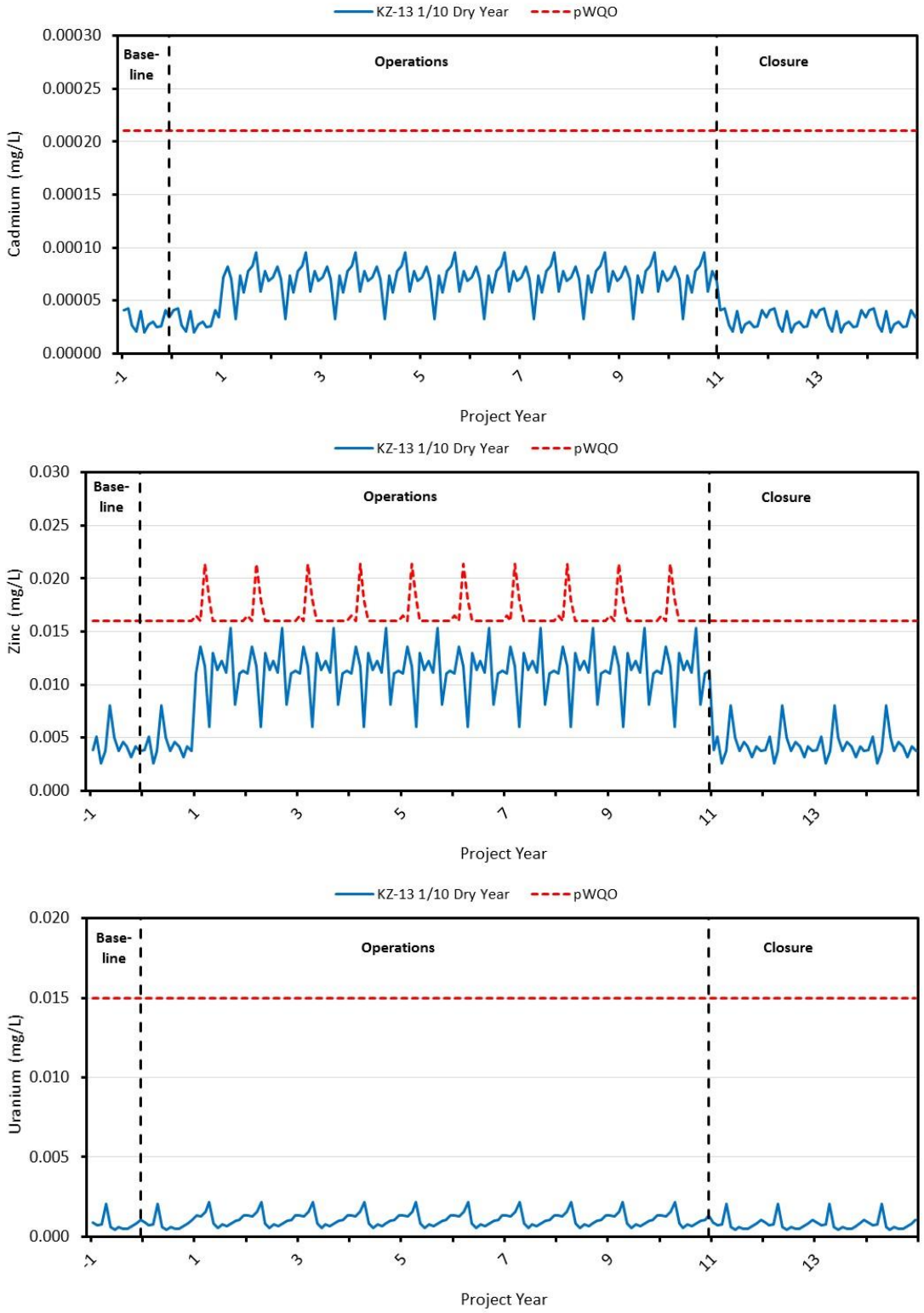


Figure 8-30: Model Estimated Total Concentrations of Cadmium, Zinc, and Uranium at site KZ-13 in South Creek in the 1/10 Dry Year Scenario

8.4.1.3 Changes in Surface Water Quantity and Quality as a Result of Water Diversions and Dewatering Activities during Construction

ABM Open Pit Dewatering During Construction

The proposed ABM open pit is located in the Geona Creek valley floor in a natural groundwater discharge area with a shallow groundwater table, local artesian conditions in the deeper bedrock aquifer, and vertical upward hydraulic gradients. The open pit will require dewatering to Geona Creek to allow development of the ABM Deposit and has the potential to have an effect on surface water quantity and quality.

Prior to the initial mine development, overburden drainage will be conducted by excavating a trench to the top of the fractured/weathered bedrock approximately along the alignment of the former Geona Creek watercourse. Based on borings, the trench is expected to be approximately 15 m to 20 m deep. Simulations have demonstrated that a trench excavated to the top of the weathered bedrock will permit efficient drainage of the overburden in the area of the proposed open pit. Excavation of the trench will begin near the northern-most extent of the ABM Zone in the form of a sump extending to bedrock and used to dewater the overburden. As water levels are reduced in the overburden by pumping from the sump, the trench will be further extended to the south along the channel of Geona Creek until it reaches the southern extent of the Krakatoa Zone part of the proposed open pit.

To more efficiently dewater the overburden, two trenches, approximately 300 m long, will be excavated west of the central drainage trench. The establishment of the trench, which will extend the entire length of the eventual pit, will minimize the likelihood of the overburden re-saturating as drainage paths will be kept as short as practicable. Permanent sumps will be established at the north and south ends of the trench to remove water on a continual basis. The water from the ABM open pit development dewatering activities will be directed to Pit Rim Pond prior to discharge into Geona Creek.

The dewatering rates during construction are presented in Table 8-11. The resulting percent change in runoff during the dewatering period for the receiving environment (Geona Creek, KZ-9, KZ-37 and KZ-17; Finlayson Creek, KZ-15 and KZ-26; South Creek, KZ-13) are presented in Table 8-12, Table 8-13, and Table 8-14 for the mean, 1/50 wet year, and the 1/10 dry year scenarios, respectively. The changes in discharge at Geona Creek (KZ-37), Finlayson Creek (KZ-15 and KZ-26) and South Creek (KZ-13) under the three precipitation scenarios are shown graphically in Figure 8-31, Figure 8-32, Figure 8-33 and Figure 8-34, respectively. The surface water quantity effects are greatest closest to the ABM open pit and during the winter months. The overall change for the construction period is a 9% increase at KZ-37, Geona Creek just below the Project footprint. There is a nominal 5% increase in Finlayson Creek flows below Geona Creek (KZ-15) and 2% at the Robert Campbell Highway (KZ-26). The effect of this change on surface water quantity on Geona Creek and Finlayson Creek will be low but more notable within Geona Creek. The potential effects to aquatic ecosystems and resources from the ABM open pit dewatering activities during construction are assessed in Section 10.4.

Table 8-11: Dewatering Rates for ABM Open Pit Overburden during Construction

Month	Mean Rate (m^3/d)	Mean Rate (m^3/month)
1	17,700	531,000
2	8,500	255,000
3	7,367	221,010
4	5,525	165,750
5	4,142	124,260
6-18	3,600	108,000

Table 8-12: Percent Change in Discharge during 18-Month Construction Period for Mean Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
July	34%	13%	4%	36%
August	14%	7%	2%	29%
September	9%	4%	2%	33%
October	13%	6%	2%	36%
November	17%	8%	3%	29%
December	26%	13%	4%	28%
January	42%	20%	7%	31%
February	56%	28%	9%	36%
March	90%	44%	14%	53%
April	20%	8%	3%	11%
May	-8%	-3%	-1%	32%
June	-7%	-3%	-1%	40%
July	-3%	-1%	0%	36%
August	-1%	-1%	0%	29%
September	-3%	-1%	-1%	33%
October	3%	1%	1%	36%
November	13%	7%	2%	29%
December	26%	13%	4%	28%
Mean	***19%***	***9%***	***3%***	***33%***

Table 8-13: Percent Change in Discharge during 18-Month Construction Period for 1/50 Wet Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
July	10%	5%	1%	25%
August	7%	3%	1%	26%
September	2%	1%	0%	29%
October	0%	2%	1%	47%
November	5%	5%	2%	38%
December	13%	9%	3%	37%
January	28%	16%	4%	39%
February	40%	21%	6%	46%
March	69%	35%	9%	68%
April	10%	5%	2%	11%
May	-11%	-4%	-2%	31%
June	-8%	-3%	-1%	30%
July	-3%	-2%	0%	25%
August	-5%	-2%	-1%	26%
September	-5%	-2%	-1%	29%
October	-9%	-1%	0%	47%
November	2%	4%	1%	38%
December	13%	9%	3%	37%
Mean	***9%***	***6%***	***2%***	***35%***

Table 8-14: Percent Change in Discharge during 18-Month Construction Period for 1/10 Dry Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
July	58%	27%	10%	40%
August	24%	12%	5%	33%
September	17%	9%	4%	36%
October	57%	13%	7%	40%
November	62%	16%	8%	32%
December	75%	24%	12%	31%
January	98%	37%	17%	34%
February	119%	49%	23%	40%
March	170%	78%	35%	58%
April	34%	11%	5%	11%
May	-7%	-3%	-1%	32%
June	-6%	-3%	-1%	42%
July	-1%	-1%	0%	40%

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
August	2%	1%	0%	33%
September	0%	0%	0%	36%
October	43%	5%	3%	40%
November	57%	13%	7%	32%
December	75%	24%	12%	31%
Mean	***49%***	***17%***	***8%***	***36%***

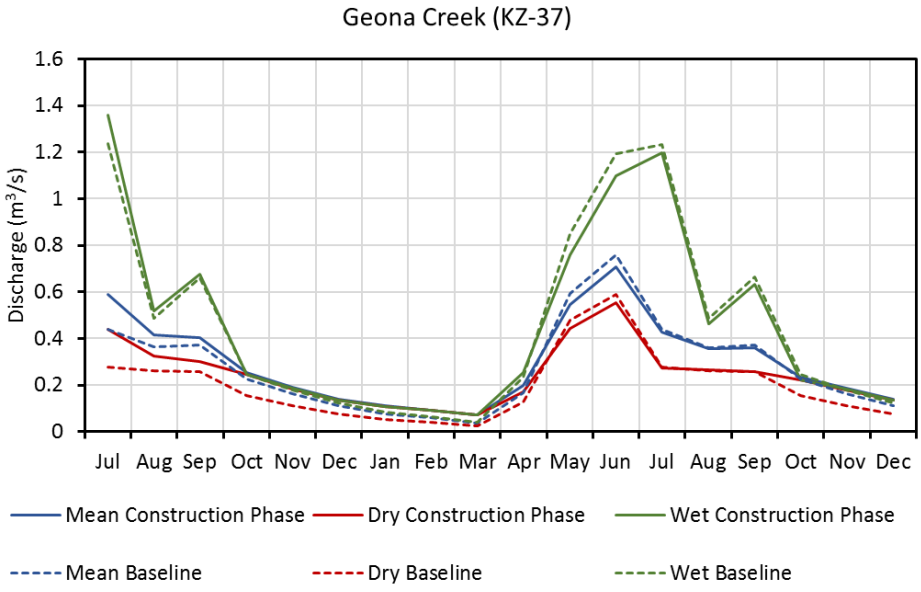


Figure 8-31: Modelled Baseline and Construction Phase Discharge Rates in Geona Creek (KZ-37) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

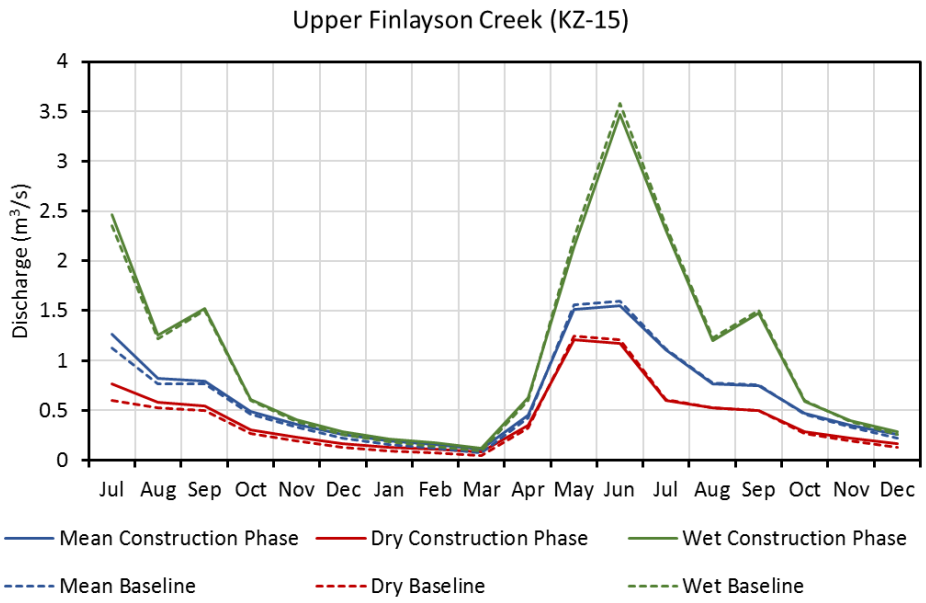


Figure 8-32: Modelled Baseline and Construction Phase Discharge Rates in Upper Finlayson Creek (KZ-15) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

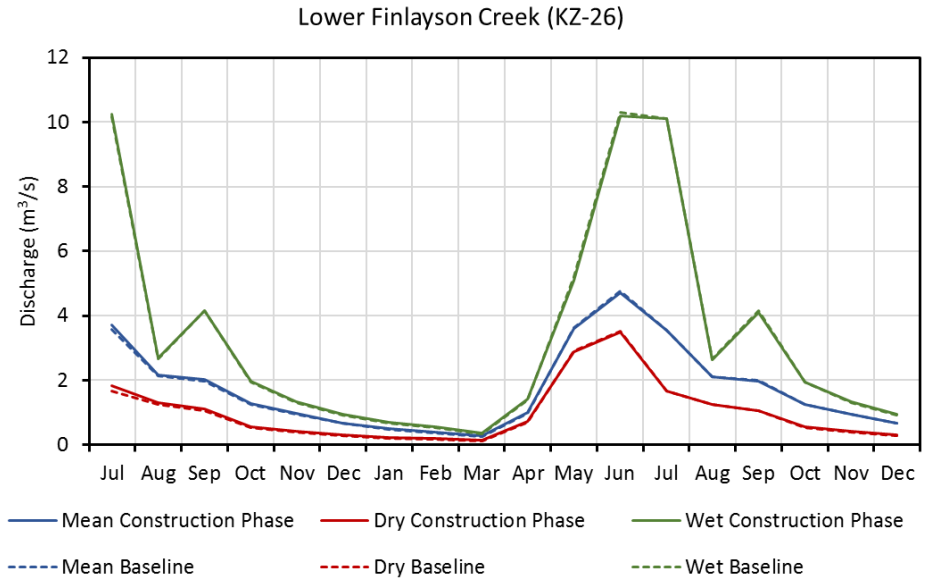


Figure 8-33: Modelled Baseline and Construction Phase Discharge Rates in Lower Finlayson Creek (KZ-26) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

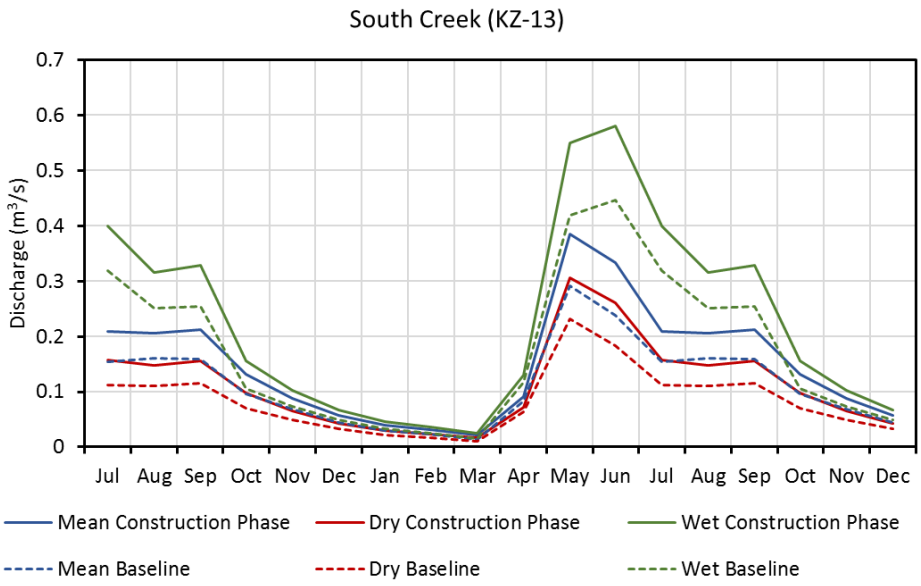


Figure 8-34: Modelled Baseline and Construction Phase Discharge Rates in South Creek (KZ-13) for Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

Water quality data from groundwater monitoring wells in the vicinity of the ABM open pit were used to calculate the additional load contributed from dewatering to Geona Creek. The average of water quality data from shallow bedrock (<50 m depth) and overburden wells was used to approximate the water quality from groundwater and surface pit dewatering (Table 8-15 and Figure 8-35). The water from the ABM open pit development dewatering activities will be directed to Pit Rim Pond to allow TSS to settle and allowed to equilibrate with atmospheric oxygen. Discharge from Pit Rim Pond to Geona Creek during construction will be required to meet the metal mining effluent regulations which includes standard for pH, TSS, arsenic, copper, lead, nickel, radium, and zinc and have a non-toxic designation.

The results for key water quality parameters are presented in Figure 8-7 to Figure 8-30 and the full set of results are presented in Appendix D-7. Based on the presented dewatering rates in Table 8-11 and the groundwater quality expected during construction, changes in surface water quality to Geona Creek and Finlayson Creek are predicted to be moderate in magnitude. During the constructions, COPI concentrations in the Geona Creek (KZ-37) and upper and lower Finlayson Creek (KZ-15 and KZ-26, respectively) receiving environment are estimated to be comparable to baseline levels. Only fluoride was estimated to marginally exceed its pWQO during the construction phase of the Project due to dewatered groundwater contributions, but only marginally in March for Geona Creek and upper Finlayson Creek (0.13 mg/L vs pWQO of 0.12 mg/L; Figure 8-7 and Figure 8-13).

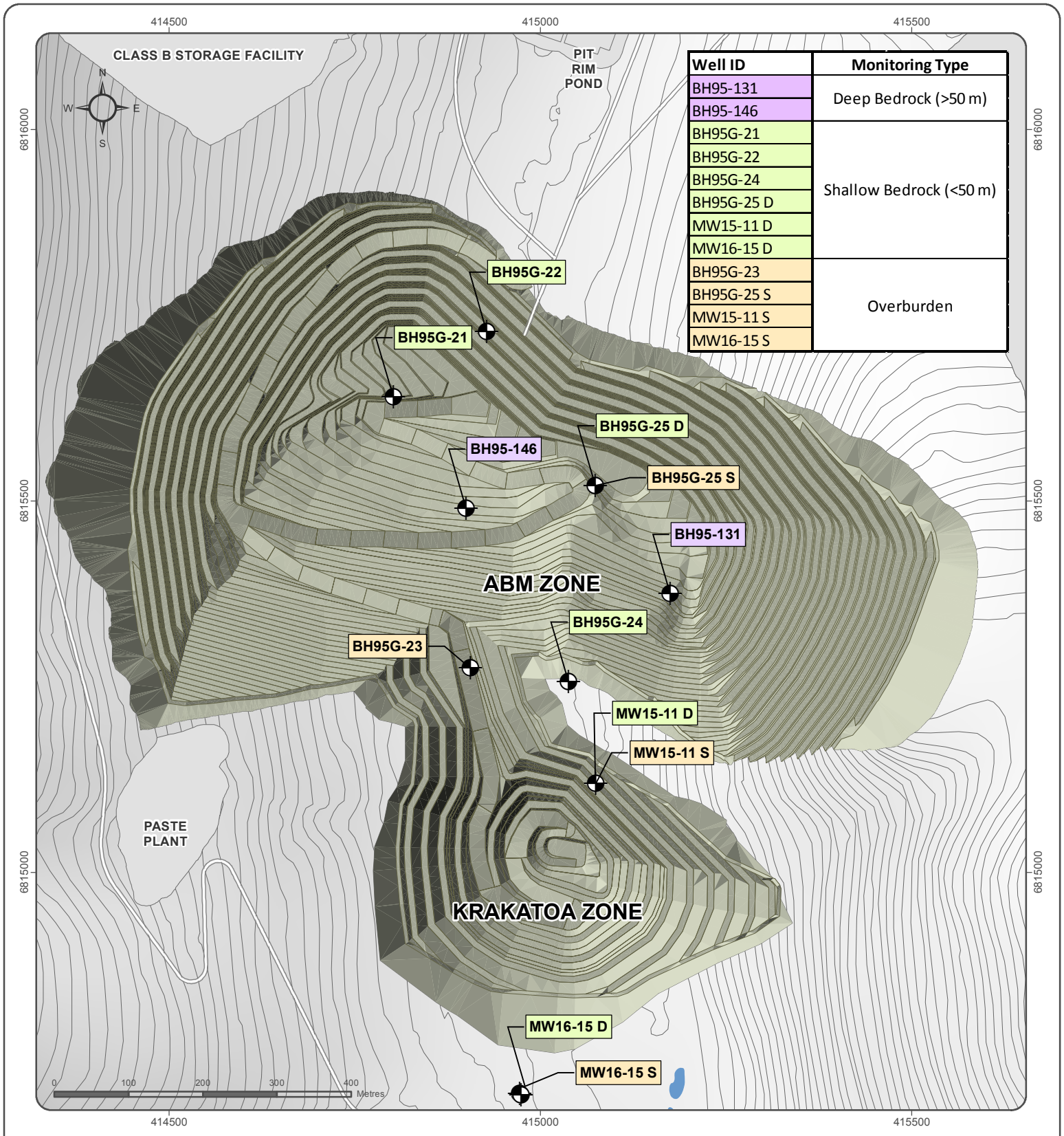
No constituents assessed were estimated to exceed Canadian drinking water guidelines in the publicly accessible lower Finlayson Creek (KZ-26) during the construction period.

Table 8-15: Groundwater Wells and Average Dissolved Groundwater Quality Data used in Water Quality Model (mg/L)

Parameter	Average Concentration (mg/L)	
	Deep Groundwater*	Shallow and Overburden**
Hardness	637	264
Sulphate	233	89
Nitrate-N	0.0015	0.0030
Nitrite-N	0.0010	0.0010
Ammonia-N	0.041	0.13
Fluoride	0.093	0.11
Dissolved Organic Carbon	1.0	2.3
Dissolved Aluminum	0.000705	0.0022
Dissolved Antimony	0.000688	0.000097
Dissolved Arsenic	0.0018	0.0010
Dissolved Cadmium	0.0000086	0.0000089
Dissolved Copper	0.00014	0.00013
Dissolved Iron	0.0034	0.0051
Dissolved Lead	0.00026	0.000013
Dissolved Manganese	0.14	0.26
Dissolved Nickel	0.00012	0.00075
Dissolved Silver	0.0000095	0.0000025
Dissolved Selenium	0.000020	0.000020
Dissolved Uranium	0.013	0.0045
Dissolved Zinc	0.0027	0.0031

*Wells used to calculate average concentrations for deep groundwater: BH95-131 and BH95-146.

** Wells used to calculate average concentrations for shallow groundwater: BH95-21, BH95-22, BH95-23, BH95-24, BH95-25S/D, MW16-15S/D, and MW15-11S/D .



Well ID	Monitoring Type
BH95-131	Deep Bedrock (>50 m)
BH95-146	
BH95G-21	Shallow Bedrock (<50 m)
BH95G-22	
BH95G-24	
BH95G-25 D	
MW15-11 D	
MW16-15 D	
BH95G-23	Overburden
BH95G-25 S	
MW15-11 S	
MW16-15 S	

Groundwater Monitoring Locations

ABM Open Pit

Location of Proposed Mine Infrastructure

ABM Open Pit Contour

Project Site Road

Contour (5 m Interval)

KUDZ ZE KAYAH PROJECT

FIGURE 8-35

GROUNDWATER MONITORING WELLS IN ABM OPEN PIT VICINITY

FEBRUARY 2017

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.
Datum: NAD 83; Projection: UTM Zone 9N

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(Last edited by: amatlashevska; 28/02/2017/09.47 AM)

Diversions during Construction

Diverting clean water around the Project is one of the main objectives of the surface water management plan. Reducing the volume of contact water requiring management and treatment is critical to the success of the water management strategy for the Project. The Project includes three major diversions (Figure 8-36), which will be constructed during the construction phase of the Project to minimize effects during operations. These diversions are expected to have a small effect to surface water quality when the mitigations identified by the Sediment and Erosion Control Plan are implemented (Section 18.6) and changes to surface water quantity are predicted to have a greater potential effect.

The Fault Creek and associated south diversions will re-route water that would otherwise flow into the ABM open pit and will divert it to South Creek. The northwestern diversion will route water above the Class A Storage Facility and the Class B Storage Facility past the water management ponds into Geona Creek at KZ-9. The northeastern diversion will redirect water above the Class C Storage Facility and Overburden Stockpile. The runoff from the Class C Storage Facility and Overburden Stockpile will also enter the northeastern diversion, which will be directed into Geona Creek at KZ-9 below the Lower Water Management Pond. The water balance has assumed the diversions have a 50% efficiency rating other than the Fault Creek diversion which has an assumed efficiency of 100% (Appendix C-7).

The modelled flows for Fault Creek and the south diversion are presented in Table 8-16 for the mean, 1/50 wet year, and 1/10 dry year scenarios. The modelled flows for the northwest and the northeast diversion are presented in Table 8-17 for the mean, 1/50 wet year and 1/10 dry year scenarios. The percent change in runoff from baseline during this period is presented in Table 8-12, Table 8-13, and Table 8-14 above. The north diversions are expected to have a low magnitude effect on discharge below the Project Footprint during construction, but the south diversions will increase discharge in South Creek by 35% during this period resulting in a high magnitude effect. The diversions will potentially affect aquatic habitat and those effects are discussed in Section 10.4.

Table 8-16: South Diversion and South Creek Flows

Month	Mean (m^3/month)		1/50 Wet Year (m^3/month)		1/10 Dry Year (m^3/month)	
	KZ-13	South Diversion	KZ-13	South Diversion	KZ-13	South Diversion
Oct	324,668	66,000	387,460	105,000	235,491	59,000
Nov	199,886	26,000	237,065	57,000	142,166	32,000
Dec	125,773	26,000	150,775	45,000	86,324	25,000
Jan	78,544	20,000	96,025	34,000	51,478	19,000
Feb	50,005	12,000	63,092	23,000	31,000	13,000
Mar	29,871	11,000	41,331	21,000	15,668	12,000
Apr	211,065	23,000	310,214	40,000	157,795	26,000
May	1,002,481	117,000	1,442,976	242,000	791,770	176,000
Jun	836,316	113,000	1,479,819	158,000	647,570	102,000

Month	Mean (m^3/month)		1/50 Wet Year (m^3/month)		1/10 Dry Year (m^3/month)	
	KZ-13	South Diversion	KZ-13	South Diversion	KZ-13	South Diversion
Jul	533,633	123,000	1,042,423	106,000	395,811	63,000
Aug	525,313	104,000	818,620	135,000	368,866	76,000
Sep	522,116	96,000	823,502	148,000	379,108	83,000
Total (m^3/year)	***4,439,673***	***737,000***	***6,893,301***	***1,114,000***	***3,303,046***	***686,000***

Table 8-17: Northwest and Northeast Diversion Flows

Month	Mean (m^3/month)	1/50 Wet Year (m^3/month)	1/10 Dry Year (m^3/month)
October	89,000	126,000	71,000
November	44,000	63,000	36,000
December	30,000	41,000	24,000
January	23,000	31,000	18,000
February	17,000	25,000	14,000
March	17,000	25,000	14,000
April	38,000	55,000	31,000
May	321,000	458,000	257,000
June	334,000	475,000	266,000
July	186,000	263,000	148,000
August	156,000	221,000	123,000
September	164,000	232,000	130,000
Total (m^3/year)	***1,419,000***	***2,015,000***	***1,132,000***

Characterization of the potential surface water quality effects associated with the diversions during construction (and operations) is limited to the activity of the south diversion which includes the Fault Creek diversion. The northwest and northeast diversions are not discussed further as the water quality is estimated to remain consistent with baseline concentrations and the water is diverted to Geona Creek below the Lower Water Management Pond. The monthly median concentrations used for the south diversion are presented in Table 8-18.

The loading model results for South Creek (KZ-13) are presented in Figure 8-25 to Figure 8-30 and the full set of results are presented in Appendix D-7. Notable changes in South Creek water quality were modelled for cadmium, selenium and zinc due to the elevated baseline concentrations of these elements in Fault Creek relative to South Creek (the median concentrations of selenium, cadmium, and zinc in Fault Creek are approximately seven to eight fold higher than those of South Creek); however, despite the higher COPI concentrations in the diverted Fault Creek, no constituents were estimated to exceed their respective water quality objectives. As such, the predicted water quality effects of the south diversion to South Creek are of low magnitude.

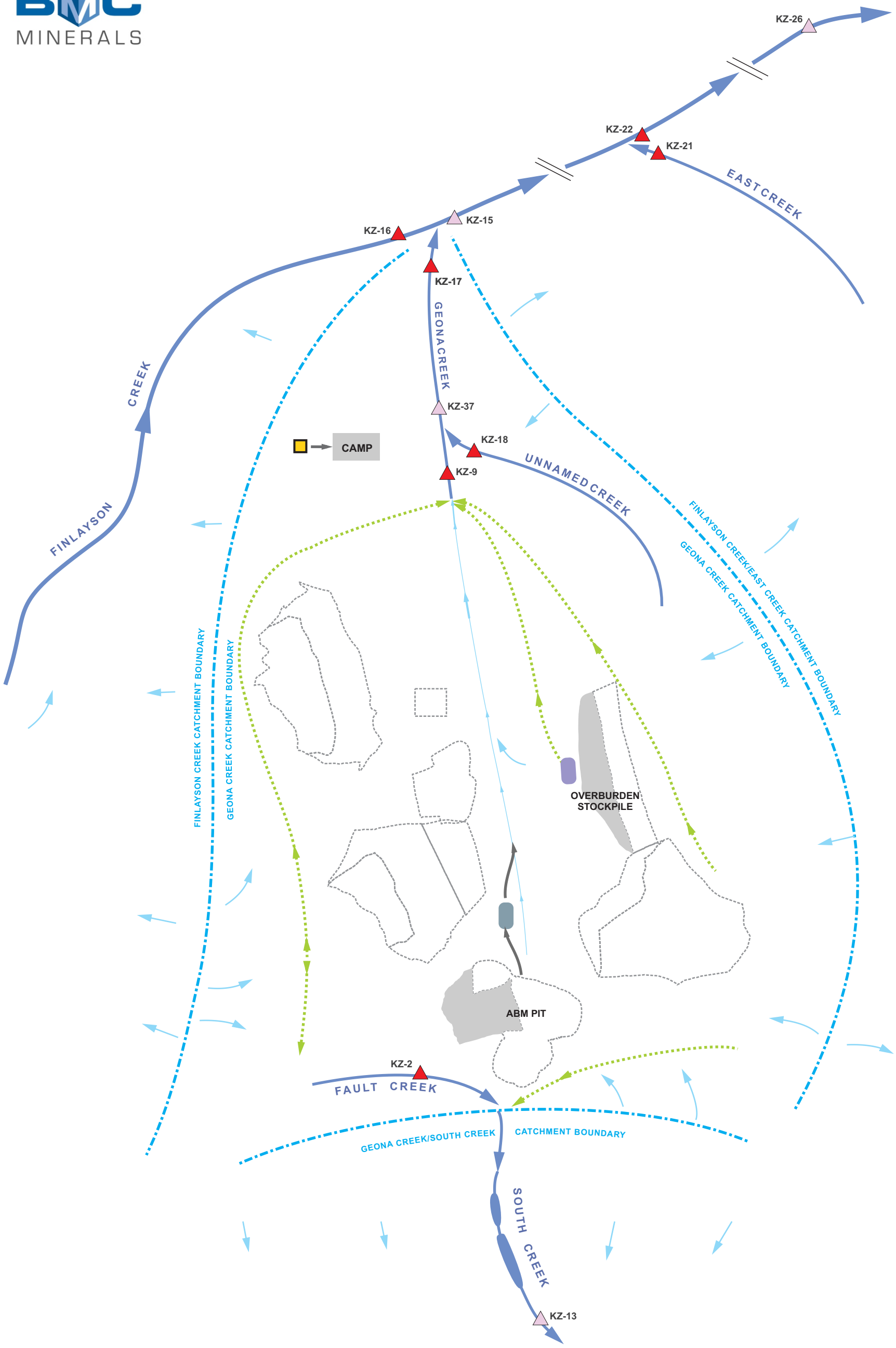
Similarly, no constituents were estimated to exceed drinking water guidelines in South Creek during the construction period. The water quality in Fault Creek itself will not be affected by the Project and will continue to meet drinking water guidelines for the constituents assessed at all phases of the Project. It should be noted that the assessment does not consider bacteriological parameters such as coliforms, which are often naturally present in most surface waters and require treatment to be suitable for drinking.

Table 8-18: South Diversion Monthly Median Concentrations of Select Parameters (mg/L)

Month	Hardness	Sulphate	Nitrate-N	Nitrite-N	Ammonia-N	P	F	Cl	Cyanide total	Cyanide, Weak Acid Dissociable	Al	Sb	As	Cd
January	129	53	0.16	0.0010	0.016	0.0010	0.051	0.25	0.00053	0.00062	0.0032	0.000020	0.000069	0.00022
February	127	53	0.17	0.0010	0.0064	0.0010	0.042	0.25	0.00025	0.00025	0.019	0.000033	0.00011	0.00024
March	133	51	0.16	0.0010	0.0079	0.0010	0.041	0.68	0.00025	0.00025	0.0030	0.000025	0.000076	0.00020
April	135	48	0.13	0.0025	0.016	0.0010	0.047	0.54	0.00025	0.00025	0.023	0.000030	0.000094	0.00020
May	80	25	0.10	0.0010	0.016	0.0036	0.044	0.66	0.00063	0.00025	0.048	0.000031	0.00012	0.00019
June	68	28	0.08	0.0010	0.0025	0.0010	0.037	0.47	0.00058	0.00050	0.014	0.000029	0.000096	0.00021
July	86	37	0.07	0.0010	0.016	0.0029	0.036	0.25	0.00025	0.00045	0.022	0.000025	0.00010	0.00024
August	91	40	0.11	0.0010	0.0025	0.0041	0.034	0.42	0.00025	0.00050	0.025	0.000038	0.00023	0.00035
September	101	50	0.13	0.0010	0.0051	0.0010	0.038	0.52	0.00066	0.00060	0.011	0.000022	0.000073	0.00031
October	101	44	0.13	0.0010	0.0054	0.0024	0.035	0.41	0.00025	0.00025	0.018	0.000022	0.00010	0.00020
November	112	48	0.13	0.0021	0.0025	0.0010	0.058	5.4	0.00025	0.00025	0.0072	0.000026	0.000077	0.00021
December	116	47	0.16	0.0030	0.0037	0.0013	0.037	0.25	0.00025	0.00025	0.0063	0.000028	0.000056	0.00023

Month	Cu	Fe	Pb	Mn	Ni	Ag	Se	U	Zn	Dissolved Organic Carbon	Alkalinity	Ca	Mg
January	0.00053	0.005	0.000028	0.00010	0.00026	0.0000025	0.0021	0.0044	0.029	0.80	79	42	6.2
February	0.00087	0.052	0.00055	0.0021	0.00031	0.0000025	0.0021	0.0045	0.029	0.25	85	41	6.0
March	0.00043	0.002	0.000021	0.000025	0.00025	0.0000025	0.0022	0.0049	0.023	1.0	88	42	6.6
April	0.0010	0.061	0.00050	0.0010	0.00049	0.0000025	0.0028	0.0053	0.024	1.0	89	44	7.1
May	0.0029	0.071	0.00037	0.0021	0.00058	0.0000025	0.0013	0.0019	0.024	2.5	57	29	3.8
June	0.00083	0.021	0.00011	0.00093	0.00035	0.0000025	0.0004	0.0011	0.034	0.93	41	25	2.1
July	0.00081	0.025	0.000083	0.00092	0.00035	0.0000025	0.00050	0.0015	0.040	1.1	51	31	2.9
August	0.0011	0.022	0.00020	0.00080	0.00050	0.0000050	0.00047	0.0015	0.042	1.4	48	32	2.8
September	0.00073	0.016	0.000072	0.00050	0.00050	0.0000025	0.00067	0.0020	0.047	0.53	49	35	3.3
October	0.00061	0.035	0.00015	0.0014	0.00033	0.0000025	0.0011	0.0026	0.027	1.2	57	34	3.8
November	0.00050	0.0094	0.000033	0.00018	0.00027	0.0000025	0.0015	0.0031	0.025	0.54	63	37	4.8
December	0.00052	0.0059	0.00036	0.00051	0.00050	0.0000038	0.0016	0.0035	0.038	0.76	70	41	5.4

BMC MINERALS



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CONCEPTUAL DRAWING AND FOR ILLUSTRATION PURPOSES ONLY; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

- Surface Water Monitoring Station
- Modelled Location
- Groundwater Well
- Storage Facility Collection Pond
- Pit Rim Pond
- Year 1 Mine Feature Footprint
- Year 10 Mine Feature Footprint
- Pipeline
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant

KUDZ ZE KAYAH PROJECT

FIGURE 8-36
CONSTRUCTION WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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8.4.1.4 Changes in Surface Water Quantity and Quality as a Result of Water Management and Discharge during Operations

Operations of ABM Open Pit and Underground Workings

The operations phase of the ABM open pit and underground workings requires dewatering activities as the mine workings are advanced. This activity has the potential to affect surface water quality and quantity due to discharging additional water collected from the mine workings and discharge from mine contact water to Geona Creek and Finlayson Creek.

Dewatering of the underlying weathered/fractured bedrock will be a longer-term sustained process (starting during the construction period and extending through to year 10), but one which will not benefit from systematic active dewatering of the general bedrock area. Initial simulations of weathered-bedrock dewatering using various configurations of dewatering wells showed that the permeability of the weathered bedrock is low enough that dewatering wells would have a very limited radius of dewatering influence in which the tight cone-of-depression would result in drawdown of about 5 m extending only 25 to 50 m from the pump location. This means that for dewatering of the weathered/fractured rock to be efficacious, a large number of wells would potentially need to be bored which is unlikely to be cost effective.

Instead, the modified conceptual dewatering strategy for bedrock consists of a combination of fault-zone dewatering wells and a system of horizontal drains within the pit for dewatering and pit-wall depressurization. Dewatering wells are planned to intersect each of the three major fracture zones associated with the East Fault, the northwest Fault and Fault Creek Lineation. Each of these wells will be drilled to a depth of 150 m to 200 m. The conceptual configuration of the groundwater model predicts that these wells should each be pumped at a rate of 20 gallons per minute (US gpm) (109 m^3/d) to 40 US gpm (218 m^3/d) for the six months of initial dewatering. As each of these faults is anticipated to represent a significant contribution of water flow to the pit, an early strategy of dewatering will likely result in less flow to the pit during later years. After the initial dewatering period, the rate at which each of these wells can be pumped will decrease as the saturated thickness of bedrock declines. Higher permeability and more extensive fracture zones will likely produce water at the higher end of this range.

The in-pit dewatering strategy is essentially unchanged from that originally proposed by Golder Associates Ltd. (1996). Competent bedrock will drain naturally through the high wall and end wall of the ABM open pit. Horizontal drain holes will be installed in areas of high pore pressure or structural instability. Competent, unfractured bedrock is not anticipated to generate significant rates of seepage due to its low permeability; however, it is anticipated that zones of fracturing are likely to be present and represent sources of higher rates of flow. Installation of horizontal drains in these zones will be used to dissipate the hydraulic head as necessary. Drainage from the walls and horizontal drains will be conveyed to sumps located on each of the bench levels and at the pit floor. Collected water will be pumped from the sumps to the surface where it can be routed to the water treatment or storage facilities.

As in the strategy for in-pit dewatering, the dewatering strategy for the underground workings will involve the collection of seepage water augmented by horizontal drains, as needed, to reduce bedrock saturation near the tunnel face in the event of elevated flow rates or structural instability. Drainage from the walls and horizontal drains will be conveyed to a series of sumps to be located at the deepest level of the workings. The water pumped from the ABM open pit and underground workings will be sent to the Pit Rim Pond where it will settle TSS before either being sent to the Process Plant Facility, Paste Plant, or to the Upper Water Management Pond before being discharge via the Lower Water Management Pond to the receiving environment.

The pumping rates from the ABM open pit and underground workings during operations (year10) are presented in Table 8-19.

Table 8-19: ABM Open Pit and Underground Working Pumping Rates during Operations (year 10)

Month	Underground Workings (m^3/month)	ABM Open Pit Dewatering (m^3/month)		
	Groundwater	Groundwater	Surface Water	Total
Jan	141,000	44,000	12,000	196,000
Feb	141,000	44,000	9,000	194,000
Mar	141,000	44,000	10,000	194,000
Apr	141,000	44,000	31,000	215,000
May	141,000	44,000	231,000	415,000
Jun	141,000	44,000	243,000	427,000
Jul	141,000	44,000	129,000	314,000
Aug	141,000	44,000	110,000	294,000
Sep	141,000	44,000	112,000	296,000
Oct	141,000	44,000	51,000	235,000
Nov	141,000	44,000	23,000	207,000
Dec	141,000	44,000	15,000	200,000
Annual (m^3/year)	1,692,000	528,000	976,000	3,187,000

The effect of dewatering the ABM open pit and underground workings during operations is an overall increase in surface water quantity in the LSA, but the effect on Geona Creek downstream of the Project footprint is a decrease in runoff due to the south diversions and the management of contact water such that a portion is piped to Finlayson Creek, thus bypassing lower Geona Creek. Table 8-20, Table 8-21, and Table 8-22 present the modelled monthly percent change from baseline for runoff in Year 10 of operations for the mean, 1/50 wet, and 1/10 dry scenarios, respectively. These represent the maximum effect with an expected gradual transition from the effects during the construction phase to the maximum operations effect over the course of the operations period. The modelled reduction in runoff at KZ-37 in the final year of operations when the effect is the greatest is a 46% decrease in runoff for a mean year and is high magnitude, whereas KZ-15 is modelled to increase by 10% and KZ-26 by 5% in a mean year resulting in a low magnitude effect. The effect on South Creek

is still an increase, as during construction dewatering, but reduced by the drawdown of the ABM open pit and underground workings to a 24% increase in runoff and a high magnitude effect. The potential effect on aquatic ecosystems and resources due to the changes in water quantity are discussed in Section 10.4.

Table 8-20: Percent Change in Discharge during Year 10 of Operations for Mean Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
Oct	-48.1%	12.1%	6.2%	25.7%
Nov	-53.7%	8.0%	4.4%	13.8%
Dec	-54.1%	8.0%	4.0%	5.3%
Jan	-52.8%	8.3%	3.8%	-3.3%
Feb	-52.1%	8.6%	3.6%	-9.5%
Mar	-45.4%	13.4%	4.8%	-20.5%
Apr	-55.8%	4.5%	5.7%	-1.8%
May	-40.7%	10.6%	8.0%	28.0%
Jun	-45.0%	10.8%	4.6%	36.0%
Jul	-46.5%	9.0%	2.0%	29.7%
Aug	-46.1%	12.4%	6.4%	22.2%
Sep	-44.8%	13.9%	7.6%	26.1%
Mean	-46.3%	10.4%	5.3%	23.5%

Table 8-21: Percent Change in Discharge during Year 10 of Operations for 1/50 Wet Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
Oct	-43.0%	2.6%	1.1%	37.3%
Nov	-50.1%	2.8%	1.0%	23.6%
Dec	-51.3%	2.2%	0.6%	15.6%
Jan	-50.0%	2.5%	0.5%	8.2%
Feb	-47.2%	4.0%	0.6%	4.6%
Mar	-38.2%	8.1%	1.5%	0.7%
Apr	-55.7%	1.7%	4.3%	2.0%
May	-40.8%	7.9%	7.0%	28.8%
Jun	-47.1%	-3.9%	-0.3%	28.2%
Jul	-56.9%	-1.4%	-2.2%	21.6%
Aug	-44.9%	6.7%	7.6%	21.8%
Sep	-49.9%	5.5%	3.3%	25.1%
Mean	-48.9%	1.8%	1.4%	23.9%

Table 8-22: Percent Change in Discharge during Year 10 of Operations for 1/10 Dry Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
Oct	-41.4%	38.5%	24.3%	25.1%
Nov	-47.6%	34.0%	21.1%	11.1%
Dec	-48.3%	34.1%	20.3%	-0.8%
Jan	-47.2%	34.7%	19.8%	-13.0%
Feb	-45.7%	36.5%	19.8%	-23.0%
Mar	-37.6%	42.8%	21.8%	-42.7%
Apr	-54.3%	10.2%	9.1%	-5.3%
May	-40.6%	14.4%	9.6%	27.2%
Jun	-44.2%	16.7%	6.9%	35.9%
Jul	-41.1%	17.1%	7.5%	30.4%

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
Aug	-44.1%	18.0%	10.3%	23.5%
Sep	-42.0%	19.2%	13.0%	27.3%
Mean	-43.6%	19.2%	10.5%	22.5%

The use of nitrogen-based explosives is a source of nitrogen compound(s) that could be released to the environment and have the potential to affect surface water quality. Nitrate (NO_3), ammonia (NH_3) and nitrite (NO_2, an oxidation product of NH_3) could accumulate in the ABM open pit and/or on blasted waste rock, as a result of blasting. These constituents are readily soluble when contacted with infiltration and runoff water. The concentration of residual nitrogen leftover from blasting activities depends on the quantity and type of explosive used and the efficiency with which nitrogen is consumed during blasting.

The amount of explosives used by year and tonnage of Class A, B, and C waste rock is provided in Table 8-23 and the resulting predicted annual nitrogen loads are presented in Table 8-24. Water quality modelling for Geona Creek and Finlayson Creek did not return any pWQO exceedances for nitrogen species during operations for any precipitation scenario (Figure 8-7 to Figure 8-22; Appendix D-7).

Table 8-23: Anticipated Explosives Use and Estimated Waste Production by Year

	Explosives Used (tonnes)	Waste Rock Production (tonnes)		
		Class A	Class B	Class C
Year -1	2,942	584,300	2,381,900	3,413,400
Year 1	5,591	687,300	3,796,700	5,246,400
Year 2	6,142	1,142,200	6,482,000	7,218,100
Year 3	6,351	1,583,700	7,583,900	10,294,100
Year 4	5,395	1,563,600	5,656,200	6,444,300
Year 5	4,936	1,310,600	3,675,500	8,854,400
Year 6	3,695	1,025,300	2,889,000	7,248,500
Year 7	1,704	859,600	3,445,700	6,314,300
Year 8	838	1,037,300	4,208,500	4,482,800
Year 9	235	1,341,500	5,418,200	3,722,000
Year 10	31	481,100	1,945,000	730,400
Total	37,859	11,616,600	47,482,800	63,968,700

Table 8-24: Annual Nitrogen Loading to Storage Facilities, Nitrogen Load Stored in Storage Facility at Year's end and Nitrogen Load Released

	Class A			Class B			Class C		
	Load to Facility (kg N)	Load Stored (kg N)	Load Released (kg N)	Load to Facility (kg N)	Load Stored (kg N)	Load Released (kg N)	Load to Facility (kg N)	Load Stored (kg N)	Load Released (kg N)
Year 1	1,441	1,441	-	5,105	5,105	-	10,918	10,918	-
Year 2	2,033	2,971	503	8,563	11,747	1,920	22,594	31,952	1,561
Year 3	1,832	4,076	727	8,955	17,645	3,057	25,679	54,583	3,047
Year 4	2,901	5,917	1,060	12,562	25,621	4,586	22,242	72,368	4,457
Year 5	1,317	5,977	1,257	12,176	31,593	6,205	18,538	85,524	5,382
Year 6	1,170	5,925	1,222	7,026	32,008	6,611	21,106	100,231	6,399
Year 7	1,358	6,023	1,260	5,812	31,139	6,681	14,763	107,780	7,214
Year 8	894	5,697	1,220	2,466	27,571	6,034	6,758	107,263	7,275
Year 9	698	5,269	1,126	1,620	23,933	5,258	2,655	102,845	7,073
Year 10	-	4,299	970	-	19,531	4,402	506	96,650	6,700
Year 11	-	3,507	792	-	15,939	3,592	-	90,384	6,266
Year 12	-	2,861	646	-	13,007	2,932	-	84,525	5,860
Year 13	-	2,334	527	-	10,615	2,392	-	79,045	5,480
Year 14	-	2,311	23	-	9,893	722	-	73,920	5,125
Year 15	-	2,288	23	-	9,221	672	-	69,128	4,792
Year 20	-	2,176	22	-	6,485	473	-	49,443	3,428
Year 25	-	2,070	21	-	4,561	333	-	35,363	2,452
Year 30	-	1,969	20	-	3,208	234	-	25,293	1,753
Year 35	-	1,873	19	-	2,256	165	-	18,090	1,254
Year 36	-	1,854	19	-	2,103	153	-	16,918	1,173

The water quality from the ABM open pit was calculated considering the constituent loading from:

- Pit wall runoff;
- Accumulated pit wall load released once submerged during flooding of the pit;
- Groundwater inflow; and
- Baseline surface flow.

The loads from pit walls were determined based on geodomain-specific source terms developed from geochemical test results (Appendix D-5) and the estimated planar area of each geodomain on the exposed pit wall. The groundwater inflows by year were determined by the Hydrogeology Model Report (Appendix D-4). Groundwater loads were calculated based on baseline groundwater concentrations as shown in Table 8-15 (Appendix D-4). Surface flow was based on baseline water quality acquired at monitoring stations in the vicinity of the proposed ABM open pit. Concentrations in the pit were calculated by summing input loads and dividing by the water volume in the pit.

The water pumped from the ABM open pit and underground workings will be sent to the Pit Rim Pond where it will settle TSS before either being sent to the Process Plant Facility, Paste Plant, or to the Upper Water Management Pond before being discharged via the Lower Water Management Pond to the receiving environment.

Class A and B Storage Facilities and Associated Collection Ponds during Operations

Tailings and waste rock will be separated depending on their geochemical characteristics and potential to produce acid drainage and/or neutral metal leaching potential. The testwork completed for the identification of the different classes of waste rock is presented in Appendix D-5.

Class A waste rock is defined as strongly potentially acid generating (PAG) and metal leaching over the short term. This material will be placed in the Class A Storage Facility with controlled drainage during operations and will be progressively reclaimed (encapsulated) as the waste storage facility is developed to minimize contact with oxygen.

Class B waste rock is defined as PAG with metal leaching potential over the long-term (after cessation of mining activities). Storage of this material will require controlled drainage during operations, and will be progressively reclaimed (encapsulated).

Class C waste rock is defined as non-PAG and having low metal leaching potential. This material is suitable for construction purposes around the Project area as well as capping material for progressive reclamation during operations and closure requirements. Geochemical test work indicated minimal concern with respect to contact water quality (Appendix D-5) from Class C material, therefore possible seepage from the Class C Storage Facility is not further discussed here.

Based on the above definitions, the Class A and B Storage Facilities have the potential to affect surface water quality directly through runoff water quality collected in the Class A and B Storage Facilities and indirectly affect surface water quality via potential seepage from the Class A and B Storage Facilities.

The following paragraphs discuss the potential for seepage from the Class A and B Storage Facilities described in the groundwater chapter, Section 9.4.1.5:

> *Potential seepage from both Class A and Class B Storage Facilities has the potential for adverse effects on surface water quality underneath and downgradient of these facilities. However, since both facilities will be constructed with low permeability compacted till liners and lined drainage collection ponds, it is expected that any effects on groundwater quality due to seepage from these facilities is very unlikely. In addition, the progressive reclamation of the Class A and Class B Storage Facilities (that includes a low permeability till layer and engineered low permeability cover as a seepage barrier) will further reduce the low likelihood of seepage from the facilities into the underlying aquifer with associated effects on groundwater quality.*
>
> *In the case of potential leakage of the low permeability liners of the Class A and Class B Storage Facilities or the associated drainage canals and collection ponds, the flow paths of potentially affected groundwater was evaluated using the numerical flow model. Figure 9-10 shows the simulated flow paths of groundwater underneath and downgradient of the Class A and B Storage Facilities post closure conditions. It should be noted that the flow paths will be very similar during the operational phase of the Project, with the exception that some of the groundwater*

from the southern part of the Class B Storage Facility will flow toward and into the open pit or underground workings where it will be extracted as part of the dewatering of the mine workings.

As is apparent from Figure 9-10, groundwater from the Class A and Class B Storage Facilities flows toward Geona Creek and/or the Water Management Ponds during mine operations. Except for groundwater from the northernmost part of the Class A Storage Facility which may discharge to Geona Creek downstream of the Lower Water Management Pond. Potentially affected groundwater by leakage from the Class A and Class B Storage Facilities will be collected in the Water Collection Ponds at each facility and treated as necessary before it is discharged to the Water Management Ponds and eventually released into the receiving environment.

The Class A and Class B Storage Facilities have each been designed with collection ponds to both store storm event water and provide settling of solids prior to water conveyance to other facilities or prior to discharge. The Class A and Class B Storage Facility Collection Ponds will be constructed with high density polyethylene (HDPE) liners. The ponds have been sized to manage a 1 in 200-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. The pond design specifications are provided in Table 8-25, which identifies their volume, design criteria freeboard and liner type.

Table 8-25: Pond Design Specifications

Parameter	Class A Storage Facility Pond	Class B Storage Facility Pond	Lower Water Management Pond	Upper Water Management Pond	Pit Rim Pond
Volume	60,000 m^3	40,000 m^3	500,000 m^3	250,000 m^3	60,000 m^3
Design Criteria	1:200 year 24 hour storm event and freshet inflow	1:200 year 24 hour storm event and freshet inflow	1:200 year 24 hour storm event	1:200 year 24 hour storm event	1:100 year 24 hour storm event
Freeboard	1 m	1 m	1 m	1 m	1 m
Liner	HDPE	HDPE	HDPE	HDPE	HDPE

The receiving environment estimated median concentrations of selected constituents of interest in the Class A and B Storage Facility drainage are presented in Table 8-26 and Table 8-27, respectively, for the mean precipitation and 1/10 dry year scenarios. The 1/50 wet year has not been presented, however, the associated higher dilution for this scenario would result in lower concentrations than those listed in Table 8-26 and Table 8-27. Additional details on the model are described in Appendix D-7 (surface water quality model).

The water from the Class A and Class B Storage Facility Collection Ponds will be treated during operations to mitigate potential effects to surface water quality. The treated water from the Water Treatment Plant (WTP) may be used in the Process Plant Facility or will be sent to the Lower Water Management Pond for additional polishing, prior to discharge to the receiving environment. The potential effects of discharge from the Lower Water Management Pond are further discussed in Section 8.4.1.4.

Table 8-26: Estimated Median Class A Storage Facility Drainage Chemistry (mg/L)

Dissolved Constituent	Year 10	
	Mean Precipitation	1/10 Dry Year
Sulphate	2,150 [a]	2,263 [a]
Fluoride	0.78	0.89
Aluminum	0.0051	0.0058
Arsenic	0.0048	0.0055
Cadmium	0.062	0.070
Copper	0.0086	0.010 [a]
Iron	0.00047 [a]	0.00047 [a]
Manganese	0.22 [a]	0.23 [a]
Nickel	0.11	0.13
Lead	0.021	0.024
Antimony	0.012	0.013
Selenium	0.84	0.95
Uranium	0.0013	0.0015
Zinc	3.6	4.1

[a] Concentrations adjusted following equilibrium with gypsum (sulphate), malachite (copper), ferrihydrite (iron), and birnessite (manganese)

Table 8-27: Estimated Median Class B Storage Facility Drainage Chemistry (mg/L)

Dissolved Constituent	Year 10	
	Mean Precipitation	1/10 Dry Year
Sulphate	35	44
Fluoride	0.10	0.13
Aluminum	0.044	0.056
Arsenic	0.026	0.033
Cadmium	0.000050	0.000063
Copper	0.00068	0.00086
Iron	0.00041 [a]	0.00041 [a]
Manganese	0.071 [a]	0.073 [a]
Nickel	0.0014	0.0018
Lead	0.00016	0.00020
Antimony	0.023	0.029
Selenium	0.0025	0.0032
Uranium	0.011	0.014
Zinc	0.0032	0.0041

[a] Concentrations adjusted following equilibrium with ferrihydrite (iron) and birnessite (manganese)

Project Water Management and Treatment during Operations

The Project will have a positive water balance; therefore, active water management including water treatment and discharge to the receiving environment will be required. The discharge from the Lower Water Management Pond has the potential to affect the surface water quality in Geona Creek and Finlayson Creek due to its elevated concentrations of metals and nutrients from mine operations relative to the receiving environment. The Project water management strategy is illustrated in Figure 8-37. The strategy includes diverting as much clean water as practicable to minimize the volume of contact water requiring management within the Project footprint.

The goal of the water management plan is to re-use water within the Project to the maximum practicable extent. Surplus water will be stored on site within the Upper and Lower Water Management Ponds and used in the Process Plant (as required), with the excess water being released to Geona Creek and the remainder piped directly to Finlayson Creek (to meet the proposed discharge ratios to both water sources as discussed below).

The key components of the operations water management strategy are summarised below:

- Ditches and diversions will be established during the construction phase and will be maintained through operations. Three main diversions will be constructed, including the south diversion, northwest diversion, and northeast diversion (Figure 8-37);
- Runoff from the Class A, Class B, and Class C Storage Facilities will be collected in a pond at the base of each storage facility. The routing of the water from each facility will be based on its quality;
- A water treatment plant will be in place to treat excess water as required to maintain dischargeable water quality in the Lower Water Management Pond;
- The water treatment plant will have the design capacity to treat Class A Storage Facility collection pond water as well as water from other less impacted sources such as the Class B Waste Storage Facility or ABM open pit water;
- The Class C Storage Facility and Overburden Stockpile runoff water will be conveyed from their collection ponds directly to Geona Creek downstream of the Lower Water Management Pond as it is predicted to be of similar or better than the water discharged from the Lower Water Management Pond (Appendix D-8);
- A two-stage water management pond will be constructed in the Geona Creek valley, where the Upper Water Management pond will be used to manage contact water (as required) and the Lower Water Management Pond will be used for settling and polishing prior to discharge to the receiving environment;
- Water will be discharged to both Geona Creek and Finlayson Creek at established water quality discharge standard concentrations and at discharge volume ratios no less than 3:1 (receiving water volume: effluent volume) for Geona Creek at KZ-37 and 2:1 for Finlayson Creek at KZ-15 to meet water quality objectives in the receiving environment. Energy dissipation structures, such as rip rap channels, will be constructed below the discharge locations to both Geona and Finlayson Creeks; and

- Groundwater and surface water intercepted during the construction and operation of the ABM open pit will be collected and pumped to the pit rim pond. The water will be conveyed to Geona Creek during construction or used for dust suppression. During operations the pit rim pond water may be conveyed to the Process Plant for use or to the Upper Water Management Pond prior to the release to the receiving environment.

Water use for the Process Plant will be 240,000 m^3 per month from surface water sources which include treated water from the WTP, Pit Rim Pond, and the Upper Water Management Pond. Water will also be required for other components of the mine operations including dust suppression and wash bays. Dust suppression will utilize water the Lower Water Management Pond. The water quality of the Lower Water Management Pond will be monitored regularly to ensure suitable quality for use. Dust suppression will only be required during the snow free months and would only occur as required to maintain air quality for the Project.

The WTP will be constructed at the Process Plant Facility and designed to treat:

- Class A contact water from the Class A Storage Facility collection pond;
- Class B contact water from the Class B Storage Facility collection pond; and
- Runoff from the Process Plant Facility site collected in the perimeter sumps, including Low Grade Ore (LGO) and Run of Mine Ore (ROM) stockpile contact water.

The WTP will have additional capacity to treat ABM open pit dewatering, if required. The treatment will consist of pH adjustment, clarification, and any other processes that may be required to bring the water to a suitable standard for discharge to the environment. Additionally, a second stage process will be added to treat selenium such as reverse osmosis or biological treatment. The treated effluent will be discharged to the Lower Water Management Pond final polishing before discharge to the receiving environment or may be used in the Process Plant circuit.

The Overburden Stockpile and Class C Storage Facility Collection Ponds will be constructed with a compacted glacial till (low permeability) liner. The ponds have been designed to provide 30 days storage capacity from seepage, surface runoff for the 1 in 10-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. Flow from the ponds will be conveyed downstream of the Lower Water Management Pond and discharged into Geona Creek. The predicted median water quality from the Class C Storage Facility and overburden stockpile are presented in Table 8-28 and Table 8-29, respectively. The water quality for the Class C Storage Facility was predicted using kinetic test results, whereas the overburden water quality was predicted using shake flask extractions.

BMC MINERALS

KZ-26
KZ-22
KZ-21
EAST CREEK
KZ-16
KZ-15
KZ-17
GEONA CREEK
KZ-37
KZ-18
KZ-9
UNNAMED CREEK
CREEK
FINLAYSON
CAMP
LOWER WMP
UPPER WMP
CLASS A
WTP
OVERBURDEN STOCKPILE
PROCESS PLANT
ROM
LGO
CLASS B
CLASS C
ABM PIT
PASTE PLANT
KZ-2
FAULT CREEK
FINLAYSON CREEK CATCHMENT BOUNDARY
GEONA CREEK CATCHMENT BOUNDARY
FINLAYSON CREEK/EAST CREEK CATCHMENT BOUNDARY
GEONA CREEK CATCHMENT BOUNDARY
GEONA CREEK/SOUTH CREEK CATCHMENT BOUNDARY
SOUTH CREEK
KZ-13

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CONCEPTUAL DRAWING AND FOR ILLUSTRATION PURPOSES ONLY; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

- Progressive Reclamation Footprint
- Mine Feature Footprint
- Process Plant Pond
- Storage Facility Collection Pond
- Pit Rim Pond
- Surface Water Monitoring Station
- Modelled Location
- Groundwater Well
- Water Management Pond
- Pipeline
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant
ROM - Run of Mine
LGO - Low Grade Ore

KUDZ ZE KAYAH PROJECT

FIGURE 8-37
OPERATIONS WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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Table 8-28: Estimated Median Class C Storage Facility Drainage Chemistry (mg/L)

Dissolved Constituent	Year 10	
	Mean Precipitation	1/10 Dry Year
Sulphate	86	113
Fluoride	0.29	0.38
Aluminum	0.14	0.19
Arsenic	0.0014	0.0019
Cadmium	0.000058	0.000076
Copper	0.00089	0.0012
Iron	0.00041	0.00041
Manganese	0.073	0.081
Nickel	0.0013	0.0017
Lead	0.00031	0.00040
Antimony	0.0060	0.0079
Selenium	0.0030	0.0039
Uranium	0.030	0.039
Zinc	0.0041	0.0054

Table 8-29: Overburden Stockpile Concentrations used in Model

Parameter	Concentration (mg/L)	Parameter	Concentration (mg/L)
Hardness (from total)	6.5	Copper	0.0036
Sulphate	0.55	Iron	0.11
Phosphorus	0.0050	Lead	0.00035
Fluoride	0.049	Manganese	0.0053
Aluminum	0.095	Nickel	0.00031
Antimony	0.00012	Silver	0.000040
Fluoride	0.049	Selenium	0.00010
Arsenic	0.00048	Uranium	0.000075
Cadmium	0.000065	Zinc	0.0030

Water collected from the Class A and B Storage Facilities collection ponds will be directed to the WTP, which will be located at the Process Plant Facility. The WTP discharge will be directed to the Lower Water Management Pond. Water from the Class C Pond and the Overburden Stockpile Pond will be directed to Geona Creek as it is predicted to be similar or better water quality then the predicted Lower Water Management Pond discharge to Geona Creek and Finlayson Creek.

Groundwater will be monitored in wells situated downstream of the Class A, Class B, and Class C Collection Ponds and the Water Management Ponds. On-going water quality monitoring will be used to assess the effectiveness of the water collection systems. In the unlikely event that the water collection systems are found to not effectively recover seepage, it will be necessary to install additional seepage control provisions.

The Upper Water Management Pond will temporarily store site runoff water from the area surrounding the Process Plant Facility, and the east side of Geona Creek, including runoff from the Overburden Stockpile and Class C Facility that is unsuccessfully diverted around site. Settling of sediment and associated particulate metals will occur in the Upper Water Management Pond and the

water will be conveyed to the larger Lower Water Management Pond where it will be stored for use as reclaimed water for the Process Plant, or discharged to the environment.

The discharge from the Lower Water Management Pond will either be discharged to Geona Creek or piped to Finlayson Creek. Water will be discharged year-round to Geona Creek at a minimum 3:1 ratio (receiving water: effluent) and piped to Finlayson Creek at a rate no less than 2:1 ratio with Finlayson Creek (receiving water: effluent). The discharge rates from the Lower Water Management Pond to Geona Creek and Finlayson Creek for the mean, 1 in 50 wet year and 1 in 10 dry year are presented in Table 8-30.

Table 8-30: Lower Water Management Pond Discharge Volumes to Geona and Finlayson Creeks (year 10) (m^3)

Month	Mean		1/50 Wet Year		1/10 Dry Year	
	Geona Creek at KZ-9	Finlayson Creek at KZ-15	Geona Creek at KZ-9	Finlayson Creek at KZ-15	Geona Creek at KZ-9	Finlayson Creek at KZ-15
January	24,500	100,000	28,500	85,000	17,500	75,000
February	17,250	70,000	21,000	60,000	12,750	53,000
March	13,750	52,000	17,250	42,000	10,250	39,000
April	47,000	255,000	66,000	320,000	37,000	235,000
May	235,000	990,500	335,000	1,264,000	189,000	1,045,000
June	270,000	949,000	405,000	1,196,750	212,500	1,000,000
July	158,000	730,000	356,000	960,000	108,000	490,000
August	130,000	515,000	179,000	695,000	97,000	450,000
September	133,000	500,000	215,000	815,000	97,000	400,000
October	78,000	310,000	95,000	253,000	57,000	225,000
November	49,000	205,000	58,000	176,000	35,500	155,000
December	34,000	145,000	39,500	123,000	24,500	106,000
Annual (m^3/yr)	***1,189,500***	***4,821,500***	***1,815,250***	***5,989,750***	***898,000***	***4,273,000***

The percentage changes in Geona Creek, Finlayson Creek, and South Creek for the mean, wet, and dry scenario during operations are presented in Table 8-20, Table 8-21, and Table 8-22. The effect is a decrease in overall runoff in Geona Creek below the mine site due to the south diversion losses and discharge of water directly to Finlayson Creek. While runoff in Geona Creek at KZ-37 is expected to decrease by 46% at maximum extent of operation (a high magnitude effect) it is expected to increase by 10% in Finlayson Creek at KZ-15 (low magnitude effect) due to the increased groundwater contributions provided by the dewatering, which equates to a 5% increase in Finlayson Creek at KZ-26 (a low magnitude effect).

The water quality in the Lower Water Management Pond for a given month was calculated by summing the mass load inflows and subtracting the water management pond effluent load outflow in that month to determine the net load present in the water management pond. The load in the water management pond was then divided by the water volume in the pond in that given month which

provides a concentration. The modelled average and maximum concentrations for the Water Management Pond are presented in Table 8-31. Changes in the COPI concentrations in the water management pond discharge over the operations period are also presented in Figure 8-38, Figure 8-39, and Figure 8-40. In general, concentrations of modelled parameters in the Water Management Pond discharge water increase slightly throughout operations as more surface area of the ABM open pit wall rock becomes exposed. The concentrations under the 1/10 dry year scenario were generally higher than the mean and 1/50 wet year scenario due to Lower Water Management Pond having lower volumes in the dry year scenario to dilute the load.

COPI concentrations in Geona Creek (KZ-37) during the operations phase are predicted to be higher than the baseline and construction period as the Lower Water Management Pond discharge and the Class C Storage Facility contributed load to Geona Creek (Figure 8-7 to Figure 8-12). The KZ-37 concentrations progressively increased through Years 1 to 10 reflecting the increasing size of the Class C Storage Facilities and the greater surface area of the exposed wall rock in the ABM open pit. COPI concentrations at KZ-37 were estimated to be less than their respective water quality objective under mean precipitation conditions (Figure 8-7 to Figure 8-9), with the exception of fluoride and selenium. Fluoride was estimated to fractionally exceed its pWQO (0.12 mg/L) in September of Years 8 and 9 (0.121 mg/L). Selenium concentrations were forecast to marginally exceed the relevant water quality objective in September and October of Years 7 to 10 (0.0022 mg/L vs SSWQO of 0.0021 mg/L).

Similar trends at KZ-37 were observed for the 1/10 dry year scenario (Figure 8-10 to Figure 8-12), except the modelled concentrations were higher due to the lower flow volumes. During operations fluoride concentrations were estimated to exceed its pWQO (0.12 mg/L) between August and October of Years 6 to 10 (0.122 to 0.139 mg/L). Slight water quality objective exceedances for fluoride were also estimated in May and July for Years 7 to 10 (0.121 to 0.128 mg/L). Selenium concentrations (0.0021 to 0.0023 mg/L) were also forecast to slightly exceed the relevant SSWQO (0.0021 to 0.0022 mg/L) in September and October of Years 4 to 10 of the operations phase.

In upper Finlayson Creek (KZ-15), COPI concentrations during the operations phase were higher than the baseline and construction period levels. This is due to the discharge from the Lower Water Management Pond directly into Finlayson Creek, in addition to the load that the Class C Storage Facility contributes to upstream waters of Geona Creek. The estimated KZ-15 concentrations showed a muted progressive increase through Years 1 to 10 reflecting the increasing size of the Class C Storage Facility and the ABM open pit. The increase was most marked for nitrite-N (Figure 8-13). None of the proposed water quality objectives for KZ-15 were exceeded with the exception of a slight excursion for fluoride in April of each year of operations (0.13 mg/L vs pWQO of 0.12 mg/L; Figure 8-13) due to fluoride loading from the Class C Storage Facility added to the naturally high fluoride concentrations at KZ-15 during a relatively low-flow (i.e. low dilution volume) month. For the 1/10 dry year scenario (Figure 8-16 to Figure 8-18), fluoride concentrations were estimated to exceed its pWQO (0.12 mg/L) in April of each calendar year, but the exceedances were minimal (0.122 to 0.124 mg/L). Similarly, selenium concentrations were estimated to exceed the relevant SSWQO every January of the operations phase, but only marginally (0.0021 mg/L vs SSWQO of 0.0020 mg/L). The effects on water quality in upper Finlayson Creek are of moderate magnitude due to these slight water quality objective excursions.

COPI concentrations at KZ-26 in lower Finlayson Creek were also higher during the operations phase (Years 1 to 10) than the baseline and construction period levels; however, no COPIs exceeded their respective water quality objectives. Similar results were observed for the 1/10 dry year scenario (Figure 8-22 to Figure 8-24), in which no COPI water quality objectives were estimated to be exceeded.

The potential change in South Creek at KZ-13 is discussed in Section 8.4.1.3 for the construction phase, which identified that no exceedances of the KZ-13 pWQO resulted from the diversion of Fault Creek. As there is no activity change from construction to operations, the predictions remain the same and a low magnitude effect to surface water quality is predicted.

Overall, the fluoride pWQO exceedances observed in Geona and upper Finlayson Creeks are of moderate magnitude, and experienced locally given their lack of occurrence in lower Finlayson Creek. Nevertheless, it should be noted that fluoride is naturally elevated in the KZK receiving environment, particularly at East Creek (median fluoride concentration of 0.17 mg/L; Appendix D-1), which is a significant tributary to lower Finlayson Creek (Figure 8-3). Furthermore, although the interim CCME fluoride water quality guidelines do not provide a short term threshold, an approved acute fluoride guideline is provided by BCMoE. The BCMoE short term fluoride guideline for Geona Creek and Finlayson Creek ranges between 1.5 mg/L and 1.9 mg/L depending on water hardness. This is more than one order of magnitude higher than the slight pWQO fluoride exceedances estimated by the model in the receiving environment, and such excursions were typically forecast for only one or two months of the calendar year under the mean precipitation scenario, suggesting they would be short-lived.

The marginal selenium SSWQO exceedance in September and October in Geona Creek during operations is also considered moderate magnitude and experienced locally (i.e., Geona Creek only) in terms of geographic extent. Under the 1/10 dry year scenario, the water quality objective exceedances observed at KZ-37 (fluoride and selenium) and KZ-15 (fluoride, selenium, and cadmium) were also considered to be of moderate magnitude due to their slight excursions above their respective guidelines for only a few months of the year, and experienced locally (i.e., Geona and upper Finlayson Creek only) in terms of geographic extent.

No constituents modelled were estimated to exceed drinking water guidelines at the publicly accessible sites in South Creek (KZ-13) and lower Finlayson Creek (KZ-26) during the operations period.

Table 8-31: Average and Maximum Total Concentrations of Modelled Parameters in the Lower Water Management Pond throughout Operations in each of the Precipitation Scenarios

		Hardness	Sulphate	Nitrate-N	Nitrite-N	Ammonia-N	P	F	Cl	Cyanide, total	Cyanide, Weak Acid Dissociable	Al	Sb	As	Cd
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Mean Precipitation	Average	387	143	0.2	0.005	0.06	0.0017	0.08	0.3	0.00039	0.00039	0.012	0.0008	0.0015	0.00032
	Max	519	185	0.4	0.01	0.07	0.0038	0.10	0.7	0.00085	0.00082	0.027	0.0016	0.0019	0.00064
1/50 Wet	Average	340	126	0.2	0.006	0.06	0.0020	0.08	0.3	0.00045	0.00045	0.013	0.0008	0.0015	0.00036
	Max	475	169	0.4	0.01	0.07	0.0039	0.09	0.7	0.00088	0.00085	0.027	0.0019	0.0020	0.00068
1/10 Dry	Average	398	146	0.2	0.005	0.06	0.0016	0.09	0.3	0.00035	0.00035	0.011	0.0008	0.0016	0.00029
	Max	521	186	0.3	0.02	0.07	0.0039	0.10	0.8	0.00078	0.00075	0.023	0.0026	0.0026	0.00065

		Cu	Fe	Pb	Mn	Ni	Ag	Se	U	Zn	Dissolved Organic Carbon	Alkalinity	Ca	Mg
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Mean Precipitation	Average	0.0004	0.10	0.0004	0.30	0.0024	0.0000074	0.0017	0.0074	0.042	1.5	102	54	8
	Max	0.0006	0.14	0.0007	0.46	0.0047	0.0000082	0.0034	0.010	0.077	2.1	126	65	10
1/50 Wet	Average	0.0004	0.17	0.0004	0.32	0.0026	0.0000069	0.0019	0.0062	0.047	1.5	97	51	7
	Max	0.0007	0.1	0.0008	0.47	0.005	0.0000078	0.0036	0.0094	0.081	2.0	120	63	9
1/10 Dry	Average	0.0004	0.14	0.0004	0.29	0.0021	0.0000075	0.0015	0.0077	0.038	1.5	106	56	8
	Max	0.0008	0.1	0.0011	0.44	0.0045	0.0000086	0.0033	0.011	0.074	2.0	232	97	10

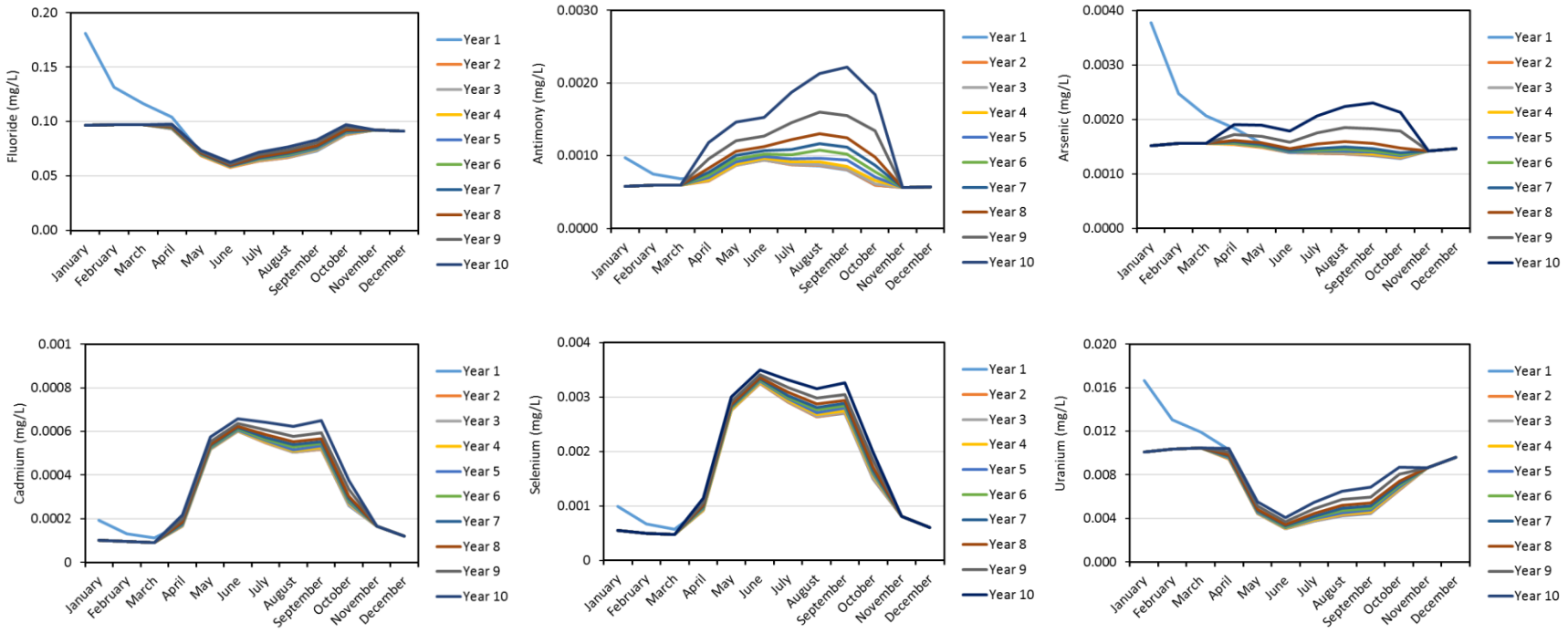


Figure 8-38: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the Mean Precipitation Scenario

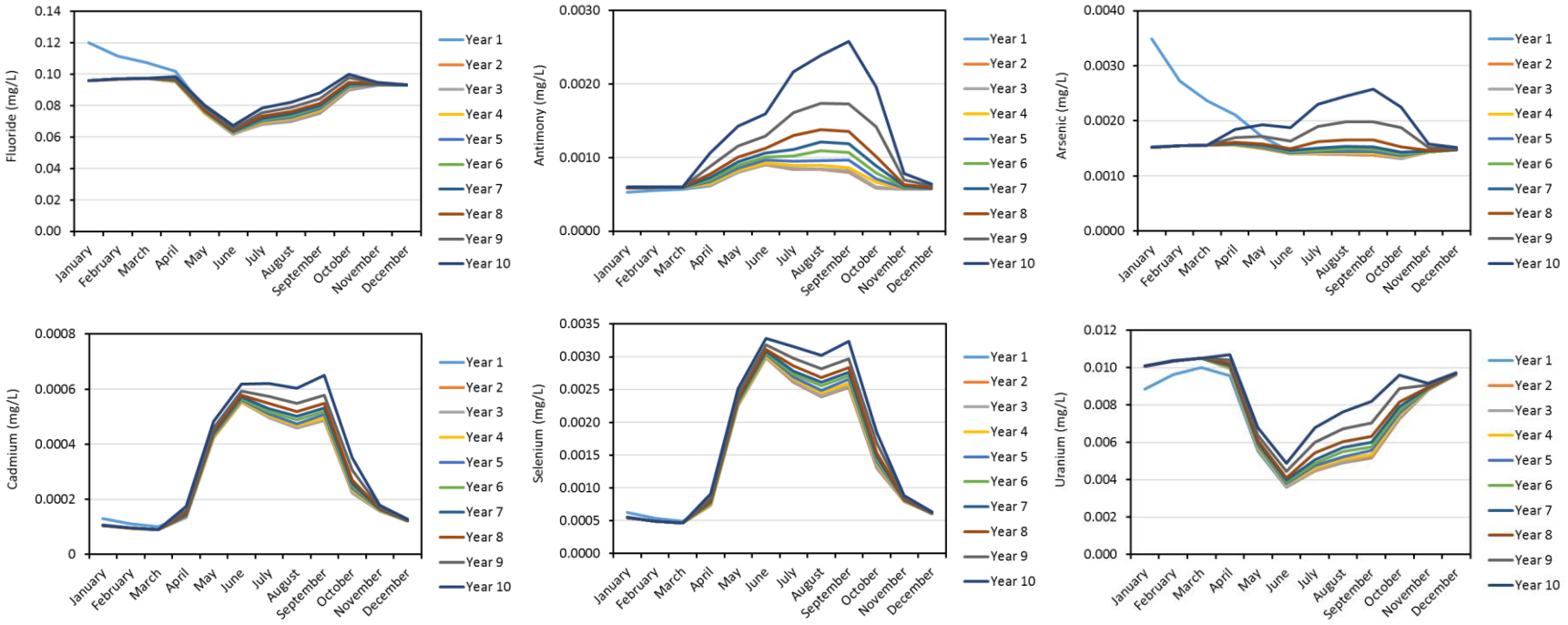


Figure 8-39: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the 1/10 Dry Year Precipitation Scenario

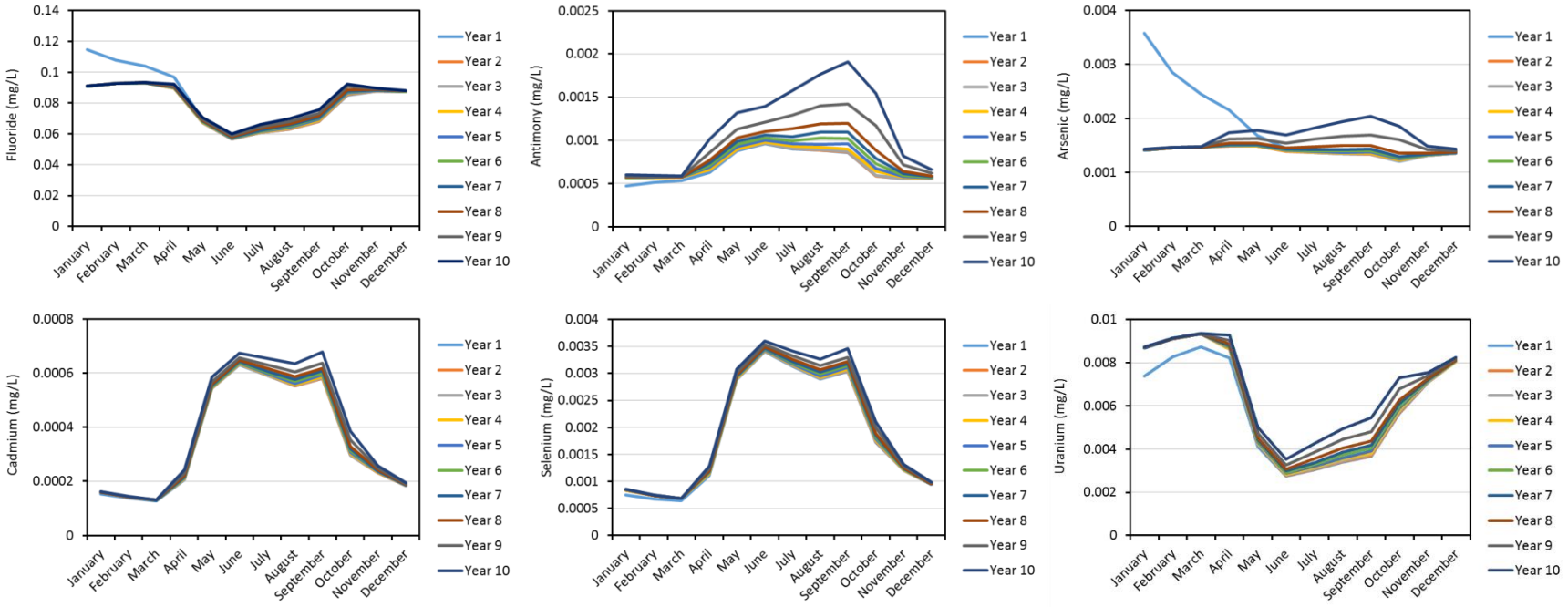


Figure 8-40: Model Estimated Total Concentrations of Fluoride, Antimony, Arsenic, Cadmium, Selenium, and Uranium in the Water Management Pond throughout Operations (Year 1 through Year 10) in the 1/10 Wet Year Precipitation Scenario

8.4.1.5 Changes in Surface Water Quantity and Quality as a Result of Flooding of ABM Open Pit at Closure and ABM Lake Formation

At the end of mining, dewatering of the groundwater table will cease and the Fault Creek diversion will be removed. As such, the ABM open pit will begin to fill due to:

- Inputs from the rebounding groundwater table;
- The flow from Fault Creek which will flow into the ABM open pit; and
- Local runoff.

These three water sources will provide load to the ABM lake that forms, in addition to the pit wall rock, which is expected to accumulate load during the time period it is exposed to the atmosphere, of which a portion will be rinsed into the pit as it fills. It is expected that the ABM lake will reach a surface elevation of 1,380 masl during year 26 of the Project (approximately 16 years after the cessation of operations), at which point ABM lake outflow will start towards Geona Creek via two constructed wetland treatment systems (CWTS). These processes are summarized in the conceptual mass transfer model presented in Figure 8-41.

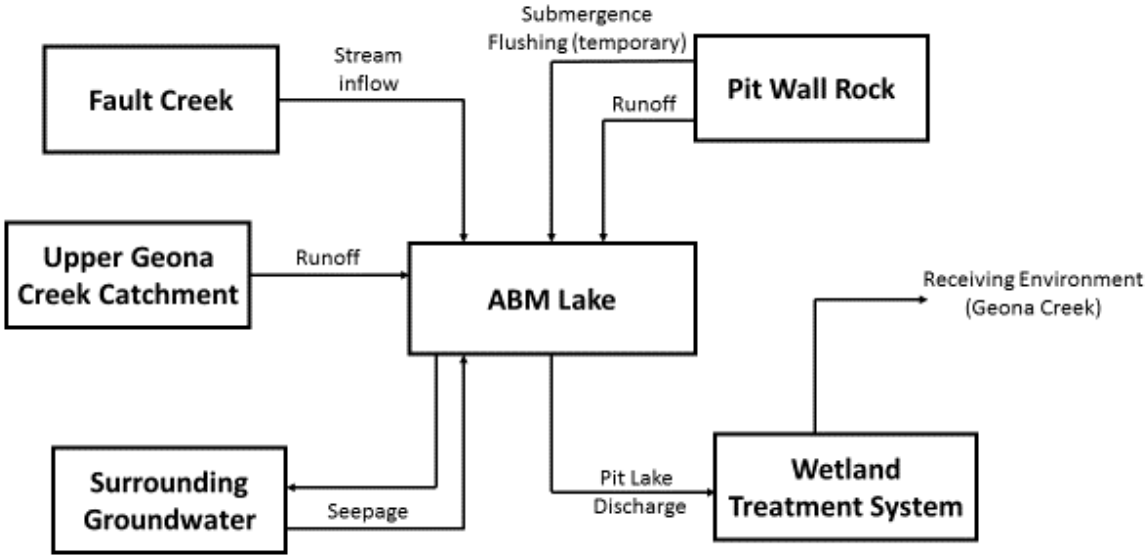


Figure 8-41: ABM Lake Mass Transfer Flowpaths during Closure Phases

The ABM lake water balance model (Table 8-35) was developed by EBA (Appendix D-4) to estimate the inflow and outflow rates to the pit and the time until the pit fills and begins to discharge surface flow to the wetland treatment system. It was predicted that the pit would fill to a final volume of approximately 34,355,000 m^3 at a surface elevation of 1,380 masl during year 26 of the Project.

As the ABM open pit fills with water, the surface water area of the ABM Pit Lake will increase. The ABM Pit Lake elevation versus stored volume and surface area was plotted using data from the EBA water balance (Appendix D-4) and is provided in Figure 8-42.

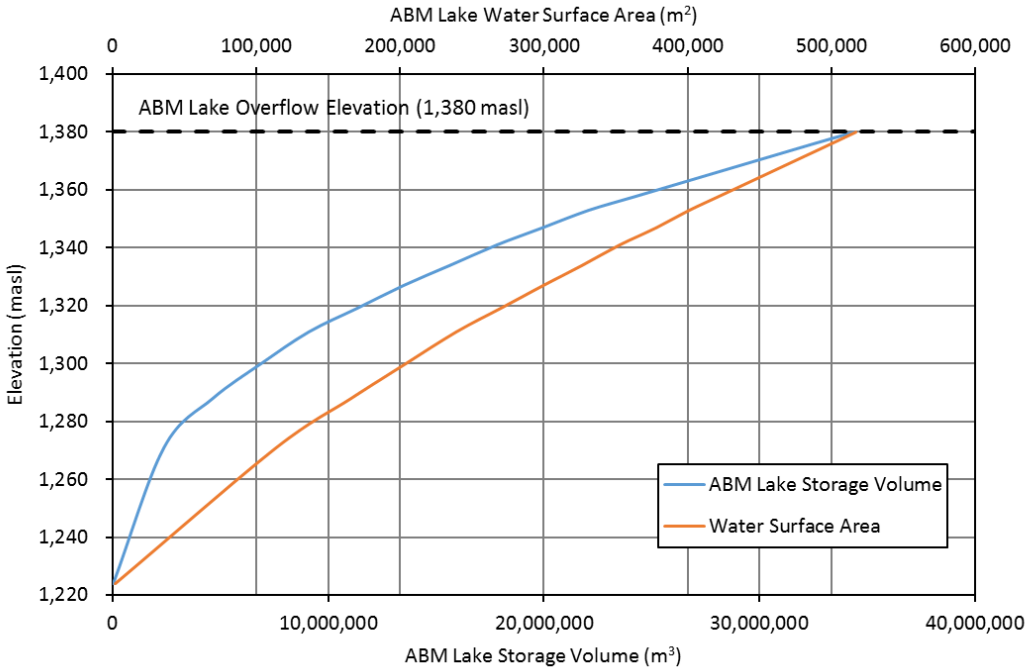


Figure 8-42: ABM lake Storage-Elevation and Area-Elevation Curves

Runoff was modelled in Geona, Finlayson, and South Creeks during the active closure and closure transition phases. While closure activities will modify water routing, they are not expected to alter the overall water quantities during this period at downstream sites. The main effect of the ABM open pit flooding period will be the removal of the south diversions and pit catchment area from downstream surface water contributions including the effect of groundwater drawdown. Drawdown will slowly decrease over this period; therefore, the maximum reduction to surface water was modelled and presented in Table 8-32, Table 8-33, and Table 8-34 for the mean, the 1/50 wet, and the 1/10 dry scenarios, respectively. The surface water quantity effect will be greatest during the first years of closure and will decrease as the ABM lake approaches its final surface elevation and therefore only the effect of the maximum drawdown was modelled. In Geona Creek at KZ-37 a high magnitude effect of 21% below baseline annual discharge is expected. In Finlayson Creek, a low magnitude effect is expected to be an approximately 8% reduction in flows at KZ-15 and a 3% reduction at KZ-26. A low magnitude effect and a 9% reduction in runoff from baseline is expected at KZ-13, South Creek. These are the maximum changes in total annual discharge expected during the closure transition period. They will decrease as the ABM open pit nears its final static water level. The potential effects on aquatic ecosystems and resources from the ABM lake formation and associated drawdown are assessed in Section 10.4.

Table 8-32: Percent Change in Discharge from Baseline during Active and Transition Closure for Mean Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
October	-20.9%	-7.6%	-2.5%	-10.7%
November	-20.9%	-7.6%	-2.5%	-15.3%
December	-20.9%	-7.6%	-2.5%	-23.2%
January	-20.9%	-7.6%	-2.5%	-34.1%
February	-20.9%	-7.6%	-2.5%	-45.7%
March	-20.9%	-7.6%	-2.5%	-73.7%
April	-17.0%	-7.6%	-2.5%	-12.5%
May	-17.3%	-7.6%	-2.4%	-3.5%
June	-24.2%	-7.6%	-2.5%	-4.4%
July	-24.5%	-7.9%	-3.9%	-6.7%
August	-19.9%	-7.6%	-2.3%	-6.4%
September	-21.0%	-7.6%	-2.4%	-6.5%
Mean	***-21.2%***	***-7.7%***	***-2.7%***	***-9.1%***

This is the maximum impact during the first year of closure transition and will steadily decrease towards the level of impact during post closure.

Table 8-33: Percent Change in Discharge from Baseline during Active and Transition Closure for 1/50 Wet Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
October	-20.7%	-7.7%	-2.4%	-9.8%
November	-20.7%	-7.6%	-2.2%	-14.0%
December	-20.7%	-7.6%	-2.2%	-21.2%
January	-20.7%	-7.6%	-2.2%	-31.2%
February	-20.7%	-7.6%	-2.2%	-41.8%
March	-20.7%	-7.6%	-2.2%	-67.5%
April	-16.7%	-7.6%	-2.4%	-8.8%
May	-17.2%	-7.6%	-2.4%	-2.5%
June	-20.6%	-7.7%	-2.8%	-2.3%
July	-26.7%	-7.6%	-2.5%	-3.2%
August	-16.9%	-7.7%	-2.4%	-4.1%
September	-21.7%	-7.6%	-3.0%	-4.1%
Mean	***-21.1%***	***-7.6%***	***-2.6%***	***-5.9%***

This is the maximum impact during the first year of closure transition and will steadily decrease towards the level of impact during post closure.

Table 8-34: Percent Change in Discharge from Baseline during Active and Transition Closure* for 1/10 Dry Scenario

Month	Geona Creek	Finlayson Creek		South Creek
	KZ-37	KZ-15	KZ-26	KZ-13
October	-21.5%	-7.7%	-3.7%	-14.7%
November	-21.5%	-7.7%	-3.7%	-20.9%
December	-21.5%	-7.7%	-3.7%	-31.8%
January	-21.5%	-7.7%	-3.7%	-46.8%
February	-21.5%	-7.7%	-3.7%	-62.7%
March	-21.5%	-7.7%	-3.7%	-101.2%
April	-17.0%	-7.6%	-2.6%	-16.1%
May	-17.4%	-7.6%	-2.5%	-4.4%
June	-24.3%	-7.6%	-2.5%	-5.6%
July	-22.1%	-7.7%	-2.8%	-9.1%
August	-21.9%	-7.7%	-3.0%	-9.3%
September	-21.1%	-7.7%	-3.2%	-9.0%
Mean	***-21.2%***	***-7.7%***	***-2.8%***	***-12.1%***

This is the maximum impact during the first year of closure transition and will steadily decrease towards the level of impact during post closure

A model was developed to estimate the water quality of the ABM lake as it fills during closure and eventually discharges to the CWTS (north and south wetlands) and then into Geona Creek. Water balance flows (from Appendix D-4 and Appendix D-6) were combined with pit wall loading rate source terms developed in the ARD/ML Characterization Report (Appendix D-5)), baseline surface water quality data (Appendix D-1), and groundwater quality (Appendix D-4) to predict mass loading to the pit and estimate the concentrations of COPIs in ABM lake.

The average ABM lake water quality for select parameters are shown for Year 26 (prior and after treatment) in Table 8-36 when it is anticipated the water will begin to discharge from the ABM lake to the CWTS. During the later stages of filling, in situ treatment of the ABM lake will be performed to lower constituent concentrations. In situ treatment involves the creation of reducing conditions within the ABM lake water column by the addition of soluble organic carbon (such as alcohol and/or molasses) to stimulate indigenous microorganisms. Enough organic carbon will be added to ABM lake to consume the dissolved oxygen, the oxidized nitrogen forms (nitrate+nitrite), and support sulphate reduction. Under these reducing conditions, some elements such as uranium and selenium will be transformed to less soluble forms, whereas chalcophile elements such as zinc, cadmium, copper, antimony, and lead will precipitate as metal sulphide minerals. The insoluble phases formed will settle to the lake bottom alongside iron sulphide (as “acid volatile sulphide”) which helps maintain reduced metals in their stable precipitated forms in the sediment.

Both the untreated and in situ treated scenarios for ABM lake chemistry in Year 26 (i.e., at overflow) are presented in Table 8-36. These are compared with the pWQO developed for the Project (Table 8-9; Appendix D-8). The estimated post-treatment water quality incorporates conservative

assumptions regarding constituent concentration reductions from in situ treatment which range between 50 and 90% (Appendix D-7).

The surface waters that will discharge from the ABM lake are anticipated to contain elevated concentrations of sulphate, nitrite-N, fluoride, phosphorus, aluminum, antimony, arsenic, cadmium, copper, selenium, uranium, and zinc. Relative to the pWQO, ABM lake concentrations of antimony, arsenic, cadmium, and uranium showed the highest exceedances, present at levels that were between four and 13 times higher than the pWQO. Following in situ treatment, pWQO exceedances were estimated to remain for fluoride, antimony, arsenic and uranium with concentrations between 1.4 and 4 times greater than their respective pWQO.

In addition, the wetland treatment systems, which are located between the ABM lake outflow and Geona Creek, will provide additional polishing treatment of the majority of constituents that exhibit pWQO exceedances (with the exception of fluoride and sulphate, which are not anticipated to be treated). The potential effect to surface water quality from the discharge from ABM lake via the constructed wetland treatment system to Geona Creek is discussed in the Section 8.4.1.6.

Table 8-35: ABM Lake Formation and Water Budget

Years After Mine Closure	Project Year	Precipitation (m^3/d)	Evaporation (m^3/d)	Streams		Groundwater			ABM Lake		
				Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	Net Flow (Total Inflows – Outflows; m^3/day)	Stage (masl)	Volume (m^3)	Lake Area (m^2)
0	10	1,122	1	3,316	-	7,836	-	12,273	1,224	3,022	1,598
1	11	1,122	103	3,321	-	3,034	-	7,374	1,271	2,355,783	113,700
2	12	1,122	150	3,333	-	2,984	-	7,289	1,288	4,621,094	165,700
3	13	1,122	184	3,344	-	2,950	-	7,232	1,300	6,858,305	203,700
4	14	1,122	216	3,355	-	2,913	-	7,174	1,311	9,075,671	238,870
5	15	1,122	243	3,364	-	2,890	-	7,133	1,319	11,276,370	269,190
6	16	1,122	271	3,373	-	2,865	-	7,089	1,327	13,463,160	299,320
7	17	1,122	295	3,382	-	2,840	-	7,049	1,334	15,630,780	326,540
8	18	1,122	319	3,391	-	2,820	-	7,014	1,341	17,786,220	352,400
9	19	1,122	342	3,399	-	2,797	-	6,976	1,347	19,928,180	378,100
10	20	1,122	362	3,407	-	2,779	-	6,946	1,353	22,057,160	400,940
15	25	1,122	452	3,719	-	1,249	4	5,634	1,376	32,503,170	499,810
16	26	1,123	467	3,726	4,818	1,149	114	599	1,380	34,360,280	516,840
17	27	1,123	467	3,729	5,509	1,203	49	30	1,380	34,355,810	516,800
20	30	1,123	467	3,730	5,553	1,215	48	0	1,380	34,355,650	516,800
25	35	1,123	467	3,731	5,560	1,221	48	0	1,380	34,355,760	516,800
30	40	1,123	467	3,731	5,562	1,223	48	0	1,380	34,355,800	516,800
40	50	1,123	467	3,732	5,564	1,224	48	0	1,380	34,355,820	516,800
50	60	1,123	467	3,732	5,564	1,225	48	0	1,380	34,355,840	516,800

Table 8-36: ABM Lake Water Quality Results

Parameter	Units	pWQO	ABM Lake Chemistry (Untreated; Year 26) [a]	ABM Lake Chemistry (After In Situ Treatment; Year 26)	In Situ Treatment Reduction (% Removal)
Sulphate	mg/L	429 [b]	302	302	-
Hardness (as $CaCO_3$)	mg/L	Not applicable	573	573	-
Nitrate-N	mg/L	3	0.19	0.019	90%
Nitrite-N	mg/L	0.2 [c]	0.13	0.013	90%
Ammonia-N	mg/L	1.1 [d]	0.16	0.080	50%
Phosphorus	mg/L	0.035	**0.085**	**0.060**	25%
Fluoride	mg/L	0.12	**0.23**	**0.23**	-
Aluminum	mg/L	0.1	0.069	0.069	-
Antimony	mg/L	0.009	**0.025**	**0.013**	50%
Arsenic	mg/L	0.005	**0.020**	**0.020**	-
Cadmium	mg/L	0.00037 [b]	**0.0031**	**0.00077**	75%
Copper	mg/L	0.01 [b]	0.0068	0.0068	-
Iron	mg/L	0.3	0.84	0.84	-
Lead	mg/L	0.0196 [b]	0.0096	0.0048	50%
Manganese	mg/L	2.59 [b]	0.58	0.58	-
Nickel	mg/L	0.15 [b]	0.0078	0.0039	50%
Selenium	mg/L	0.0066 [e]	**0.010**	0.0050	50%
Uranium	mg/L	0.015	**0.046**	**0.023**	50%
Zinc	mg/L	0.188 [b]	**0.19**	0.049	75%

[a] Concentrations that exceed the pWQO are highlighted in **bold**
[b] Based on ABM lake hardness subject to the maximum hardness limits outlined in Table 8-9 for each hardness dependent pWQO.
[c] Based on chloride concentration >10 mg/L in ABM lake
[d] Ammonia-N pWQO calculated for pH 8 and 10°C
[e] Site specific water quality objective: When sulphate >60 mg/L: total selenium (mg/L) = (0.1736*[sulphate]0.597)/1000)

8.4.1.6 Changes in Surface Water Quantity and Quality as a Result of Water Management and Discharge during Closure

Class A, B and C Storage Facilities during Closure

The Class A Storage Facility will contain strongly PAG waste rock and filtered reactive tailings. Based on the design and supporting information, the Class A Storage Facility requires a very low permeability engineered cover, to reduce loading to the environment, to achieve the required reduction in net infiltration and minimize potential indirect effects to surface water quality due to seepage from Class A Storage Facility. There are alternatives to produce this very low permeability, ranging from a complex cover with a geosynthetic (polyethylene, e.g. HDPE), a geosynthetic clay liner (GCL), or a modified complex soil cover. Reclamation research will assist in determining the details of the approved cover method prior to implementation.

The main components of the conceptual design of the Class A Storage Facility closure cover are:

- A three-layer cover will be placed on the surface of the facility (at 2% grade) and the slopes (4H:1V). If a geosynthetic liner is used in the cover it will be keyed into the liner underneath the tailings. This cover will comprise from surface downwards:
  - A surface layer of 0.3 m growth medium from local topsoil and overburden to support revegetation, which will be graded at surface to blend with the natural topography;
  - 3.0 to 5.0 m of Class C waste rock to act as a frost protection layer and to prevent erosion; and,
  - A very low permeability material (e.g., geosynthetic, HDPE, geosynthetic clay, highly modified soil layer) with approximately 0.2 m of local till on both sides to serve as a bedding and a protective layer to prevent damage to the liner.

A constructed French drain at the toe will collect drainage during operations and active closure, until the cover is established to limit water flux through the Storage Facility. Following closure, the non-contact water (runoff from the cover) will be directed away from the collection pond. Based on the site characterization information, the expected long term net percolation for the Class A Storage Facility described above ranges from 0.5 to 2% (Appendix H-1). The water quality model has assumed a 98% load reduction based on the design objective for the cover described above (Appendix H-1).

The Class B Storage Facility contains weakly PAG material and as such it will require a low permeability cover to minimize potential indirect effects to surface water quality. The main components of the Class B Storage Facility cover are:

- A three-layer cover will be placed on the surface of the facility (at 2% grade) and the slopes (3H:1V). The compacted till cover will be keyed into the liner underneath the tailings. This cover will comprise:
  - A surface layer of 0.3 m growth medium from local topsoil and overburden to support revegetation, which will be graded at surface to blend with the natural topography;
  - A minimum 3.0 m of Class C waste rock to act as a frost protection layer and to prevent erosion; and
  - A 1.0 m layer of compacted till directly on the Class B waste rock to minimize net percolation.

A constructed French drain built into the foundation will collect drainage during operations and active reclamation, until the cover is established to limit water flux through the waste rock. Following closure, the cover will shed surface water to the environment once monitoring demonstrates it is acceptable for discharge. The water quality model has assumed a 75% load reduction based on the design objective for the cover described above (Appendix H-1).

The Class C Storage Facility will contain acid consuming waste rock, and as such, a cover that reduces net percolation is not required. The key components of this cover are a 0.3 m growth medium from local topsoil and overburden to support revegetation.

The cover will be installed progressively once the appropriate volume of waste has been stored in the facility as per the mine plan. The water quality model has assumed a 10% load reduction based on the design objective for the cover described above (Appendix H-1).

The effectiveness of the covers on the Class A and B Storage Facilities are integral to successful reclamation and closure of the project. Based on the cover designs discussed above and the conservative load reductions modelled, the potential effect from long term seepage is considered minimal to surface water quality and management and treatment of these loads are discussed in the subsequent section.

Water Management, Treatment and Discharge at Closure

Following the completion of mining and processing, the site will be fully decommissioned with the exception of some water management features to ensure water quality is maintained in the receiving environment. The routing of water from various sources will be modified as reclamation activities are completed. The water management schematics for active closure, transition closure, and post-closure are presented in Figure 8-43, Figure 8-44, and Figure 8-45, respectively. The Fault Creek and south diversions will be removed to allow the ABM open pit to flood which is estimated to take approximately 16 years. The WTP will remain in place and will continue to treat the water from the Class A and Class B collection ponds until the facility closure measures (i.e., storage facility covers) are meeting design objectives, or until the commissioning of wetlands to treat this water.

Wetlands will be constructed within the Lower Water Management Pond footprint (north wetland) and immediately downstream of the ABM lake outflow (south wetland) within Geona Creek as required to provide passive water treatment during the transition closure and post-closure period. Ultimately, water management for the Project in the post closure phases will be almost entirely passive, with only long term monitoring and maintenance of structures and their performance required. The water management and treatment during closure has the potential to affect surface water quality and quantity as a result of the proposed reclamation and closure measures discussed in Appendix H-1.

The effects of closure activities during the time in which the ABM open pit is filling are covered in Section 8.4.1.5. When the ABM lake reaches its final surface elevation of 1,380 masl the upper areas of Geona Creek will again contribute to downstream runoff. Additional influx of deep groundwater will also increase runoff above baseline levels. The effect of direct precipitation and evaporation to and from the lake were also incorporated into the model but have a minimal effect. The ABM lake will still exert a drawdown effect which extends into South Creek and reduces runoff below baseline by 8% annually at KZ-13. Geona Creek at KZ-37 will be 4% higher annually, whereas Finlayson Creek will be 2% and 1% higher annually at KZ-15 and KZ-26, respectively. These effects are permanent and of low magnitude. Table 8-38 and Table 8-39 present the percent change in modelled monthly runoff from baseline in post closure for the mean, 1/50 wet, and 1/10 dry scenarios, respectively. Modelled discharge rates for baseline and post closure are also shown graphically for Geona Creek (KZ-37), Finlayson Creek (KZ-15 and KZ-26) and South Creek (KZ-13) in Figure 8-46, Figure 8-47, Figure 8-48 and Figure 8-49, respectively.

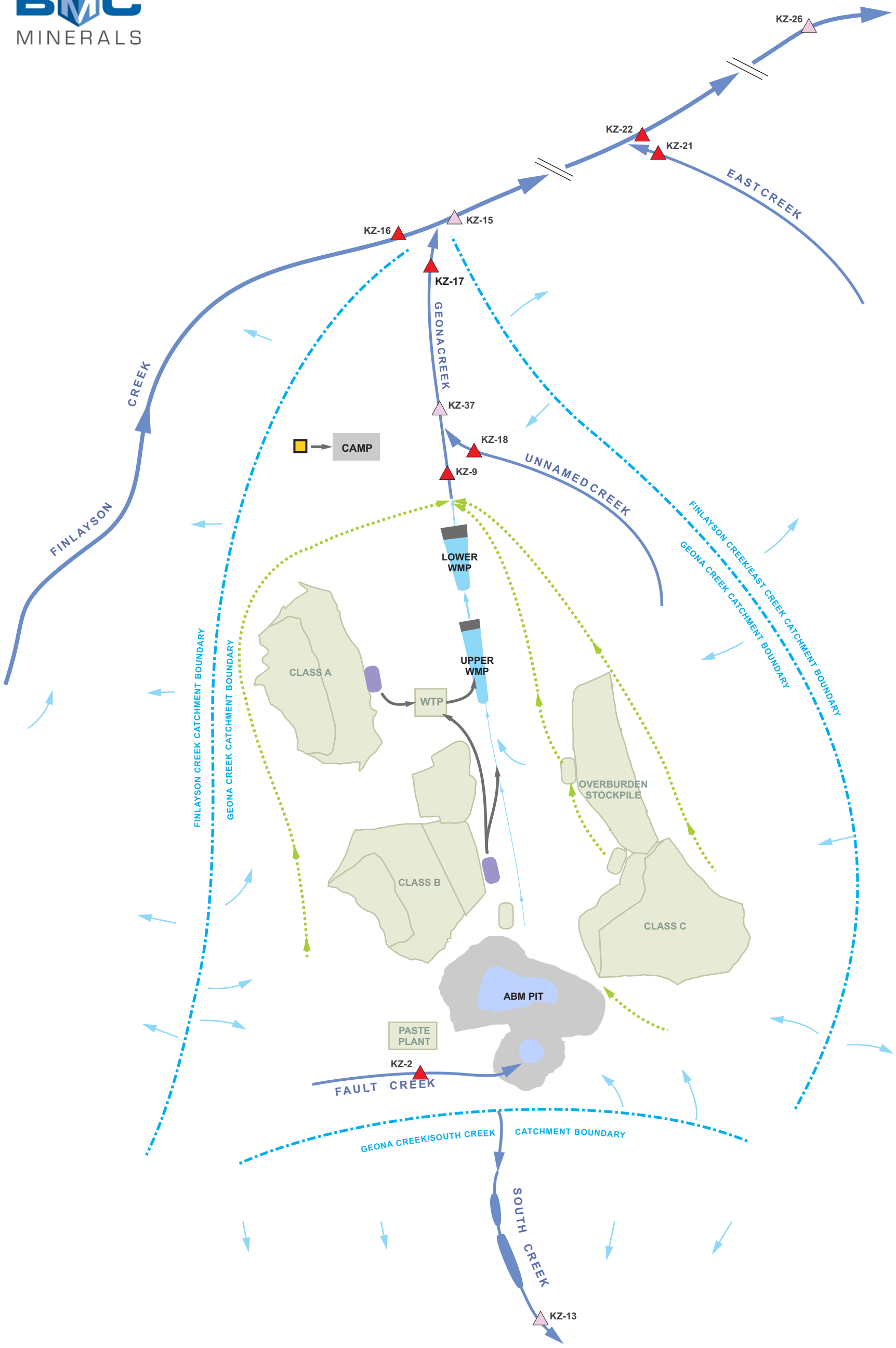
Table 8-37: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for Mean Scenario

Month	Geona Creek			Finlayson Creek						South Creek		
	KZ-37			KZ-15			KZ-26			KZ-13		
	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change
Oct	0.23	0.24	4.8%	0.46	0.47	2.7%	1.25	1.27	1.0%	0.10	0.09	-9.7%
Nov	0.16	0.17	6.3%	0.33	0.34	3.4%	0.93	0.94	1.3%	0.07	0.06	-13.9%
Dec	0.11	0.12	10.4%	0.23	0.24	5.4%	0.65	0.66	1.9%	0.04	0.04	-21.1%
Jan	0.08	0.09	15.9%	0.16	0.17	8.1%	0.47	0.48	2.8%	0.03	0.02	-31.0%
Feb	0.06	0.07	21.4%	0.12	0.13	10.9%	0.37	0.38	3.6%	0.02	0.01	-41.5%
Mar	0.04	0.05	34.9%	0.08	0.09	17.5%	0.24	0.26	5.6%	0.01	0.00	-67.0%
Apr	0.17	0.18	8.8%	0.42	0.44	3.5%	0.96	0.98	1.7%	0.08	0.07	-11.3%
May	0.60	0.61	2.1%	1.56	1.58	0.8%	3.65	3.66	0.5%	0.29	0.28	-3.2%
Jun	0.76	0.77	1.1%	1.60	1.61	0.8%	4.77	4.79	0.3%	0.24	0.23	-4.0%
Jul	0.44	0.45	1.1%	1.12	1.13	0.5%	3.57	3.58	0.2%	0.15	0.14	-6.1%
Aug	0.36	0.37	2.3%	0.77	0.78	1.3%	2.12	2.13	0.5%	0.16	0.15	-5.9%
Sep	0.37	0.38	3.2%	0.76	0.77	1.9%	1.99	2.00	0.8%	0.16	0.15	-5.9%

Table 8-38: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for 1/50 Wet Scenario

Month	Geona Creek			Finlayson Creek						South Creek		
	KZ-37			KZ-15			KZ-26			KZ-13		
	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change
Oct	0.25	0.26	4.5%	0.60	0.61	2.0%	1.9	2.0	0.6%	0.11	0.10	-8.9%
Nov	0.18	0.19	5.6%	0.39	0.40	2.8%	1.3	1.3	0.8%	0.074	0.065	-12.7%
Dec	0.12	0.13	9.4%	0.26	0.27	4.6%	0.91	0.92	1.3%	0.049	0.039	-19.3%
Jan	0.085	0.10	14.4%	0.18	0.20	6.9%	0.66	0.67	1.9%	0.033	0.024	-28.4%
Feb	0.065	0.078	19.5%	0.14	0.15	9.2%	0.52	0.53	2.5%	0.025	0.015	-38.0%
Mar	0.041	0.055	31.9%	0.090	0.10	14.9%	0.34	0.35	3.9%	0.015	0.0059	-61.4%
Apr	0.23	0.25	6.5%	0.60	0.61	2.6%	1.4	1.4	1.2%	0.12	0.11	-8.0%
May	0.85	0.87	2.3%	2.2	2.3	0.9%	5.2	5.2	0.5%	0.42	0.41	-2.2%
Jun	1.2	1.2	1.1%	3.6	3.6	0.3%	10.3	10.3	0.2%	0.45	0.44	-2.1%
Jul	1.2	1.2	-0.6%	2.3	2.3	0.1%	10.1	10.1	0.0%	0.32	0.31	-2.9%
Aug	0.49	0.50	2.3%	1.2	1.2	1.0%	2.7	2.7	0.6%	0.25	0.24	-3.7%
Sep	0.66	0.67	1.6%	1.5	1.5	0.9%	4.1	4.2	0.4%	0.25	0.24	-3.7%

BMC MINERALS



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CONCEPTUAL DRAWING AND FOR ILLUSTRATION PURPOSES ONLY; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

- Reclaimed and Revegetated Mine Feature Footprint
- Mine Feature Footprint
- Storage Facility Collection Pond
- Pit Rim Pond
- ABM Pit Lake @ 1300 masl
- Surface Water Monitoring Station
- Modelled Location
- Groundwater Well
- Water Management Pond
- Pipeline
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant

KUDZ ZE KAYAH PROJECT

FIGURE 8-43
ACTIVE CLOSURE
WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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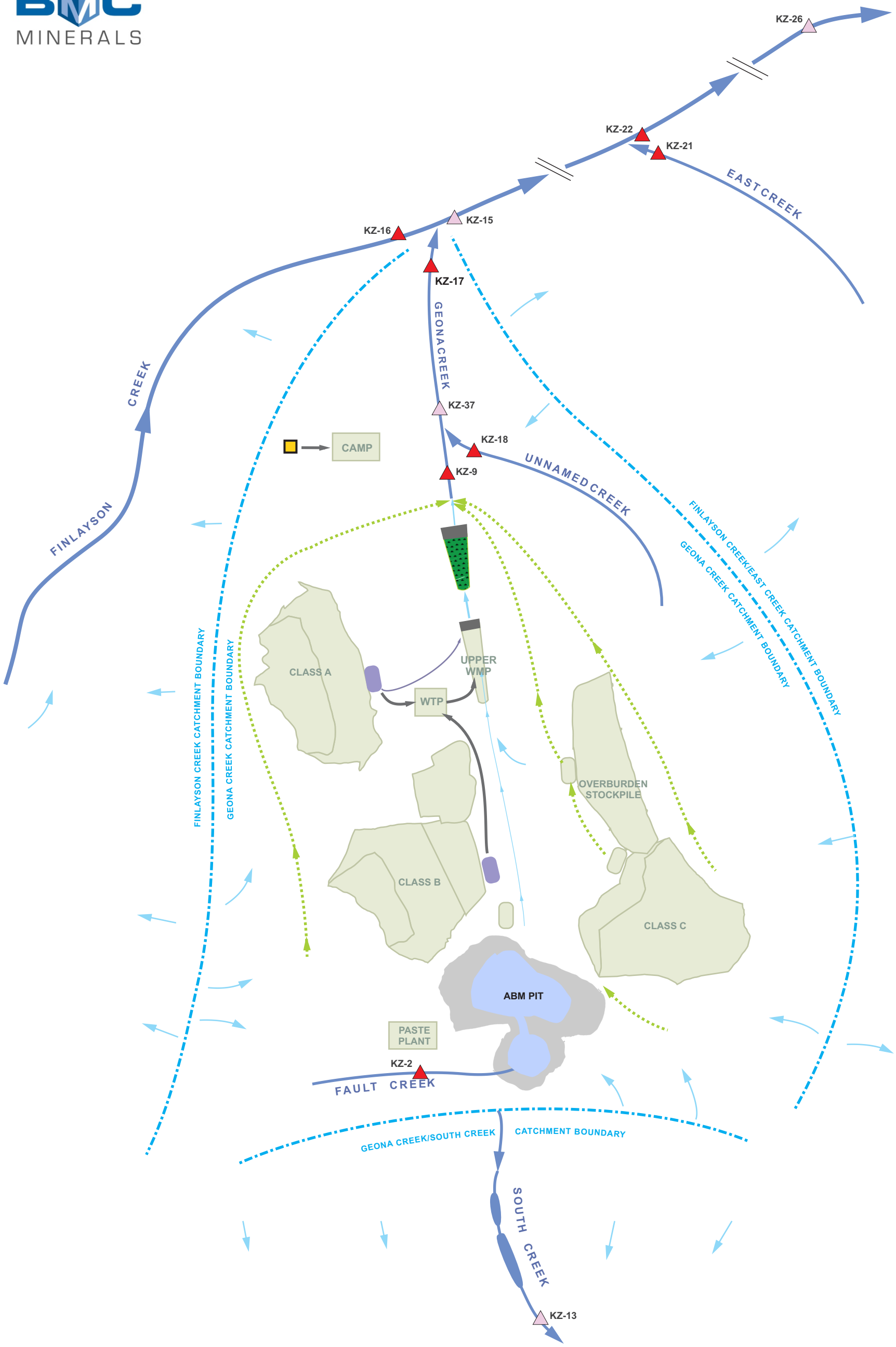
BMC MINERALS



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CONCEPTUAL DRAWING AND FOR ILLUSTRATION PURPOSES ONLY; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

- Reclaimed and Revegetated Mine Feature Footprint
- Mine Feature Footprint
- Storage Facility Collection Pond
- ABM Pit Lake @ 1350 masl
- Surface Water Monitoring Station
- Modelled Location
- Groundwater Well
- Constructed Wetland Treatment System
- Pipeline
- Seepage
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant

KUDZ ZE KAYAH PROJECT

FIGURE 8-44
TRANSITION CLOSURE WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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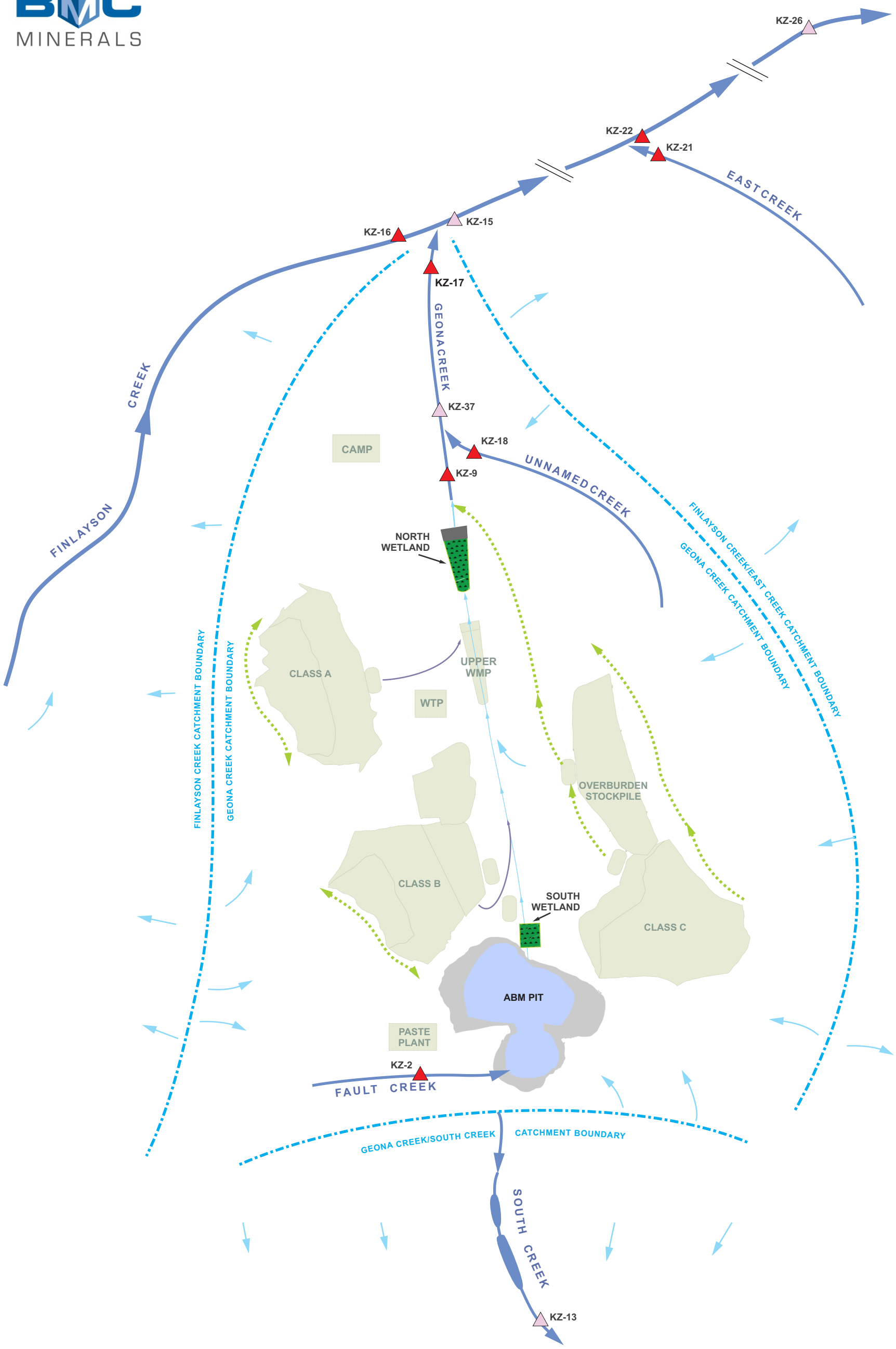
BMC MINERALS



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CONCEPTUAL DRAWING AND FOR ILLUSTRATION PURPOSES ONLY; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

- Reclaimed and Revegetated Mine Feature Footprint
- Mine Feature Footprint
- ABM Pit Lake @ 1380 masl
- Surface Water Monitoring Station
- Modelled Location
- Constructed Wetland Treatment System
- Seepage
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant

KUDZ ZE KAYAH PROJECT

FIGURE 8-45
POST CLOSURE
WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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Table 8-39: Average Flow Rates (m^3/s) in Baseline (BL) and Post-Closure (PC) and Percent Change in Discharge from Baseline Post-Closure for 1/10 Dry Scenario

Month	Geona Creek			Finlayson Creek						South Creek		
	KZ-37			KZ-15			KZ-26			KZ-13		
	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change	BL m^3/s	PC m^3/s	% Change
Oct	0.16	0.17	7.7%	0.27	0.28	5.0%	0.53	0.54	2.7%	0.070	0.061	-13.4%
Nov	0.11	0.12	10.2%	0.20	0.21	6.4%	0.39	0.41	3.4%	0.049	0.040	-19.0%
Dec	0.077	0.089	16.2%	0.13	0.15	9.8%	0.27	0.29	4.9%	0.032	0.023	-28.9%
Jan	0.054	0.066	24.1%	0.093	0.11	14.4%	0.20	0.21	6.9%	0.022	0.013	-42.5%
Feb	0.041	0.054	32.1%	0.071	0.085	19.0%	0.16	0.17	8.8%	0.016	0.007	-57.0%
Mar	0.026	0.040	51.6%	0.046	0.059	30.3%	0.10	0.12	13.6%	0.010	0.00082	-92.0%
Apr	0.13	0.14	11.5%	0.32	0.33	4.7%	0.69	0.70	2.3%	0.064	0.055	-14.6%
May	0.48	0.48	1.8%	1.24	1.25	0.8%	2.92	2.93	0.4%	0.23	0.22	-4.0%
Jun	0.59	0.59	1.0%	1.21	1.22	0.8%	3.52	3.53	0.3%	0.18	0.17	-5.1%
Jul	0.28	0.28	2.0%	0.60	0.61	1.2%	1.67	1.67	0.5%	0.11	0.10	-8.3%
Aug	0.26	0.27	3.0%	0.52	0.53	1.8%	1.24	1.25	0.9%	0.11	0.10	-8.4%
Sep	0.26	0.27	4.7%	0.50	0.51	2.8%	1.06	1.07	1.5%	0.11	0.11	-8.2%

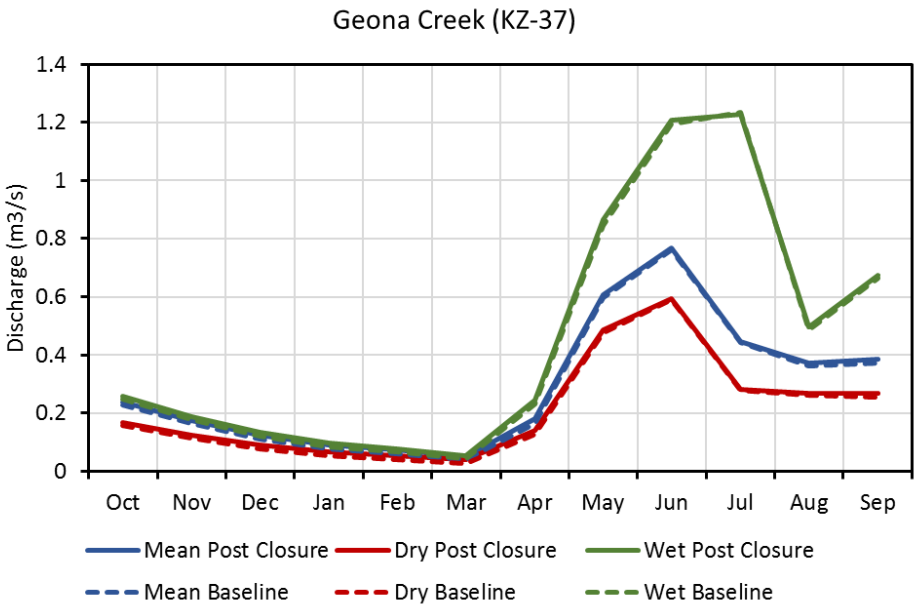


Figure 8-46: Modelled Post Closure and Baseline Discharge Rates in Geona Creek (at KZ-37) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

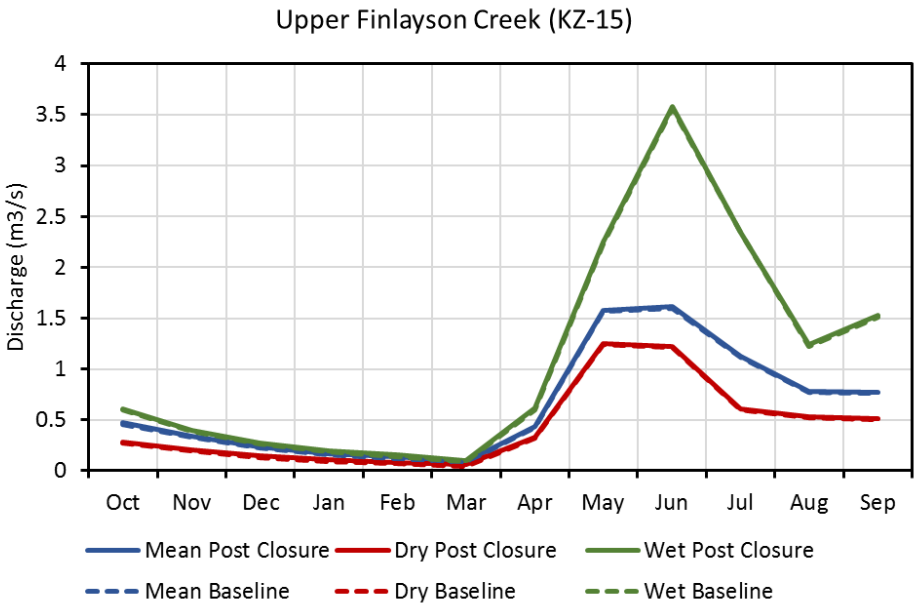


Figure 8-47: Modelled Post Closure and Baseline Discharge Rates in Upper Finlayson Creek (KZ-15) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

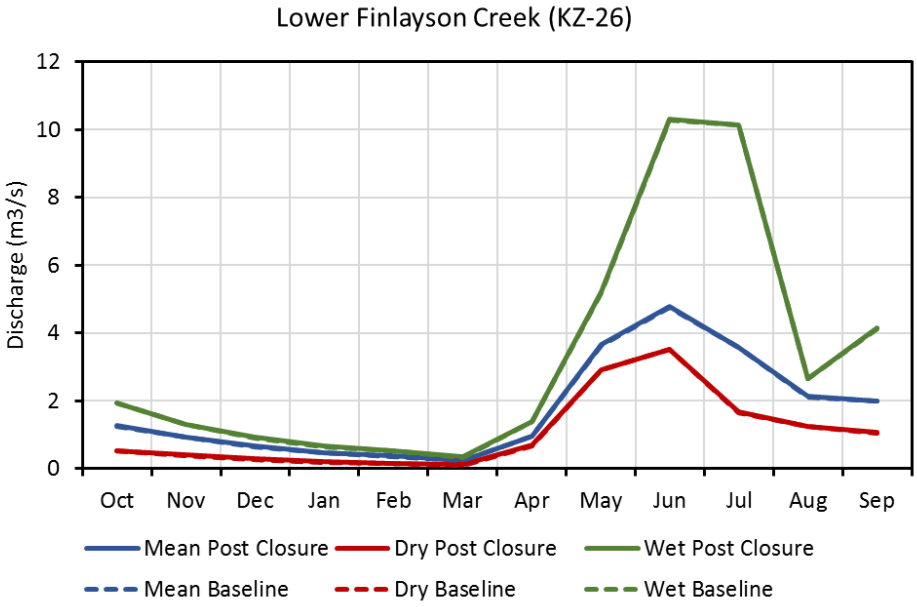


Figure 8-48: Modelled Post Closure and Baseline Discharge Rates in Lower Finlayson Creek (KZ-26) under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

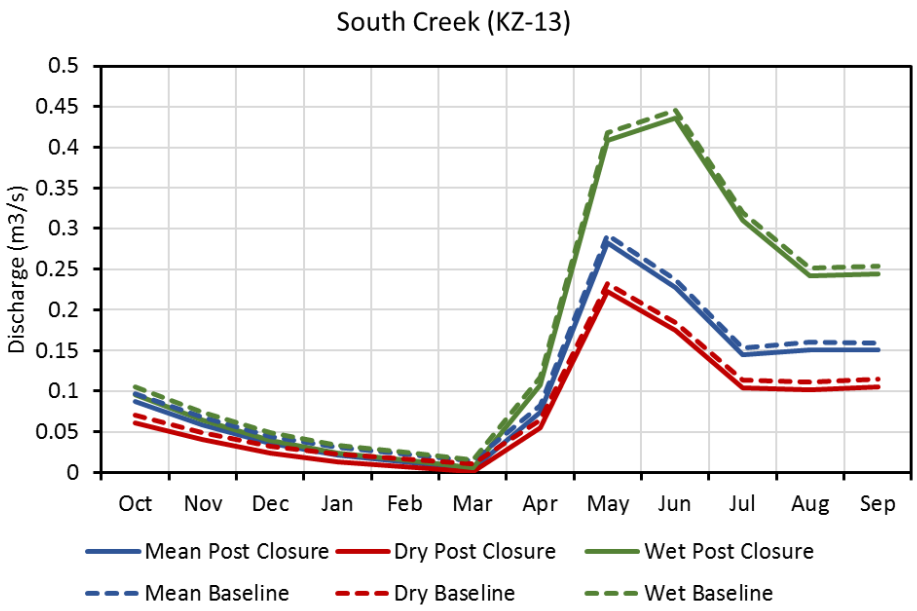


Figure 8-49: Modelled Post Closure and Baseline Discharge Rates in South Creek (KZ-13) Under Mean, 1/10 Dry Year and 1/50 Wet Year Precipitation Scenarios

The covers for the Class A, B, and C Storage Facilities are in place for the transition closure phase, which significantly lowers the load from each Storage Facility. The lower, long term steady state source terms are used in the water quality model at this time, in situ treatment is maintaining lower COPI concentrations in ABM lake, and the CWTS is in place. Monthly reduction factors for antimony, arsenic, cadmium, selenium, and antimony were developed by Contango Strategies Ltd. (Contango) for the constructed wetlands in mean and 1/10 dry precipitation scenarios (Appendix H-1). The conservative reduction factors incorporated into the water quality model for the receiving environment at closure are presented below for transition (Table 8-40; north constructed wetland receiving Class A and B seepage) and post-closure (Table 8-42 and Table 8-41; south constructed wetland receiving ABM lake outflow; and north constructed wetland receiving Class A and B seepage and south constructed wetland outflow). Reduction factors were set to 0% if the water quality entering the wetland was meeting the pWQO.

Table 8-40: Reduction Factors used in Modelling for the North Constructed Wetland during Transition Phase

	Mean Precipitation						1/10 Dry Year					
	Sb	As	Cd	Se	U	Zn	Sb	As	Cd	Se	U	Zn
January	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
February	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
March	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
April	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
May	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%
June	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Mean Precipitation						1/10 Dry Year					
	Sb	As	Cd	Se	U	Zn	Sb	As	Cd	Se	U	Zn
July	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%
August	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%
September	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%
October	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	0%
November	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
December	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 8-41 Reduction Factors Used in Modelling for the South Constructed Wetland in Post-Closure Phase

	Mean Precipitation						1/10 Dry Year					
	Sb	As	Cd	Se	U	Zn	Sb	As	Cd	Se	U	Zn
January	31%	75%	58%	42%	35%	64%	31%	75%	58%	50%	35%	71%
February	31%	75%	58%	48%	35%	69%	31%	75%	58%	55%	35%	74%
March	31%	75%	58%	57%	35%	75%	31%	75%	58%	63%	35%	79%
April	31%	75%	44%	23%	35%	44%	31%	75%	50%	28%	35%	50%
May	31%	55%	19%	8%	29%	18%	31%	70%	23%	10%	23%	23%
June	31%	51%	17%	7%	17%	17%	31%	66%	22%	10%	22%	21%
July	31%	75%	27%	13%	27%	27%	31%	75%	38%	19%	35%	37%
August	31%	75%	30%	14%	29%	29%	31%	75%	38%	19%	35%	38%
September	31%	75%	28%	13%	28%	28%	31%	75%	37%	18%	35%	36%
October	31%	75%	40%	21%	35%	40%	31%	75%	49%	27%	35%	48%
November	31%	75%	49%	27%	35%	48%	31%	75%	57%	34%	35%	57%
December	31%	75%	58%	34%	35%	57%	31%	75%	58%	42%	35%	65%

Table 8-42 Reduction Factors Used in Modelling for the North Constructed Wetland in Post-Closure Phase

	Mean Precipitation						1/10 Dry Year					
	Sb	As	Cd	Se	U	Zn	Sb	As	Cd	Se	U	Zn
January	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
February	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
March	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
April	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
May	0%	0%	0%	5%	0%	0%	0%	0%	0%	6%	0%	0%
June	0%	0%	0%	5%	0%	0%	0%	0%	0%	6%	0%	0%
July	0%	0%	0%	8%	0%	0%	0%	0%	0%	10%	0%	0%
August	0%	0%	0%	8%	0%	0%	0%	0%	0%	10%	0%	0%
September	0%	0%	0%	8%	0%	0%	0%	0%	0%	9%	0%	0%
October	0%	0%	0%	14%	0%	0%	0%	0%	0%	8%	0%	0%
November	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

	Mean Precipitation						1/10 Dry Year					
	Sb	As	Cd	Se	U	Zn	Sb	As	Cd	Se	U	Zn
December	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

These combined closure measures resulted in a significant improvement in water quality of Geona and Finlayson Creeks during the transition closure phase (Figure 8-7 to Figure 8-24) such that no water quality objective exceedances were modelled for any COPI in the receiving environment during this phase under the mean precipitation scenario. For the 1/10 dry year scenario, no COPI concentrations were estimated to exceed their respective water quality objectives; however, active water treatment was retained for September and October of each year for the 1/10 dry year scenario in order to address slight selenium exceedances for these months in Geona Creek (0.0024 and 0.0021 mg/L, respectively).

The outflow of the ABM lake in Year 26 at the start of the post-closure phase resulted in increases in COPI concentrations at KZ-37; however, no pWQO exceedances were estimated under any precipitation scenario (Figure 8-7 to Figure 8-12) during post-closure.

Farther downstream in upper Finlayson Creek (KZ-15), pWQO exceedances were estimated for fluoride only (Figure 8-13). These exceedances were confined to March and April for fluoride, and were relatively marginal (0.13 to 0.15 mg/L vs pWQO of 0.12 mg/L). In the 1/10 dry year scenario, slightly higher COPI concentrations were observed due to the lower flow volume (Figure 8-16 to Figure 8-18). Water quality objective exceedances were still only observed for fluoride at KZ-15 (Figure 8-16) with exceedances estimated to occur over March, April, and June in the calendar year (0.12 to 0.17 mg/L).

Although increases in COPI concentrations at KZ-26 were also observed at that start of the post-closure phase, only fluoride concentrations were estimated to exceed the relevant SSWQO (0.13 mg/L). The fluoride exceedances were confined to June (0.16 mg/L) and October (0.133 mg/L) (Figure 8-19). In the 1/10 dry year scenario, water quality objective exceedances were again only observed for fluoride (Figure 8-22), but were more marked than those modelled for the mean precipitation scenario and were confined to May to October (0.14 mg/L to 0.25 mg/L).

Overall, the post-closure fluoride pWQO exceedances observed in Geona and Finlayson Creeks are of moderate magnitude, and experienced regionally given their occurrence in lower Finlayson Creek. As noted previously, fluoride is naturally elevated in the KZK receiving environment, particularly at East Creek (median fluoride concentration of 0.17 mg/L; Appendix D-1), which is a significant tributary to lower Finlayson Creek (Figure 8-3). Furthermore, the BCMoE short term fluoride guideline for Geona Creek and Finlayson Creek ranges between 1.2 mg/L and 1.9 mg/L depending on the water hardness, which is approximately one order of magnitude higher than the slight pWQO fluoride exceedances estimated by the model in the receiving environment.

Following the removal of the diversion berms during the active closure phase, the chemistry of Fault Creek (KZ-13) is assumed to return to pre-operations phase baseline conditions, resulting in a diminution in COPI concentrations (Figure 8-25 to Figure 8-30). No pWQO or SSWQO exceedances were modelled for South Creek and a low magnitude effect is predicted.

No constituents were estimated to exhibit drinking water guideline exceedances at any monitoring location in the receiving environment at closure.

8.4.1.7 Summary

Table 8-43 provides a summary of the identified potential effects that are carried forward for consideration of mitigation measures.

Table 8-43: Identified Potential Project Effects for Surface Water

Subcomponent	Potential Effect	Project Phase
Surface water quantity	Changes in surface water quantity as a result of water diversions and dewatering activities during construction to Geona Creek, Finlayson, and South Creek	Construction
	Changes in surface water quantity as a result of water management and discharge during operations to Geona Creek, Finlayson, and South Creek	Operations
	Changes in surface water quantity as a result of flooding of ABM Open Pit at closure and ABM lake formation and discharge to Geona Creek, Finlayson, and South Creek	Closure
	Changes in surface water quantity as a result of water management and discharge during closure to Geona Creek, Finlayson, and South Creek	Closure
Surface water quality	Changes in surface water quality as a result of water diversions and dewatering activities during construction to Geona Creek, Finlayson, and South Creek	Construction
	Changes in surface water quality as a result of water management and discharge during operations to Geona Creek, Finlayson, and South Creek	Operations
	Changes in surface water quality as a result of flooding of ABM Open Pit at closure and ABM lake formation and discharge to Geona Creek, Finlayson, and South Creek	Closure
	Changes in surface water quality as a result of water management and discharge during closure to Geona Creek, Finlayson, and South Creek	Closure

8.4.2 Mitigation Measures

The following conceptual management plans outline mitigation measures to minimize potential effects to surface water from Project activities:

- Waste Management Plan (Section18.2);

- Hazardous Materials Management Plan (Section 18.3);
- Surface Water Management Plan (Section 18.4);
- Spill Response Plan (Section 18.5);
- Sediment and Erosion Control Plan (Section 18.6);
- Waste Rock Management (Section 4.9); and
- Conceptual Reclamation and Closure Plan (Appendix H-1).

Additionally, the water quality objectives have been established and will be incorporated into the adaptive management plan to mitigate potential effects to surface water quality. Effluent quality standards will be established during the Water Use Licencing process for the WTP and the Lower Water Management Pond to mitigate potential effects and the Project will be subject to effluent standards under MMER.

Potential effects on surface water and identified mitigation measures are summarized in Table 8-44 and discussed further below.

Table 8-44: Proposed Mitigation Measures for Surface Water

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Surface Water Quantity				
Changes in surface water quantity as a result of Water Diversions and Dewatering activities during Construction	Construction	Diversion of Fault Creek to South Creek; and Diversion of Geona Catchment above Project footprint to KZ-9 (North Diversions).	Medium	Yes
Changes in surface water quantity as a result of Water Management and Discharge during Operations	Operations	Diversion of Fault Creek to South Creek; and Diversion of Geona Catchment above Project footprint to KZ-9 (North Diversions).	Medium	Yes
Changes in surface water quantity as a result of Flooding of ABM Open Pit at Closure and ABM lake Formation	Closure	Removal of diversions to return; baseline catchment boundaries; and Installation of low permeability covers with natural vegetation to approximate natural cover and runoff.	Medium	Yes
Changes in surface water quantity as a result of Water Management and Discharge during Closure	Closure	Removal of diversions to return baseline catchment boundaries; and Installation of low permeability covers with natural vegetation to approximate natural cover and runoff.	High	Yes
Surface Water Quality				

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Changes in surface water quality as a result of Water Diversions and Dewatering activities during Construction	Construction	Manage Pit development water in Pit; Rim Pond to settle TSS and aerate water; Lined Fault Creek diversion ditch; and Energy dissipation structure at diversion outlet to South Creek catchment.	Medium	Yes
Changes in surface water quality as a result of Water Management and Discharge during Operations	Operations	WTP; Discharge at minimum dilution ratio to Geona Creek (3:1) and Finlayson Creek (2:1); Class A and B Storage Facilities will be constructed with a compacted low-permeability till liner; Upper Water Management Pond, Lower Water Management Pond, Pit Rim Pond, Class A and B Storage Facilities Water Collection Ponds will be constructed with an impermeable HDPE liner; and Progressive reclamation of Class A, B and C Storage Facilities.	High	Yes
Changes in surface water quality as a result of Flooding of ABM Open Pit at Closure and ABM lake Formation	Closure	ABM lake treatment with lime and carbon source as it fills.	Medium	Yes
Changes in surface water quality as a result of Water Management and Discharge during Closure	Closure	ABM lake treatment with lime and carbon source as it fills; CWTS; Low permeability covers for Class A and B Storage Facilities; and WTP will remain onsite and available until Storage Facilities and CWTS are meeting design objectives.	Medium	Yes

8.4.2.1 Water Diversions and Dewatering Activities during Construction

Fault Creek and other small portions of the upper Geona Creek catchment which would drain to the ABM open pit will be diverted into South Creek to mitigate the volume of water becoming contact water in Geona Creek during dewatering of the overburden in the location of the proposed ABM open pit. This will limit the increases in contact water volumes in Geona Creek as a result of dewatering, which must be pumped from the ABM open pit. The resulting water volumes following the above mitigation from the ABM open pit development dewatering activities will be directed to Pit Rim Pond to allow TSS to settle and allowed to equilibrate with atmospheric oxygen.

Additionally, the northwest and northeast diversions have been designed to minimize water entering the Project footprint and contacting mine materials during construction (i.e., keep clean waters clean). A riprap channel will be constructed at the outflow of the diversions to mitigate the potential

for erosion and manage TSS concentrations. Sediment and erosions control practices outlined in Section 18.6 will be followed to mitigate and manage TSS concentrations in diversions.

8.4.2.2 Water Management and Discharge during Operations

Water management is designed to minimize contact and treatment water which needs to be actively managed and discharged to the receiving environment. One component of this mitigation is the north diversions which will minimize entry of water into the Project Footprint and maintain more natural runoff in lower Geona Creek. Overburden and Class C material will be stored on the east side of Geona Creek and runoff will be diverted to KZ-9 to also reduce the volume of contact water and help maintain natural runoff regimes in the receiving environment. Contact water from Class A and B Storage Facilities, and LGO/ROM ore stockpiles will be treated as necessary and collected in the Lower Water Management Pond. The discharge from the Lower Water Management Pond will be directed to both Geona Creek and Finlayson Creek at minimum dilution ratios (Creek:effluent) of 3:1 and 2:1, respectively. Progressive reclamation will occur during operations including the construction of the covers for the Class A, B and C Storage Facilities.

8.4.2.3 Flooding of ABM Open Pit at Closure and ABM Lake Formation

In closure the south and north diversions will be removed and low permeability covers revegetated with native plant species will be completed as per the Conceptual Reclamation and Closure Plan on the Class A and B Storage Facilities (Appendix H-1). This will facilitate a return to as close to baseline runoff regimes as possible. The covers will approximate the natural overburden over time and the catchment area of Geona and South Creeks will be returned to their pre-Project areas. This mitigation will be effective in reducing the increased runoff South Creek experienced during operations, though it will fall below baseline levels as a result of drawdown from the ABM lake. The removal of the diversions will not be effective in returning Geona Creek to baseline water levels until after the ABM pit fills and begins to discharge in post-closure. The covers will return the Geona Creek catchment to a more natural cover state and discharge will more closely resemble baseline distributions though at lower volumes.

As the ABM open pit fills, water quality will be managed using in situ treatment. Soluble organic carbon (such as alcohol and/or molasses) and lime, as required, will be added to stimulate sulphate-reducing conditions, consuming nitrate and nitrite in the process and promoting the precipitation COPIs as low solubility reduced forms (e.g., selenium and uranium) or metal sulphide phases (e.g., cadmium, copper, lead, antimony, and zinc).

8.4.2.4 Water Management and Discharge During Closure

In closure the south and north diversions will be removed and low permeability covers with revegetated with native plant species will be put in place on Class A and B Storage Facilities. This will facilitate a return to as close to baseline runoff regimes as possible. The designed covers will approximate the natural overburden over time and the catchment area of Geona and South Creeks will be returned to their pre-Project areas. This mitigation will be effective in reducing the increased runoff South Creek experienced during operations, though it will fall below baseline levels. As the ABM lake reaches 1,380 masl, the discharge from those parts of the catchment above the pit will again

contribute to downstream runoff in Geona Creek and a runoff regime slightly elevated from baseline will be achieved. The covers will return the Geona Creek catchment to a more natural cover state and discharge will more closely resemble baseline conditions than during operations.

Low permeability engineered covers will be constructed for the proposed Class A and B Storage Facilities to minimize load by 98% and 75%, respectively. The WTP will remain in place and will continue to treat the water from the Class A and Class B Storage Facilities collection ponds until the Storage Facility closure measures (i.e., Storage Facility covers) are meeting design objectives, or until the commissioning of wetlands to treat this water are put online. CWTS will be established to improve water quality outflow from ABM lake and any residual seepage from the Class A and B Storage Facilities.

Additionally, surface water monitoring will be conducted during the closure phase to confirm predictions, optimise passive treatment processes and adaptively manage the site to refine proposed mitigations.

8.4.3 Residual Effects, Consequence and Significance Determination

Effects are considered at four locations:

- KZ-37: Geona Creek below the Project Footprint and the major eastern tributary (KZ-18);
- KZ-15: Finlayson Creek below the confluence with Geona Creek;
- KZ-26: Finlayson Creek at the Robert Campbell Highway; and
- KZ-13: South Creek at near confluence with North River.

All effects are of neutral environmental and socio-economic context. Kaska members have and continue to use the Project area for hunting and fishing with a particular focus on the North Lakes area (south of the proposed Project). Access is controlled by the Tote Road gate and gatekeeper, but Kaska citizens do have access to South Creek and lower Finlayson Creek at the Robert Campbell Highway (KZ-26). The effects are summarized in Table 8-45 and Table 8-46 for surface water quantity and quality, respectively.

8.4.3.1 Changes in Surface Water Quantity and Quality as a Result of Water Diversions and Dewatering Activities during Construction

During the Construction phase (Years -1, 0) Fault Creek and other small portions of the upper Geona Creek catchment will be diverted into South Creek to facilitate dewatering of the overburden in the location of the proposed ABM open pit. The effect will be a 33% increase in runoff for the period in South Creek and an increase in discharge in Geona Creek at KV-37 of 19% with that increase dropping to just 3% at KZ-26.

The overall effect on surface water quantity for all study sites on Geona, Finlayson and South Creeks are adverse, short term effects of regular frequency, but all of neutral environmental and socio-economic context and not considered significant. The probability of these effects is high. The

magnitude differs from site to site with Geona Creek at KZ-37 and Finlayson Creek at KZ-15 and KZ-26 being of moderate magnitude while the effects are low magnitude on South Creek at KZ-13.

No residual effects for surface water quality have been identified in South Creek based on the model results during construction and the proposed mitigations.

8.4.3.2 Changes in Surface Water Quantity and Quality as a Result of Water Management and Discharge during Operations

During operations, areas outside the Project Footprint and runoff from the east side of Geona Creek including the Class C and overburden storage facilities will be diverted to Geona Creek below the Lower Water Management Pond. Water managed inside the Project Footprint will be stored in the Lower Water Management Pond and directed to both Geona Creek and Finlayson Creek at minimum dilution ratios (Creek:effluent) of 3:1 and 2:1, respectively. As the ABM pit is excavated the drawdown of local groundwater increases and runoff in South Creek is reduced, compared to operations, to 24% above baseline annually. Runoff in Geona Creek downstream of the Project will decrease by 46% while at KZ-15 it will increase by only 10% and 5% at KZ-26.

The overall effects on surface water quantity are adverse, regular, reversible, long term, and of neutral environmental and socio-economic context. On Geona Creek at KZ-37 and South Creek at KZ-13 the effect is high magnitude whereas on Finlayson Creek at KZ-15 and at KZ-26 it is moderate. In all cases the effects to surface water quantity are not considered significant, but the probability of occurrence is high.

During operations, COPI concentrations were estimated to be higher than baseline, but lower than pWQO for the majority of constituents. The exception was fluoride, which was estimated to marginally exceed its pWQO/SSWQO in Geona Creeks and Finlayson Creeks for some months of the calendar year during operations. Uranium was also estimated to exhibit marginal pWQO exceedances under the 1/10 dry year scenario in Geona Creek in October only. These effects on water quality in Geona and Finlayson Creek are considered to be adverse, regular, reversible long term, and of neutral environmental and socio-economic context. They are of moderate magnitude and occur on a local (uranium) to a regional (fluoride) geographic extent. In all cases the effects are not considered significant, but the probability of occurrence is very likely.

No changes in COPI concentrations are expected in South Creek, and although COPI concentrations are anticipated to be higher than baseline in South Creek due to the diversion of Fault Creek, no pWQO exceedances were modelled. As such, no residual effects on water quality in South Creeks are predicted.

8.4.3.3 Changes in Surface Water Quantity and Quality as a Result of Flooding of ABM Open Pit at Closure and ABM Lake Formation

In closure, diversions will be removed and covers will be put in place. South Creek will be reduced to 9% below baseline during the transition closure period following the removal of the south diversions. The discharge in Geona and Finlayson Creeks will all be below baseline with the re-establishment of Fault Creek into the ABM open pit, but the effects on Geona Creek will be reduced as more water is

allowed to discharge directly from the former Project footprint. Runoff in Geona Creek at KZ-37 will increase to 21% below baseline while runoff in Finlayson Creek will decrease to 8% below baseline at KZ-15 and 3% below at baseline at KZ-26.

The effects are a regular, adverse reduction to downstream runoff for a long term. These effects are reversible long term and of neutral environmental and socio-economic context. They have a high probability of occurring and are not significant. The magnitude of the effect to surface water quantity is high on Geona Creek, but low on Finlayson Creek and South Creek.

During the transition closure phase when the ABM open pit lake forms, marginal selenium SSWQO exceedances were estimated at KZ-37 in Geona Creek for one month of the calendar year under both the mean precipitation and 1/10 dry year conditions. In the 1/10 dry year scenario, slight fluoride pWQO exceedances were also estimated in upper Finlayson Creek. These effects are adverse, reversible long term and of neutral environmental and socio-economic context. Although experienced on a local scale, the magnitude of such slight pWQO and SSWQO exceedances is considered moderate. They have a likely probability of occurring and are not significant.

8.4.3.4 Changes in Surface Water Quantity and Quality as a Result of Water Management and Discharge during Closure

Once the post-closure phase begins, the ABM lake will begin discharging water to the receiving environment and covers will be well established. Runoff is expected to return to near baseline levels, but slightly elevated in Geona and Finlayson Creeks due to the addition of deep groundwater to the ABM pit lake. In Geona Creek runoff will be 4% above baseline at KZ-37 while in Finlayson Creek it will be 2% higher at KZ-15 and 1% higher at KZ-26. Discharge will be 8 % below baseline in South Creek due to the drawdown effect of the ABM pit Lake. These increases are all well within natural variation ranges.

The effects to surface water quantity are still considered adverse insomuch as they are a deviation from baseline. The effects are permanent or far future in duration, occur regularly, are irreversible, have low environmental and socio-economic context and are high probability. The magnitude is low at all sites and in all cases the effects to surface water quantity are not considered significant.

During post-closure, no COPI were estimated to exceed their respective water quality objectives in Geona or Lower Finlayson Creeks under the mean precipitation scenario. Only fluoride was estimated to exceed its water quality objective in upper Finlayson Creek, but the excursion was marginal (<10% higher than the pWQO) and only occurred in April of each year. Under the 1/10 dry year scenario, fluoride was estimated to exceed its water quality objective at KZ-37, KZ-15, and KZ-37. The modelled fluoride excursion was marginal for all three sites and occurred only in March or April.

These modelled effects on surface water quality are permanent or far future in duration, occur regularly, are irreversible, have neutral environmental and socio-economic context and are high probability. The magnitude is moderate for fluoride and low for all other COPI and in all cases the

effects are not significant. No residual effect for surface water quality in South Creek during closure is predicted.

8.4.3.5 Summary

The significance of residual effects as a result of the Project on surface water quantity and quality are summarized in Table 8-45 and Table 8-46, respectively.

Table 8-45: Project Effects Significance Assessment for Surface Water Quantity

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quantity in Geona Creek at KZ-37 as a result of water diversions and dewatering activities during construction	Adverse	Moderate overall, high sporadically	Local	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Finlayson Creek at KZ-15 as a result of water diversions and dewatering activities during construction	Adverse	Low overall, high sporadically	Local	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Finlayson Creek at KZ-26 as a result of water diversions and dewatering activities during construction	Adverse	Low	Regional	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in South Creek at KZ-13 as a result of water diversions and dewatering activities during construction	Adverse	High	Local	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quantity in Geona Creek at KZ-37 as a result of water management and discharge during operations	Adverse	High	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Finlayson Creek at KZ-15 as a result of water management and discharge during operations	Adverse	Moderate	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Finlayson Creek at KZ-26 as a result of water management and discharge during operations	Adverse	Low	Regional	Long Term	Regular	Reversible	Neutral	High	Not significant
Changes in surface water quantity in South Creek at KZ-13 as a result of water management and discharge during operations	Adverse	High	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Geona Creek at KZ-37 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	High	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quantity in Finlayson Creek at KZ-15 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	Low	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Finlayson Creek at KZ-26 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	Low	Regional	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in South Creek at KZ-13 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	Low	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quantity in Geona Creek at KZ-37 as a result of water management and discharge during closure	Adverse	Low	Local	Far future	Regular	Irreversible	Neutral	High	Not significant
Changes in surface water quantity in Finlayson Creek at KZ-15 as a result of water management and discharge during closure	Adverse	Low	Local	Far future	Regular	Irreversible	Neutral	High	Not significant

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quantity in Finlayson Creek at KZ-26 as a result of water management and discharge during closure	Adverse	Low	Regional	Far future	Regular	Irreversible	Neutral	High	Not significant
Changes in surface water quantity in South Creek at KZ-13 as a result of water management and discharge during closure	Adverse	Low	Local	Far future	Regular	Irreversible	Neutral	High	Not significant

Note: Criteria definitions are provided in Table 8-2.

Table 8-46: Project Effects Significance Assessment for Surface Water Quality

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quality in Geona Creek at KZ-37 as a result of water diversions and dewatering activities during construction	Adverse	Moderate	Local	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ-15 as a result of water diversions and dewatering activities during construction	Adverse	Moderate	Local	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quality in Finlayson Creek at KZ-26 as a result of water diversions and dewatering activities during construction	Adverse	Moderate	Regional	Short Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Geona Creek at KZ-37 as a result of water management and discharge during operations	Adverse	Moderate	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ-15 as a result of water management and discharge during operations	Adverse	Moderate	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ--26 as a result of water management and discharge during operations	Adverse	Moderate	Regional	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Geona Creek at KZ-37 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	Moderate	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ-15 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	Moderate	Local	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ-26 as a result of flooding of ABM Open Pit at closure and ABM lake formation	Adverse	Moderate	Regional	Long Term	Regular	Reversible Long Term	Neutral	High	Not significant

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Changes in surface water quality in Geona Creek at KZ-37 as a result of water management and discharge during closure	Adverse	Moderate	Local	Far future	Regular	Irreversible	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ-15 as a result of water management and discharge during closure	Adverse	Moderate	Local	Far future	Regular	Irreversible	Neutral	High	Not significant
Changes in surface water quality in Finlayson Creek at KZ-26 as a result of water management and discharge during closure	Adverse	Moderate	Regional	Far future	Regular	Irreversible	Neutral	High	Not significant

Note: Criteria definitions are provided in Table 8-2.

8.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for surface water follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to Yukon Environmental and Socio-economic Assessment Board (YESAB). The following Project residual effects have been identified for surface water and are considered through the CEA:

- Changes in surface water quantity and quality as a result of water diversions and dewatering activities during construction;
- Changes in surface water quantity and quality as a result of water management and discharge during operations;
- Changes in surface water quantity and quality as a result of flooding of ABM Open Pit at closure and ABM lake formation; and
- Changes in surface water quantity and quality as a result of water management and discharge during closure.

8.5.1 Cumulative Effects Characterization

For past, present and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the project or activity results in a demonstrable or measurable effect on surface water;
2. The Project-specific residual effect on surface water overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on surface water overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for surface water are identified through the screening in Table 8-47 and Table 8-48. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

8.5.1.1 Surface Water

The results of the surface water quantity CEA are presented in Table 8-47.

Table 8-47: Cumulative Effects Screening for Surface Water Quantity

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Quartz Mining and Exploration				
Fyre Lake Property (*Pacific Ridge Exploration)*	No	N/A	N/A	No
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/Veris Group*)	No	N/A	N/A	No
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	No	N/A	N/A	No
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	N/A	N/A	No
The Yukon Base Metal Project *(Overland Resources Ltd.)*	No	N/A	N/A	No
Wolverine Mine (*Yukon Zinc Corp.)*	No	N/A	N/A	No
Roads, Access Roads and Trails				
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	N/A	N/A	No
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	N/A	N/A	No
Other Activities				
Single/Group Trapline Concessions	No	*N/A*	*N/A*	No
Outfitting Concessions	No	*N/A*	*N/A*	No
Campgrounds	No	*N/A*	*N/A*	No

As indicated in Table 8-47, no projects or activities have been identified to overlap with Project residual effects for surface water quantity in type of effect, in time and in space. Therefore, no potential cumulative effects have been identified for surface water quantity and no further assessment is required.

8.5.1.2 Surface Water Quality

The results of the surface water quality CEA are presented in Table 8-48.

Table 8-48: Cumulative Effects Screening for Surface Water Quality

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Quartz Mining and Exploration				
Fyre Lake Property (*Pacific Ridge Exploration)*	No	N/A	N/A	No
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/ Veris Group*)	No	N/A	N/A	No
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	No	N/A	N/A	No

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	*N/A*	*N/A*	No
The Yukon Base Metal Project *(Overland Resources Ltd.)*	No	*N/A*	*N/A*	No
Wolverine Mine (*Yukon Zinc Corp.)*	No	*N/A*	*N/A*	No
Roads, Access Roads and Trails				
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	*N/A*	*N/A*	No
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	*N/A*	*N/A*	No
Other Activities				
Single/Group Trapline Concessions	No	*N/A*	*N/A*	No
Outfitting Concessions	No	*N/A*	*N/A*	No
Campgrounds	No	*N/A*	*N/A*	No

As indicated in Table 8-48, no projects or activities have been identified to overlap with Project residual effects for surface water quality in type of effect, in time and in space. Therefore, no potential cumulative effects have been identified for surface water quality and no further assessment is required.

8.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

8.6.1 Historic and Current Surface Water Monitoring Program

Current surface water quantity and quality monitoring is undertaken as part of the pre-development baseline monitoring programs for the Project. Historic surface water quality monitoring also occurred as part of the baseline studies in 1994 and 1995 as well as during monitoring undertaken for the Project's type A Water Use Licence (WUL) QZ97-026-01 biannual aquatic monitoring program from 2002-2016.

8.6.2 Surface Water Monitoring Program during Construction and Operations

As a result of Project mining activities, additional surface water stations are proposed. In addition to monitoring of the receiving environment, contact water, treated effluent, water management ponds and discharge points to the receiving environment will be added to the monitoring program.

Table 8-49 outlines the existing and proposed sampling stations and the proposed schedule for internal and external lab analysis during construction and operations. Figure 8-50 and Figure 8-51 show the existing and proposed surface water monitoring station locations. Surface water monitoring will occur on a monthly basis with the exceptions of the discharge from the Class A Storage Facility collection pond, the water treatment plant, and the Lower Water Management Pond, which will all be monitored on a weekly basis.

Hydrology monitoring is undertaken on a monthly basis during the open water season at stations on Finlayson Creek (KZ-26, KZ-22, KZ-15 and KZ-16), Geona Creek (KZ-9), Fault Creek (KZ-2) and South Creek (KZ-13). Instantaneous measurements of flow are also collected during monthly sample events at all stations, where practicable. During project operations continuous water level and/or discharge rates will be monitored from the key water management infrastructure (i.e., UWMP, LWMP, Water Treatment Plant, Class A, B and C Storage Facilities ponds, Overburden Stockpile pond and Pit Rim pond).

8.6.3 Surface Water Monitoring at Closure

The monitoring of these surface water sites will continue at that sampling frequency for the first five years following closure (i.e., years 11 to 15). For the remainder of the transition closure period (i.e., years 16 to 26), the frequency of water quality monitoring at the surface water stations will be stepped downed to quarterly. Upon entering the post-closure period when the pit starts to overflow, the frequency of surface water quality monitoring will return to monthly for three years (i.e., years 27 to 29) before transitioning to quarterly sampling from year 30 until the end of the post-closure period (year 36).

Water quality monitoring of the ABM lake will begin approximately one year after the pit has started to fill with water (i.e., year 12) to allow sufficient volume to conduct sampling by boat. Sampling will be conducted on a monthly basis between June and September during the open water season and quarterly for the remainder of the year (e.g., sampling in December and March). Separate samples will be collected at the surface (i.e., top 2 m), and mid depth, and within 5 m of the pit floor in order to assess how well mixed the ABM lake is and track the development of any stratification. The samples collected will be analyzed for the same suite of in situ and laboratory measured analytes as the surface water samples (with the addition of dissolved oxygen and ORP for the in situ measurements). Once fully flooded (i.e., year 26), ABM lake sampling will continue at the same schedule for three years (i.e., until year 29). During this time, in situ parameters will be measured down the water column at 10 m intervals twice per year during the scheduled sampling events in late summer/fall and late winter to determine the presence and depth of any stratification. If the data suggest the ABM lake chemistry has largely stabilized, sampling will transition to quarterly for the

remainder of the post-closure period (i.e., year 30 to 36) and no further semi-annual depth resolved in situ measurements will occur.

8.6.4 Geochemistry Field Barrels

The operation of the waste rock field barrels using drill core that were constructed in November 2015 will continue during the construction and operations phases of the Project. Leachate from the field barrels will be collected on a monthly basis during the ice-free months (typically between April and October). The overall leachate volume will be recorded and in situ measurements of pH, conductivity, and temperature will be made. Samples will also be collected for laboratory analysis of acidity, alkalinity, major anions and metals. Data from the field barrel program such as trace metals leaching will inform waste rock management practices. The continuation of the field barrel program will be evaluated on an annual basis.

8.6.5 Quality Assurance/Quality Control

The current monitoring program includes a comprehensive Quality Assurance/Quality Control (QA/QC) program to ensure validity of the data collected. The QA/QC program includes (and will continue to include):

- All field staff are trained in surface water monitoring and sample collection based on generally accepted Yukon practices. The sampling procedures include measures to avoid sample contamination in the field, as well as during sample handling and shipping;
- Blind field duplicates are collected at a rate of 1 duplicate per 10 samples collected. The field duplicates are clearly linked to one of the sampling stations on sampling logs and field notes but not on the chain of custody forms;
- A field and travel blank are collected for each monthly sampling event throughout the year;
- All samples are sent to a Canadian Association for Laboratory Accreditation member laboratory, for analysis. The laboratory will also conduct a QA/QC program, including split duplicates (1 per 10 samples); and
- Following each sampling event, BMC conducts a review of all analytical results and QA/QC of results received from the laboratory to ensure data quality and flag any potential issues (e.g., data quality issues from the information provided by the lab, ensure data are charge balanced – typically less than 5%). Additionally, the QA/QC program includes a review of the relative percent difference in replicates and parameters measured in field blanks and trip blanks to assess data quality.

8.6.6 Reporting

All surface water data collected will be submitted as part of monthly and annual reports for the Water Licence to the Yukon Water Board and in the annual Quartz Mining License report. The surface water data will be used to ensure compliance with the Water Licence and to refine the surface water quality model to inform operational decisions. The surface water data will be evaluated against the AMP

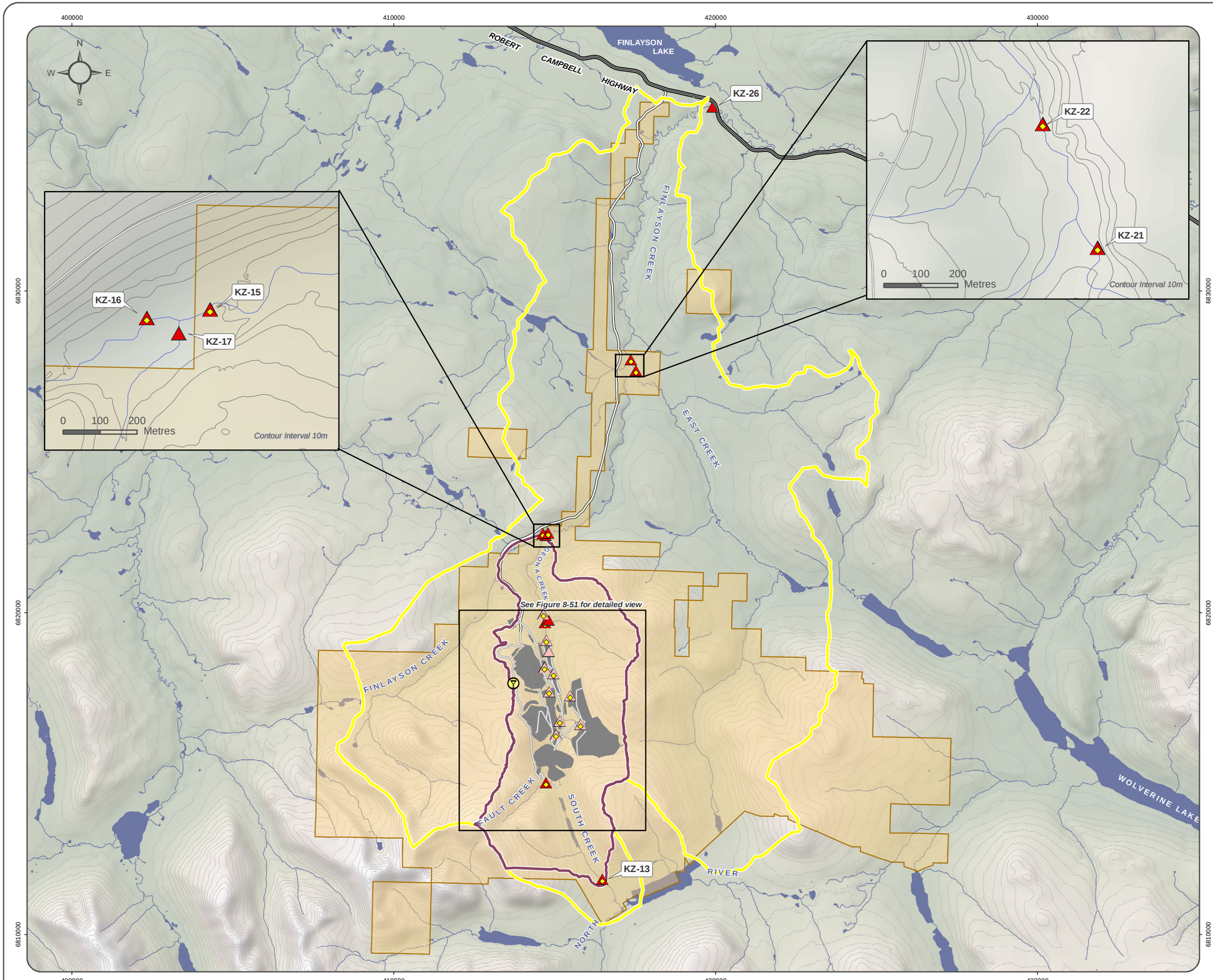
thresholds (i.e. drainage prediction chemistry, water quality objectives and effluent quality standards) on a monthly and annual basis.

Table 8-49: Kudz Ze Kayah Surface Water Quality Monitoring Program Summary

Site	Station Description	IN SITU MEASUREMENTS						EXTERNAL LAB ANALYSIS											
		Level	Flow	pH	Temperature	Specific Conductivity	TSS	Total Metals (ultra-low levels including hardness phosphorus and mercury)	Dissolved Metals (ultra-low levels including hardness phosphorus and mercury)	pH	Specific Conductivity	Total Suspended Solids	Anions	Alkalinity	Acidity	Ammonia	Dissolved Organic Carbon (DOC)	Total Cyanide	WAD Cyanide
MINE TREATMENT/ EFFLUENT DISCHARGE SITES																			
KZ-3	Class B Storage Facility Seepage Collection Pond	M	C	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KZ-5	Lower Management Water Pond	M	-	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-8	Lower Water Management Pond discharge	W	C	W	W	W	W	W	W	W	W	W	W	W	-	W	W	W	W
KZ-12	Mine Water Treatment Plant discharge	-	C	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
KZ-30	Class C Storage Facility Seepage Collection Pond	M	C	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KZ-31	Overburden Stockpile Seepage Collection Pond	M	C	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KZ-32	Pit Rim Pond	M	C	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KZ-34	Class A Storage Facility Seepage Collection Pond	W	C	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
KZ-36	Upper Management Water Pond	M	C	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
MINE SURFACE WATER SURVEILLANCE SITES																			
KZ-2	Fault Creek at discharge to South Creek headwater lake	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-9	Geona Creek downstream of KZ-10	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-13	Lower South Creek	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-15	Finlayson Creek 100m downstream of Geona Creek	-	C	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-16	Finlayson Creek immediately upstream of Geona Creek	-	C	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-17	Geona Creek at mouth	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-18	Tributary on Geona Creek downstream of KZ-9	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-21	East Creek at mouth	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-22	Finlayson Creek 100 m downstream of East Creek	-	M	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-26	Finlayson Creek at Robert Campbell Highway	-	C	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M
KZ-37	Geona Creek downstream of KZ-18	-	C	M	M	M	M	M	M	M	M	M	M	M	-	M	M	M	M

Notes:

C	Continuous	Ms	Monthly (May to Oct)
C-WD	Continuous While Discharging	M/Q	Monitoring to occur monthly for first 12 months, reverting to quarterly thereafter
D	Daily	Q	Quarterly
D-WD	Daily While Discharging	A	Annually
W	Weekly	SA	Semi Annually/ twice per year
W-WD	Weekly While Discharging	BA	Bi-Annually (every 2 years)



BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 8-50

EXISTING AND PROPOSED SURFACE WATER QUALITY MONITORING LOCATIONS

FEBRUARY 2017

- Existing Water Quality and Hydrometric Station
- Existing Water Quality Sampling Location
- Proposed Water Quality and Hydrometric Station
- Proposed Water Quality Sampling Location
- KZK Meteorological Station
- Local Study Area
- Regional Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Waterbody
- Watercourse
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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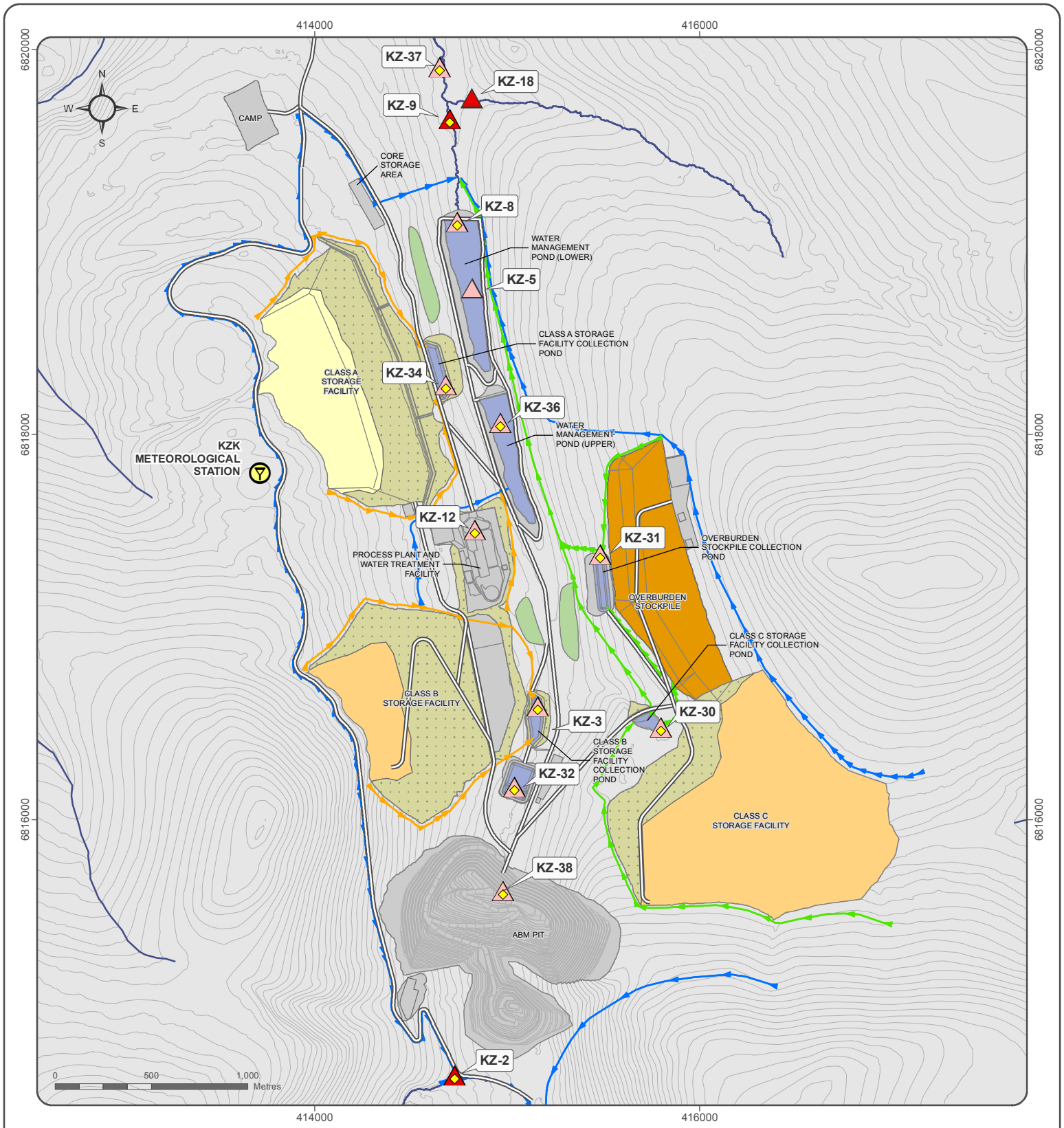

- Existing Water Quality and Hydrometric Station
- Existing Water Quality Sampling Location
- Proposed Water Quality and Hydrometric Station
- Proposed Water Quality Sampling Location
- KZK Meteorological Station
- Pipeline
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water

KUDZ ZE KAYAH PROJECT

FIGURE 8-51

EXISTING AND PROPOSED SURFACE WATER QUALITY MONITORING WITHIN PROJECT SITE

MARCH 2017

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KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

9 GROUNDWATER QUALITY AND FLOW 9-1

9.1 ASSESSMENT APPROACH 9-1
9.1.1 Selection of Subcomponents and Measurable Parameters 9-1
9.1.2 Criteria for Assessing Significance 9-3
9.2 ASSESSMENT BOUNDARIES 9-5
9.3 EXISTING CONDITIONS 9-8
9.3.1 Hydrogeological Monitoring Network and Data Collection 9-8
9.3.2 Hydrogeological Setting and Aquifer Properties 9-12
9.3.3 Groundwater Occurrence and Flow 9-13
9.3.4 Groundwater – Permafrost Interaction 9-14
9.3.5 Groundwater – Surface Water Interaction 9-14
9.3.6 Groundwater Quality 9-14
9.4 PROJECT-SPECIFIC EFFECTS 9-17
9.4.1 Effects Characterization 9-17
9.4.2 Mitigation Measures 9-38
9.4.3 Residual Effects and Significance Determination 9-42
9.5 CUMULATIVE EFFECTS 9-46
9.5.1 Cumulative Effects Characterization 9-46
9.6 EFFECTS MONITORING 9-47

LIST OF TABLES

Table 9-1: Groundwater Subcomponents and Measurable Parameters 9-2
Table 9-2: Groundwater Significance Criteria Definition 9-4
Table 9-3: Proposed Study Areas for Groundwater 9-5
Table 9-4: Monitoring Well Network at KZK 9-9
Table 9-5: Interaction Matrix for Groundwater 9-17
Table 9-6: Comparison of Groundwater Demand with Geona Creek and Finlayson Creek Baseline Low Flow 9-37
Table 9-7: Identified Potential Project Effects for Groundwater 9-38
Table 9-8: Proposed Mitigation Measures for Groundwater 9-39
Table 9-9: Project Effects Significance Assessment for Groundwater 9-45
Table 9-10: Cumulative Effects Screening for Groundwater 9-46
Table 9-11: Kudz Ze Kayah Groundwater Quality Monitoring Program Summary 9-49

LIST OF FIGURES

Figure 9-1: Groundwater Local and Regional Study Areas 9-7
Figure 9-2: Current Groundwater Monitoring Well Locations 9-11
Figure 9-3: Estimated Total Flux Rates for Dewatering of the Mine Workings 9-21
Figure 9-4: Estimated Flux Rates for Dewatering of the Mine Workings by Source of Water 9-22
Figure 9-5: Drawdown Contours for the Bedrock Aquifer during Year 9 of Mining 9-24
Figure 9-6: Drawdown Contours for Shallow Bedrock 5 Years Post Mining 9-25
Figure 9-7: Drawdown Contours for Shallow Bedrock 30 Years Post Mining 9-26
Figure 9-8: ABM Lake Formation and Water Budget (positive flow rates indicate inflow, negative flow rates indicate outflow from the ABM lake) 9-27
Figure 9-9: Predicted Flow in Geona Creek, South Creek, and Finlayson Creek during Operations, Closure, and Post Closure Relative to Baseline Conditions 9-29
Figure 9-10: Post-closure Waste Rock Particle Tracking 9-33
Figure 9-11: Estimated Drawdown of Camp and Process Plant Supply Wells 9-36
Figure 9-12: Proposed Groundwater Monitoring Sampling Locations 9-50

9 GROUNDWATER QUALITY AND FLOW

This chapter provides an overview of the existing groundwater conditions and assessment of the potential Project effects on groundwater.

Groundwater was selected as a VC because of its great importance in maintaining function of aquatic and biophysical environments. Furthermore, overall water quality and quantity has been identified as highly valued by First Nations and Yukoners.

9.1 ASSESSMENT APPROACH

The groundwater EA generally follows the methods outlined in Chapter 5 and is based upon the conceptual model of the local groundwater regime that was developed as part of the hydrogeology baseline assessment (Appendix D-3). The groundwater EA also relies on the results of the numerical groundwater model that was used to evaluate and quantify potential effects on groundwater (Appendix D-4). Additional information used to support the groundwater EA includes the local meteorological conditions described in Section 6.3.1 and the local surface water hydrology described in Section 8.3.2.

Desk-based research was conducted to identify Kaska knowledge, uses, interests, and values related to groundwater; however, none was available from publicly available secondary sources. Ongoing future TK data collection efforts as well as consultation and engagement activities with the Ross River Dena Council (RRDC), as representatives of the Kaska First Nation, may result in additional information and understanding on this issue.

9.1.1 Selection of Subcomponents and Measurable Parameters

The groundwater subcomponents and measurable parameters are provided in Table 9-1. Two subcomponents were selected for this VC:

- Groundwater quality; and
- Groundwater quantity.

The groundwater quality subcomponent is the chemical composition of the groundwater. Where groundwater discharges to surface water it can have effects on the surface water quality and aquatic life. Also, direct use of groundwater resources, such as drinking water wells, is highly dependent on groundwater quality.

Groundwater quantity is also valued subcomponent that may be affected by the Project. Groundwater quantity mainly refers to the piezometric elevations of the groundwater table that govern hydraulic gradients, groundwater flow rates, and discharge to surface water bodies (also referred to as baseflow). During extended dry periods or frozen winter conditions with little to no surface runoff or shallow interflow, groundwater discharge to creeks or rivers can be critical to sustain flow and maintain aquatic habitat. If piezometric elevations decrease (e.g., due to groundwater extraction to

dewater the proposed open pit) groundwater discharge to surface water bodies in the affected area may be reduced or eliminated.

Table 9-1: Groundwater Subcomponents and Measurable Parameters

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Groundwater	Groundwater Quality	Major ions and routine parameters (e.g., pH, water temperature, electrical conductivity). Dissolved arsenic, cadmium, iron, copper, nickel, lead, selenium, and zinc. Sulfate, ammonia-N (NH_4^+-N), nitrate-N (NO_3-N), and nitrite-N (NO_2-N).	General water quality guidelines and regulatory standards: • Yukon CSR Schedule 3, Generic Numerical Water Quality Standards for Aquatic Life (CSR-AW) (Yukon Government, 2002). • Federal Interim Groundwater (FIG) Quality Guidelines for Commercial and Industrial Land Uses and Protection of Freshwater Aquatic Life (Environment Canada, 2012). • Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME-AW) (CCME, 2015). • Yukon Territory Water Board Type A Water Use Licence Number QZ97-026 (Exp. September 28, 2018), Section E - Effluent Quality Standards (the Site Water Licence).	Current Water Use Licence and general water quality guidelines and regulatory standards were used for comparison.
	Groundwater Quantity	Groundwater elevations and hydraulic gradients. Baseflow to Geona Creek and South Creek.	Maintenance of baseflow to Geona Creek within natural variability to sustain aquatic habitat.	Most groundwater within Project area ultimately discharges to Geona Creek.

Groundwater quality is typically measured against applicable water quality guidelines. The Project would operate under a Water Use Licence issued by the Yukon Water Board. The Water Use Licence typically stipulates water quality standards for mine effluent at compliance points. Since the details of a future Water Use Licence are unknown at this time, groundwater quality within the local study

area (LSA; defined in Section 9.2) was compared to the following water quality guidelines and regulatory standards:

- Yukon Contaminated Sites Regulation (CSR) Schedule 3, Generic Numerical Water Quality Standards for Aquatic Life (CSR-AW) (Yukon Government, 2002);
- Federal Interim Groundwater (FIG) Quality Guidelines for Commercial and Industrial Land Uses and Protection of Freshwater Aquatic Life (Environment Canada, 2012);
- Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME-AW) (CCME, 2015); and
- Yukon Territory Water Board Type A Water Use Licence Number QZ97-026 (Exp. September 28, 2018), Section E - Effluent Quality Standards (the Site Water Licence).

Natural exceedances of the above water quality guidelines were identified and need to be taken into account for the development of site specific water quality objectives at compliance monitoring locations. The list of measurable parameters provided in Table 9-1 includes those parameters for which natural exceedances of water quality guidelines were observed within the LSA. In addition, the measurable parameters include major ions and routine parameters (e.g., pH, water temperature, electrical conductivity) for general hydrochemical characterization, as well as other parameters that may be affected by Project activities (e.g., ammonia, nitrate, other metals due to potential metal leaching from Class A or B material).

9.1.2 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and
- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful; and

- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for groundwater are presented in Table 9-2.

Table 9-2: Groundwater Significance Criteria Definition

Criteria	Definition	
Direction	Adverse	VC would change for the worse
	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
Magnitude	Low	***Groundwater quality*** A detectable effect occurs (a measurable change from existing conditions) but the measurable parameter is within the range of natural variation and/or below the parameter specific water quality standard/guideline, if applicable ***Groundwater quantity*** A detectable effect occurs (a measurable change from existing conditions) but the change is within the range of natural variation
	Moderate	***Groundwater quality*** An effect occurs differing from limits of natural variation for the measurable parameter and/or is below the parameter specific water quality standard/guideline, if applicable ***Groundwater quantity*** An effect occurs differing from the natural variation but is less than 20% change from the average value for existing conditions
	High	***Groundwater quality*** An effect occurs differing from the limits of natural variation for the measurable parameter and exceeding water quality standard and/or guideline, if applicable ***Groundwater quantity*** An effect occurs that is more than 20% change from the average value for existing conditions
Geographic Extent	Site	Effect limited to the Project footprint
	Local	Effect extending beyond the immediate Project footprint to monitoring locations in Geona Creek valley to the north and downgradient of the Project footprint
	Regional	Effect extending to Finlayson Creek to the north and downgradient of the Project footprint, or South Creek to the south
	Beyond Regional	Effect extending beyond Finlayson Creek and South Creek
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent Project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years

Criteria	Definition	
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

Based on the determination of significance criteria summarized in Table 9-2, a significant effect is considered to occur if it meets at a minimum, all three of the following criteria:

- The effect is of regional extent;
- The effect is of high magnitude; and
- The effect occurs over the long-term.

9.2 ASSESSMENT BOUNDARIES

The local and regional study areas for groundwater are described in Table 9-3 and are shown in Figure 9-1. The local study area (LSA) is defined as the footprint of the proposed mine infrastructure and areas immediately downgradient of these areas where groundwater quantity and/or quality may be affected by the Project activities.

The regional study area (RSA) is defined as the Geona Creek valley downstream of the proposed mine and the upper portion of the watershed to the south of the ABM Deposit. This definition is based on the groundwater flow regime in the area of the Project with groundwater flowing from the west and east valley flanks toward Geona Creek and either discharging directly to Geona Creek or following the valley floor for some distance, primarily within the conductive overburden aquifer, before ultimately discharging to Geona Creek. Based on the observed groundwater flow regime, potential effects from the Project on groundwater will be restricted to the LSA and RSA, as defined here.

Table 9-3: Proposed Study Areas for Groundwater

Study Area	Groundwater Specific Study Area Description
Local Study Area	Footprint of proposed mine infrastructure and areas immediately hydraulically downgradient.
Regional Study Area	Geona Creek valley downstream of proposed mine and upper portion of watershed to the south of the ABM Deposit.

Temporal boundaries are defined to include all Project phases within which effects are expected to occur. The Project phases considered in the groundwater EA include the following:

- **Construction Phase**: will last approximately two years and includes site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground development and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as Closure Phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required; the phase is split into two periods: transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.

6822500 417500 6817500 6815000 6812500

415000 412500

N E S W

WATER MANAGEMENT POND (UPPER)

WATER MANAGEMENT POND (LOWER)

OVERBURDEN STOCKPILE

CLASS C STORAGE FACILITY

GEONA CREEK

CORE STORAGE AREA

PROCESS PLANT AND WATER TREATMENT FACILITY

PIT RIM POND

CLASS A STORAGE FACILITY

CLASS B STORAGE FACILITY

ABM PIT

CAMP

FINLAYSON CREEK

PASTE PLANT

FAULT CREEK

6820000 6817500 6815000 412500 6812500

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Datum: NAD 83; Map Projection: UTM Zone 8N

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AEG

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0 250 500 750 Metres

- Local Study Area
- Regional Study Area
- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water
- Pipeline
- Diversion Ditch
- Tote Road/Proposed Access Road
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 9-1

GROUNDWATER LOCAL AND REGIONAL STUDY AREAS

MARCH 2017

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9.3 EXISTING CONDITIONS

This section presents a summary description of the existing environmental conditions as they relate to groundwater quality and flow in the area of the proposed mine. This characterization of the existing environment serves as the baseline against which the effects of the Project are assessed. The description of the existing environment has been focussed on those components of the environment that may be affected by the Project.

The description of the existing environment presents a compilation and review of existing information and the results of the field programs conducted as part of the EA. The following sections provide a summary of the groundwater baseline conditions with further detail provided in the Baseline Hydrogeology Report, included as Appendix D-3.

9.3.1 Hydrogeological Monitoring Network and Data Collection

Groundwater monitoring wells were installed at KZK in 1995 as part of geotechnical site investigations conducted by the previous property owner (Golder Associates Ltd., 1996a, 1996b). Data from these monitoring wells were also used for baseline groundwater characterization as part of the environmental assessment completed for the Project in the 1990s (Norecol, Dames & Moore Ltd., 1996).

The historical monitoring network was re-assessed in 2015 for its present condition and suitability to meet the current mine design and requirements of a project proposal submission under *YESAA*. In addition to the upgrade and re-development of selected historical wells, new monitoring wells were installed in 2015 and 2016 to provide relevant monitoring locations for conducting a hydrogeological baseline and effects assessment as part of this project proposal.

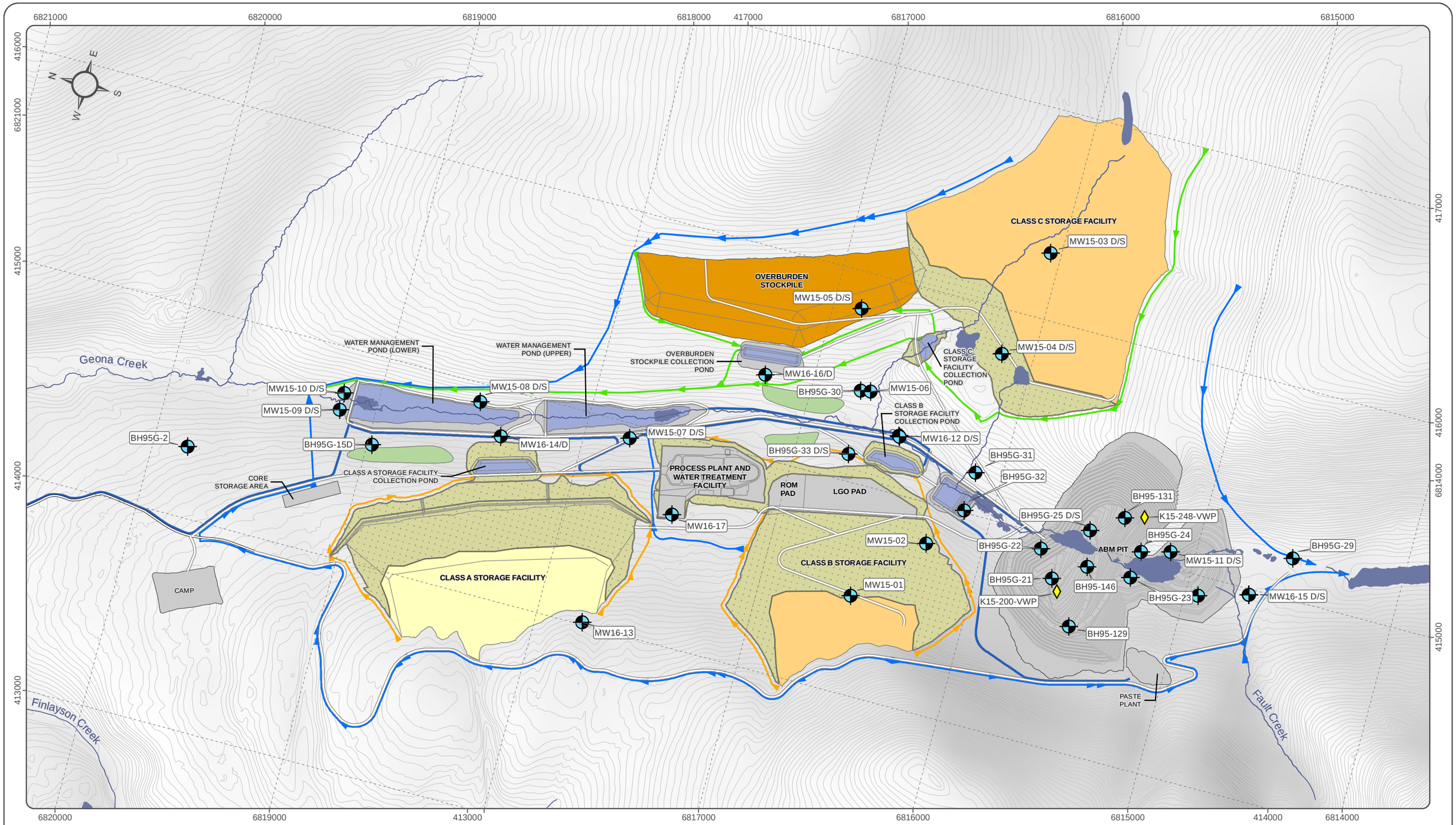
The current network consists of 44 monitoring wells, with 12 wells completed as nested installations with a shallow piezometer completed in the overburden aquifer and a deeper piezometer completed in bedrock. Table 9-4 summarizes the current monitoring well network with well completion details. Figure 9-2 shows the locations of the monitoring wells relative to the proposed mine infrastructure.

In addition to some sporadic groundwater quality data from 1995, all monitoring wells presented in Table 9-4 have been sampled quarterly starting in summer 2015 with monthly sampling conducted from May through November 2016 to characterize baseline groundwater quality including seasonal changes.

Table 9-4: Monitoring Well Network at KZK

Well ID	Easting	Northing	Date Drilled	Aquifer Monitored	Stick-up	Well Depth	Screen Interval	
	UTM Nad83, Zone 9				m above ground	m below top of casing	From	To
							m below ground	
MW15-01	414472	6816559	August 11, 2015	Bedrock	1.29	20.03	10.0	18.8
MW15-02	414808	6816270	August 12, 2015	Bedrock	1.26	32.97	23.0	31.7
MW15-03S	416317	6816052	August 17, 2015	Overburden	0.99	8.42	4.1	7.1
MW15-03D	416317	6816052	August 17, 2015	Bedrock	0.99	16.94	10.1	16.0
MW15-04S	415786	6816156	August 15-16, 2015	Overburden	1.04	15.10	11.2	14.1
MW15-04D	415786	6816156	August 15-16, 2015	Bedrock	1.05	32.30	27.1	32.9
MW15-05S	415852	6816872	August 14, 2015	Overburden	1.07	8.09	4.6	7.6
MW15-05D	415852	6816872	August 14, 2015	Bedrock	0.00	28.56	22.4	29.8
MW15-06	415460	6816722	August 14, 2015	Overburden	0.98	10.02	6.5	9.4
MW15-07S	414922	6817784	August 13, 2015	Overburden	0.90	11.01	8.1	11.0
MW15-07D	414922	6817784	August 13, 2015	Bedrock	0.91	33.14	26.3	32.1
MW15-08S	414904	6818518	August 12, 2015	Overburden	1.09	12.66	8.7	11.6
MW15-08D	414904	6818518	August 12, 2015	Bedrock	1.06	36.89	29.8	35.6
MW15-09S	414709	6819177	August 10, 2015	Overburden	0.59	18.98	11.4	17.3
MW15-09D	414709	6819177	August 10, 2015	Bedrock	0.57	41.32	35.1	40.9
MW15-10S	414794	6819203	August 11, 2015	Overburden	0.88	10.45	6.6	9.6
MW15-10D	414794	6819203	August 11, 2015	Bedrock	0.88	32.35	25.7	31.5
MW15-11S	415079	6815119	November 6-7, 2015	Overburden	1.09	8.14	4.2	7.1
MW15-11D	415079	6815119	November 6-7, 2015	Bedrock	1.10	36.36	20.6	35.2
MW16-12S	415274	6816530	July 21-22, 2016	Overburden	1.2	8.00	2.6	4.3
MW16-12D	415278	6816530	July 20-21, 2016	Bedrock	0.8	28.20	20.5	27.6
MW16-13	414011	6817774	July 6-7, 2016	Bedrock	0.8	27.90	20.3	27.7
MW16-14D	414779	6818386	July 24-25, 2016	Bedrock	1.0	40.20	30.8	38.8
MW16-15S	414977	6814699	July 5, 2016	Overburden	1.0	6.00	3.1	5.3
MW16-15D	414976	6814702	July 4-5, 2016	Bedrock	1.1	42.20	28.8	36.6
MW16-16D	415395	6817229	July 18-20, 2016	Bedrock	0.8	40.30	31.5	38.8
MW16-17	414634	6817489	July 7-8, 2016	Bedrock	0.8	31.10	20.3	27.7
BH95G-2	414341	6819836	May 17, 1995	Bedrock	0.43	19.47	15.2	19.8
BH95G-21	414802	6815641	August 9, 1995	Bedrock	1.12	10.06	6.1	9.1
BH95G-22	414928	6815729	August 9, 1995	Bedrock	0.95	6.56	2.8	5.8
BH95G-23	414906	6815276	August 10, 1995	Overburden	1.21	13.56	9.8	12.8
BH95G-24	415037	6815258	August 11, 1995	Bedrock	0.71	9.12	6.4	9.4
BH95G-25D	415074	6815522	August 12, 1995	Bedrock	1.08	21.08	17.8	20.8
BH95G-25S	415073	6815522	August 12, 1995	Overburden	1.08	12.34	8.5	11.5

Well ID	Easting	Northing	Date Drilled	Aquifer Monitored	Stick-up	Well Depth	Screen Interval	
	UTM Nad83, Zone 9				m above ground	m below top of casing	From	To
							m below ground	
BH95G-29	415197	6814543	August 17-18, 1995	Overburden	1.07	16.51	15.6	18.6
BH95G-30	415437	6816766	August 19-21, 1995	Bedrock	0.10	19.20	16.2	19.2
BH95G-31	415199	6816129	August 21, 1995	Bedrock	1.02	8.70	7.0	10.0
BH95G-32	415008	6816134	August 22-23, 1995	Bedrock	1.22	15.83	12.2	15.2
BH95G-33D	415130	6816745	August 24, 1995	Bedrock	1.17	12.92	9.1	12.1
BH95G-33S	415130	6816745	August 24, 1995	Overburden	1.16	6.44	2.8	5.8
BH95-129	414601	6815499	May 12, 1995	Bedrock	1.05	150.90	154.5	160.0
BH95-131	415182	6815377	May 13, 1995	Bedrock	1.07	128.00	123.5	128.0
BH95-146	414898	6815504	May 21, 1995	Bedrock	1.04	137.73	134.1	138.7



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AEG

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0 250 500 750 Metres

- Vibrating Wire Piezometer
- Groundwater Monitoring
- Existing Watercourse
- Existing Waterbodies
- Mine Feature Footprint
- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Pipeline
- Tote Road/Proposed Access Road
- Proposed Mine Road

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KUDZ ZE KAYAH PROJECT

FIGURE 9-2

CURRENT GROUNDWATER MONITORING WELL LOCATIONS

FEBRUARY 2017

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9.3.2 Hydrogeological Setting and Aquifer Properties

The local hydrogeological system within the study area consists of two principal aquifers, a bedrock aquifer overlain across valley floors by an overburden aquifer.

Overburden in the study area is primarily composed of till and glacial deposits ranging in thickness from a thin veneer on valley flanks, to more than 20 m near the centreline of the valley. An overburden aquifer over 10 m thick is present within the sediments along the valley floor. The thickness of the overburden deposits generally decreases with increasing elevation. Above about 1,500 masl, the surficial deposits consist of a layer of organic material less than 0.5 m thick, overlying colluvium. The latter originates from frost loosening of bedrock.

Numerous hydraulic response tests were conducted in overburden monitoring wells and a 12-hour constant rate pumping test was performed in overburden within the area of the proposed open pit. The results of these tests predict that fine-grained overburden has a geometric mean hydraulic conductivity of 5.2×10^{-6} m/s. The hydraulic conductivity of coarse-grained (sand and gravel) overburden is estimated to be about 1.3×10^{-4} m/s.

Recharge to the overburden aquifer is expected to be through discharge from the underlying bedrock aquifer and infiltration of precipitation and snowmelt through surficial soils on valley flanks. Recharge through surface water infiltration may be limited due to the expected upward hydraulic gradient in the overburden aquifer across much of the valley floor. At higher elevations where overburden thins, perched water may sit on top of the bedrock contact and migrate through higher permeability overburden in the direction of the surface dip. Towards the centre of the valley, groundwater is expected to move through the upper compact to dense sand layer and discharge to Geona Creek and low lying surface water bodies that line the valley floor.

The primary bedrock aquifer in the vicinity of the mineralized zones mainly consists of schistose felsic volcanics intersected with thick felsic tuff and sill/flow complexes that host the ore deposit. Groundwater flow in bedrock aquifers predominantly occurs in secondary pore space (fractures and fault zones) as primary porosity is usually very small, or essentially non-existent as in the case of volcanic and metamorphic rocks like those encountered at KZK. Bedrock aquifers therefore typically act like confined aquifers. In general, groundwater flow in fractured rocks is complex and can vary greatly in direction and rate, depending on the local hydrogeological and structural geological conditions. Transmissivity values can change over several orders of magnitude within the same rock mass over short distances (scale of metres), and groundwater flow may be largely controlled by a few conductive fractures or other rock mass discontinuities.

In the depth range of 10 to 70 metres below ground surface, the results of packer tests conducted in bedrock were generally in the range of 1×10^{-7} to 1×10^{-5} m/s, and do not appear to exhibit a trend of increasing or decreasing hydraulic conductivity with depth. Packer tests are representative of short discrete test intervals and of bedrock in the immediate vicinity of the wellbore. Single features such as joints or fractures can significantly affect or dominate the test results, which may explain the two order-of-magnitude variability in the measured hydraulic conductivity values. The packer tests conducted in bedrock provide a geometric mean hydraulic conductivity of 1.2×10^{-6} m/s, which is

similar to the result of a 24-hour bedrock pumping test conducted by Tetra Tech during 2015 (1.7×10^{-6} m/s) (Tetra Tech, 2016). For site characterization, an average bedrock hydraulic conductivity equal to 1.5×10^{-6} m/s is considered reasonable.

Recharge to the bedrock aquifer occurs primarily through infiltration of precipitation and snow melt on valley flanks, where bedrock outcrops or overburden is thin. Within the study area, discharge occurs to the overlying overburden along the valley floor, and eventually to Geona Creek and/or its tributaries.

9.3.3 Groundwater Occurrence and Flow

Groundwater elevations are variable across the study area with the water table at or very near surface across the valley floor, while beneath the mountains the water table may be greater than 200 m below surface.

Based on the mountainous terrain that dominates the study area, groundwater flow is expected to be mainly controlled by the area's topographic features with flow from the topographically high mountain tops and slopes on either side of the valley toward discharge zones along the valley floors. This flow regime was confirmed by piezometric elevations collected from nested monitoring wells and vibrating wire piezometers (VWP) across the study area, with the general flow observed to be from areas of higher piezometric elevations (upper mountain slopes) to areas with lower piezometric elevations (across the valley floor).

Recharge to the bedrock aquifer would be expected to migrate into deep local flow paths, moving towards the valley though fractures and faults prior to discharging to the overburden aquifer. Groundwater moves through the overburden aquifer prior to discharging to surface water features on the valley floor. Flowing wells and upward hydraulic gradients at nested wells across the study area confirm this general flow pattern.

On valley flanks, the water table is generally located within the competent bedrock. However, during periods of snow melt, it is expected that a perched or temporary water table develops within the fractured bedrock and overlying overburden.

Horizontal hydraulic gradients are generally reflective of topography and tend to have higher values in areas of steeper topography. Groundwater flow within the project area is generally toward Geona Creek.

Using the observed range in hydraulic gradient for overburden (0.12 to 0.31 m/m), an effective porosity of 0.20 for granular materials, and the geometric mean hydraulic conductivity of 5.2×10^{-6} m/s, the groundwater seepage velocity of fine-grained overburden is computed to range from 0.27 to 0.70 m/day. For coarse-grained overburden, with an estimated hydraulic conductivity of 1.3×10-4 m/s, the computed seepage velocity ranges from 6.7 to 17.4 m/day.

Using the observed range in hydraulic conductivity for bedrock (0.06 to 0.27 m/m), an effective porosity of 0.05, and an estimated average hydraulic conductivity of $1.5x10^{-6}$ m/s, the groundwater seepage velocity for bedrock is computed to range from 0.16 to 0.70 m/day. Fault zones that are

highly fractured or have permeable gouge material, may provide preferential groundwater flow paths. This is particularly noted for the Fault Creek Fault, which extends for several km southwest of the pit area.

9.3.4 Groundwater – Permafrost Interaction

The Project is located in an area with discontinuous permafrost. Norecol, Dames & Moore Ltd. (1996) noted that permafrost is present on north and west facing slopes along the Geona Creek valley, especially above 1,400 masl. Permafrost was found to be mostly absent on the western valley walls as well as in the area of the proposed open pit, except for some localized ice lenses. Where present, permafrost acts as a confining or semi-confining layer depending on the spatial extent and thickness, thereby limiting recharge to the aquifer in this area which causes the groundwater table to be located at greater depth when compared to the east facing slopes where permafrost is believed to be mostly absent.

9.3.5 Groundwater – Surface Water Interaction

Groundwater discharges to receiving water bodies along the valley floors, with Geona Creek being the primary discharge feature within the study area. The amount of baseflow, i.e., groundwater seepage into the creeks, depends on the hydraulic gradient and hydraulic conductivity of the shallow overburden aquifer in the vicinity of the receiving stream.

In general, the fraction of baseflow in the creek will be much larger in the winter when there is little or no surface runoff or shallow subsurface runoff (also referred to as interflow). The (late) winter creek discharge usually provides a good estimate of the baseflow as it amounts to nearly 100% of the total discharge observed during this time of the year.

9.3.6 Groundwater Quality

In general, the chemical composition of groundwater depends on the local and upgradient aquifer lithologies. As groundwater flows through an aquifer it assumes and continuously evolves a characteristic chemical composition due to interaction with the aquifer matrix. As such, a groundwater sample represents the local and upstream aquifer conditions, and its composition is a function of aquifer lithology, solution kinetics, groundwater residence time, mixing, and groundwater flow patterns.

Groundwater quality has been assessed at a total of 45 wells during the 1995 and 2015 through 2016 field programs, with samples analyzed for general chemical parameters, total and dissolved metals, and nutrients.

Groundwater quality can be seen to vary considerably across the study area, which is considered due to the considerable extent of the study area (over 5 km north to south), the various groundwater flow systems and recharge sources (east and west of Geona Creek) and the potential for differing chemistry in the vicinity of the ABM deposit.

9.3.6.1 General Chemistry

Field pH values ranged from 5.68 to 8.50 units and averaged a slightly alkaline 7.38 in both overburden and bedrock aquifers across the whole study area. Dissolved hardness concentrations are variable across the site, ranging from 78.9 to 2,108 mg/L. The maximum dissolved hardness concentration was reported in a bedrock well located at the northern end of the study area and was over two times higher than the next highest concentration (in a bedrock well below the ABM pit area). Average and maximum dissolved hardness concentrations were typically higher in bedrock wells than overburden wells and appear to increase in concentration with depth within the bedrock aquifer.

Groundwater has an average total dissolved solids (TDS) concentration of 379 mg/L across the study area with an average concentration of 406 mg/L in bedrock wells and 306 mg/L in overburden wells. The highest TDS (1,960 mg/L) was recorded in a bedrock well at the northern extent of the study area and was over twice as high as the TDS concentration at any other well within the study area.

Ammonia was elevated in several wells spread across the entire KZK Project area and was not specific to a particular area, although the concentrations observed were generally higher in the pit area. Fluoride was elevated in many wells across the site, and was one of the few parameters to indicate a difference between bedrock and overburden concentrations, primarily in the proposed Class A and Class C Storage Facility areas. Bedrock wells tended to have higher concentrations than the overburden wells likely reflecting the water-rock interaction and the leaching of fluoride from mineral host rocks, such as mica. Fluoride concentrations across the site were the most consistent with little fluctuation relative to the other general parameters and metals.

Sulphate concentrations were typically more elevated within the pit area, with a maximum sulphate concentration of 280 mg/L and an average of 112 mg/L. The remainder of the Project area had average sulphate concentrations of 61 mg/L. Higher concentrations in the pit area is likely due to the oxidation of the sulphidic minerals in the deposit.

Many monitoring wells showed considerable variability in analytical results over the course of the monitoring program suggesting there may be a seasonal influence on groundwater chemistry. Ongoing groundwater monitoring will provide additional data to characterize seasonal changes in groundwater quality and quantity.

9.3.6.2 Dissolved Metals

Zinc, lead and copper are key metals expected to be associated with the massive sulphide ore deposit and consequently, concentrations of these metals may be elevated in areas hydraulically downgradient of where groundwater contacts the ABM deposit. Lead and zinc concentrations were higher in the pit areas as well as in the wells that were located in the bottom of the valley beside Geona creek, downgradient of the pit. Average zinc and lead concentrations were over 100 times and 25 times higher, respectively, close to the deposit area than the average across the rest of the study area. Copper concentrations were relatively similar across the study area and concentrations were similar in overburden and bedrock wells.

Dissolved arsenic, cadmium, selenium, and iron are considered "key parameters" that have been detected at concentrations above guideline values in multiple wells across the site over the monitoring program. Dissolved arsenic and cadmium concentrations were generally more elevated in the pit area, compared to the rest of the Project area. Dissolved selenium was elevated across the Project area in numerous wells; however, concentrations in select wells were much higher in the areas surrounding the proposed Class A and Class B Storage Facilities.

Similar to lead and zinc, iron was elevated in the pit area, as well as in the bottom of the Geona creek valley. Elevated iron in the pit area may be related to oxidation of iron sulphide minerals in and around the mineral deposit, but are most likely to be governed by reducing conditions in these circumneutral groundwaters. The highest iron concentrations were observed in wells at the northern end of the study area and within the deposit area. Within the central study area, iron concentrations are lower. Across the study area iron concentrations were similar in both bedrock and overburden monitoring wells.

9.3.6.3 Comparison with Applicable Regulatory Water Quality Guidelines

Groundwater quality results were compared against the following regulatory guidelines and standards:

- Yukon CSR Schedule 3, Generic Numerical Water Quality Standards for Aquatic Life (CSR-AW) (Yukon Government, 2002);
- Federal Interim Groundwater (FIG) Quality Guidelines for Commercial and Industrial Land Uses and Protection of Freshwater Aquatic Life (Environment Canada, 2012);
- Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME-AW) (CCME, 2015); and
- Yukon Territory Water Board Type A Water Use Licence Number QZ97-026 (Exp. September 28, 2018), Section E - Effluent Quality Standards (the Site Water Licence).

The Yukon CSR-AW standards and FIG guidelines apply to dissolved metals rather than total metals. This is also in accordance with general industry practice of using dissolved rather than total metals to characterize groundwater quality. Total metal concentrations are often dependent on well completion, well development and sampling method and are typically less representative of in situ groundwater quality and mobile dissolved phase concentrations that discharge to surface. Dissolved metals were therefore used for comparison with the applicable regulatory water quality standards and guidelines.

Groundwater collected from every well at KZK over the period of monitoring reported at least one parameter that naturally exceeded one or more guideline values. Guideline exceedances by one or more of the following parameters were observed: aluminium, ammonia, arsenic, cadmium, chromium, copper, fluoride, iron, pH, phosphorus, selenium, sulphate, uranium and zinc.

While there are multiple natural exceedances of the applicable regulatory water quality guidelines, there are no obvious overall spatial trends or differences between aquifers with respect to

exceedances of water quality guidelines. The exceedances do not imply that the groundwater at the site is currently contaminated. Rather, the exceedances indicate that background concentrations of these parameters are naturally elevated, reflecting the local geological and hydrogeological conditions in the Project area.

9.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on groundwater as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

9.4.1 Effects Characterization

In order to focus the EA, the first step is to identify any potential interactions between Project activities and groundwater. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1 or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects; and*
2 – Higher risk interactions- *it is reasonably foreseeable that residual effects may result.*

The results of the interactions screening are presented in Table 9-5.

Table 9-5: Interaction Matrix for Groundwater

Project Activity	Groundwater Quality	Groundwater Quantity
Construction		
Tote Road upgrade to Access Road	0	0
Finlayson Lake airstrip upgrade	0	0
Site preparation and clearing	0	0
Site grading, including soil and overburden removal and stockpiling	1	1
Off site traffic (construction equipment and materials delivery)	0	0
On site traffic	0	0
ABM open pit development (including dewatering and Fault Creek diversion)	2	2
Infrastructure construction	0	0
Waste handling	1	1
Water use and management	2	2
Power generation	0	0
Worker transport	0	0
Construction camp operations	1	1

Project Activity	Groundwater Quality	Groundwater Quantity
Workforce, procurement and hiring	0	0
Operations		
ABM open pit operations (including blasting and dewatering)	2	2
Underground operations	2	2
Ore processing	1	1
On site traffic	0	0
Off site traffic (highway)	0	0
Finlayson Lake airstrip operations	1	0
Storage facilities management (Class A, B, and C)	2	0
Progressive reclamation of storage facilities	1	0
Water use (potable and non-potable)	2	2
Mine water management and treatment (including effluent discharge)	1	1
Waste management	1	0
Power generation	0	0
Worker transport	0	0
Camp operations	1	1
Workforce, procurement and hiring	0	0
Closure		
Processing plant decommissioning and site reclamation	0	0
ABM lake filling	2	2
Final storage facilities reclamation	2	2
Support infrastructure removal and site reclamation	0	0
Water management and treatment (including effluent discharge)	2	2
On site traffic	0	0
Off site traffic	0	0
Access Road reclamation	0	0
Workforce, procurement and hiring	0	0

In addition to the direct Project interactions identified above, the following indirect interactions are identified for groundwater:

- Potential effect to surface water quality and flow as a result of changes to groundwater quality and quantity.

Based on the screening of anticipated interactions between proposed Project Activities and groundwater quality and/or quantity, the activities and potential effects can be grouped as follows:

1. Mine dewatering and effects on groundwater quality and quantity;
2. Flooding of mine workings at closure and ABM lake formation, and potential effects on groundwater quantity and quality;

3. Residual drawdown from mine dewatering and indirect effects on flow in Geona Creek and South Creek;
4. Use of explosives in open pit and underground workings and potential effects on groundwater quality;
5. Seepage from Class A and B Storage Facilities and associated Collection Ponds and potential effects on groundwater quality;
6. Seepage from Water Management Ponds and potential effects on groundwater quality;
7. Seepage from Waste Management Facility and potential effects on groundwater quality;
8. Groundwater extraction for potable and process water use and potential effects on groundwater quantity;
9. Sewage and grey water effluent from camp and potential effects on groundwater quality; and

Spills of fuel or other deleterious substances may have potential effects on groundwater quality and are addressed in Chapter 17 (Accidents and Malfunctions).

The identified potential effects are discussed in more detail in the following sections.

9.4.1.1 Mine Dewatering

The proposed ABM open pit and underground workings are located at the valley floor in a natural groundwater discharge area with a shallow groundwater table, local artesian conditions in the deeper bedrock aquifer, and vertical upward hydraulic gradients. Both the open pit and underground workings will therefore require dewatering to allow mining of the ABM Deposit. The mine dewatering will result in a hydraulic depressurization of the surrounding rock mass and a lowering of the groundwater table (referred to as the cone of depression). The drawdown of the groundwater table will alter the flow regime within the area of influence with groundwater flowing radially toward the mine workings. The groundwater will then either be extracted from perimeter dewatering wells or collected by the in-pit and underground dewatering system (see Section 4.10).

A numerical groundwater flow model was developed to further the understanding of the groundwater regime within the local and regional study area and to simulate future conditions associated with the proposed mining activities to predict their hydrological effects. The numerical groundwater flow model is described in Appendix D-4.

The ABM open pit and underground workings will be mined out over a nine-year period of time, initially starting with the ABM Zone, then expanding to include the Krakatoa Zone. Prior to the first phase of excavation, a six-month period of dewatering will be performed to allow the overburden to be stripped and the initial open pit to be advanced.

Overburden Dewatering

Prior to the initial mine development, overburden drainage will be conducted by excavating a series of trenches and sumps to the top of the fractured/weathered bedrock. The water will be pumped into the Pit Rim Pond for sediment settlement and subsequently discharged to the receiving environment, provided that it meets the discharge requirements. If the water quality in the Pit Rim Pond does not meet the discharge requirements it will either be treated prior to discharge or pumped to the

Operations Water Management Ponds for eventual discharge to the receiving environment (Section 4.10).

The overburden dewatering will cause the groundwater table of the shallow overburden aquifer to decrease with the eventual complete dewatering of the shallow aquifer near the proposed ABM open pit. Under baseline conditions, shallow groundwater from the overburden aquifer flows toward and discharges to Geona Creek. The overburden dewatering will therefore result in a reduction of the baseflow to Geona Creek in the area of the proposed open pit and immediately to the north. However, all water extracted during the dewatering of the overburden will be discharged to Geona Creek downstream of the mine via the Pit Rim Pond with no major reduction in the groundwater contribution to the overall flow in Geona Creek.

The overburden dewatering is not expected to have any adverse effects on groundwater quality. Based on the location of the area to be dewatered in a natural groundwater discharge area, the extracted water that will be discharged to Geona Creek would have also discharged to the stream under natural conditions. Potential effects related to sediment mobilization and water turbidity are minimized by the initial conveyance of the water to the Pit Rim Pond where sediments are allowed to settle out prior to discharge of the water. The Pit Rim Pond will be constructed with a synthetic liner made of high-density polyethylene (HDPE) to eliminate or minimize the potential for seepage losses.

Bedrock Dewatering

While overburden dewatering will initially be performed for a six-month period to permit access to the bedrock, dewatering of the bedrock will be performed concurrently with mining as the pit is deepened. The bedrock aquifer in the vicinity of the proposed mine workings will be dewatered using a combination of perimeter dewatering wells installed to a depth of about 200 m and pumped at a rate of about 400 to 800 m^3/d. Pumping rates on the higher end of this range will initially be necessary, but as the thickness of saturated bedrock decreases, lower rates will likely be sufficient. Dewatering wells are planned to intersect each of the three major fracture zones associated with the East Fault, the Northwest Fault and Fault Creek Lineation (see Appendix D-4).

Competent bedrock will drain naturally through the high and end walls of the open pit. Horizontal drain holes will be installed in areas of high pore pressure or structural instability. Competent, unfractured bedrock is not anticipated to generate high rates of seepage due to its low permeability; however, it is anticipated that zones of fracturing are likely to be present and represent sources of higher rates of flow. Installation of horizontal drains in these zones will be used to dissipate the hydraulic head as necessary. Drainage from the walls and horizontal drains will be conveyed to sumps located on each of the bench levels and at the pit floor. Collected water will be pumped from the sumps to the surface where it can be routed to the water treatment or storage facilities.

Similar to the strategy for in-pit dewatering, the dewatering strategy for the underground workings involves the collection of seepage water augmented by horizontal drains as needed to reduce bedrock saturation near the tunnel face in the event of elevated flow rates or structural instability. Drainage from the walls and horizontal drains will be conducted to a series of sumps to be located at the deepest level of the workings.

Groundwater and surface water intercepted during the operations of the ABM open pit will be collected and pumped to the Pit Rim Pond for sediment settlement. Once TSS levels have reduced to approved levels, the water may then be conveyed to the Process Plant for use, to the Water Treatment Plant or to the Upper Water Management Pond prior to the release to the receiving environment.

The dewatering of the mine workings will have a notable effect on groundwater quantity due to the aquifer depressurization and formation of a cone of depression of the groundwater table within the area of the workings. The numerical groundwater flow model was used to estimate both the anticipated dewatering flux rates and extent of the cone of depression. The detailed results of these simulations in presented in Appendix D-4. Figure 9-3 shows the estimated dewatering flux rates for the pre-mining period and anticipated nine-year mine life. The estimated dewatering rates range from about 7,500 m^3/d during the pre-mining overburden dewatering to about 3,500 m^3/d during Year 2 of the mine life. During the early mine life, the dewatering rates decrease after the initial overburden dewatering before the rates increase again with deepening of the open pit and underground workings due to the increasing hydraulic gradient.

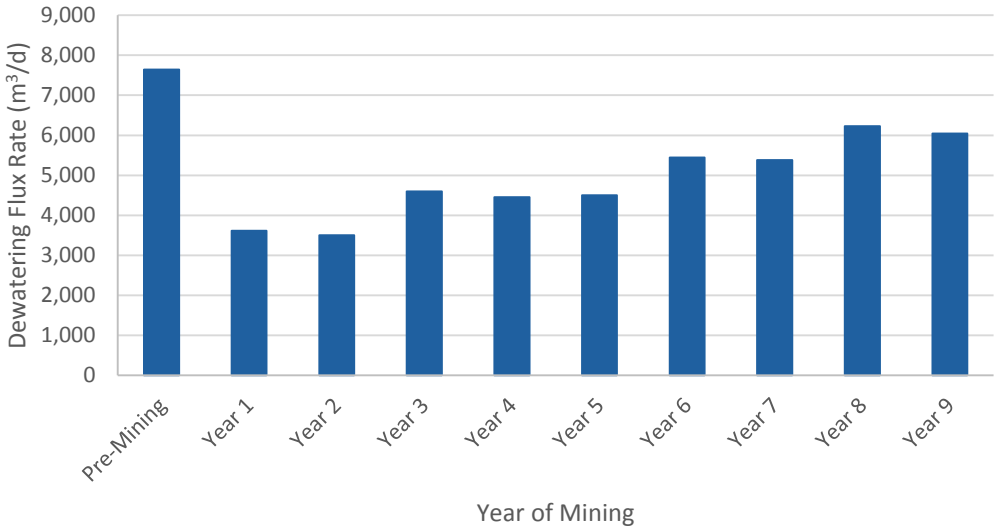


Figure 9-3: Estimated Total Flux Rates for Dewatering of the Mine Workings

Figure 9-4 illustrates the estimated dewatering rates by the contribution of different sources. During the phases of pre-mining dewatering and early mine life, the majority of the water comes from the shallow overburden aquifer. From Year 3 forward, most of the overburden aquifer in the vicinity of the mine workings will be dewatered and most of the water from dewatering will come from the deeper bedrock aquifer. Of note, the major fault zones that have been identified in the area of the ABM Deposit, namely the Northwest and East Faults as well as the Fault Creek lineament, also contribute significant amounts of water to the overall dewatering flux rates, particularly during the later mine life when the underground workings may intersect these fault zones.

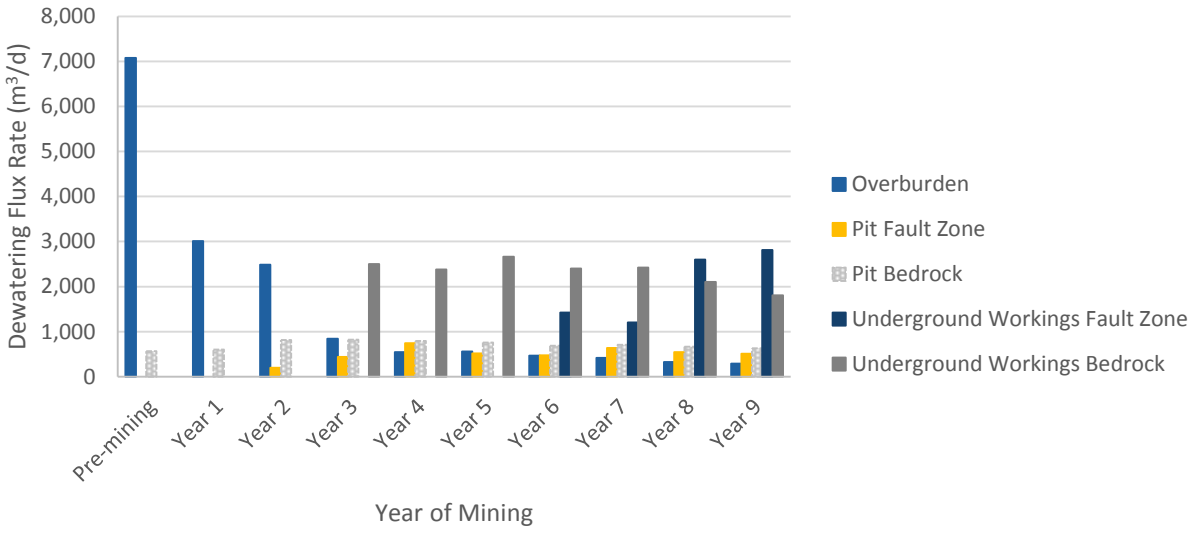


Figure 9-4: Estimated Flux Rates for Dewatering of the Mine Workings by Source of Water

As indicated above, the dewatering of the mine workings results in the formation of a cone of depression with a drawdown of the groundwater table in the area of the ABM Deposit. Figure 9-5 shows the simulated drawdown contours during the final year of mining (Year 9). The simulation results indicate that the zone of influence extends about 4 km to the southwest and about 1.5 km in the northern, eastern, and southern directions. The main propagation of the drawdown effect to the southwest is related to the assumed extent of the Fault Creek fault. If this fault does in fact not extend that far or has a lower permeability than currently assumed in the model, the cone of depression would be smaller with most of the effects limited to a radius of about 1.5 to 2 km from the ABM Deposit. The depth of the ABM open pit and underground workings determine the required drawdown of the water table. Figure 9-5 shows the maximum drawdown in the immediate vicinity of the ABM Deposit during the final mining phase when the mine workings reach their maximum depth.

Upon mine closure and ceasing of dewatering of the mine workings, the groundwater table will start to rebound. Figure 9-6 shows the drawdown associated with the mining activities at 5-years post mining. After five years, water levels will remain about 50 m lower than pre-mining conditions on the western side of the pit and between about 50 and 120 m lower on the east side. Within 1 km of the pit, the overburden water levels will have rebounded to within a few metres of pre-mining conditions as the annual snowmelt saturates the alluvium quickly each year. However, the underlying drawdown within the low-permeability bedrock requires additional time to re-pressurize.

After 30 years post mining, the hydrological system will have reached conditions approaching a new steady-state equilibrium. Figure 9-7 shows the water-table drawdown associated with the mining activities at 30 years post mining. Water levels will be within 10 m of pre-mining conditions at the pit and approximately within 20 m in the low-permeability bedrock east of the pit 30 years post mining. In the model, the simulated water table remains approximately 50 m lower than pre-mining conditions. While this seems counter-intuitive, the reason is that the pit lake (see below) represents

a volume with uniform hydraulic heads from the surface to the bottom of the pit. During pre-mining conditions, hydraulic heads in the deeper bedrock are higher than those at the surface with associated upward flow gradients. Without the presence of the rock, the heads in the immediate vicinity of the pit are therefore lower than under pre-mining conditions. Although there remains a net upward flow gradient near the pit, the gradient is much lower compared to pre-mining conditions. Flow into the pit continues to occur as deeper groundwater discharges into the pit, but due to the low hydraulic conductivity of the bedrock, this discharge rate is low.

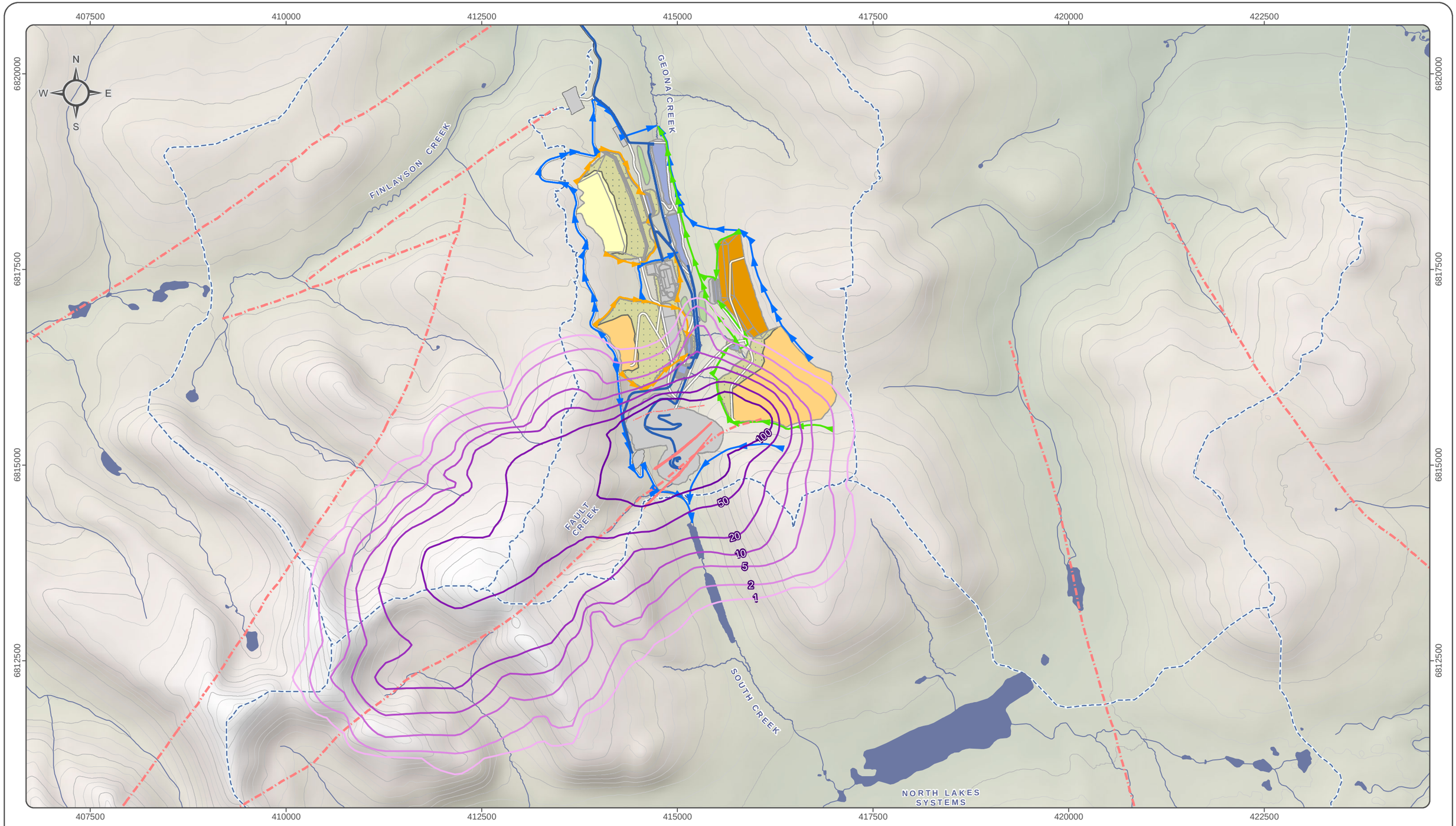
The quality of groundwater that is extracted for the dewatering of the mine workings can potentially be affected by the following:

- Contact with explosive residues; and
- Contact with exposed rock.

The potential contact of groundwater with explosive residues is further discussed in Section 9.4.1.4.

Where rock faces are exposed to atmospheric air and oxygen within the open pit or underground workings there is a potential for oxidation and weathering of minerals which may release metals and other constituents into groundwater that comes into contact with these rocks. For example, sulphide minerals exposed to air and water can oxidize and generate acidity with an associated release of dissolved metals into the water. This process is also known as Acid Rock Drainage (ARD). The potential for the generation of ARD and related effects on water quality depends on the geochemistry of the rock. The geochemical composition of the ABM Deposit and potential for ARD has been assessed through extensive laboratory testing and predictive water quality modelling (see Chapter 8 [discussing predictive water quality], Appendix D-5 [Metal Leach and Acid Rock Drainage Prediction Report] and Appendix D-7 [Water Quality Model Report]).

All groundwater from dewatering of the mine workings will be collected and pumped to the Pit Rim Pond for sediment settlement. The clear water may then be conveyed to the Process Plant for use, to the Water Treatment Plant or to the Upper Water Management Pond prior to the release to the receiving environment (Geona or Finlayson Creek).



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AEG

1:45,000 (when printed on 11 x17 inch paper)

0 1 2 Kilometres

Drawdown Contours (m)

- 1
- 2
- 5
- 10
- 20
- 50
- 100
- Mapped Faults near Pit (BMC)

*Model Layer 6: Bedrock (320 m depth, approx)

- Regional Catchments
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Pipeline

- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 9-5

DRAWDOWN CONTOURS FOR BEDROCK AQUIFER DURING YEAR 9 OF MINING

DECEMBER 2016

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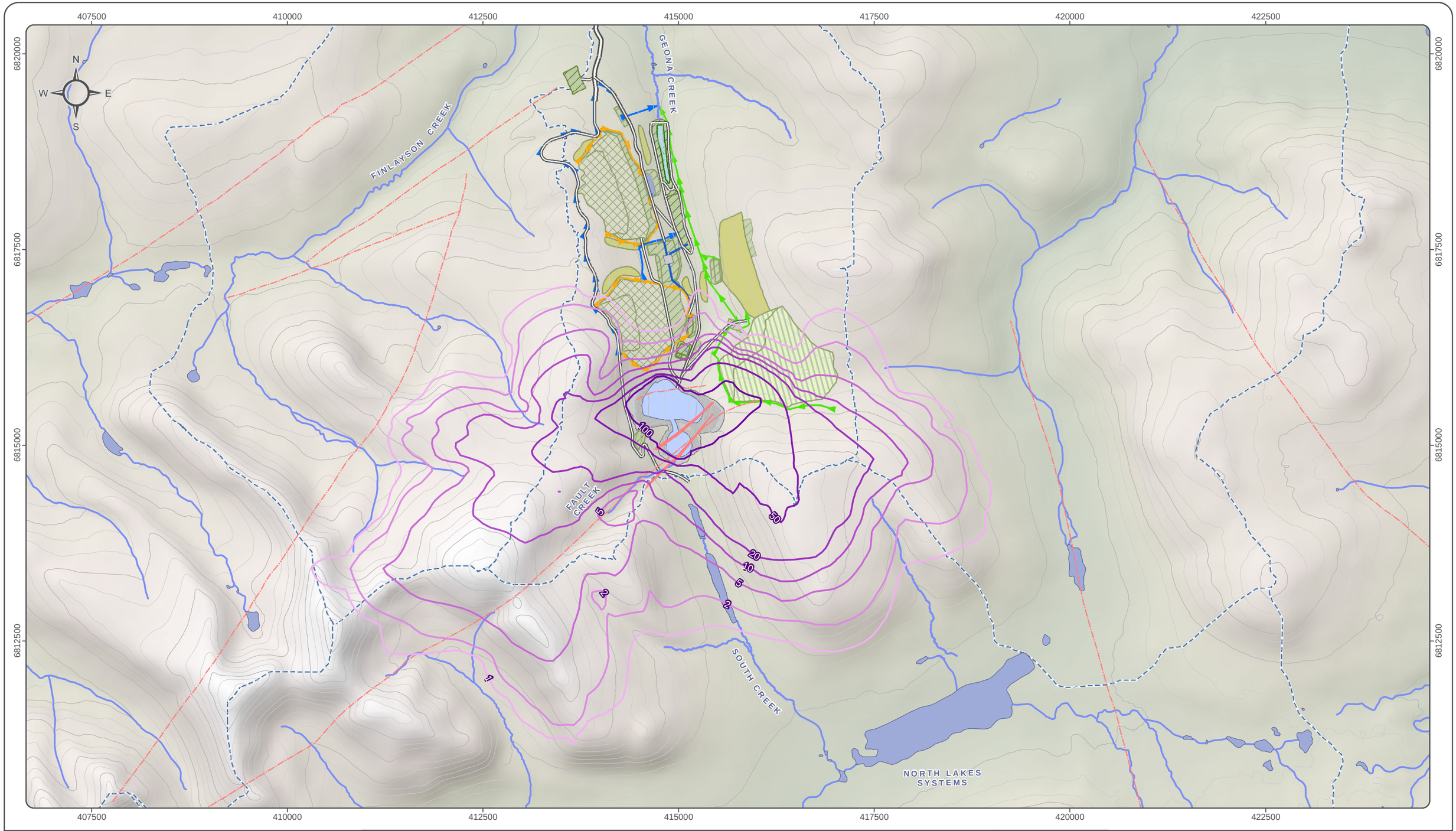

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1:45,000 (when printed on 11 x17 inch paper)

0 1 2 Kilometres

Drawdown Contours (m)

- 1
- 2
- 5
- 10
- 20
- 50
- 100

*Model Layer 5

- Mapped Faults near Pit (BMC)
- Mine Footprint
- Materials used for Reclamation,
- Covered with Engineered Low
- Covered with Overburden, Surface Revegetated
- Constructed Wetland Treatment System
- Infrastructure Removed, Footprint Reclaimed and Revegetated
- ABM Open Pit Lakes at 1350 masl
- Regional Catchments
- Pipeline
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Tote Road/Proposed Access Road
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 9-6

DRAWDOWN CONTOURS FOR SHALLOW BEDROCK AQUIFER 5 YEARS POST MINING

MARCH 2017

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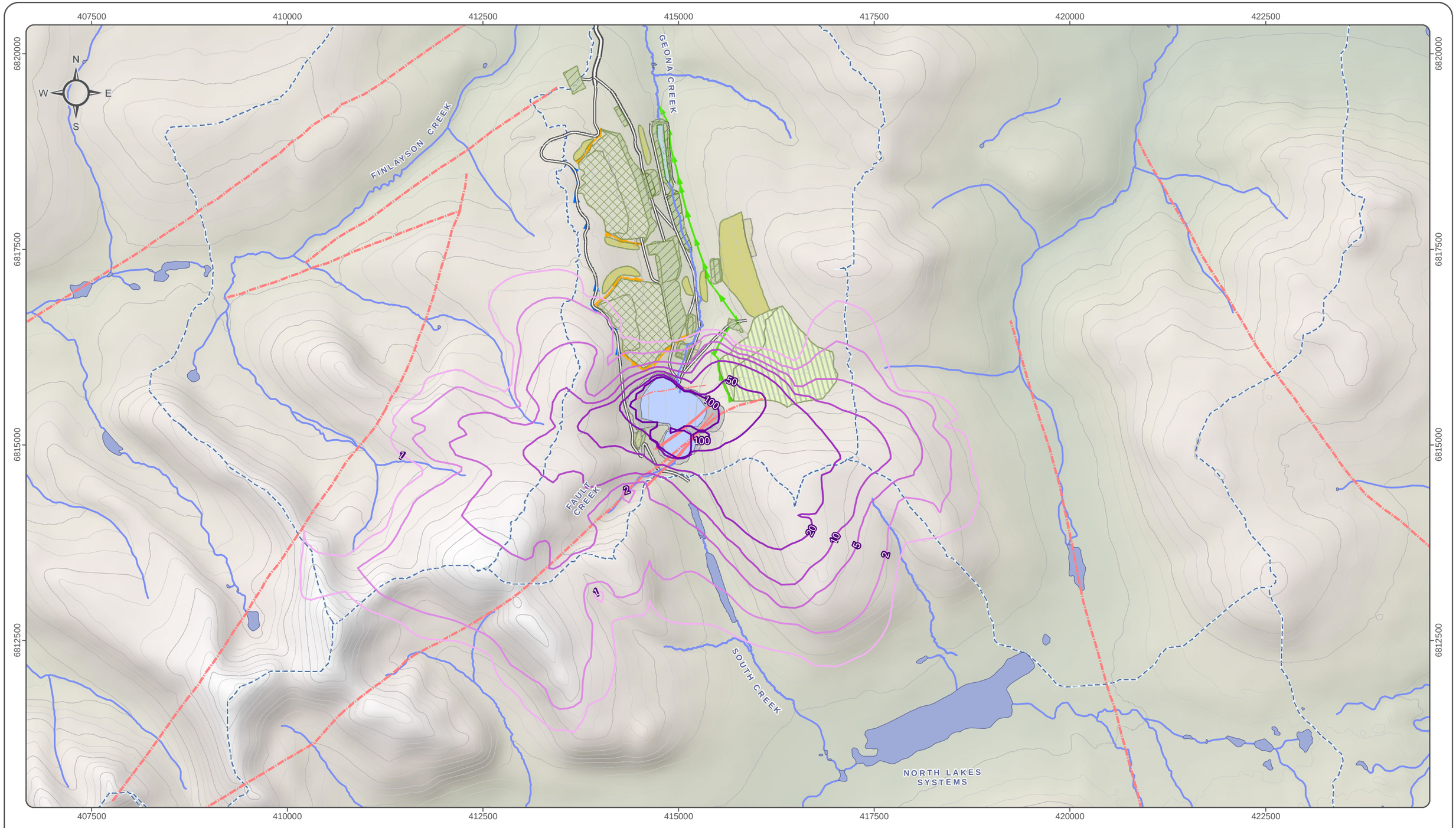

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0 1 2 Kilometres

Drawdown Contours (m)

- 1
- 2
- 5
- 10
- 20
- 50
- 100

*Model Layer 5

- Mapped Faults near Pit (BMC)
- Mine Footprint
- Materials used for Reclamation,
- Covered with Engineered Low
- Covered with Overburden, Surface Revegetated
- Constructed Wetland Treatment System
- Infrastructure Removed, Footprint Reclaimed and Revegetated

- ABM Open Pit Lakes at 1380 masl
- Regional Catchments
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Tote Road/Proposed Access Road
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 9-7

DRAWDOWN CONTOURS FOR SHALLOW BEDROCK AQUIFER 30 YEARS POST MINING

DECEMBER 2016

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9.4.1.2 Flooding of Mine Workings and ABM Lake Formation

At mine closure, the entrance to the underground workings will be sealed to prevent flow from occurring between the pit and the abandoned underground workings. The pre-mining diversion of Fault Creek will then be removed, allowing the creek to resume its natural flow path, north toward Geona Creek and to flow directly into the pit, accelerating the rate of filling of the pit void. Filling the open pit will create a pit lake referred to as ABM lake. Upon filling to capacity (elevation of 1,380 masl) ABM lake will spill directly into Geona Creek. The formation of the ABM lake upon mine closure and the lake's water budget are illustrated in Figure 9-8.

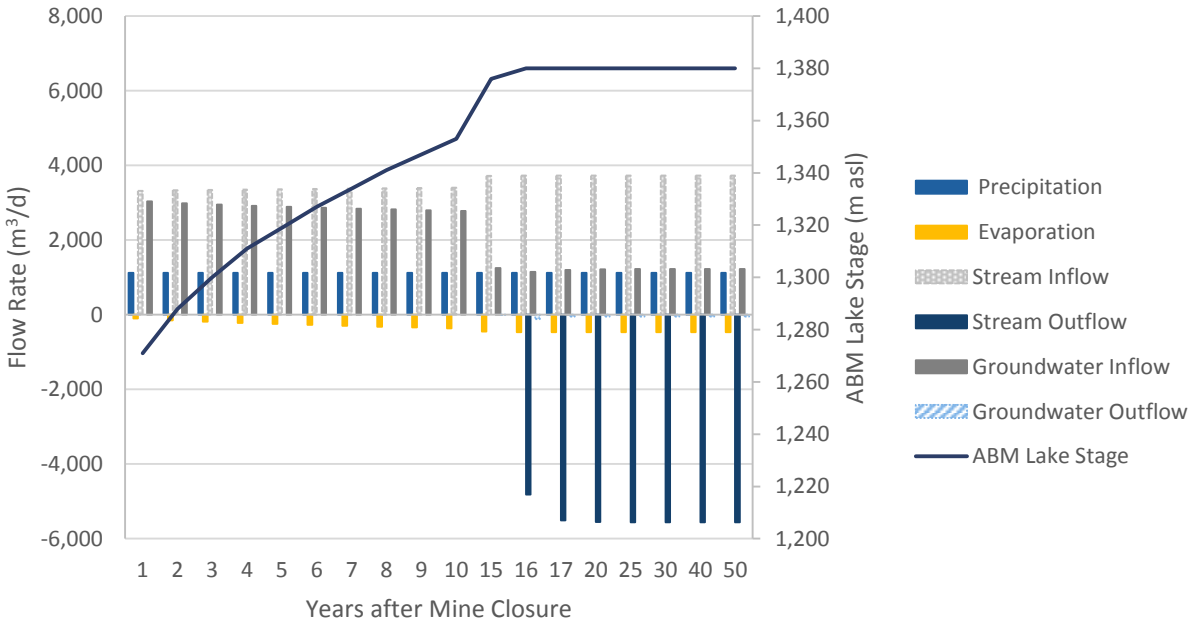


Figure 9-8: ABM Lake Formation and Water Budget (positive flow rates indicate inflow, negative flow rates indicate outflow from the ABM lake)

It is expected that the ABM lake reaches its spill elevation after about 16 years upon cessation of mining and redirection of Fault Creek. Groundwater presents a significant component of the ABM lake water budget, particularly during the first 16 years after mine closure while the lake is filling. After the lake has filled to the spill elevation of 1,380 masl groundwater continues to discharge to ABM lake at a rate of about 1,200 m^3/d.

As discussed in Section 9.4.1.1, it is expected that the overall flow regime will return to conditions that are similar to pre-mining conditions. Even though hydraulic heads in the bedrock aquifer will remain slightly below pre-mining conditions, due to the presence and the hydraulic behaviour of the ABM lake, overall groundwater flow will be similar to that pre-mining. Groundwater from both valley flanks will flow toward the valley floor and discharge to either ABM lake or Geona Creek further downstream. Water from ABM lake will spill directly into Geona Creek similar to the ponds that are currently present in the area of the ABM Deposit.

Potential effects of the ABM lake on water quality are discussed in detail in Chapter 8 (Surface water).

9.4.1.3 Residual Drawdown and Effects on Flow in Geona and South Creek

The diversion of Fault Creek, dewatering of the mine workings during operations, and the formation of ABM lake after closure will result in associated residual drawdown of hydraulic heads (see Sections 9.4.1.1 and 9.4.1.2). This drawdown of hydraulic heads will have potential effect on the flows in Geona Creek, South Creek, and Finlayson Creek. Figure 9-9 shows the predicted average annual flows in Geona Creek downstream of the mine site (station KZ-9), South Creek at station KZ-13, and Finlayson Creek upstream of the confluence with Geona Creek (KZ-16).

During the mine operational phase, the flow in Geona Creek will initially decrease due to the diversion of Fault Creek into the South Creek watershed. The flow will then remain relatively unchanged throughout the operations of the mine, during closure, and into the early post closure phase. Upon filling of ABM lake, which is estimated to take about 16 years following mine closure, water from ABM lake will spill over into Geona Creek, indicated in Figure 9-9 by a sharp increase in flow at KZ-9. The post closure flow in Geona Creek downstream of the mine site will reach a new steady-state equilibrium after about 20 years following closure with a flow of about 109% relative to baseline conditions. The increase in flow relative to baseline is due to the shift of the water divide between the Geona Creek and South Creek watersheds. This is a change of about 100 m to the south which is caused by the residual drawdown from mine dewatering and the formation of ABM lake. Note that the predicted flows in Figure 9-9 assume that all groundwater extracted for mine dewatering is returned to Geona Creek downstream of station KZ-9. Please refer to Chapter 8 for a more detailed discussion of predicted surface water flows during mine operations.

The flow at station KZ-13 on South Creek initially increases to about 112% of the average baseline flow upon the diversion of Fault Creek into South Creek. The flow then decreases gradually over the mine life to about 94% of the baseline conditions due to dewatering of the mine workings and the associated reduction in baseflow, and shift of the water divide between the Geona Creek and South Creek watersheds to the south. At closure, Fault Creek will be re-directed into the ABM open pit which will cause another reduction in South Creek flow at KZ-13 by approximately 5% to about 89% of the baseline conditions. With the partial recovery of the depressed hydraulic heads after cessation of the mine dewatering, the flow in South Creek will increase slightly again until a new steady-state equilibrium will be reached at approximately 90% of the average baseline flow at KZ-13 (Figure 9-9). This reduction in flow in South Creek will be permanent due to the formation of the ABM lake and the associated hydraulic changes in the area, i.e., shift of the water divide to the south and reduction in baseflow due to a decreased vertical hydraulic gradient (see further below in this section).

The cone of depression caused by the mine dewatering and residual drawdown due to the formation of the ABM lake also reaches into the upper Finlayson Creek watershed. However, the predicted changes in piezometric elevations and associated effects on baseflow to Finlayson Creek are so small that no measureable changes in flow are anticipated at station KZ-16, which is located upstream of the confluence with Geona Creek (see Figure 9-9).

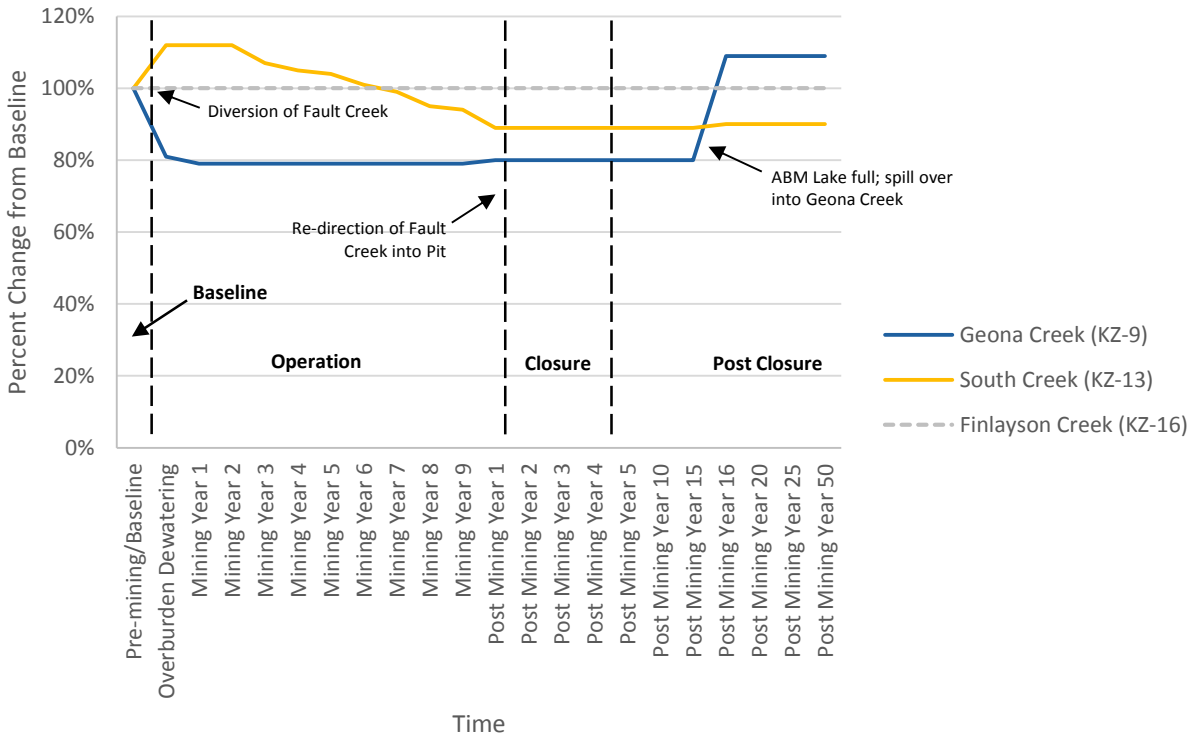


Figure 9-9: Predicted Flow in Geona Creek, South Creek, and Finlayson Creek during Operations, Closure, and Post Closure Relative to Baseline Conditions

The remaining cone of depression created by the dewatering of the mine workings causes the water divide between the Geona Creek and South Creek watersheds to move to the south by about 100 m relative to baseline conditions. Figure 9-6 and Figure 9-7 show the residual drawdown in the bedrock aquifer five years and 30 years post closure which indicates that the hydraulic head of the bedrock aquifer remains about 10 m below baseline conditions in the area of the northern pond near the headwaters of South Creek once a new steady state equilibrium has been reached.

The residual drawdown in the upper portion of the South Creek watershed may also have potential effects on the ponds located near the headwaters of South Creek. These potential effects on the ponds may involve a reduction in flow through the ponds as well as a possible reduction in the surface area and pond depth. Post closure, the change in flow through the ponds associated with the shift of the water divide and residual drawdown in groundwater is likely similar to the predicted reduction in flow of 10% at monitoring station KZ-13 which is located on South Creek to the south of the two ponds.

Given the location of the ponds near the headwater of South Creek with little inflow of surface water, it is likely that the ponds are mostly groundwater fed and closely controlled by the groundwater table within the adjacent overburden aquifer. The potential reduction in pond size and depth is therefore likely related to the residual drawdown in the overburden aquifer due to the formation and hydraulic behaviour of the ABM lake. The predicted residual drawdown in the overburden aquifer (i.e.,

shallowest layer of the groundwater model) is about 2 m at the north end of the northern pond and about 0.2 m at the south end of the northern pond. The residual drawdown in the shallow overburden aquifer is therefore considerably smaller than the residual drawdown in the deeper bedrock aquifer (see above). This suggests that the main residual drawdown effect associated with ABM lake is a reduction in vertical hydraulic gradient rather than a lowering of the shallow groundwater table and increase of unsaturated zone thickness.

As a result, it is expected that the pond water level of the northern pond may decrease slightly by about 1 m or less, i.e., similar to the residual drawdown in the overburden aquifer. The surface area of the ponds may also be slightly reduced based on the pond elevation/surface area relationship. The residual drawdown in the overburden aquifer adjacent to the southern pond is less than 0.1 m and therefore, no material change in pond depth or surface area is anticipated for the southern pond.

9.4.1.4 Use of Explosives in Mine Workings

Bulk explosives and blasting agents will be utilized for mining activities. Blasting will be carried out using an ammonium nitrate and fuel oil emulsion (ANFO) product. Bulk ammonium nitrate prill and bulk ammonium nitrate emulsion will be transported to site and stored in separate prill and emulsion silos in the bulk explosive compound. Explosives will not be manufactured on site; however, the explosives trucks for the open pit operations will be capable of mixing ammonium nitrate prill and emulsion to meet the individual requirements of each blast.

Residues from blasting will contain nitrogen compounds that will remain on the rock surfaces. These residues have the potential to be introduced into contact water, e.g., groundwater seepage into the mine workings. Generally, ANFO mostly consists of NH_4NO_3 (of which 35% is nitrogen) and a minor fuel oil component. However, during blasting the reaction often does not completely consume the explosive, leaving behind residual nitrogen. The amount of nitrogen residue is dependent on many different factors including the handling of explosives and efficiency of the blast. The main nitrogen species that may be released into contact water with blasting residues include nitrate, ammonia, and nitrite. Nitrate and ammonia are both formed through blasting whereas nitrate is an intermediate species generated by the oxidation of ammonia into nitrate.

As discussed above, all water extracted from the open pit and underground workings will be pumped into the Pit Rim Pond for sediment settlement. The clear water may then be conveyed to the Process Plant for use, to the Water Treatment Plant or to the Upper Water Management Pond prior to the release to the receiving environment (Geona or Finlayson Creek). Since the ABM open pit and underground workings act as a terminal sink for groundwater within the cone of depression during mine operations and active dewatering, all groundwater potentially affected by explosive residues will be captured by the dewatering system. Therefore, there is negligible risk for potentially contaminated groundwater from the area of the mine workings to be uncontrollably released into the environment.

9.4.1.5 Seepage from Class A and Class B Storage Facilities

Tailings and waste rock produced from the ABM Deposit will be segregated depending on their geochemical characteristics and potential to produce acid drainage and/or neutral metal leaching potential.

Class A waste rock is defined as potentially acid generating and metal leaching over the short term. This material will be placed in the Class A Storage Facility with controlled drainage during operations and will be progressively reclaimed (encapsulated) as the waste storage facility is developed to minimize contact with oxygen.

Class B waste rock is defined as potentially being acid generating with metal leaching potential over the long-term (after cessation of mining activities). Storage of this material will require controlled drainage during operations, although encapsulation during operations will not be required due to the lower reactivity of the rock in comparison to Class A waste rock.

Class C waste rock is defined as not being acid generating, or potentially acid consuming, and having low metal leaching potential. This material is suitable for construction purposes around the Project area as well as capping material for progressive reclamation during operations and closure requirements. Since the geochemical testwork indicated no concern with respect to contact water quality (Chapter 8), possible seepage from the Class C Storage Facility is not further discussed here.

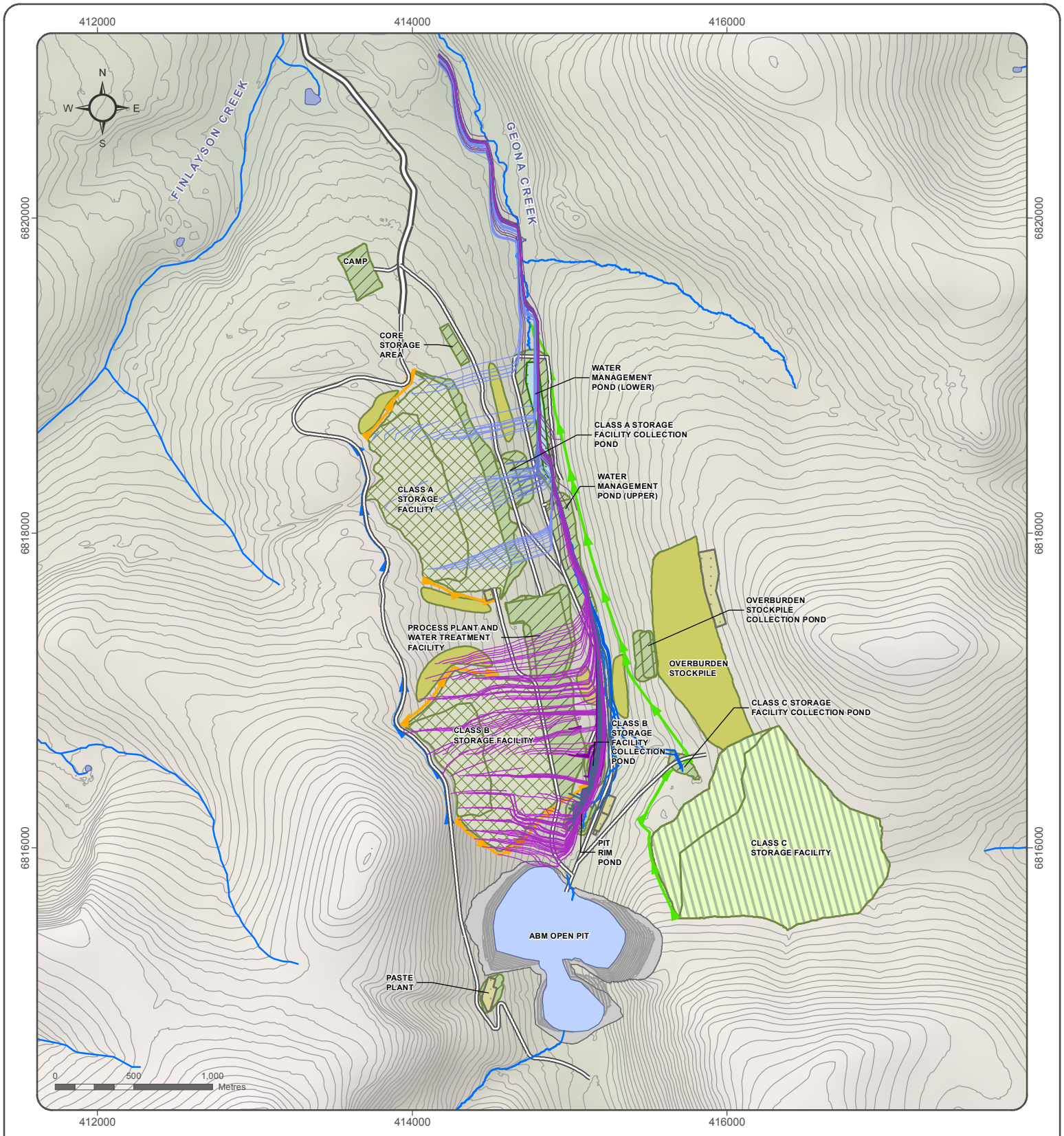
Potential seepage from both Class A and Class B Storage Facilities has the potential for adverse effects on groundwater quality underneath and downgradient of these facilities. However, since both facilities will be constructed with low permeability compacted till liners and lined drainage collection ponds, it is expected that any effects on groundwater quality due to seepage from these facilities is very unlikely. In addition, the progressive reclamation of the Class A and Class B Storage Facilities (that includes a low permeability till layer and engineered low permeability cover as a seepage barrier) will further reduce the low likelihood of seepage from the facilities into the underlying aquifer with associated effects on groundwater quality.

In the case of potential leakage of the low permeability liners of the Class A and Class B Storage Facilities or the associated drainage canals and collection ponds, the flow paths of potentially affected groundwater was evaluated using the numerical flow model. Figure 9-10 shows the simulated flow paths of groundwater underneath and downgradient of the Class A and B facilities post closure conditions. It should be noted that the flow paths will be very similar during the operational phase of the mine, with the exception that some of the groundwater from the southern part of the Class B Storage Facility will flow toward and into the open pit or underground workings where it will be extracted as part of the dewatering of the mine workings.

As is apparent from Figure 9-10, groundwater from the Class A and Class B Storage Facilities flows toward Geona Creek and/or the Water Management Ponds during mine operations. Except for groundwater from the northernmost part of the Class A Storage Facility which may discharge to Geona Creek downstream of the Lower Water Management Pond. Potentially affected groundwater by leakage from the Class A and Class B Storage Facilities will be collected in the Water Collection

Ponds at each facility and treated as necessary before it is discharged to the Water Management Ponds and eventually released into the receiving environment.

Upon mine closure, groundwater from the areas of the reclaimed Class A and Class B Storage Facilities will continue to discharge to Geona Creek. Wetlands will be constructed within Geona Creek, as required, to provide passive water treatment during the post-closure period.



PATHLINE
- Water Management Pond
- Class A
- Class A Water Collection Pond
- Class B
- Class B Water Collection Pond
- Class C Water Collection Pond
- Pit-Rim Pond

- Mine Footprint
- Materials used for Reclamation,
- Covered with Engineered Low
- Covered with Overburden, Surface Revegetated
- Constructed Wetland Treatment System
- Infrastructure Removed, Footprint Reclaimed and Revegetated
- Water/Pond

- ABM Open Pit Lakes at 1380 masl
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Tote Road/Proposed Access Road
- Proposed Mine Road

KUDZ ZE KAYAH PROJECT

FIGURE 9-10

POST-CLOSURE PARTICLE TRACKING

FEBRUARY 2017

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.
Datum: NAD 83; Projection: UTM Zone 9N

AEG

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BMC MINERALS

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9.4.1.6 Seepage from Water Management Ponds

A two-stage Water Management Pond will be constructed in the Geona Creek valley with the Upper Water Management Pond being used for management of contact water and the Lower Water Management Pond for final settling and polishing before the water is discharged to the receiving environment.

The Upper Water Management Pond will store water from the dewatering of the mine workings (once it has settled in the Pit Rim Pond). It is expected that the water quality in the Upper Water Management Pond will undergo further settling prior to discharge into the Lower Water Management Pond. Contact water from the Class A material will be treated in the on site water treatment plant and then discharged to the Lower Water Management Pond. It is expected that the water quality in the Lower Water Management Pond will meet discharge criteria and therefore does not pose any potential risk for seepage from the Lower Water Management Pond to have adverse effects on groundwater downgradient of the pond.

To further eliminate or minimize the risk for seepage both Upper and Lower Water Management Ponds will be lined with an impermeable synthetic liner (HDPE).

In the case of liner leakage, seepage from the Upper Water Management Pond will have potential adverse effects on the shallow groundwater quality underneath and downgradient of the facility. However, based on the location of the Water Management Ponds, which are in a natural discharge area with upward hydraulic gradients, it is expected that seepage from the Upper Water Management Pond will daylight near the toe of the dam below the pond and discharge to the Lower Water Management Pond, but not uncontrollably escape into the downgradient environment.

9.4.1.7 Seepage from Waste Management Facility

The Waste Management Facility will be located between the Class A Storage Facility and the Process Plant and will contain all waste, recyclables and contaminated materials, excluding waste oil which will be stored in a tank at the Mine Workshop. The Waste Management Facility will also include an incinerator, a small Land Treatment Facility (LTF), and a small landfill area for non-hazardous waste.

Combustible refuse that can safely be burned in the incinerator will be burned daily. The incinerator ash will be disposed of in the Class A Storage Facility or used in the Paste Plant. All special waste will be collected and shipped off site to licensed recycle or disposal facilities, except for waste oil which will be burned in a suitable waste oil burner.

The main concern with respect to seepage from the Waste Management Facility and associated effects on groundwater quality is related to the LTF for remediation of contaminated soil and snow from possible spills. The LTF will be constructed and licensed in accordance with applicable regulations. Under the Yukon CSR all LTFs in Yukon must obtain a LTF Permit before construction of the facility begins. The regulations include requirements for the siting of the facility and suitable low permeability liner to minimize the risk of seepage from the LTF and to effectively protect the environment. These requirements include, but are not limited to:

- A land treatment facility cannot be constructed on any land where:
- The slope is greater than 6 %;
- The seasonal high water table is less than 3 m below the surface;
- The Facility would be within 100 m of a surface water body; or
- The land is identified as being within a 25-year floodplain.
- An artificial impermeable liner must be installed beneath the remediation cells of an LTF unless the hydraulic conductivity of the native soils is less than 10^{-5} cm/s, and this layer of low permeability soil is a minimum of 1 m thick and continuous throughout the proposed LTF location. More stringent requirements exist for LTFs permitted to receive special waste.

Since the LTF proposed for the Project will meet or all regulatory requirements outlined above, the risk of any adverse effects on groundwater quality is considered negligible.

9.4.1.8 Groundwater Extraction for Potable and Process Water Use

Potable water for the camp will be supplied by one or more drinking water wells that will be installed near the camp facilities. The Project includes a 250 person camp during mine operations with an additional 100 person Camp for construction. The maximum anticipated water demand that needs to be met by the groundwater supply well(s) will therefore be up to 3.7 m^3/hr (1 L/s or 16.3 USgpm) based on 350 people at a daily demand of 250 L/day.

Groundwater will be required for reagent mixing for the ore processing, as well as additional potable water. One or more groundwater wells will be installed near the Process Plant to supply up to about 5.5 m^3/hr.

Based on available information on the hydrogeological conditions in the areas of the camp and Process Plant, it is anticipated that the groundwater supply wells will be installed in the bedrock aquifer due to absence or very small thickness of overburden at both locations. Packer testing conducted in shallow bedrock across the LSA indicate that the mean hydraulic conductivity is about 7×10^{-7} m/s. Packer tests conducted by Knight Piesold (KP) in a geotechnical drill hole at the process plant facility site suggested a similar hydraulic conductivity of the shallow bedrock of 4×10^{-7} m/s (Knight Piesold Ltd., 2016; Appendix C-3). No data are currently available for the camp area but it is expected that the bulk hydraulic conductivity of the shallow bedrock in the area of the camp is similar to that at the Process Plant given the similar bedrock lithology at both locations.

The steady-state equation for radial flow to a pumping well (Thiem solution) can be used to estimate the drawdown in a supply well:

$$s = \frac{Q}{2\pi T}\ln\left(\frac{R}{r}\right)$$

Where s is the drawdown at the radial distance r from the pumping well, Q is the discharge rate of the well, T is the aquifer transmissivity, and R is the radius of influence, or the distance at which the drawdown is nil. The transmissivity T is:

$$T = K \cdot b$$

Where K is the hydraulic conductivity and b is the aquifer thickness. For a typical pumping well the aquifer thickness can be assumed to be similar to the screen length or open bedrock interval of the well.

Figure 9-11 shows the estimated drawdown of imaginary supply wells providing the required pump rate of 3.7 m^3/hr at the camp and 5.5 m^3/hr at the Process Plant based on the Thiem equation, a well with a 100 m long open interval within the bedrock aquifer and for a range of hydraulic conductivities.

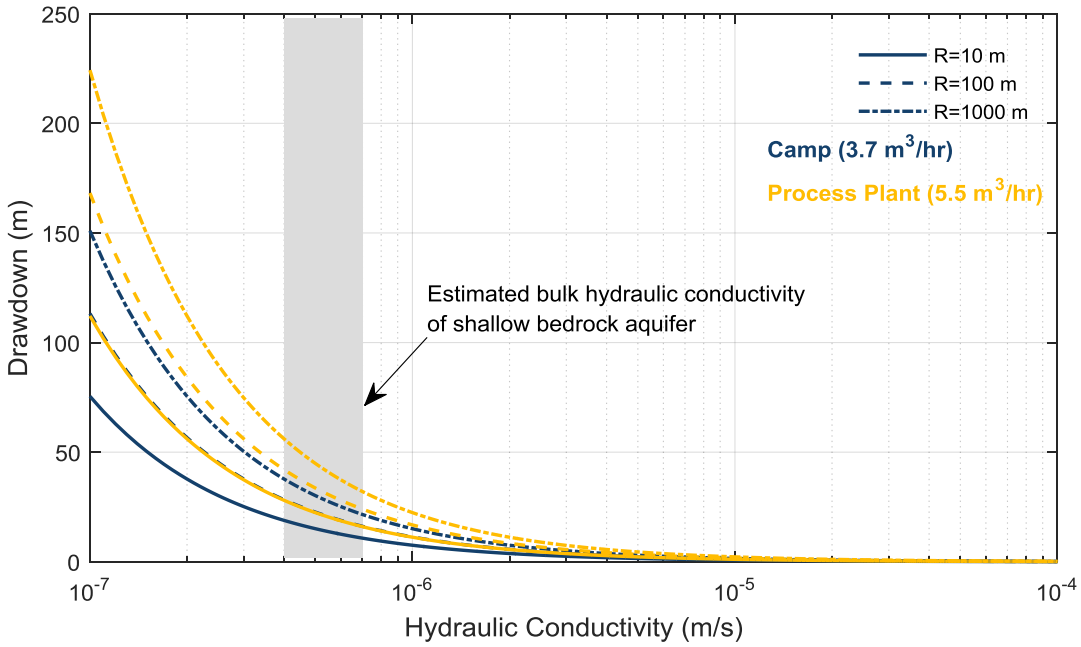


Figure 9-11: Estimated Drawdown of Camp and Process Plant Supply Wells

As is apparent from Figure 9-11, the anticipated bulk hydraulic conductivity of the shallow bedrock aquifer in the order of 4×10^{-7} to 7×10^{-7} m/s will likely be sufficient to supply the required water demand for the camp and Process Plant with an estimated drawdown at the pumping wells of about 50 m or less. It should be noted that the Thiem equation and the derived drawdowns do not take into account head losses due to well inefficiencies. Ideally, the proposed supply wells at the camp and Process Plant should target higher permeability zones within the bedrock aquifer to minimize well depth, drawdown, and associated costs for well drilling, installation and operation.

The Process Plant is located within the Geona Creek watershed and the camp is located on the water divide between the Geona Creek and Finlayson Creek watersheds. Groundwater extraction for

potable water supply and reagent mixing will result in a potential slight decrease in the baseflow to Geona Creek and possibly Finlayson Creek depending on the exact location of the groundwater divide underneath the camp. However, the effect on baseflow in both creeks is considered negligible for the following reasons:

- The extracted water will be returned to the Geona Creek watershed as effluent from the sewage disposal system and discharge from the Process Plant which will be treated and ultimately discharged to Geona or Finlayson Creek; and
- The estimated mean baseline low flow of Geona Creek and Finlayson Creek downstream of the mine site is shown in Table 9-6. The extracted groundwater for camp potable water supply is only 3.7% and 1.7% of the Geona and Finlayson Creek low flow, respectively. Groundwater required for reagent mixing/potable water in the Process Plant is only 5.5% of the Geona Creek low flow. During higher flow at other times of the year, the potential reduction in baseflow to Geona and Finlayson Creek will be an even smaller percentage of the total flow, mostly less than 1%.

Based on the above, it is very likely that any potential change in baseflow due to extraction of groundwater for potable water supply and reagent mixing will be very small and within natural variation.

Table 9-6: Comparison of Groundwater Demand with Geona Creek and Finlayson Creek Baseline Low Flow

Surface Water Monitoring Station	Mean Annual Low Flow	Percentage of Camp Water Demand (3.7 m^3/hr)	Percentage of Process Plant Water Demand (5.5 m^3/hr)
	(m^3/s)	(%)	(%)
Low Flow KZ-9 (Geona Creek)	0.028	3.7	5.5
Low Flow KZ-15 (Finlayson Creek below Geona Creek)	0.104	1.7	2.6
Low Flow KZ-16 (Finlayson Creek above Geona Creek)	0.059	1.0	1.5

All groundwater supply wells will be constructed in accordance with regulatory requirements and appropriate industry practices. At a minimum, all water wells will be drilled and installed in accordance with the Canadian Groundwater Association *Guidelines for Water Well Construction* that are also referenced in Yukon's *Drinking Water Regulation*. These guidelines include requirements to properly seal the annulus around the well casing and to install a sanitary surface seal to protect the aquifer and well water from potential contamination from surface sources. Effects on groundwater quality from the proposed installation and use of supply wells at the camp and Process Plant are therefore not anticipated.

9.4.1.9 Sewage and Grey Water Treatment and Disposal

Sewage and grey water produced by the camp and Process Plant will be disposed of by on site sewage disposal systems, consisting of septic tanks and a soil absorption system. The construction and

operation of sewage disposal systems is regulated in Yukon under the *Waters Act, Waters Regulation* and *Sewage Disposal Systems Regulation* to ensure both protection of the environment and proper function of the sewage disposal system. The design specifications for sewage disposal systems include requirements for setback distances of the sewage disposal system from surface water bodies and drinking water wells. The system also has to be constructed so that it is a minimum of 1.2 m from the seasonal high groundwater table.

Since the sewage disposal system proposed for the Project will meet all regulatory requirements outlined above, the risk of any adverse effects on groundwater quality is considered negligible.

9.4.1.10 Summary

Table 9-7 provides a summary of the identified potential effects from the above section that are carried forward for consideration of mitigation measures.

Table 9-7: Identified Potential Project Effects for Groundwater

Subcomponent	Potential Effect	Project Phase
Groundwater Quality	Effects on groundwater quality in mine workings (explosive residues, contact with exposed rock)	Operations
	Effects on groundwater quality from ABM lake discharge	Post-closure
	Effects on groundwater quality by seepage from Class A and B Storage Facilities, Water Management Ponds, or Waste Management Facility	Operations, post-closure
	Effects on groundwater quality by effluent from the sewage disposal system	Operations
Groundwater Quantity	Lowering of groundwater table for dewatering of mine workings	Operations, post-closure
	ABM lake formation and long-term effects on groundwater table	Post-closure
	Residual drawdown from mine dewatering and effects on flow in Geona Creek and South Creek	Operations, closure, post-closure
	Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant	Operations

9.4.2 Mitigation Measures

Potential effects on groundwater and identified mitigation measures are summarized in Table 9-8 and discussed further below.

Table 9-8: Proposed Mitigation Measures for Groundwater

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Groundwater Quality				
Effects on groundwater quality in mine workings (explosive residues, contact with exposed rock)	Operations	See Section 8.4.1.3		
Effects on groundwater quality from ABM lake effluent	Post Closure	See Section 8.4.1.6		
Effects on groundwater quality by seepage from Class A and B Storage Facilities, Water Management Ponds, or Waste Management Facility	Operations, post closure	• Class A and B Storage Facilities will be constructed with a compacted low-permeability till liner • Upper and Lower Water Management Ponds, Pit Rim Pond, and Class A and B Facility Water Collection Ponds will be constructed with an impermeable synthetic (HDPE) liner • Waste Management Facility will be constructed and operated in accordance with applicable regulations and guidelines (e.g., LTF will be constructed in accordance with the Yukon *CSR*)	High	No
Effects on groundwater quality by effluent from the sewage disposal systems	Operations	Sewage disposal system will be constructed and operated in accordance with applicable regulations (*Waters Act, Waters Regulation* and *Sewage Disposal Systems Regulation*) and guidelines (*Design Specifications for Sewage Disposal Systems*) that considerations for protection of the environment	High	No
Groundwater Quantity				
Lowering of groundwater table for dewatering of mine workings	Operations, post closure	Dewatering system will be designed to minimize the required groundwater extraction and associated drawdown of the groundwater table	Low	Yes
ABM lake formation and long-term effects on groundwater table	Post closure	Re-divert Fault Creek into Geona Creek watershed and the ABM lake for accelerate the filling of the open pit	Medium	Yes

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Residual drawdown from mine dewatering and effects on flow in Geona Creek and South Creek	Operations, closure, post closure	Dewatering system will be designed to minimize the required groundwater extraction and associated drawdown of the groundwater table	Low	Yes
Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant.	Operations	Water wells for groundwater supply to camp and Process Plant will be designed and constructed to maximize well performance and minimize drawdown of the groundwater table and associated effects	Low	Yes

9.4.2.1 Mine Dewatering

Dewatering of the open pit and underground workings will result in dewatering volumes that require appropriate disposal. The dewatering system will be designed to minimize water volumes that have to be extracted to meet safe mining conditions. The detailed design, which will be finalized prior to construction of the dewatering system, will also aim to minimize the potential contact of groundwater with Class A and Class B material in the open pits and underground workings to limit the risk of detrimental effects on water quality.

During construction, water from dewatering will report to the Pit Rim Pond and if does not meet the discharge objectives it will be treated prior to discharge to the receiving environment. During operations water from dewatering will report to the pit rim pond for settling and then to the Upper Water Management Pond for further settling and then to the Lower Water Management Pond prior to discharge to the receiving environment.

Mitigation measures associated with the dewatering of the mine workings will likely reduce the effects related to the drawdown of the groundwater table and potentially affected water produced by the dewatering system; however, there will be residual effects including:

- Considerable drawdown of the groundwater table in the vicinity of the proposed mine workings; and
- Changes in flow conditions in Geona Creek and South Creek.

Potential effects on the quality of water extracted by the dewatering system and management of this water are discussed in Section 8.4.

9.4.2.2 Use of Explosives in Mine Workings

Safe practices will be applied when handling explosives and during blasting to reduce undetonated explosive residues to a minimum and to avoid water contamination with ammonia, nitrite, and nitrate.

9.4.2.3 Seepage from Class A and B Storage Facilities and Water Management Ponds

To eliminate or minimize seepage from the Class A and B Storage Facilities as well as the Class A and B Collection Ponds, Upper and Lower Water Management Ponds, and Pit Rim Pond, all these facilities will be constructed with a low-permeability or impermeable liner.

The Class A and B Storage Facilities will be constructed with a compacted low-permeability till liner to control seepage from the facilities. All seepage will be directed into the Class A and Class B Collection Ponds at the toe of the facilities. The Collection Ponds will be lined with an impermeable synthetic HDPE liner. Water from the Class A and the Class B Collection Ponds will be treated prior to discharge to the Lower Water Management Pond. The Upper and Lower Water Management Ponds as well as the Pit Rim Pond and Class A and B water collection ponds will also be constructed with an impermeable synthetic HDPE liner.

The aforementioned measures implemented into the design of the Class A and Class B Storage Facilities and water management infrastructure are anticipated to successfully mitigate any potential effects on groundwater quality underneath or downgradient of these facilities.

Potential effects related to water quality of collected seepage form the Class A and Class B Storage Facilities and management of this water are discussed in Section 8.4.

9.4.2.4 Seepage from Waste Management Facility

Solid waste will be brought to the Waste Management Facility, segregated and disposed of either on site or off site. Liquid waste (sewage and grey water) will be disposed of by an on site sewage disposal system. Contaminated soil will be treated in an LTF constructed on site at the location of the Waste Management Facility. As discussed in Sections 9.4.1.7and 9.4.1.9, the Waste Management Facility and sewage disposal system will be designed and constructed in accordance with all applicable regulatory requirements which include considerations for the protection of the environment, including seepage/leachate control for the prevention of adverse effects on groundwater quality.

It is therefore anticipated that potential effects on groundwater quality related to waste handling and disposal will be sufficiently mitigated by following the regulatory requirements for facility design and construction as well as environmental monitoring. No residual effects are predicted on the groundwater quality subcomponent from the waste management facilities.

9.4.2.5 Groundwater Extraction for Potable and Process Water Use

The camp potable water and water for reagent mixing in the Process Plant will be supplied by groundwater wells that are proposed to be installed near the camp and Process Plant. The water wells will be designed and constructed in accordance with applicable regulations and guidelines that include measures to protect the integrity of the resource and also maximize well efficiency. However, the potential effects on groundwater quantity related to the drawdown of the water table caused by the extraction of groundwater cannot be fully mitigated, even though they are considered small as discussed in Section 9.4.1.8. Therefore, residual effects are predicted on the groundwater quantity subcomponent from the extraction of groundwater for the camp and Process Plant.

9.4.3 Residual Effects and Significance Determination

9.4.3.1 Mine Dewatering

As discussed in Sections 9.4.1.1 and 9.4.2.1, the dewatering of the mine workings will result in a drawdown of the groundwater table in the area of the ABM Deposit that cannot be fully mitigated. Figure 9-5 shows the maximum extent of the cone of depression as a result of the dewatering of the mine workings. Based on the limited indirect effects on flow in Geona Creek and South Creek (less than 20% change relative to baseline conditions post closure), the magnitude of the effects was deemed moderate. The extent of the cone of depression reaches into the RSA and the geographic extent is therefore deemed regional. The effect is considered long-term as it will occur during the full period of mine operations, closure, and into post closure; however, the groundwater table is predicted to recover relatively fast upon cessation of active dewatering. Most of the recovery will occur during the first few years after mine closure. However, as discussed in Sections 9.4.1.1 through 9.4.1.3, there is a small residual effect with depressed hydraulic heads that is irreversible and related to the formation of the ABM lake (see Section 9.4.3.2).

Based on the moderate magnitude and the fact that most of the effect will be reversed within the first few years after mine closure, the overall effect of changes in groundwater quantity related to mine dewatering is deemed not significant (Table 9-9).

Potential effects on the quality of water extracted by the dewatering system and management of this water are discussed in Section 8.4.

9.4.3.2 Flooding of Mine Workings and ABM Lake Formation

The flooding of the mine workings and the formation of the ABM lake will result in residual effects to groundwater quantity and associated effects on the baseflow to Geona Creek and South Creek. As these effects are closely interrelated, they are discussed together in this section.

At closure, dewatering of the mine workings will cease and Fault Creek will be re-directed into the ABM open pit. Over a period of approximately 16 years, the open pit will flood due to a combination

of surface water and groundwater inflow and the ABM lake will be created. After 16 years, ABM lake will reach the spill elevation at 1,380 masl and overflow into Geona Creek.

The cone of depression caused by the mine dewatering will partially recover beginning at mine closure when dewatering stops. Most of the recovery of the hydraulic heads in the shallow and deep aquifers will occur during the first few years after closure. Figure 9-6 and Figure 9-7 shows the residual drawdown in the bedrock aquifer 5 years and 30 years after closure. However, due to the formation of the ABM lake and the new spill elevation of 1,380 masl, the hydraulic heads in the vicinity of ABM lake will not fully recover back to baseline conditions. Figure 9-7, which shows the residual drawdown 30 years after closure, represents the new steady-state equilibrium conditions. It should be noted that the residual drawdown in the overburden and shallow bedrock aquifer is less pronounced than in the deeper bedrock aquifer shown in Figure 9-7. For example, the residual drawdown near the northern pond at the South Creek headwaters is about 10 m in the bedrock aquifer; however, the residual drawdown in the overburden aquifer is only about 1 m at the same location. This is because the main effect of the ABM lake is a reduction in the vertical hydraulic gradient rather than a decrease of the shallow groundwater table with an associated increase in the unsaturated zone thickness.

Based on the above, the residual effects on groundwater quantity related to the formation of the ABM lake are deemed of low magnitude, regional extent and will occur into the far future, i.e., the effects will be irreversible. The residual effects on the groundwater quantity are therefore deemed not significant (Table 9-9).

Potential effects related to ABM lake water quality are discussed in Section 8.4.

9.4.3.3 Residual Drawdown and Effects on Flow in Geona and South Creek

As discussed in Sections 9.4.1.3, the formation of the ABM lake with an associated residual drawdown and shift of the water divide between the South Creek and Geona Creek watersheds, will have effects on the baseflow to these creeks and potentially on the ponds near the headwaters of South Creek.

The irreversible changes to the groundwater regime in the area of the ABM lake result in a predicted decrease of the flow in South Creek at station KZ-13 of about 10% relative to baseline conditions.

The flow in Geona Creek is predicted to initially decrease to about 80% of the baseline flow upon mine closure while the ABM lake is filling. Once the ABM lake reaches its spill elevation, the flow in Geona Creek is predicted to increase to about 110% of the baseline flow.

Based on the above, the residual effects on flow in Geona Creek and South Creek related to the formation of the ABM lake are deemed of low magnitude, regional extent and will occur into the far future, i.e., the effects will be irreversible. The residual effects on the groundwater quantity are therefore deemed not significant (Table 9-9). The indirect effects related to changes in flow in both Geona Creek and South Creek are further discussed in Section 8.4.

9.4.3.4 Groundwater Extraction for Potable and Process Water Use

The extraction of groundwater for potable water use in the camp and reagent mixing in the Process Plant will result in local drawdown of the groundwater table near the proposed water wells at the camp and Process Plant. However, the demand of 3.7 m^3/hr and 5.5 m^3/hr at the camp and Process Plant, respectively, is small relative to the estimated baseflow in Geona Creek and Finlayson Creek (see Section 9.4.1.8). The effect of the drawdown and associated reduction in baseflow to those creeks is therefore deemed to be of low magnitude. The groundwater table will recover upon mine closure and decommissioning of the water wells and it is expected that the effect is fully reversible within the short period of time (i.e., during the mine closure phase).

Overall, the effects from groundwater extraction at the camp and Process Plant are therefore deemed not significant (Table 9-9).

9.4.3.5 Summary of Significance Determination of Residual Effects on Groundwater

The significance of residual effects as a result of the Project on groundwater are summarized in Table 9-9.

Table 9-9: Project Effects Significance Assessment for Groundwater

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Lowering of groundwater table for dewatering of mine workings	Adverse	Moderate	Regional	Long term	Continuous	Reversible long term (small residual effect that is irreversible)	Low	High	Not significant
ABM lake formation and long-term effects on groundwater table	Adverse	Low	Regional	Far future	Continuous	Irreversible	Low	High	Not significant
Residual drawdown and associated effects on Geona Creek and South Creek	Adverse	Low	Regional	Far future	Continuous	Irreversible	Low	High	Not significant
Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant	Adverse	Low	Local	Medium term	Continuous	Reversible short term	Low	Medium (possibility that effect of reduced baseflow is not measurable)	Not significant

Note: Criteria definitions are provided in Table 9-2.

9.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for groundwater follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. The following Project residual effects have been identified for groundwater and are considered through the CEA:

- Lowering of groundwater table for dewatering of mine workings;
- ABM lake formation and long-term effects on groundwater table;
- Indirect effects from ABM lake formation on Geona Creek and South Creek; and
- Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant.

9.5.1 Cumulative Effects Characterization

For past, present and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the Project or activity results in a demonstrable or measurable effect on groundwater;
2. The Project-specific residual effect on groundwater overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on groundwater overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for groundwater are identified through the screening in Table 9-10. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

Table 9-10: Cumulative Effects Screening for Groundwater

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Quartz Mining and Exploration				
Fyre Lake Property (*Pacific Ridge Exploration)*	No	N/A	N/A	No
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/ Veris Group*)	No	N/A	N/A	No
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	No	N/A	N/A	No

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	N/A	N/A	No
The Yukon Base Metal Project *(Overland Resources Ltd.)*	No	N/A	N/A	No
Wolverine Mine (*Yukon Zinc Corp.)*	No	N/A	N/A	No
Roads, Access Roads and Trails				
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	N/A	N/A	No
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	N/A	N/A	No
Other Activities				
Single/Group Trapline Concessions	No	N/A	N/A	No
Outfitting Concessions	No	N/A	N/A	No
Campgrounds	No	N/A	N/A	No

Note: If "No" is indicated for a condition the remaining conditions are indicated as N/A (not applicable) as all conditions must be met for potential cumulative effect to be identified.

As indicated in Table 9-10, no projects or activities have been identified to overlap with Project residual effects for groundwater in type of effect, in time and in space. Therefore, no potential cumulative effects have been identified for groundwater. No further assessment is required.

9.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

Groundwater monitoring was undertaken as part of the pre-development baseline monitoring programs for the Project and presented in Section 9.3. Table 19-2 outlines the proposed sampling locations and schedule for internal and external lab analysis in the area of the Project footprint. Figure 9-12 shows the proposed groundwater monitoring station locations. Groundwater will be monitored upgradient and downgradient to monitor for potential change in groundwater quality or level due to the Project.

Groundwater quality monitoring will occur on a quarterly basis during operations, throughout the active and transition closure periods, and the first three years of the post-closure period (i.e., years 26 to 29). After that, groundwater sampling will be reduced to a semi-annual frequency during the non-frozen months of the year until the end of the post-closure period (i.e., year 36).

The monitoring program includes (and will continue to include) a comprehensive QA/QC program to ensure validity of the data collected. The QA/QC program includes:

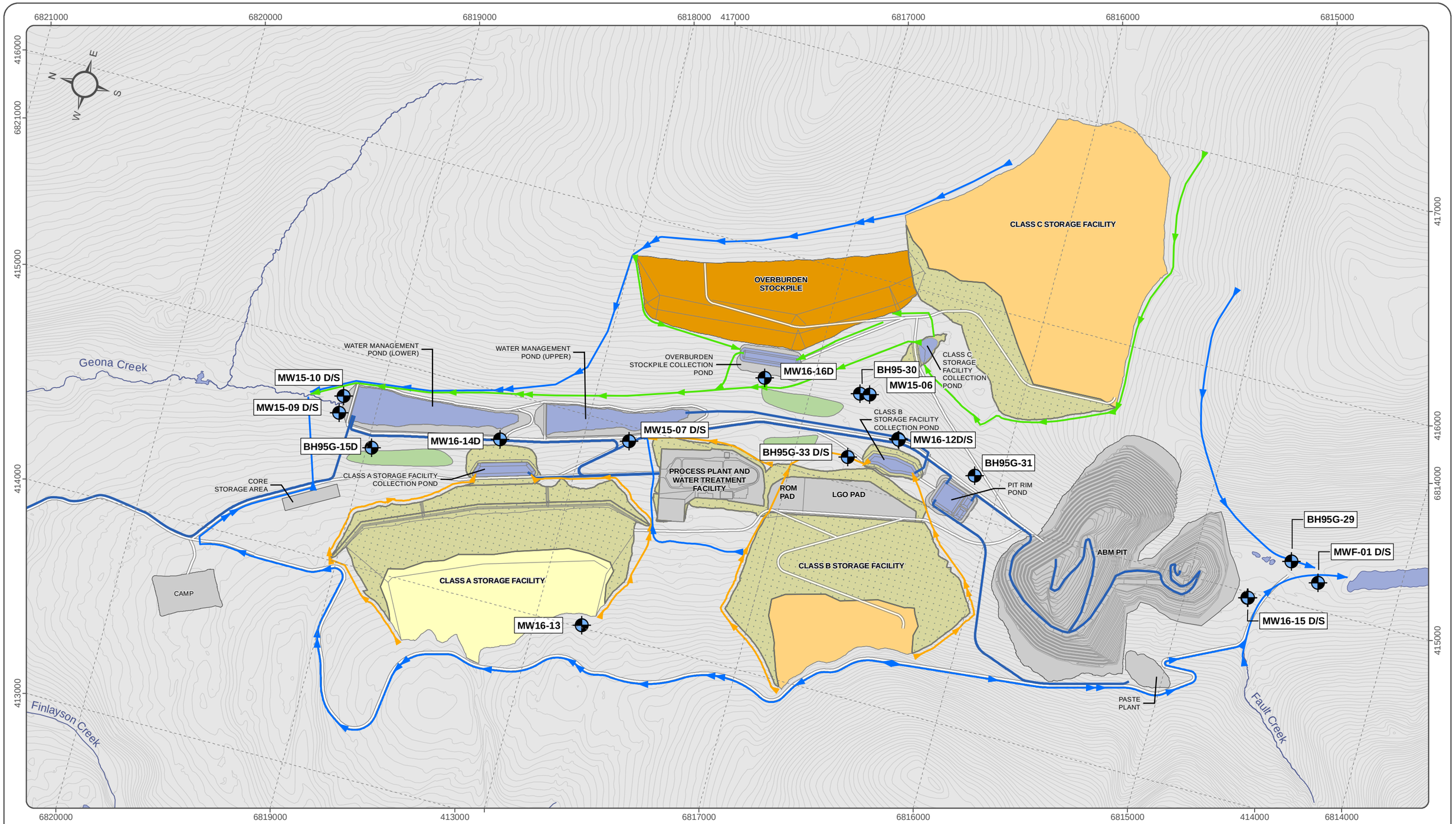
- All field staff are trained in groundwater monitoring and sample collection that are based on generally accepted Yukon practices. The sampling procedures include measures to avoid sample contamination in the field, as well as during sample handling and shipping;
- A blind field duplicates are collected at a rate of 1 duplicate per 10 samples collected. The field duplicates are clearly linked to one of the monitoring wells on sampling logs and field notes but not on the chain of custody forms;
- A field and travel blank are collected for each monthly sampling event throughout the year;
- All samples will be sent to a Canadian Association for Laboratory Accreditation member, for analysis. The laboratory will also conduct a QA/QC program, including split duplicates (1 per 10 samples); and
- Following each sampling event, BMC conducts a review of all analytical results and QA/QC results received from the laboratory to ensure data quality and flag any potential issues (e.g., data quality issues from the information provided by the lab, ensure data are charge balanced – typically less than 5%). Additionally, the QA/QC program includes a review of the relative percent difference in replicates and parameters measured in field blanks and trip blanks to assess data quality.
- All groundwater data collected will be submitted as part of monthly and annual reports for the Water Licence to the Yukon Water Board and in the annual Quartz Mining Licence report. The groundwater data will be used to ensure compliance with the Water Licence and to refine the water quality model to inform operational decisions. The groundwater data will be evaluated against the AMP thresholds (i.e., groundwater levels, water quality objectives and effluent quality standards) on a monthly and annual basis.

Table 9-11: Kudz Ze Kayah Groundwater Quality Monitoring Program Summary

Site	Description	Aquifer	IN SITU MEASUREMENTS					EXTERNAL LAB ANALYSIS							
			Level	pH	Temperature	Specific Conductivity	Oxidation and Reduction Potential	Dissolved Metals (ultra-low levels including hardness phosphorus, and mercury)	pH	Specific Conductivity	Total Dissolved Solids	Anions (incl. nitrate, nitrite)	Alkalinity	Ammonia	WAD Cyanide
MW15-09S	Downgradient of Lower Management Pond	Overburden	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW15-09D	Downgradient of Lower Management Pond	Bedrock	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW15-10S	Downgradient of Lower Management Pond	Overburden	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW15-10D	Downgradient of Lower Management Pond	Bedrock	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW15-07S	Downgradient of Process Plant	Overburden	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW15-07D	Downgradient of Process Plant	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW16-13	Upgradient of Class A Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW16-14D	Downgradient of Class A Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
BH95G-15D	Downgradient of Class A Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
MW16-12S	Downgradient of Class B Storage facility	Overburden	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MW16-12D	Downgradient of Class B Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-33S	Downgradient of Class B Storage facility	Overburden	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-33D	Downgradient of Class B Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-33S	Downgradient of Class B Storage facility	Overburden	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-33D	Downgradient of Class B Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MW16-16D	Downgradient of overburden stockpile	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MW15-06	Downgradient of Class C Storage facility	Overburden	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-30	Downgradient of Class C Storage facility	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-31	Downgradient of ABM pit	Bedrock	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MW16-15S	Upgradient of ABM pit	Bedrock	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MW16-15D	Upgradient of ABM pit	Bedrock	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
BH95G-29	Upgradient of ABM pit in South Creek watershed	Overburden	C	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MWF-01S	Upgradient of ABM pit in South Creek watershed	Overburden	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-
MWF-01D	Upgradient of ABM pit in South Creek watershed	Bedrock	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-

Notes:

C	Continuous	Ms	Monthly (May to Oct)
C-WD	Continuous While Discharging	M/Q	Monitoring to occur monthly for first 12 months, reverting to quarterly thereafter
D	Daily	Q	Quarterly
D-WD	Daily While Discharging	A	Annually
W	Weekly	SA	Semi Annually/ twice per year
W-WD	Weekly While Discharging	BA	Bi-Annually (every 2 years)
M	Monthly	-	Not Applicable



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Datum: NAD 83; Map Projection: UTM Zone 9N

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AEG

1:17,000 (when printed on 11 x17 inch paper)

0 250 500 750 Metres

- Groundwater Monitoring Well
- Mine Feature Footprint
- Class A Storage Facility
- Class B and C Storage Facility
- Overburden Stockpile
- Topsoil Stockpile
- Progressive Reclamation
- Pond/Water
- Pipeline
- Non Contact Diversion
- Contact Class A & B Diversion
- Contact Class C Diversion
- Proposed Mine Road
- Contour (5 m)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 9-12

PROPOSED GROUNDWATER MONITORING SAMPLING LOCATIONS

FEBRUARY 2017

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\01_WaterQuality\02-Groundwater\03-Proposed\OperationalGW_Proposed_20170227.mxd
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KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

10 AQUATIC ECOSYSTEMS AND RESOURCES 10-1

10.1 ASSESSMENT APPROACH 10-1
10.1.1 Regional Setting 10-1
10.1.2 Selection of Subcomponents and Measurable Parameters 10-2
10.1.3 Criteria for Assessing Significance 10-6
10.2 ASSESSMENT BOUNDARIES 10-9
10.2.1 Local Study Area 10-9
10.2.2 Regional Study Area 10-9
10.2.3 Temporal Boundaries 10-11
10.3 EXISTING CONDITIONS 10-11
10.3.1 Traditional Knowledge 10-12
10.3.2 Fish and Aquatic Habitat 10-12
10.3.3 Benthic Invertebrates, Periphyton, and Aquatic Plants 10-21
10.4 PROJECT-SPECIFIC EFFECTS 10-23
10.4.1 Effects Characterization 10-23
10.4.2 Mitigation Measures 10-50
10.4.3 Residual Effects and Significance Determination 10-54
10.5 CUMULATIVE EFFECTS 10-59
10.5.1 Cumulative Effects Characterization 10-59
10.6 EFFECTS MONITORING 10-60
10.6.1 Aquatic Environmental Program 10-61
10.6.2 Benthic Invertebrate Monitoring Program 10-61
10.6.3 Sediment Monitoring Program 10-62
10.6.4 Fisheries Monitoring Program 10-63
10.6.5 Fish Tissue Sampling 10-63
10.6.6 Metal Mining Effluent Regulations - Environmental Effects Monitoring 10-63

LIST OF TABLES

Table 10-1: Aquatic Ecosystems and Resources Subcomponents and Measurable Parameters 10-3
Table 10-2: Fish and Aquatic Habitat Significance Criteria Definition 10-6
Table 10-3: Benthic Invertebrates, and Periphyton and Aquatic Plants Significance Criteria Definition 10-8
Table 10-4: Local and Regional Study Areas for Aquatic Ecosystems and Resources 10-9
Table 10-5: Interaction Matrix for Aquatic Ecosystems and Resources 10-24
Table 10-6: Low Flow Water Quality Predictions in Geona (KZ-37), Year -1 through Year 13 10-40
Table 10-7: Low Flow Water Quality Predictions in Finlayson Creek (KZ-15), Year -1 through Year 13 10-40
Table 10-8: Total Phosphorus Trigger Ranges for Canadian Lakes and Rivers 10-42
Table 10-9: Mean Monthly Water Temperature (°C) 10-47

Table 10-10: Identified Potential Project Effects for Aquatic Ecosystems and Resources 10-49
Table 10-11: Proposed Key Mitigation Measures for Aquatic Ecosystems and Resources 10-52
Table 10-12: Project Effects Significance Assessment for Aquatic Ecosystems and Resources 10-58
Table 10-13: Cumulative Effects Screening for Aquatic Ecosystems and Resources.....10-60

LIST OF FIGURES

Figure 10-1: Local and Regional Study Areas for Aquatic Ecosystems and Resources 10-10
Figure 10-2: Historical Aquatic Resource Monitoring Stations.....10-13
Figure 10-3: 2015/2016 Fisheries Monitoring Locations 10-14
Figure 10-4: 2015/2016 Aquatic Resource Sampling Locations 10-15
Figure 10-5: Proposed Project Site Layout (Year 10) 10-29
Figure 10-6: Regional Catchments and Water Quality and Hydrometric Monitoring Stations 10-30
Figure 10-7: Regional Catchments and Water Quality and Hydrometric Stations 10-33
Figure 10-8: Predicted percent change in runoff relative to baseline in Geona Creek (KZ-37).....10-35
Figure 10-9: Predicted percent change in runoff relative to baseline in South Creek (KZ-13).....10-37
Figure 10-10: Predicted percent change in runoff relative to baseline in Finlayson Creek (KZ-15) throughout Project phases under three precipitation scenarios 10-38
Figure 10-11: Predicted percent change in runoff relative to baseline in Finlayson Creek (KZ-26) 10-39

10 AQUATIC ECOSYSTEMS AND RESOURCES

This section provides an overview of existing aquatic conditions and assessment of the potential Project effects on aquatic ecosystems and resources. Aquatic ecosystems and resources were selected as a Valued Component (VC) for the Project because of their great importance in maintaining function of aquatic and biophysical environments as well as the cultural and recreational importance of fish. This assessment is linked to the assessment of surface water quality and quantity (Chapter 8).

10.1 ASSESSMENT APPROACH

The fisheries and aquatic resources effects assessment (EA) will generally follow the methods detailed in Chapter 5; however, some considerations are specific to fisheries and aquatic resources. In particular, water quality predictions from the receiving environment water quality model (Appendix D-7) will be the basis for evaluating the potential effects on aquatics ecosystems and resources. The proposed aquatic ecosystems and resources subcomponents and measurable parameters are provided in Table 10-1.

10.1.1 Regional Setting

In Yukon, fisheries management is jointly managed by Fisheries and Oceans Canada (DFO) and Yukon Government (YG) (Environment Yukon) under a combination of federal legislation and regulations. The federal *Fisheries Act* and its supporting regulations is the primary legislation governing fisheries and fish habitat in Yukon.

Cominco Ltd. (Cominco), as the previous owners of the Kudz Ze Kayah (KZK) property successfully obtained a *Fisheries Act* authorization (FAA) in 1997, which allowed the company to undertake harmful alteration of fish habitat in the upper Geona Creek valley. In addition to measures to mitigate/reduce harm during development of the mine project, the FAA largely relied on a Fish Habitat Compensation Plan (FHCP) to "*ensure no net loss of fish production*".

Since the previous FAA was issued in 1997, there have been updates made to the *Fisheries Act* and the Fisheries Protection Program. The changes made reflect the new provisions of the *Fisheries Act,* which came into force on November 25, 2013. The new Section 6.1 of the *Fisheries Act* sets out the purpose for decision making under the fisheries protection provisions, which is "*to provide for the sustainability and ongoing productivity of commercial, recreational and Aboriginal fisheries".*

In this context, DFO interprets:

- Sustainability as the use of the environment and resources to meet the needs of the present, without compromising the ability of future generations to meet their needs; and
- Productivity as the sustained yield of all component populations, species, and habitats that support and contribute to a fishery in a specified area.

The previous regulatory regime under the *Fisheries Act* included two prohibitions for the management of effects to fish and fish habitat:

1. The killing of fish by means other than fishing (Section 32).
2. The harmful alteration or disruption, or the destruction of fish habitat (subsection 35(1)).

The amended fisheries protection provisions effectively combine these into a single new prohibition:

> *35. (1) No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.*

It is understood that Section 35 is not a permitting scheme but rather a prohibition against serious harm to fish. With respect to the Project, serious harm to fish cannot be avoided and an authorization under Section 35(2) will be required. Therefore, Minerals (No. 1) Ltd (BMC) has developed a preliminary Fisheries Offsetting Plan (FOP) (Appendix E-4) based upon guidance from DFO (DFO, 2013).

The *Species at Risk Act* (SARA) is also applicable in Yukon. No freshwater fish species on Schedules 1 or 2 of SARA are present in the Finlayson Creek watershed or the entire Yukon Territory.

10.1.2 Selection of Subcomponents and Measurable Parameters

The protection of fish and fish habitat is included in the environmental legislation of the *Fisheries Act*, which is intended to ensure that the overall productive capacity of fish habitat is not affected by project activities. Fish have commercial, cultural and recreational value for people of Yukon, including Kaska First Nation (Kaska), whose Traditional Territory the proposed Project is located within. Fish also play a key role in the functioning of aquatic ecosystems. Kaska Dena Council has developed Kaska Dena Management Practices that provide measures specific to maintaining water quality and fisheries resources in Kaska territory (Dena Kayeh Institute (DKI), 2010), which along with the desk-based information in Appendix F-3 were also used to identify and confirm subcomponents and measurable parameters for the aquatic ecosystems and resources VC. Benthic invertebrates and periphyton also play a key role in aquatic ecosystems as both primary and secondary producers which provide food sources for higher trophic levels (i.e., fish and birds). These organisms are commonly used as biological indicators for freshwater because they are sedentary (stay in one place and therefore integrate site-specific effects), ubiquitous and generally abundant (can be collected everywhere), long-lived (can reflect cumulative effects), and diverse (respond to a wide range of stressors).

The aquatic ecosystems and resources subcomponents and measurable parameters are provided in Table 10-1.

Table 10-1: Aquatic Ecosystems and Resources Subcomponents and Measurable Parameters

Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Fish (Arctic grayling)	Arctic grayling Population (Catch per unit effort (CPUE), Condition factor)	Endpoint: Maintenance of healthy fish populations Criteria: No statistically significant difference in measurable parameters between exposure and reference areas and/or baseline data	Environmental Effects Monitoring (EEM) requirements under the Metal Mining Effluent Regulations (MMER)
	Sublethal Effects	Criteria: Pass sublethal toxicity testing of mine effluent	EEM requirements under the MMER
Aquatic habitat	Habitat availability, distribution and connectivity	Endpoint: Maintenance of the productive capacity of aquatic habitats Criteria: Maintain or improve productive capacity of available habitat (rearing, overwintering, spawning and staging/holding) such that baseline fish populations are maintained or enhanced	Fisheries Protection Program of the federal *Fisheries Act*
	Total suspended solids (TSS)	Endpoint: Maintenance of the productive capacity of aquatic habitats. Criteria: No guideline, objective or standard exceedance	Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life (PAL), British Columbia Ministry of the Environment (BC MOE) Ambient Water Quality Guidelines, MMER Regulations and Water Use Licence Effluent Quality Standards (EQS)
	Surface water quantity	Low = change of 0-10% in flow from baseline conditions Moderate = change of 10-20%in flow from baseline conditions High = greater than 20% change in flow and a change outside of the natural variability of baseline	No substantial alteration of surface water quantity within RSA outside of natural variability of baseline flows to protect quantity and quality of aquatic habitat
	Surface water quality	Endpoint: Maintenance of the productive capacity of aquatic habitats Criteria: Low = results less than Preliminary Water Quality Objectives (pWQO) Moderate = results greater than pWQO but less than 10 times pWQO High = results greater than 10 times pWQO	pWQO including Site Specific Water Quality Objectives (SSWQOs), CCME guidelines for the PAL, BC MOE Ambient Water Quality Guidelines, MMER and Water Use Licence EQS
	Water temperature	Endpoint: Maintenance of the productive capacity of aquatic habitats Criteria: Remain below 20°C	Water temperature (°C) should remain within optimal or suitable ranges for various life history stages of Arctic grayling
	Stream sediments chemistry and particle size distribution	Endpoint: Maintenance of the productive capacity of aquatic habitat Criteria: No exceedance of guidelines, change in particle size distribution remains within natural variability	CCME (1999) interim freshwater sediment quality guidelines (ISQG), and probable effects levels (PEL)

Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Benthic invertebrates, periphyton and aquatic plants	Benthic Invertebrate community (taxon richness, mean invertebrate density (average number of organisms per m^2), Simpson's Evenness Index and Bray-Curtis Index of Dissimilarity)	Endpoint: Maintenance of healthy benthic invertebrate populations Criteria: No statistically significant difference in measurable parameters between exposure and reference areas	EEM requirements under the MMER
	Abundance and diversity of periphyton communities	Endpoint: Maintenance of the productive capacity of aquatic habitats Criteria: Change remains within natural variability	Periphyton is valuable biological monitoring tool to assess potential effects of nutrient enrichment and metal toxicity
	Chlorophyll *a*	Endpoint: Maintenance of the productive capacity of aquatic habitats Criteria: Change remains within natural variability	Determining chlorophyll *a* concentrations provides a measure of algae biomass and thus, the primary productivity of a given location
	Sublethal Effects	Endpoint: Maintenance of healthy, benthic invertebrate, plant and algae populations Criteria: Pass sublethal toxicity testing of mine discharge	EEM requirements under the MMER

10.1.2.1 Rationale for Measurable Parameters

Measurable parameters can provide management or scientific evidence of ecosystem quality, or reliable evidence of trends or changes in quality. Measurable parameters were selected to enable the quantitative measurement of potential Project and cumulative effects.

Selection of the threshold criteria for each measurable parameter was based on regulatory criterion (i.e., water quality guidelines and *Fisheries Act*) or quantitative forms of measurement that can be used to assess potential effects through the duration of the Project. The following sections provide a brief summary of the measurable parameters for the subcomponents listed in Table 10-1.

Fish (Arctic grayling)

CPUE and condition factor results can be used to indicate spatial and temporal changes in populations. Comparison with baseline will indicate temporal changes while comparisons between effluent exposed and reference areas will indicate spatial changes. Also, baseline data on fish populations and observed fish accidentally killed as a result of the Project would directly inform effects on mortality.

With respect to fish monitoring on-going investigations will compare sampling results to baseline conditions. However, once the Project triggers MMER, BMC will be required to undertake an EEM study which includes an effects assessment on fish. The EEM protocols require a comparison between fish captured in effluent exposed waters to a pristine reference site.

In the case of effluent deposited into fresh waters; mine effluent sublethal toxicity testing is required to be undertaken, as part of the MMER EEM requirements, on a fish species, an invertebrate species, a plant species and an algal species, (Government of Canada, 2014). Results will allow determination of potential sublethal effects of both the fish andbenthic invertebrates, and the periphyton and aquatic plants subcomponents.

Aquatic Habitat

For aquatic habitat availability distribution and connectivity, the area of change in available habitat due to physical disturbance or modification of flows (for example) is a means of quantifying disturbance to the productive capacity of fish habitat. The extent of habitat made inaccessible can be totalled and included in fish habitat compensation (offsetting) measures. Kaska Dena Management Practices (DKI, 2010) underscore the importance of establishing thresholds of fish habitat disturbance and loss, especially spawning sites.

Measurement of total suspended solids (TSS) provides an indicator of turbidity and sediment loads relative to baseline conditions and is a good measure of the quality or viability of aquatic habitat.

Changes in surface water quantity can be determined through direct measurement and can directly or indirectly affect habitat availability or suitability.

Changes in water quality may result in potential effect to aquatic life due to changes in stream water quality for the project area. Measurement of various water quality parameters provides an indicator of water quality as it pertains to the health of aquatic biota. Preliminary Water Quality Objectives (pWQO) have been developed using CCME and BC MOE guidelines for protection of aquatic life. Additional SSWQOs have been developed (Chapter 8). Key Kaska Dena Management Practices include the introduction of measures that maintain the water quality to support productive fisheries resources (DKI, 2010).

Changes in water temperature can be determined through direct measurement. Temperature should remain within suitable ranges for the various life stages of Arctic grayling (optimal range is 7.5 to 15°C, with an upper threshold of 20°C) and other aquatic biota.

Incremental fine sediment loading in a stream is known to potentially affect both stream morphology and aquatic biota. Sediments may act as sinks or sources for trace pollutants, but they are also important natural habitats for aquatic organisms. Changes in particle size distribution or sediment chemistry may indicate Project-related effects.

Benthic invertebrates, periphyton and aquatic plants

The metrics of taxon richness, mean invertebrate density (average number of organisms per m^2), Simpson's Evenness Index and Bray-Curtis Index of Dissimilarity are used as an indicator of benthic invertebrate health and can provide details of spatial and temporal changes over time when compared with either baseline conditions or with a reference area.

Periphyton is a valuable biological monitoring tool used to assess potential effects of nutrient enrichment and metal toxicity; spatial or temporal changes in a community can indicate Project-related effects.

Determining chlorophyll *a* concentrations provides a measure of algae biomass and thus, the primary productivity of a given location. Spatial or temporal changes in chlorophyll *a* can indicate Project-related effects.

10.1.3 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and
- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, the determination of 'likelihood' is separate from the above criteria. The likelihood determination provides context to the assessment and identified effects. The likelihood of an effect is qualitatively discussed, and gives consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful; and
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The consideration of uncertainty is VC-specific and may include quantitative (i.e., sensitivity analysis) or qualitative discussion. The uncertainty addresses any assumptions made through the assessment.

The definition of criteria used for determining significance of residual effects for aquatic ecosystems and resource are presented in Table 10-2 (fish and fish habitat) and in Table 10-3 (benthic invertebrate and periphyton communities and populations).

Table 10-2: Fish and Aquatic Habitat Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	An increase in fish habitat productive capacity, a reduction in the risk of fish mortality

Criteria	Definition	
	Neutral	Productive capacity of fish habitat and the risk of fish mortality remain unchanged from baseline conditions
	Adverse	A reduction in fish habitat productive capacity; an increase in the risk of fish mortality
Magnitude	Negligible	No measurable environmental effect on Arctic grayling population or habitat function is anticipated
	Low	Change in productive capacity of aquatic habitat or in Arctic grayling population but within the natural variability of baseline conditions Water quantity: change of 0-10% in flow from baseline conditions Water quality: results less than pWQO
	Moderate	Subcomponent: Arctic graying - measurable change in Arctic grayling population outside of natural variability of baseline conditions Subcomponent: Aquatic habitat - measurable change in productive capacity of aquatic habitat Water quantity: change of 10-20% in flow from baseline conditions Water quality: results greater than pWQO but less than 10 times pWQO TSS, water temperature and sediment quality parameters below applicable guidelines or threshold
	High	Subcomponent: Arctic graying - statistically significant difference in Arctic grayling CPUE and/or condition factor between reference and/or exposure sites, or failure of sublethal toxicity test Subcomponent: Aquatic habitat - measurable change in productive capacity of aquatic habitat Water quantity: greater than 20% change in flow and a change outside of the natural variability of baseline Water quality: results greater than 10 times pWQO TSS, water temperature or sediment quality parameters exceeding applicable guidelines or threshold
Geographic Extent	Site	Effects are restricted to the stream within the Project activity area (i.e., Upper Geona Creek and Fault Creek)
	Local	Effects extend beyond the Project activity area but remain within the assessment area (i.e., Lower Geona Creek, Finlayson Creek and South Creek)
	Regional	Effects extend beyond the Project assessment area (i.e., Finlayson River and North River)
	Beyond Regional	Effects extend to watershed/regional level (i.e., Liard River)
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)

Criteria	Definition	
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

A significant effect is considered to occur on fish or aquatic habitat if it is of high magnitude and extends across the regional study area or is of high magnitude within the local study area and occurs over the long term.

Table 10-3: Benthic Invertebrates, and Periphyton and Aquatic Plants Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	An increase in aquatic productivity, abundance, diversity or richness
	Neutral	Benthic invertebrate, periphyton and aquatic plants communities remain unchanged from baseline conditions
	Adverse	A reduction in aquatic productivity, abundance, diversity or richness
Magnitude	Low	Detectable change in benthic invertebrates, periphyton or aquatic plants endpoints, but within the normal variability of baseline conditions
	Moderate	Change in benthic invertebrates, periphyton or aquatic plants endpoints outside of normal variability of baseline conditions
	High	Statistically significant difference for benthic invertebrates, periphyton or aquatic plants endpoints between reference and exposure sites, or failure of sublethal toxicity test
Geographic Extent	Site	Effects are restricted to the stream within the Project activity area (i.e., Upper Geona Creek and Fault Creek)
	Local	Effects extend beyond the Project activity area but remain within the assessment area (i.e., Lower Geona Creek, Finlayson Creek and South Creek)
	Regional	Effects extend beyond the assessment area (i.e., Finlayson River and North River)
	Beyond Regional	Effects extend to watershed/regional level (i.e., Liard River)
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)

Criteria	Definition	
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

A significant effect is considered to occur on benthic invertebrates, periphyton, or aquatic plants if it is of high magnitude and extends across the regional study area or is of high magnitude within the local study area and occurs over the long term.

10.2 ASSESSMENT BOUNDARIES

10.2.1 Local Study Area

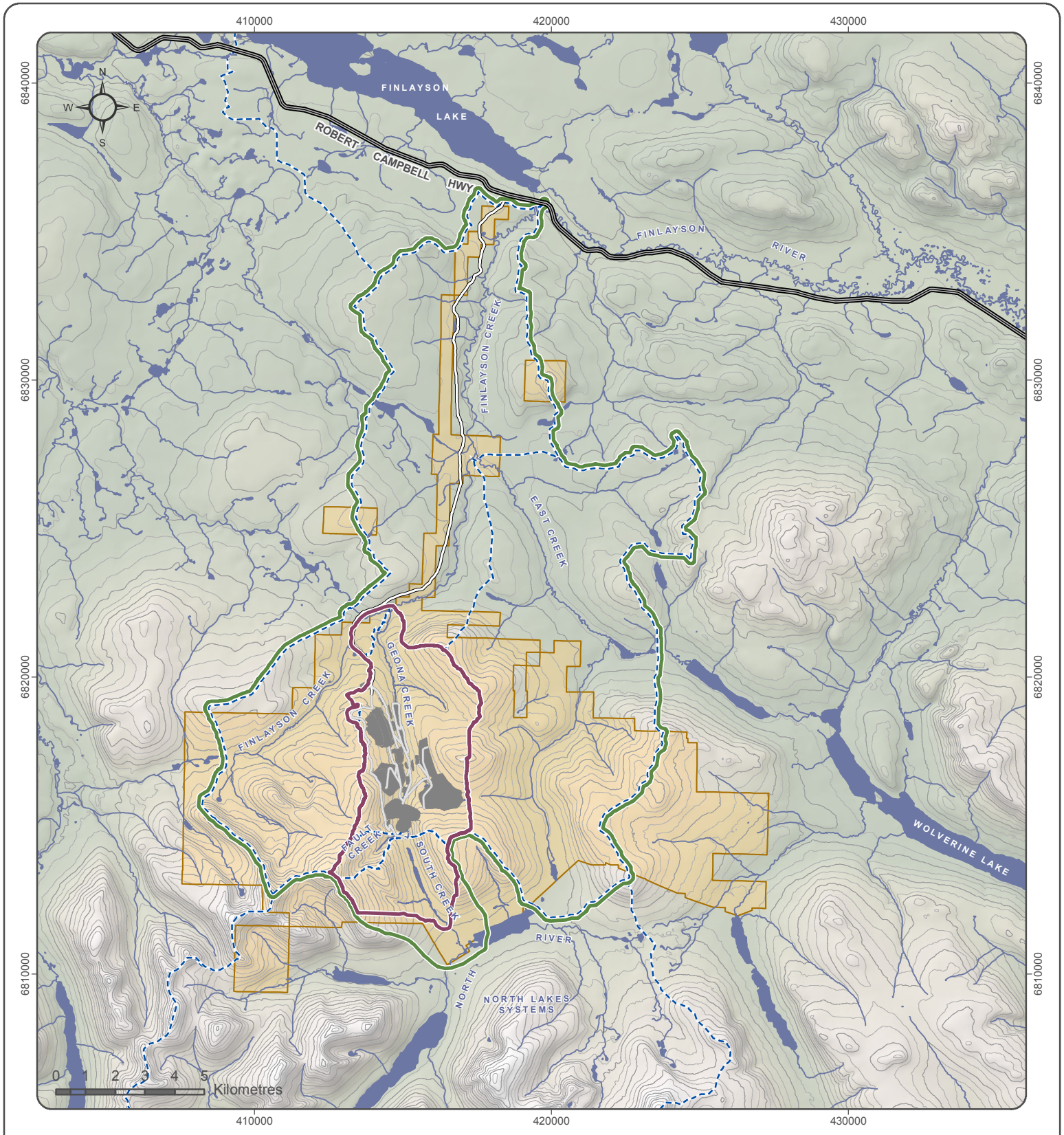
The local study area (LSA) consists of freshwater fish habitats within the Project perimeter, including Geona Creek from its headwaters until its confluence with Finlayson Creek (Figure 10-1). Finlayson Creek upstream of the confluence until the location where non-contact water will be discharged into the creek as well as the South Creek catchment and Fault Creek are located within the LSA.

10.2.2 Regional Study Area

The regional study area (RSA) includes the Finlayson Creek, and East Creek catchments (Figure 10-1). The local and regional study areas for aquatic ecosystems and resources are described in Table 10-4.

Table 10-4: Local and Regional Study Areas for Aquatic Ecosystems and Resources

Study Area	Aquatic Ecosystems and Resources Study Area Description
Local Study Area	Geona Creek Watershed, Fault Creek Watershed, South Creek Watershed
Regional Study Area	Finlayson Creek Watershed, East Creek Watershed



Local Study Area

Regional Study Area

Location of Proposed Mine Infrastructure

Drainages/Catchments

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Tote Road/Proposed Access Road

Proposed Mine Road

KUDZ ZE KAYAH PROJECT

FIGURE 10-1

KZK LOCAL AND REGIONAL STUDY AREA FOR AQUATIC ECOSYSTEMS AND RESOURCES

JANUARY 2017

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AEG

BMC MINERALS

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10.2.3 Temporal Boundaries

The temporal boundaries below are used for the assessment of Project effects on aquatic ecosystems and resources:

- **Construction Phase**: approximately two-year period including site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: approximately 10-year period including open pit and underground development and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as closure phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required; the phase is split into two periods: transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.

10.3 EXISTING CONDITIONS

This section presents a summary of existing environmental conditions as they relate to the aquatic ecosystems and resources. This characterization of the existing environment serves as the baseline against which effects of the Project are assessed. The description of the existing environment has been focused on those components of the environment that have potential to be affected by the Project.

The description of the existing environment for the aquatic ecosystems and resources presents a compilation and review of existing information and the results of the field programs conducted to date. The following sections provide the summary descriptions of the field programs with the detail provided in the baseline conditions report, and are included as Appendix E-3.

The 2015-16 baseline report (Appendix E-3) provides information on existing aquatic ecosystems and resources present in the LSA. It includes information pertaining to fish and fish habitat, stream sediments, benthic invertebrates, periphyton and chlorophyll *a*. This baseline report has provided important information for consideration in the Conceptual Reclamation and Closure Plan (Appendix H-1), and future aquatic resources monitoring efforts, and it has formed a basis upon which to assess effects of the proposed Project development on the aquatic ecosystems and resources. The baseline report is a compilation of survey data and observations collected under numerous investigations and application of sampling effort including the Initial Environmental Evaluation (IEE) (Norecol, Dames & Moore Ltd., 1996), subsequent compliance sampling conducted as per existing Water Licence Requirements in 2002, 2004, 2006, 2008, 2010, 2012, 2014, and 2016 as well as the results of recent additional studies conducted in 2015 and 2016.

10.3.1 Traditional Knowledge

Aquatic ecosystems and resources are of particular importance to the Kaska for cultural, sustenance, and social purposes. In this context, the water quality that supports aquatic ecosystems and resources is also of importance to the Kaska. The traditional knowledge (TK) report (Appendix F-3) indicates that fish of particular importance to Kaska include Arctic grayling, trout, jackfish, whitefish, and suckers. Kaska fishing efforts are mainly focused on Pelly Lakes, Hoole Canyon, and Frances Lake, with Kaska citizens fishing opportunistically while hunting for caribou, sheep, and moose in and around the proposed Project area (Appendix F-3). The results of the TK research indicate that Kaska fish in Finlayson Creek and, at a greater distance from the proposed Project, in North Lakes, Money Creek, and Wolverine Lake.

10.3.2 Fish and Aquatic Habitat

Historical and recent fisheries survey areas/stations are presented in Figure 10-2, Figure 10-3, and Figure 10-4. These studies have indicated the presence of Arctic grayling in the upper reaches of Geona Creek (Project Footprint), as well as throughout the regional drainages (South Creek, North River, Finlayson Creek, East Creek). Other fish species identified in the regional area include slimy sculpin, burbot and lake trout. Detailed study methods and results are presented in the Aquatic Ecosystems and Resources Baseline Report (Appendix E-3) and key findings are summarized in the sections below.

400000
410000
420000
430000
6830000
6820000
6810000

N
W
E
S

FINLAYSON LAKE

KZ-26

ROBERT CAMPBELL HIGHWAY

FINLAYSON CREEK

KZ-21

EAST CREEK

KZ-16
KZ-15

0 100 200
Metres

KZ-15
KZ-16

GEONA CREEK

KZ-9

FINLAYSON CREEK

KZ-7

FAULT CREEK

SOUTH CREEK

WOLVERINE LAKE

RIVER

KZ-27

NORTH

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 10-2

HISTORICAL AQUATIC RESOURCE MONITORING STATIONS

JANUARY 2017

AQUATIC RESOURCE MONITORING STATIONS

- Water Quality
- Stream Sediment
- Benthic Invertebrates
- Metals in Benthos Tissue
- Metals in Fish Tissue

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse
- Waterbody
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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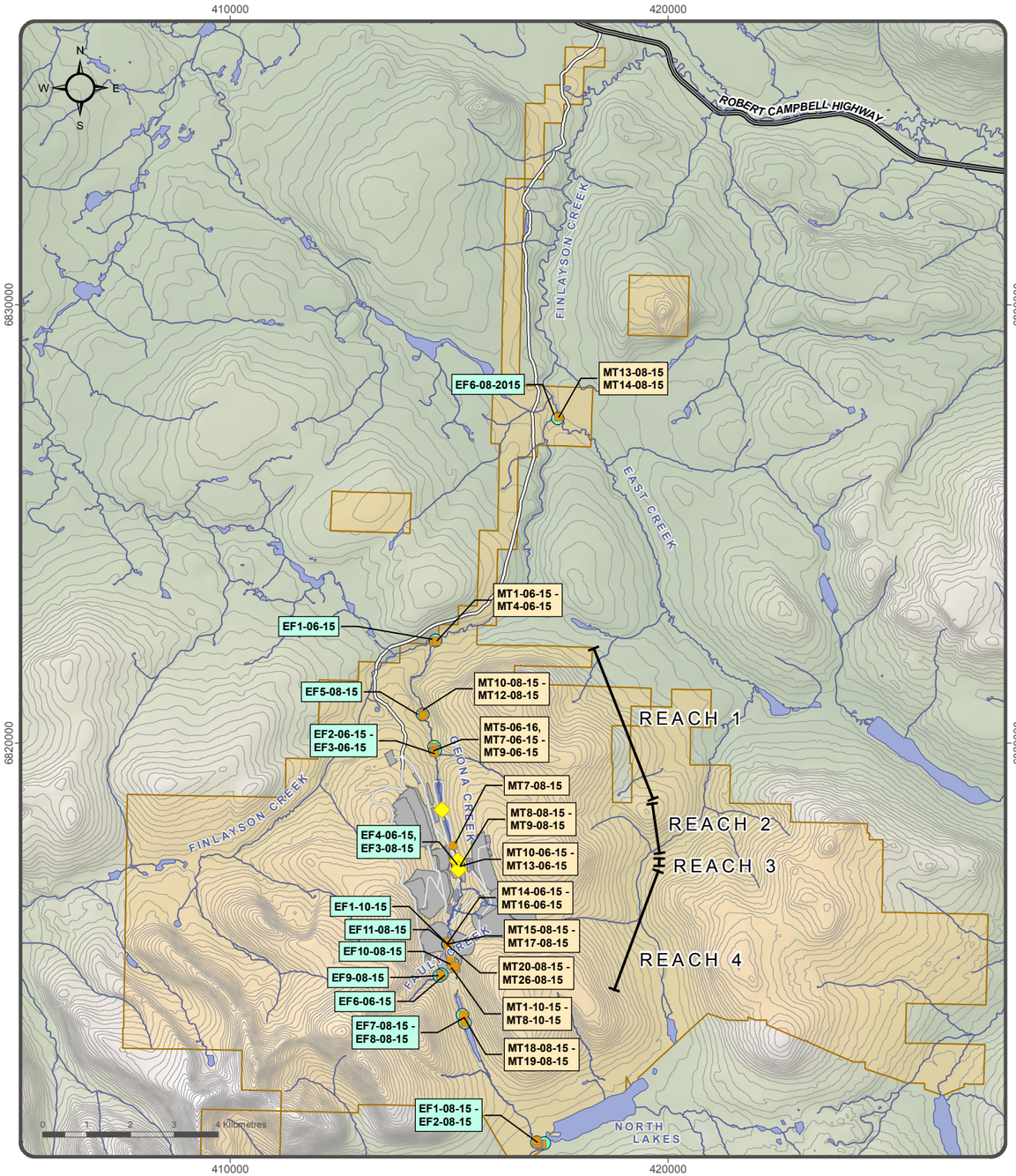
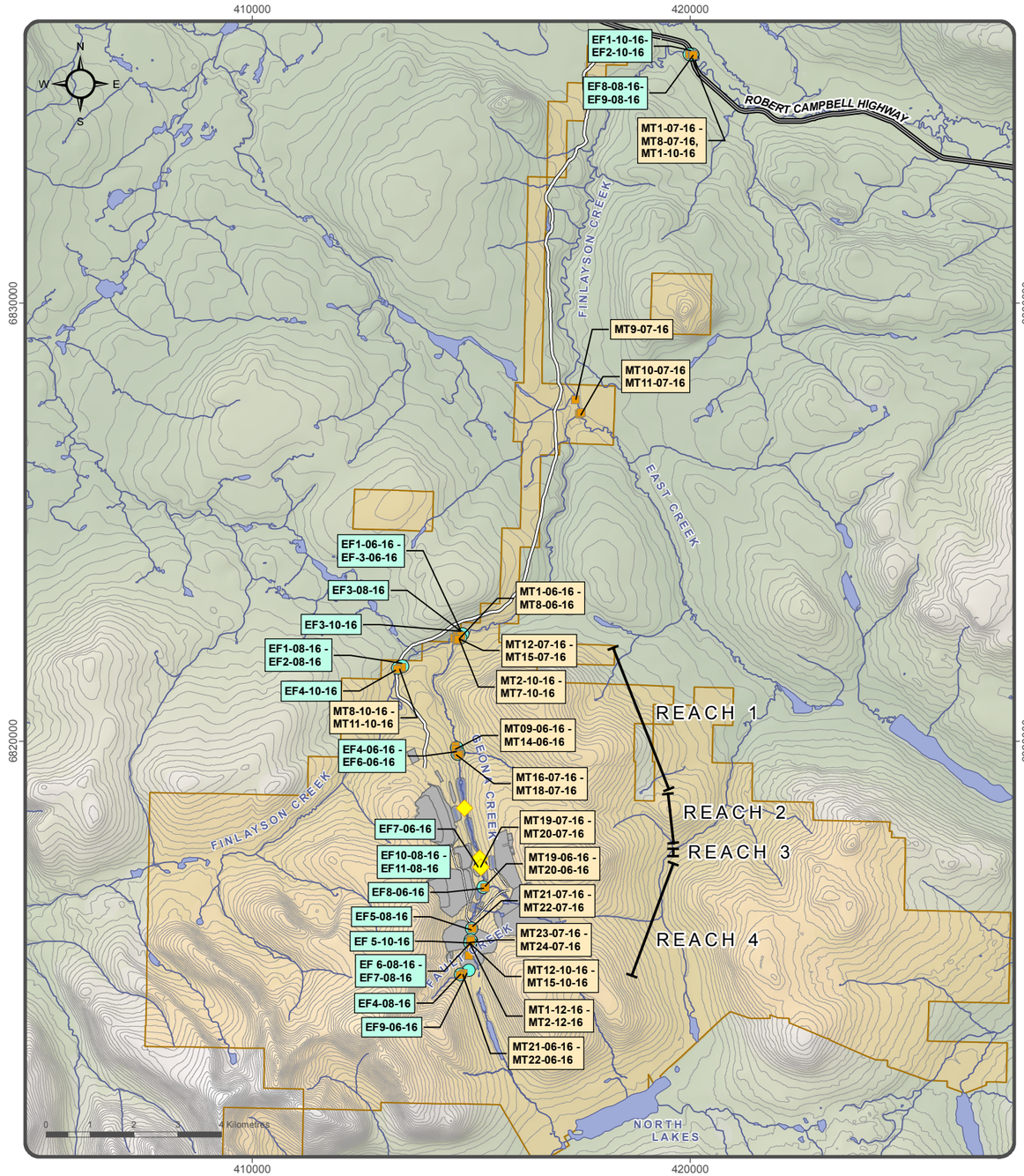
2015 FISHERIES MONITORING LOCATIONS



2016 FISHERIES MONITORING LOCATIONS



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AEG

- Reach Break
- Minnow Trapping Location
- MT-MM-YY: Minnow Trapping Location Label
- Electrofishing Location
- EF-MM-YY: Electrofishing Location Label

EF# - Electrofishing Sampling Location ID
MT# - Minnow Trap Sampling Location ID
MM - Sampling Month; YY - Sampling Year

- Location of Proposed Mine Infrastructure
- Dam/Water
- BMC Minerals (No. 1) Ltd. Claim Areas
- Waterbody

- Watercourse
- Tote/Proposed Access Road
- Proposed Mine Road

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 10-3

2015/2016 FISHERIES MONITORING LOCATIONS

JANUARY 2017

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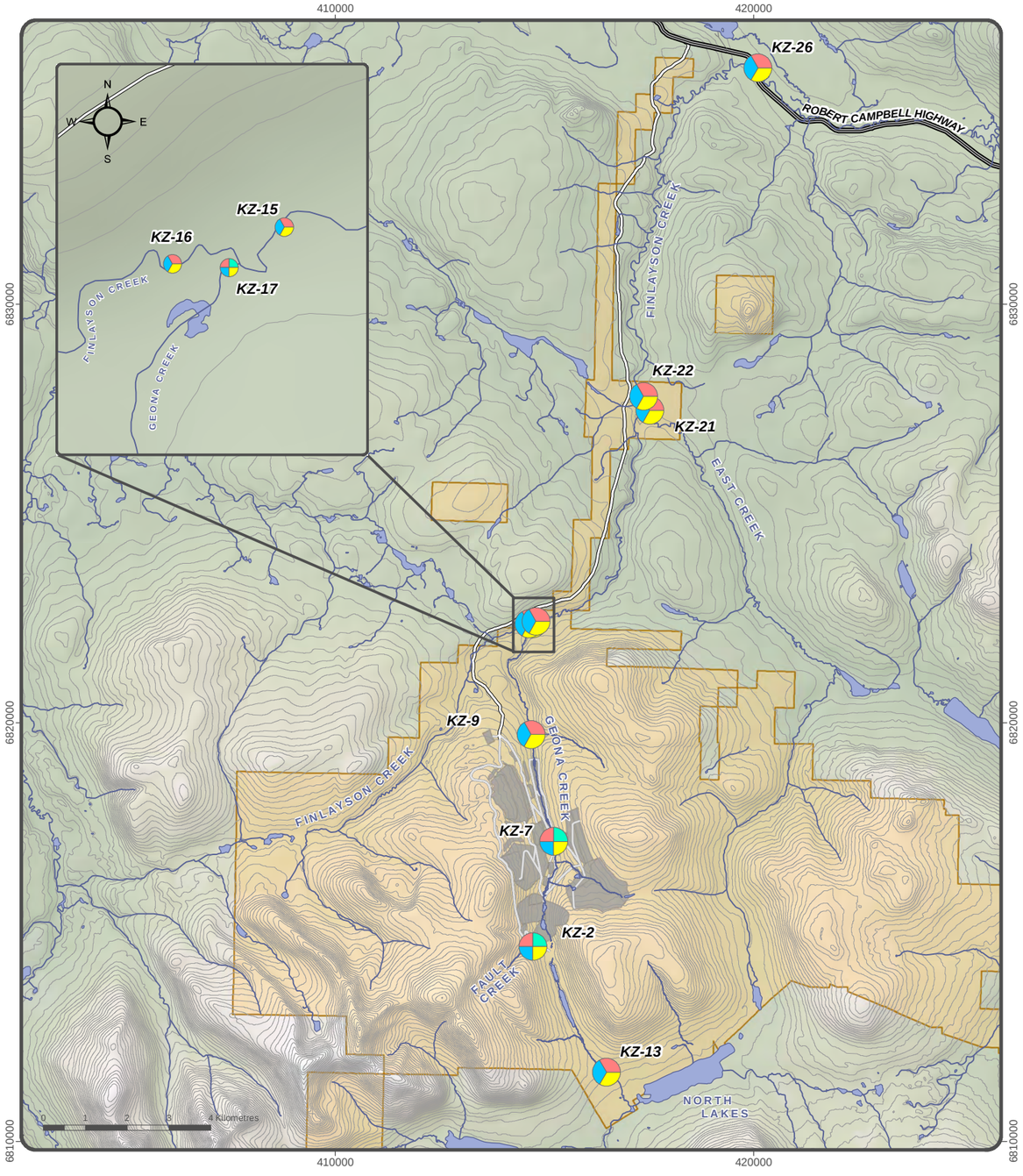
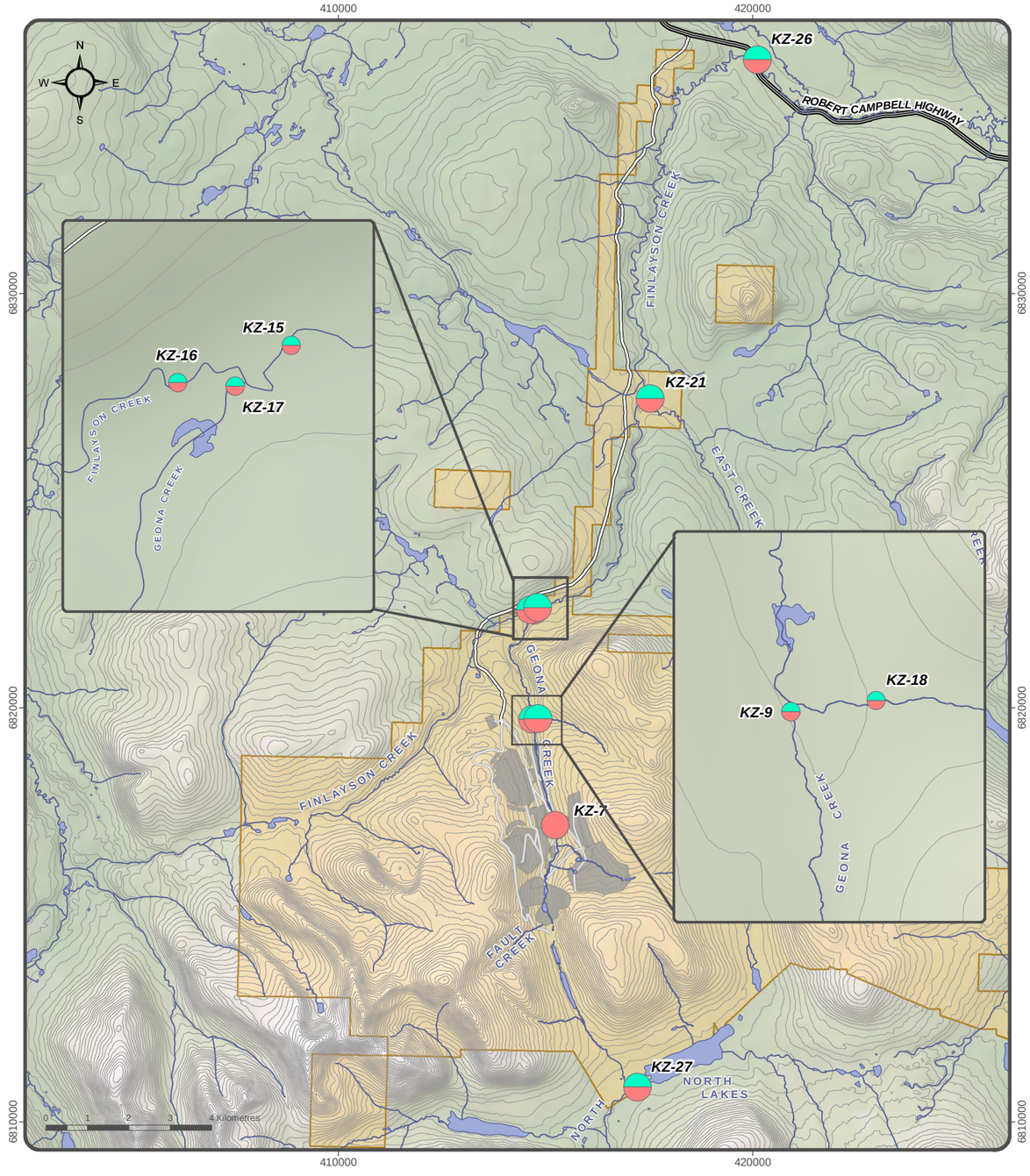
2015 AQUATIC RESOURCE SAMPLING LOCATIONS



2016 AQUATIC RESOURCE SAMPLING LOCATIONS



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AEG

AQUATIC RESOURCE MONITORING LOCATIONS

- Benthic Invertabrates
- Stream Sediment
- Chlorophyll A
- Periphyton

- Location of Proposed Mine Infrastructure
- BMC Minerals (No. 1) Ltd. Claim Areas

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 10-4
2015/2016 AQUATIC RESOURCE SAMPLING LOCATIONS

DECEMBER 2016

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10.3.2.1 Historical Studies and Existing Information

Baseline environmental and socio-economic studies for the Project, including fish and aquatic resources, were completed in 1994 and 1995 to support the IEE. Fish sampling was conducted in Geona Creek and its headwater ponds, Finlayson Creek, East Creek, South Creek and its headwater lakes and the North Lakes/River system. Surveys occurred in 1995 in early spring, late spring, summer, and fall, and included the use of backpack electrofishing units, minnow (Gee) traps, weir/fence traps and angling gear, aerial surveys, and dive surveys.

The sampling conducted in the mid-1990s found low numbers of Arctic grayling (*Thymallus arcticus*) in the immediate Project area, and it was determined that young grayling (2 to 3 years) inhabited the headwater lakes (beaver ponds) in Geona Creek and possibly overwintered in the deepest zones although no overwintering studies were conducted at that time. No full-sized adult grayling were captured or seen in Geona Creek after extensive electrofishing, while adults were caught in other parts of the study area (e.g., North Lakes system). Arctic grayling and burbot (*Lota lota*) were found to inhabit the headwater lakes in South Creek. Adult grayling and slimy sculpin (*Cottus cognatus*) were found in the Finlayson Creek system below Geona Creek in the spring of 1995. The authors concluded that the larger fish moved into the smaller watercourses from large lakes and rivers. The headwater areas of Geona Creek however, supported only grayling, and then only in low numbers. The beaver dams likely contributed to this pattern of fish distribution. Results of fish tissue metal analysis for Arctic grayling and slimy sculpin collected in the study watercourses indicated no exceedances in relation to guidelines for human consumption. Survey results for creeks crossing the Tote Road alignment indicated that none of the small creeks would likely support fish.

After regulatory approvals were received in 1999 (Water Use Licence (WUL) QZ97-026), subsequent aquatic baseline studies were conducted every two years to meet WUL compliance requirements. Three sites on Finlayson Creek (KZ-15, KZ-16, and KZ-26) were consistently monitored through electrofishing and minnow trapping during late summer for fish distribution and abundance as well as for fish tissue analyses (see Figure 10-3). Captured fish were identified, enumerated and measured for total or fork length, weighed and subsequently live-released at site of capture. In addition, at least five slimy sculpins were retained from each sampling site during each sampling event, for whole body metal analysis.

With the exception of one burbot, only slimy sculpin and Arctic grayling were captured in Finlayson Creek from 2002 to 2014; which is consistent with the 1995 study. The quantity and quality of fish habitat at KZ-26 was more extensive in comparison to the other upstream monitoring sites and as such total catch, as well as CPUE have generally been higher at this site. Only one grayling was captured at the upper Finlayson sites (KZ-15 and KZ-16) over seven years of sampling, indicating use of upper Finlayson Creek by grayling is limited during late summer.

Results of slimy sculpin tissue analyses for metals indicated generally low levels of key parameters including arsenic, cadmium, lead, copper, mercury, selenium, and zinc during the 2002 to 2014 studies, likely reflecting background concentrations. The presence of mineralization in the area does not appear to be reflected in Finlayson Creek sculpin tissue residues.

The fish studies carried out in Geona Creek during 1995 were relatively comprehensive, providing a good understanding of the fish habitat and its use; however, it only provided one year of study. Results of subsequent studies in Finlayson Creek indicate some level of ecological stability (generally consistent species composition) and aquatic conditions that continue to provide suitable habitat for fish. These biennial studies have provided a good indication of the natural variability; however, they do not include the Geona Creek watershed and were conducted during only one month (August) in each of the years. As a result, additional confirmatory work was undertaken during 2015-2016 and is described below.

10.3.2.2 2015/2016 Survey Methods

Fisheries surveys were carried out in June, August and October 2015, and in June, July and October, 2016. During these surveys electrofishing and baited minnow traps were utilized in Geona Creek, Fault Creek, South Creek, North River, and East Creek (see Figure 10-4 for sampling locations). Captured fish were identified and enumerated, measured for fork or total length, observed for abnormalities, and released at the location of capture. A reach assessment was carried out on Geona Creek in August 2015, with a focus on the upper reaches with the highest potential to be affected by the Project development. Information collected included channel characteristics, stream morphology, substrate quality, riparian vegetation, bank material, and other instream features important in quantifying fish habitat for different life stages of focal species. Identification of potential fish barriers was also included in the assessment.

In May 2016, the main stem of Geona Creek was surveyed for Arctic grayling spawning throughout the system. To characterize seasonal fish use of upper Geona Creek throughout the year, in situ water quality investigations, physical observations, minnow trapping, and a bathymetry survey were conducted on pond and creek habitat in the watershed during February, March, November, and December 2016 to characterize overwintering habitat potential in upper Geona Creek. In addition, a bathymetry survey was conducted on South Lakes in December 2016.

10.3.2.3 Results and Discussion

Results of the 2015-2016 fisheries investigations were generally consistent with the previous findings from 1995. Fish were captured in low numbers, with the highest CPUE near the headwaters of Geona Creek. The only species captured in Geona Creek was Arctic grayling, with the exception of a small number of slimy sculpin captured at the Finlayson Creek confluence (below the beaver dam in Geona Creek). Most of the Arctic grayling captured in Geona Creek were fry or juveniles except for two possible sub-adults or adults.

Only three small grayling were captured during the June 2015 survey. Based on their fork length size, these fish were likely spawned the previous year (i.e., 1^+ age class). During the August 2015 sampling event a number of the grayling captured ranged from 46 to 81 mm in fork length. Based on this size range these individuals were likely recruits from 2015 spawning events (i.e., 0^+ age class). Three additional larger grayling (juveniles) were captured in Geona Creek, during the August 2015

sampling, ranging in size from 107 to 205 mm. Sampling in Geona Creek in October 2015 resulted in the capture of only 0^{+} age class grayling ranging in fork length size of 49 to 70 mm.

In May 2016, two spawning adults grayling were observed during spring spawning surveys on three occasions: at the same location between the second and third ponds, at the top of the Geona Creek watershed, and immediately south of the ABM Deposit area. In June 2016, no grayling were captured in Geona Creek (or in any of the other creeks sampled). In July 2016, grayling captured in Geona Creek ranged in size from 36 to 215 mm and from 51 to 129 mm in October 2016. No grayling were captured in Finlayson Creek except below the Robert Campbell highway culvert suggesting that the culvert is a barrier for fish passage.

Fish sampling in surrounding creeks and systems (South Creek, North River, East Creek) indicated the presence of Arctic grayling, slimy sculpin, and burbot. No fish were captured in Fault Creek despite substantial effort. The highest CPUE for minnow trapping was observed between the headwater ponds of Geona Creek (at the ABM culvert) for Arctic grayling in July 2016. The highest CPUE for electrofishing was observed in Finlayson Creek for slimy sculpin in July 2016, upstream of the Robert Campbell highway culvert.

Results of the fisheries sampling in conjunction with reach descriptions from the August 2015 reach assessment (see Appendix E-3 for details), overwintering potential investigations in February, March, November and December 2016 and March 2016 and a spawning survey in May 2016 were used to assess the quality of fish habitat in Fault Creek and Geona Creek. It was found that Fault Creek provides very limited habitat for fish. The lack of, or very limited, overwintering habitat, high gradient profile of the stream, and poor quality substrate in the stream inhibit fish movement into Fault Creek. This assumption is supported by the fact that no fish were caught during surveys conducted in 2015 and 2016.

Stream conditions in the lower reach of Geona Creek (Reach 1; Figure 10-3) provide suitable habitat for juvenile Arctic grayling rearing; however, it is unlikely that adult grayling use this section for spawning or overwintering (except for possibly in the beaver pond at the bottom of Geona Creek). Substrate conditions in this reach are not ideal for Arctic grayling spawning and are composed primarily of fine sediments rather than gravels which are preferred by Arctic grayling.

Further upstream in Reach 2 (Figure 10-3), the creek's channel width increases substantially and as result water depth in the creek is reduced. This loss in depth inhibits the development of pool habitat which is ideal for both adult and juvenile Arctic grayling. In the reach, however, beaver ponds provide rearing and resting habitat for juveniles and adults during the open water season and possibly marginal overwintering habitat during the winter months. Substrate conditions for spawning are not ideal in Reach 2 as the dominant substrate is cobble.

In Reach 3 (Figure 10-3), channel width decreases and the bed material transitions from a cobble dominated substrate to a gravel dominated substrate. The conditions are more suitable for spawning in this reach; however, similar to Reach 2 there is a substantial amount of moss cover on the stream bed which may deter spawning in this area. Pool occurrence in Reach 3 is quite low and the pools that are found in the reach are 1 m or less in depth.

In the uppermost section of Geona Creek (Reach 4; Figure 10-3), the substrate is composed primarily of cobble and gravel which provides potential spawning habitat. The presence of large beaver ponds and the higher frequency at which they occur provides refuge during migration in spring and fall. Additionally, large boulders can be found intermittently in the channelized portion of this reach which provide some cover as well as pool habitat that could be used by Arctic grayling.

Results of the overwintering investigations conducted in 2016 indicate that upper Geona Creek provides minimal overwintering habitat for Arctic grayling which is the only species of fish found residing in the creek during the open water season due to lack of water or low dissolved oxygen (DO) during the winter months.

Based on a CPUE of zero for slimy sculpin in Geona Creek, it is suspected that sculpins do not use Geona Creek as a result of beaver activity at the Geona Creek/Finlayson Creek confluence. The beaver dam situated near the Finlayson Creek confluence would prevent sculpins from moving upstream. Further, as sculpins tend to have high site fidelity and limited instream movements (Arciszewski et al., 2010), the absence of sculpins in Geona Creek may support the finding that that conditions for overwintering in Geona Creek are limited. In other words, sculpins that may have migrated into Geona Creek over the years have not developed sustaining populations due to winter die-off in the system.

10.3.2.4 Stream Sediment Chemistry and Particle Size

Incremental fine sediment loading in a stream is known to potentially affect both stream morphology and aquatic biota. Sediments may act as sinks or sources for trace pollutants, but are also important natural habitats for aquatic organisms. Sediment monitoring is integral to assess the ecological status of a water body, as it allows for the detection of toxic constituents such as heavy metals and aids in controlling their fate and effect on that system (Reuther, 2009; Rex and Carmichael, 2002). Stream sediments in the Project area were described through various studies undertaken since 1995. Detailed study methods and results are presented in the Aquatic Ecosystems and Resources Baseline Report (Appendix E-3) and key findings are summarized in the following sections.

10.3.2.5 Stream Sediment Historical Studies and Existing Information

Stream sediments were collected in 1994 and 1995 by Cominco as part of the baseline environmental and socio-economic studies for the Project in support of the IEE (Norecol, Dames & Moore Ltd., 1996). In addition, Environment Canada collected sediment samples in 1995. After regulatory approvals were received in 1999 (Water Use Licence (WUL) QZ97-026), subsequent baseline studies including stream sediments have been conducted in Geona Creek, East Creek, Finlayson Creek and North River every two years since 2002 to meet the requirements of the WUL (see Figure 10-4 for sampling locations).

Analyses of metal concentrations in sediment have typically focused on arsenic, cadmium, copper, lead, selenium, and zinc, some of which are present in the ABM Deposit, due to their potential toxicity to aquatic systems. Results are compared to the CCME (1999) interim freshwater sediment quality

guidelines (ISQG), and to the probable effects levels (PEL). Detected concentrations of the selected metals did not show substantial variability over time at most of the sites, except in 2006 where elevated concentrations of copper and lead were observed in Geona Creek and in Finlayson Creek. These high concentrations were not duplicated during the following sampling periods. Levels of copper have exceeded the PEL at some of the sites since, but concentrations were significantly lower than in 2006. The highest concentrations of several of the selected metals occurred in the sediments at KZ-7, Geona Creek near the ore body. Cadmium and zinc concentrations have increased over the past decade at KZ-7, although there has been no disturbance at this site. It is suspected that as the stream channel changes over time, more mineralized zones are being eroded and moving sediment loads into these areas. Arsenic concentrations are considerably higher at East Creek, KZ-21 (Laberge Environmental and Can-Nic-A-Nick Environmental, 2015).

Stream bed sediment particle size distribution is determined by water velocity and influences the type and quality of habitat available for aquatic organisms. The dominant size class at each site was more or less consistent over time, and variations can possibly be attributed to the exact sampling location chosen at each sampling event. It cannot be excluded that changes in the channel morphology or flow pattern, due to beaver activity for example, may have caused some changes in dominant particle size class as well.

10.3.2.6 Stream Sediment 2015 and 2016 Studies

Stream sediments were collected on Finlayson Creek, Geona Creek, East Creek and Fault Creek (see Figure for locations) in September 2015. In 2016, stream sediments were collected on Finlayson Creek, Geona Creek, East Creek, and a tributary located on the east side of Geona Creek (KZ-18). Arsenic levels were found to be high throughout the study area, except in South Creek (KZ-13), and exceeded the PEL in Finlayson Creek (KZ-16, KZ-15, KZ-22, KZ-26), mouth of Geona Creek (KZ-17) and East Creek (KZ-21). Cadmium levels were also elevated throughout the Project area, except in South Creek (KZ-13) and East Creek (KZ-21) and exceed the PEL in Geona Creek (KZ-7). Chromium and copper levels were generally below the interim freshwater sediment quality guidelines (ISQG), except at the mouth of Geona Creek (KZ-17) for chromium and in upper Geona Creek (KZ-7) for copper. Lead and mercury showed no exceedances of their respective ISQG, while zinc was generally elevated with Fault Creek (KZ- 2) and upper Geona Creek (KZ-7) exceeding the PEL.

Dominant class is towards larger particle sizes at all sites (i.e., either 2 mm or 850 µm). Historical data indicated dominance of smaller particle sizes at some sites, while others had similar dominant size class. Differences could be attributable to a slightly different sampling location, or to a temporary change in flow pattern that could have affected sediment transport (e.g., high precipitation event prior to sampling). Overall, fractional components of stream sediments appear to vary somewhat from year to year.

The 2015 metal in sediment results generally returned lower concentrations when compared with previous monitoring events, and is likely linked to the fact that grain size distribution was towards larger particles in 2015. In the case of KZ-26, the fact that samples were collected upstream of the culvert rather than downstream as was done historically could also explain the lower values if there were an influence from the highway in historical results. The 2016 metal in sediment results were

elevated when compared to 2015, however, they were generally consistent with historical results from previous monitoring events from 1995 to 2014.

10.3.3 Benthic Invertebrates, Periphyton, and Aquatic Plants

Benthic invertebrates are an integral component of aquatic ecosystems and provide valuable biological information to assess potential effects of metal toxicity and nutrient enrichment on a system. Benthic invertebrates in the Project area were described through various studies undertaken since 1995. Detailed study methods and results are presented in the Aquatic Ecosystems and Resources Baseline Report (Appendix E-3) and key findings are summarized in the following sections.

10.3.3.1 Benthic Invertebrate Historical Studies and Existing Information

Benthic invertebrate communities were surveyed and sampled in 1995 by Cominco as part of the baseline environmental and socio-economic studies for the Project in support of the IEE (Norecol, Dames & Moore Ltd., 1996). After regulatory approvals were received in 1997 (IEE) and 1998 (Water Use Licence QZ97-026) subsequent baseline studies, including benthic invertebrates, have been conducted every two years since 2000 in Geona Creek, East Creek, Finlayson Creek, and North River to meet the requirements of the WUL.

Community composition results (diversity and dominant taxa) indicate that the populations in the study area are stable over time. Densities have typically been lower at the Finlayson Creek sites than at the other sites, especially at the background site KZ-16, upstream of Geona Creek. The study periods 2006, 2008, and 2012 had lower population numbers overall; 2000 was generally the most productive. As the study area continues to remain undisturbed these variations in density are natural fluctuations and tend to be related to the climatic conditions experienced that season. (Laberge Environmental and Can-Nic-A-Nick Environmental, 2015).

Benthos samples from three sites, KZ-15, KZ-16, and KZ-26 have been also collected for metals analysis on seven occasions since 2002. Laberge and Can-Nic-A-Nick (2015) indicated in their report that that the mean concentrations documented during the surveys fell well below the mean concentrations in the Yukon database (BISY). No clear trends emerge from these data, with generally consistent values over time.

10.3.3.2 Benthic Invertebrate 2015 Studies

Benthic invertebrate communities were sampled at monitoring stations KZ-2, KZ-7, and KZ-17 in September 2015. See Figure 10-4 for sampling locations.

Abundance and taxonomic richness results indicated that Fault Creek (KZ-2) had a much lower abundance and density than Geona Creek, which was expected given the channel characteristics. Geona Creek upstream (KZ-7) had the highest abundance and density and corresponds to a location where fish have been observed. The highest diversity was found at KZ-17.

When comparing with benthic invertebrate results from 2014, it can be noted that Geona Creek supports a greater abundance and density than surrounding watercourses (Finlayson Creek, East Creek, North River, and Fault Creek), while diversity is greatest in lower Finlayson Creek. Results obtained in 2015 for Geona Creek, although collected from different sampling locations, are in the ranges of values obtained since 1995 at KZ-9.

In terms of distribution, Diptera (true flies) was the dominant order at all three sites. Plecoptera (stoneflies) was the subdominant order at KZ-2 and KZ-7, while Ephemeroptera (mayflies) was the subdominant order at KZ-17. These results are consistent with historical results for Geona Creek. Analyzing the combined EPT (Ephemeroptera, Plecoptera, Trichoptera) at a site gives an indication of the overall health of the stream because these organisms have a low tolerance to pollution. The highest EPT abundance occurred in Geona Creek at KZ-7, however there was relatively small representation in the community. To the contrary, abundance is much lower in Fault Creek (KZ-2) but the EPT proportion is high.

10.3.3.3 Periphyton

Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. As photosynthesizers, algae form the base of the aquatic food web. Periphyton studies were not included in the initial baseline studies in 1995 or subsequently as a requirement of the Water Use Licence. As periphyton is an important component of aquatic ecosystems and can provide a valuable biological monitoring tool to assess potential effects of nutrient enrichment and metal toxicity, periphyton sampling was undertaken in 2015 to fill this information gap.

Periphyton samples were collected from Finlayson Creek, Geona Creek, East Creek and Fault Creek (see Figure 10-4 for sampling locations) in September 2015. Results showed that abundance and density were the highest in Geona Creek (KZ-9) and the lowest in Fault Creek (KZ-2). These results are generally consistent with benthic invertebrate results. Diversity was highest in East Creek (KZ-21) and lowest in Fault Creek (KZ-2).

The dominant phylum observed at all sites was *Bacillariophyta*, with other phyla generally representing less than 1% of the total number of algae. Exceptions are Cyanobacteria which represent 4.35% of algae in Fault Creek (KZ-2) and *Chlorophyta* representing 1.60% in lower Finlayson Creek (KZ-26). In the phylum *Bacillariophyta*, the dominant orders observed were *Bacillariophyceae* and *Fragilariophyceae*, representing respectively an average of 56% and 41% of cells across all sites. Of note is the presence of *Didymosphenia geminate*, an invasive species, which was observed in Finlayson Creek (KZ-22 and KZ-26), Geona Creek (KZ-7) and South Creek (KZ-13). In all cases, Dydimo represented less than 1% of the total number of cells.

10.3.3.4 Chlorophyll a

Chlorophyll *a* is the primary photosynthetic pigment and is common to all algae. Chlorophyll *a* studies were not included in the initial baseline studies in 1995 or subsequently as a requirement of the WUL. Determining chlorophyll *a* concentrations provides a measure of algae biomass and thus,

the primary productivity of a given location. Sunlight, water temperature, and nutrients are factors influencing chlorophyll *a* concentrations. Trends in chlorophyll *a* content can be an indicator of pollution levels through an increase or decrease in nutrients. Chlorophyll *a* samples were collected on Finlayson Creek, Geona Creek, East Creek, and Fault Creek (see Figure 10-4 for sampling locations) in September 2015. Results showed that chlorophyll *a* concentration in the Project area were generally low, which is an indication of low productivity systems. The highest concentration was observed at the mouth of Geona Creek (KZ-17) and the lowest in Finlayson Creek just above the confluence with Geona Creek (KZ-16). Canopy coverage, and therefore sunlight penetration, may explain in part the differences observed among the sites.

10.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on aquatic ecosystems and resources as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

10.4.1 Effects Characterization

In order to focus the effects assessment, the first step is to identify any potential interactions between Project activities and aquatic ecosystems and resource. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1, or 2 is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects; and*
2 – Higher risk interactions- *it is reasonably foreseeable that residual adverse effects may result.*

The results of the interactions screening are presented in Table 10-5.

Table 10-5: Interaction Matrix for Aquatic Ecosystems and Resources

Project Activity	Fish (Arctic grayling)	Aquatic Habitat	Benthic Invertebrates, Periphyton and Aquatic Plants
Construction			
Tote Road upgrade to Access Road	1	1	1
Finlayson Lake airstrip upgrade	0	0	0
Site preparation and clearing	2	2	2
Site grading, including soil and overburden removal and stockpiling	2	2	2
Off site traffic (construction equipment and materials delivery)	0	0	0
On site traffic	1	1	1
ABM open pit development (including dewatering and Fault Creek diversion)	2	2	2
Infrastructure construction	2	2	2
Waste handling	2	2	2
Water use and management	2	2	2
Power generation	0	0	0
Worker transport	0	0	0
Construction camp operation	0	0	0
Workforce, Procurement and Hiring	0	0	0
Operations			
ABM open pit operations (including blasting and dewatering)	1	1	1
Underground operations	1	1	1
Ore processing	1	1	1
On site traffic	1	1	1
Off site traffic (highway)	0	0	0
Finlayson Lake airstrip operations	0	0	0
Storage facilities management (Class A, B, and C)	1	1	1
Progressing reclamation of storage facilities	0	0	0
Water use (potable and non-potable)	1	1	1

Project Activity	Fish (Arctic grayling)	Aquatic Habitat	Benthic Invertebrates, Periphyton and Aquatic Plants
Mine water management and treatment (including effluent discharge)	2	2	2
Waste management	1	1	1
Power generation	0	0	0
Worker transport	0	0	0
Camp operation	0	0	0
Workforce, Procurement and Hiring	0	0	0
Closure			
Processing plant decommissioning and site reclamation	1	1	1
ABM lake filling	0	0	0
Final storage facilities reclamation	1	1	1
Support infrastructure removal and site reclamation	1	1	1
Water management, treatment and discharge	2	2	2
On site traffic	1	1	1
Off site traffic	0	0	0
Access road reclamation	1	1	1
Workforce, Procurement and Hiring	0	0	0

10.4.1.1 Fish (Arctic grayling)

Arctic Grayling Population

Changes in the Arctic grayling population (measured through CPUE) in the Project area could result from an increased mortality risk associated with Project activities. Project activities that may increase the risk of fish mortality include:

- **Use of explosives** – The detonation of explosives in or near water (i.e., fish habitat) can cause lethal and sublethal effects to fish. Damage may occur to critical organs such as the swim bladder, kidney, liver, spleen, and sinus venous. Blasting may also cause sublethal effects such as changes in fish behaviour and introduction of by-products from the blasting materials, such as ammonia, can lead to fish mortalities if blast residues are released in sufficient quantities (Wright and Hopky, 1998). Consequently, Project blasting activities have the potential to directly or indirectly result in fish mortality.
- **Alteration or loss of habitat connectivity causing stranding of fish** – Fish may become stranded as a result of Project activities such as: isolation of watercourses, diversion of

streams, construction of road crossings, and the construction of the Project infrastructure. If isolation pools are created during Project activities, fish may become stranded which may directly or indirectly result in mortality. This is further assessed in Section 10.4.1.2.

- **Increased TSS and turbidity** – Project activities could result in increased TSS loads and elevated turbidity, which can be abrasive to fish gill epithelium under sustained exposure and result in direct harm to individuals (Birtwell, 1999) or even mortality at very turbidity levels. This is further assessed in Section 10.4.1.2.
- **Use of industrial equipment** – The construction of Project infrastructure as well as upgrading the Tote Road to an Access Road may require the use of industrial equipment within streams. Risks associated with instream activities includes the direct crushing of fish, destruction of eggs and ova in substrates, and disturbance of channel substrates that may contain alevin.
- **Release of substances in receiving waters** – The release of substances as a result of construction, operation, or decommissioning activities has the potential to result in mortality to fish if water is not treated or managed appropriately. Release of substances resulting from accidents, leaks of malfunctions can also pose a direct risk to fish. Water quality is further discussed in Section 10.4.1.2.

Changes in Arctic grayling population condition (measured through the condition factor) can also occur if rearing conditions change as a result of Project activities. Such changes may include:

- Changes in food availability or quality;
- Changes in habitat type (pool, riffle, run);
- Changes in water physical or chemical parameters; and
- Changes in substrate.

Sublethal Effects

Substances may be released into receiving waters as a result of construction, operation and/or decommissioning activities (including discharge of treated mine water), in concentrations that could result in sublethal effects to fish under prolonged exposure. Sublethal effects include (but are not limited to) altered growth, reproduction effects and effects on other life processes. This is further assessed in Section 10.4.1.2.

Effluent sublethal toxicity testing is required to be carried out semi-annually under the MMER, once mine effluent discharge to receiving waters at a rate greater than 50m^3/day has been initiated.

10.4.1.2 Aquatic Habitat

The measurable parameters used to assess potential effects on fish habitat are listed in Table 10-1 and include:

- Changes in habitat availability, distribution and connectivity;

- Changes in TSS concentrations;
- Change in surface water quantity;
- Changes in surface water quality;
- Changes in water temperature; and
- Change in stream sediment chemistry and particle size distribution.

While surface water quality and quantity was assessed as part of the water quality and quantity assessment (Chapter 8), it is also an important component of aquatic habitat. Therefore, the results of the water quality modelling are also included in the assessment of fish habitat.

Habitat Availability, Distribution and Connectivity

The two main Project activities that will affect fish habitat are:

- Riparian clearing during the Tote Road upgrade to Access Road; and
- Construction of the Project facilities (e.g., open pit, Water Management Ponds) and diversion of Fault Creek.

These potential effects are described in more detail in the following sections.

Riparian Clearing: Effects on Aquatic Habitat

The productive capacity of habitat can be adversely affected by the clearing of riparian vegetation. The ecological functions provided by riparian vegetation include regulation of stream temperature, regulation of instream algal production, regulation of instream biological production, regulation of physical structure of stream channel, maintenance of bank stability, and as a buffer from contaminants, pollutants and fine sediments. Therefore, the removal of riparian vegetation may impair the functional role of the riparian zone in the regulation of physical and biological conditions within the stream ecosystem (Johnston and Slaney, 1996.)

Access to the Project is currently via an existing 24 km Tote Road originating at the Robert Campbell Highway. The Tote Road follows Finlayson Creek alignment to the upstream side of Geona Creek, and then follows the Geona Creek alignment to the mine site located at its headwaters. The road crosses several small Finlayson Creek tributaries that do not support fish and are drained by culverts. An existing clear span bridge at approximately km 17 (Finlayson Creek crossing) allows road access into the Geona Creek watershed. Immediate fish habitat along the Tote Road is limited, only occurring at the Finlayson Creek crossing, which during construction will not require any instream work.

The Tote Road requires some upgrading to form the proposed Access Road, including culvert replacement to accommodate mine development and operational traffic. Access Road upgrade activities such as clearing and grubbing have the potential to cause alteration or loss in aquatic habitat structure when they occur near or across watercourses. Instream work may require the removal of large woody debris (LWD), boulders, undercut banks and instream vegetation, which can decrease the productivity capacity of aquatic habitat. Although the upgrades are not expected to

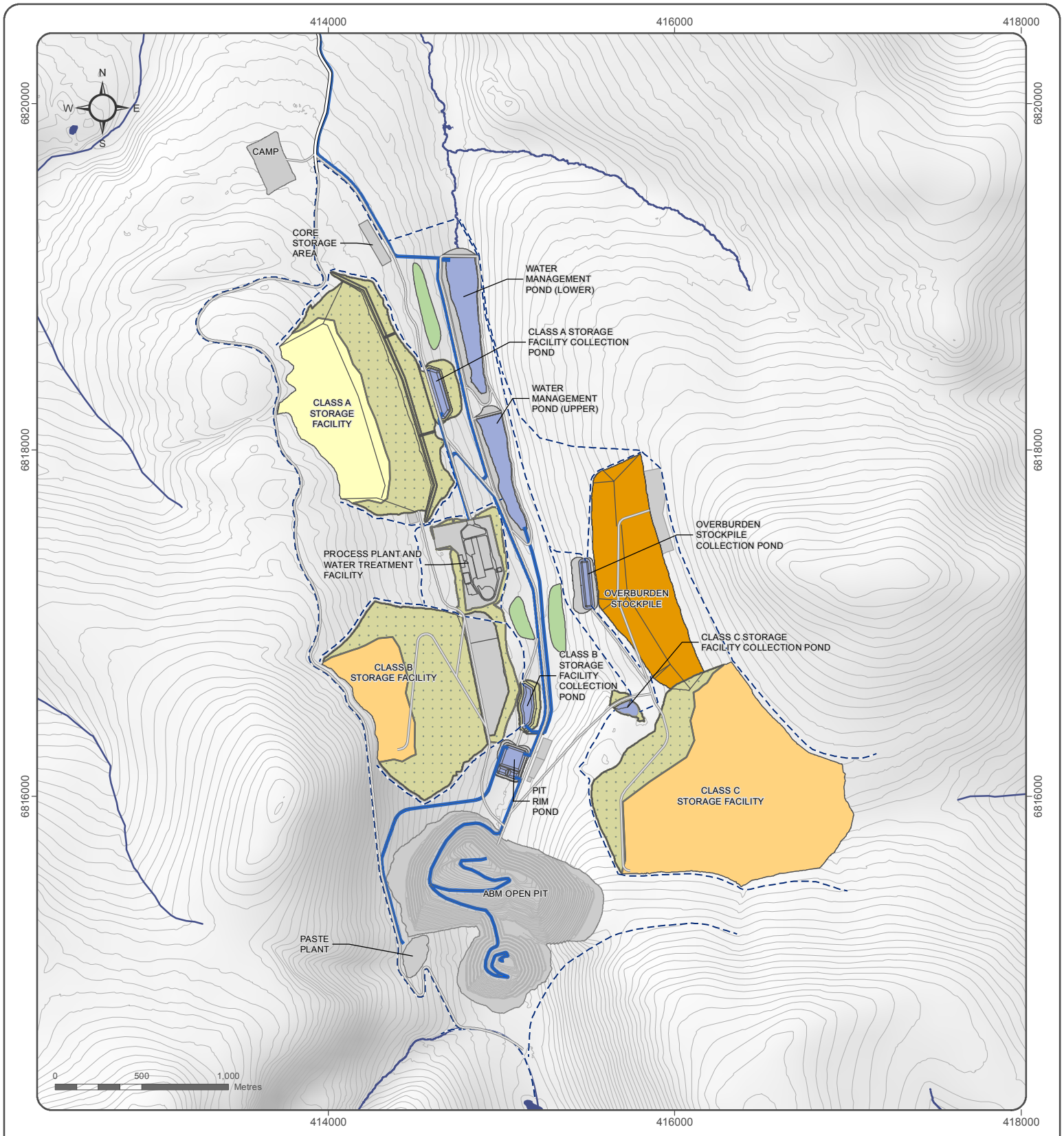
encroach into aquatic habitat, proposed upgrade work and ongoing road maintenance may result in release of substances into aquatic habitat through the mobilisation of sediments and/or fluid spills (e.g., fuels, hydraulic fluids, lubricants). An assessment of spills is provided in Chapter 17 (Accidents and Malfunctions).

Construction of Project Facilities: Effects on Aquatic Habitat

Development of Project infrastructure and certain facilities will result in a direct effect on fish habitat. Most of the mine's structures will be placed within the upper Geona Creek watershed (Figure 10-5) with three structures constructed directly in Geona Creek: ABM open pit, and the Upper and Lower Water Management Ponds. This upper section of Geona Creek contains known fish habitat that provides some habitat diversity (i.e., ponds, riffles) which is used by Arctic grayling for spawning, rearing and possibly overwintering. The proposed mine development will result in the isolation of this habitat to fish upstream of KZ-37 (Figure 10-6). The Water Management Ponds will require dam structures at their downstream ends that will be a barrier to fish passage. Isolation and placement of facilities in the creek alignment will result in a direct loss of 5.4 km of creek habitat including 4.85 ha of pond habitat. This direct loss of habitat will require BMC to obtain a FAA prior to proceeding with development in the watershed. In order to obtain a FAA, BMC has developed a preliminary FOP (Appendix E-4). The FOP details anticipated effects on fish and fish habitat, avoidance and mitigation measures to minimize effects and measures that will be undertaken to offset the effects in order to maintain or enhance the productive capacity of fish habitat within the region. Fish compensation is also recommended by Kaska, including consideration of Kaska principles of minimizing effects to aquatic resources, as well as effects on Kaska land uses (DKI, 2010).

The isolation of the aquatic habitat in upper Geona Creek will be permanent. At closure the Lower Water Management Pond will be converted to a passive water treatment system (wetland), which will continue to prevent fish migrating upstream indefinitely. Therefore, the remaining assessments of potential effects to aquatic habitat are for habitat downgradient of KZ-37.

The diversion of Fault Creek will result in increased flows to that watershed during mine construction and operations. This may result in a slight increase of the areal footprint and volumes of the two small lakes situated at the upper end of the watershed. At closure, Fault Creek will be re-diverted back to the Geona Creek watershed to fill the ABM pit. Following the re-diversion, it is predicted that flow in the South Creek watershed will be lower than baseline levels (discussed further down in Section 10.4 – hydrological effects on South Creek). This may result in shrinkage of the lakes surface area and volume.



Class A Storage Facility
Class B and C Storage Facility
Overburden Stockpile
Topsoil Stockpile
Progressive Reclamation
Pond/Water
Pipeline
Diversion Ditch
Tote Road/ Proposed Access Road
Proposed Mine Road
Contour (10 m)

KUDZ ZE KAYAH PROJECT

FIGURE 10-5

PROPOSED PROJECT SITE LAYOUT (YEAR 10)

JANUARY 2017

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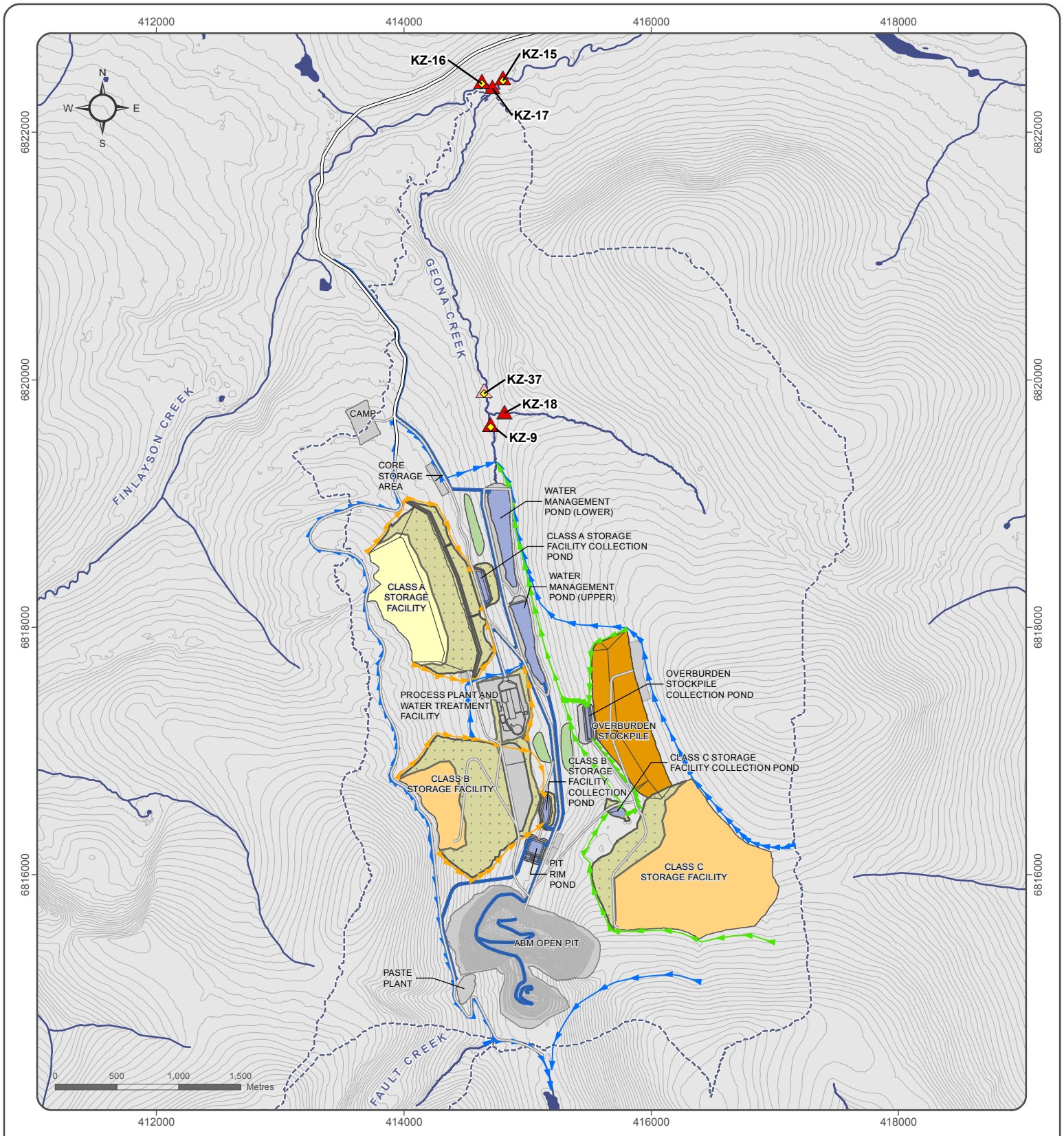

Class A Storage Facility
Class B and C Storage Facility
Overburden Stockpile
Topsoil Stockpile
Progressive Reclamation
Pond/Water

Non Contact Diversion
Contact Class A & B Diversion
Contact Class C Diversion
Pipeline
Tote Road/Proposed Access Road
Proposed Mine Road

Contour (10 m)
Water Quality and Hydrometric Station
Water Quality Sampling Location
Proposed Water Quality and Hydrometric Station
Geona and Fault Creek Catchments

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KUDZ ZE KAYAH PROJECT

FIGURE 10-6

MONITORING STATIONS AND PROPOSED PROJECT WATER DIVERSIONS

FEBRUARY 2017

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Total Suspended Solids Concentrations

Suspended solids produce two main ecological effects in streams that can affect fish and invertebrate communities; increased turbidity of the stream water, and increased siltation of stream beds. Elevated turbidity can affect the ability to find food and avoid predators.

Increased sediment loads can affect habitat by filling substrate interstitial space, thereby simplifying bed features important for macroinvertebrate colonization and growth. High TSS loading can cover incubating eggs and fill in pool habitat, resulting in reduced structural diversity of a stream/river ecosystem.

The environmental effects of TSS on habitat productive capacity is directly related to the volume of sediment introduced to the receiving waters, the depth of deposition, the type of habitat affected by deposition, the importance of affected habitat to fish, and the sensitivity of the fish species present.

An increase in TSS load is possible from point sources during instream works associated with construction activities such as clearing vegetation and stripping topsoil, stockpiling overburden and topsoil, and constructing roads and mine infrastructure. Sediment loading can also occur naturally as a result of high rainfall events or natural erosional processes.

Changes in Surface Water Quantity

Flowing water is a critical component of the aquatic environment for biota across multiple spatial and temporal scales. Critical life events of fish and benthic invertebrates are linked to flow regime, and many of these life events are synchronized with temperature and day length. If changes in flow regime occur that are not in natural harmony with these seasonal cycles, there may be adverse effects on aquatic biota (Bunn and Arthington, 2002; Nislow and Armstrong, 2012). Flow variation determines energy gain and loss, for individual fish must swim against the current to hold their positions. Additionally, flow regimes interact with the underlying geology and land uses to shape the physical dimensions of rivers and streams and determine the availability of suitable physical habitat (Nislow and Armstrong, 2012).

Each Project phase will influence site and local hydrology in different ways. Therefore, hydrological changes are first described by Project phase followed by Project effects on each individual watercourse (Geona, South and Finlayson Creeks).

Construction Phase

The duration of the construction phase of the Project is two years. Activities and developments that will affect area hydrology during construction include:

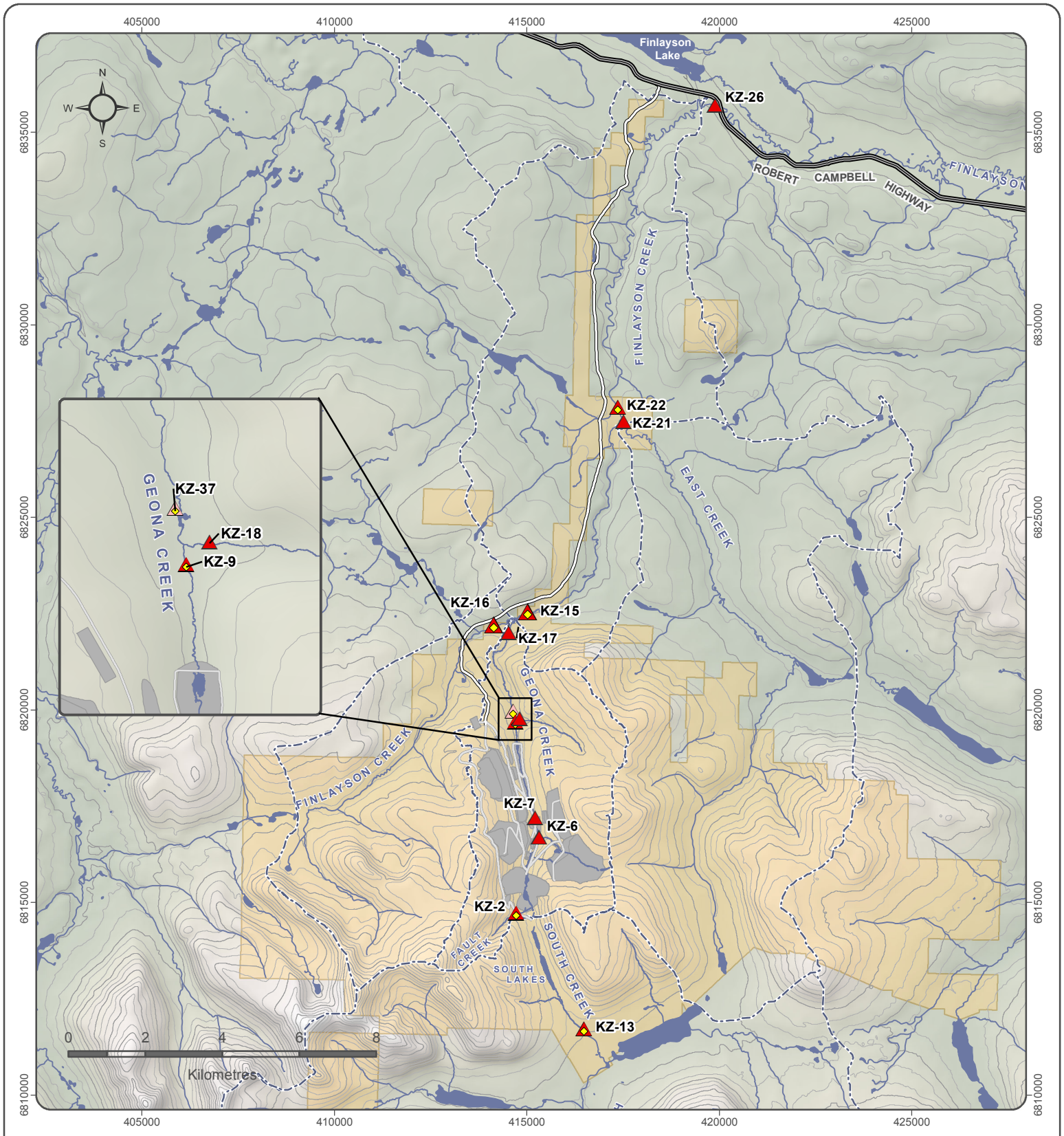
- Development of fish habitat offsetting structures in lower Geona Creek as described in the FOP (Appendix E-4);
- Re-direction of Fault Creek and a portion of the upper Geona Creek catchment to South Creek (Figure 10-5);

- Development within upper Geona Creek watershed including construction of the Upper and Lower Water Management Ponds, site water diversion ditches and development/commissioning of water treatment facilities. The developments will isolate fish habitat above KZ-37 (Figure 10-7); and
- ABM open pit dewatering. This will involve capture and pumping of high volumes of water contained within a shallow water aquifer in the overburden. Captured water will be directed first to the Pit Rim Pond and then to the Upper Water Management Pond. Water will be pumped continuously throughout construction phase and operations phase with the highest volumes produced during the construction phase.

Operations Phase

The duration of the operations phase is approximately 10 years. Activities and developments that will affect hydrology during operations include:

- Discharge of water from the Lower Water Management Pond into Geona Creek at approximately a 3:1 ratio (Creek Flow: Discharge);
- Discharge from the Lower Water Management Pond via a pipeline into Finlayson Creek (at a ratio of 2:1);
- Discharge into Geona Creek from the ditches and diversions (Figure 10-6);
- Flows to the south from the diversions from Fault Creek and south and southwest non-contact diversions to the South Creek drainage; and
- Ongoing dewatering of ABM open pit and underground workings but at a lower rate than the construction phase.



- Water Quality and Hydrometric Station
- Water Quality Sampling Location
- Proposed Water Quality and Hydrometric Station
- Regional Catchments
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Claims
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse
- Waterbody

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BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 10-7

REGIONAL CATCHMENTS AND WATER QUALITY AND HYDROMETRIC MONITORING STATIONS

JANUARY 2017

Closure and Post-Closure Phases

The closure and post-closure phases of the Project are divided into three periods: active, transition and monitoring. During the active closure period (approximately three years) the following activities will occur or cease:

- ABM open pit dewatering will cease allowing the ABM open pit to fill;
- Fault Creek will be re-directed back to the Geona Creek watershed and contribute to filling of the ABM open pit;
- Direct discharge to Finlayson Creek will cease; and
- Wetlands for passive treatment will be constructed.

Following active closure, the post-closure phase will commence with a transitional period, which is expected to last about 13 years. During this period, the passive wetland treatment system will be commissioned, the ABM open pit will continue to fill, but the hydraulic head is expected to be high enough to contribute additional groundwater flow to Geona Creek.

The post-closure phase monitoring period will begin at approximately year 26 of the Project life. At this stage, water flowing from the site will rely on passive treatment (wetlands) to meet compliance discharge limits. Flows in Geona Creek, South Creek, and Finlayson Creek will more or less return to baseline flows, albeit with some permanent changes.

Chapter 8 (Surface Water Quality and Quantity) describes in detail the predicted changes in water volumes across the Project area during the construction, operations and closure phases. For each phase, predicted flows were considered for three precipitation scenarios (mean, 1/50 wet year, 1/10 dry year) in order to assess effects during a normal precipitation year, as well as years when it is unusually wet (1/50 wet year) or dry (1/10 dry year). The following summarises those changes in Geona, South and Finlayson Creeks and discusses the potential effects of those changes in each of the systems.

Hydrological Effects to Geona Creek

Figure 10-8 illustrates the predicted change in runoff relative to baseline in Geona Creek at KZ-37 as a result of Project activities through all of Project phases and under three precipitation scenarios (Mean, 1/50 wet year, 1/10 dry year) (Chapter 8).

Figure 10-8: Predicted percent change in runoff relative to baseline in Geona Creek (KZ-37)

During Project construction, the predicted effect on Geona Creek flows varies between 10% for a wet year (when relative contribution from dewatering is lower) to 50% in a dry year (when relative contribution to baseline flows from dewatering is more substantial). Lower Geona Creek (downstream of the mine site) is an erosional system that is very responsive to rainfall events, resulting in relatively high flows during and immediately subsequent to these events. As a result, flows are highly variable and during open water months, flows can vary upwards of 150% over a short period of time. At freshet, baseline flows have reached as high as 1.6 m^3/s or over 6 times a mean open water flow in the range of 0.25 to 0.30 m^3/s at KZ-37 (Appendix D-2). Therefore, the higher flows expected in Geona Creek during construction should provide a more stable flow regime and not affect the aquatic resources in the system. The higher flows that occur naturally in the system at freshet and during rainfall events will be tempered or evened out by the upper Geona Creek water diversions and through water management. Some additional erosion of the creek channel and banks can be expected in lower Geona Creek during construction phase as a result of the consistently higher flows. This is not anticipated to be substantial and will be short-lived as Geona Creek discharges will be lowered during the operations phase.

During operations, ABM open pit dewatering flow rates will fall by about 50% (Chapter 8 – Surface Water Quality and Quantity) from the pumping rate predicted for the construction phase.

Additionally, in this phase the Process Plant will consume water and the water management strategy will include direct discharge of a portion of water from the Water Management Ponds directly into Finlayson Creek (bypassing Geona Creek). This, combined with the continued loss of flow input from Fault Creek, results in a predicted reduction of baseline flow in lower Geona Creek of about 45%, with slightly higher or lower decrease depending on the type of year with respect to precipitation (Figure 10-8).

The lower flows predicted for lower Geona Creek during operations will be adequate to sustain the small Arctic grayling population in Geona Creek and other aquatic resources during the open water months. The lowest flows will occur during late winter during the operational phase. During this phase, the water management strategy involves sending a portion of water from the Water Management Ponds directly to Finlayson Creek. The distribution of water will be managed to ensure flows are sufficient to sustain the Arctic grayling population. At closure, pumping from the ABM open pit will cease and begin to fill with groundwater and surface water from the now-removed upper Geona Creek diversions (i.e., Fault Creek and upper Geona Creek south and south-west catchments). Active closure will occur over three years (Years 11 through 13), during which time infrastructure will be decommissioned and a wetland constructed. The transition closure period will last from the end of active closure until the ABM lake is formed (years 14 through 26). During these closure periods (active and transition), Geona Creek flow is expected to be about 20% below baseline (Figure 10-8).

The post closure period begins in year 26 and is characterized by outflow of a filled ABM lake, which will begin contributing flow to Geona Creek, thereby reconnecting Fault Creek and the other south diversion areas to Geona Creek. As a result of the additional deep groundwater influx, runoff is expected to be slightly higher (2.5% to 5.0%) than baseline in Geona Creek (Figure 10-8) and downstream in perpetuity.

As per the operations phase, flows in Geona during all three closure periods will be adequate to support the aquatic resources of the system.

Hydrological Effects to South Creek

Figure 10-9 illustrates the predicted change in flow in South Creek at KZ-13 as a result of Project activities during each of the Project phases and under the three modelled precipitation scenarios (mean, 1/50 wet year, 1/10 dry year).

As described above, Fault Creek, a tributary of Geona Creek, and a portion of the upper Geona Creek watershed (south and south-west non-contact diversions) will be re-directed to South Creek watershed to accommodate the development of the open pit. This diversion will increase surface flow substantially into that system. The predicted increase in flow during construction is in the 35% range.

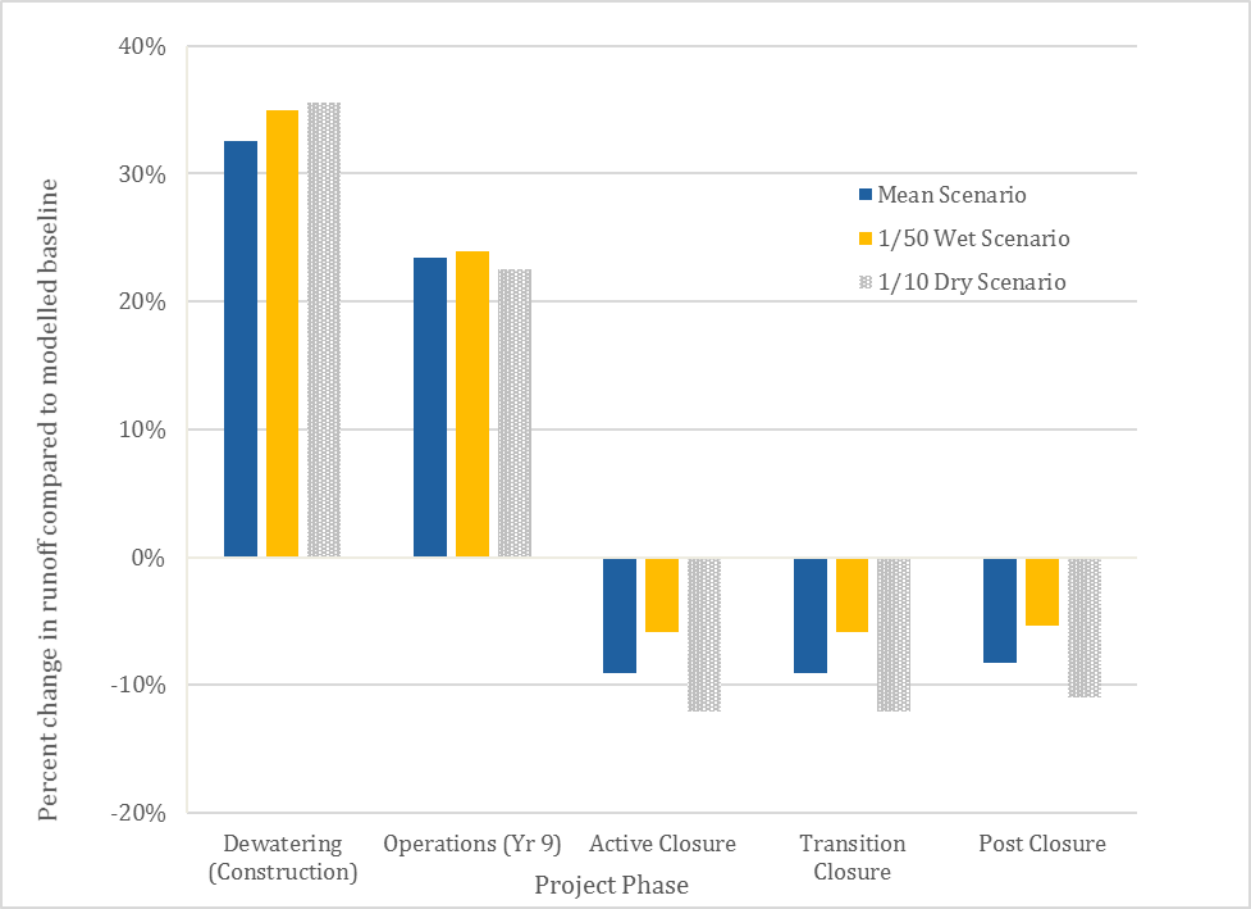


Figure 10-9: Predicted percent change in runoff relative to baseline in South Creek (KZ-13)

During the operations phase, flows in South Creek become more reliant on flow from Fault Creek as the groundwater aquifer will no longer feed as much flow into South Creek (due to ongoing dewatering of the open pit). As a result, South Creek flow is predicted to increase by 25% compared to baseline during operations (Figure 10-9).

At closure, Fault Creek will be re-directed back to the Geona Creek watershed. The resulting flows in South Creek (KZ-13) are predicted to be 5% to 12% lower than baseline flows (Figure 10-9) during the active and transition closure phases. At closure, the dewatering of the ABM open pit will cease and all of the flow from Fault Creek will report to the open pit, slowly increasing the hydraulic head in the surrounding aquifer. Once the open pit is filled at post-closure, and the groundwater hydraulic head increases in the watershed, the resulting flow in South Creek is predicted to increase (closer to baseline flows but will still remain 5% to 11% lower than baseline).

Hydrological Effects to Finlayson Creek

Total catchment area of Finlayson Creek above KZ-26 (Figure 10-7) is 215 km^2. Geona Creek catchment is approximately 25 km^2 or about 11.6% of the watershed above KZ-26. The Finlayson Creek catchment basin above Geona Creek is 41 km^2 and if Geona Creek is included, the basin in the

upper Finlayson catchment is 66 km². Geona Creek contributes about 38% of the flow in Finlayson Creek where it enters the creek (KZ-15).

Figure 10-10 and Figure 10-11 illustrates the predicted change in flow in Finlayson Creek at KZ-15 (immediately downstream of the Geona Creek confluence) and at KZ-26 (lower Finlayson Creek), respectively, as a result of Project activities through each of the Project phases and under the three modelled precipitation scenarios (mean, 1/50 wet year, 1/10 dry year). Further details are available in Chapter 8.

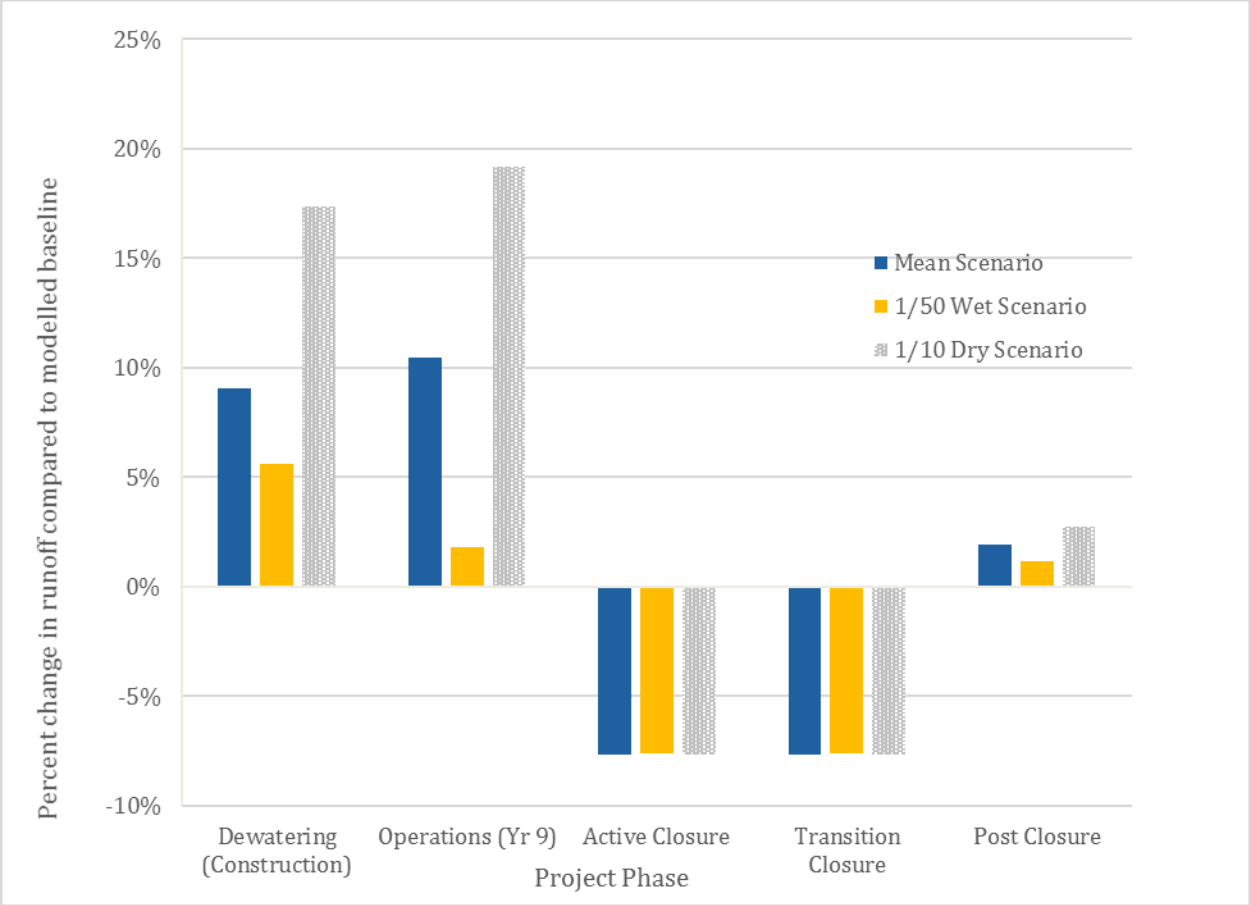


Figure 10-10: Predicted percent change in runoff relative to baseline in Finlayson Creek (KZ-15) throughout Project phases under three precipitation scenarios

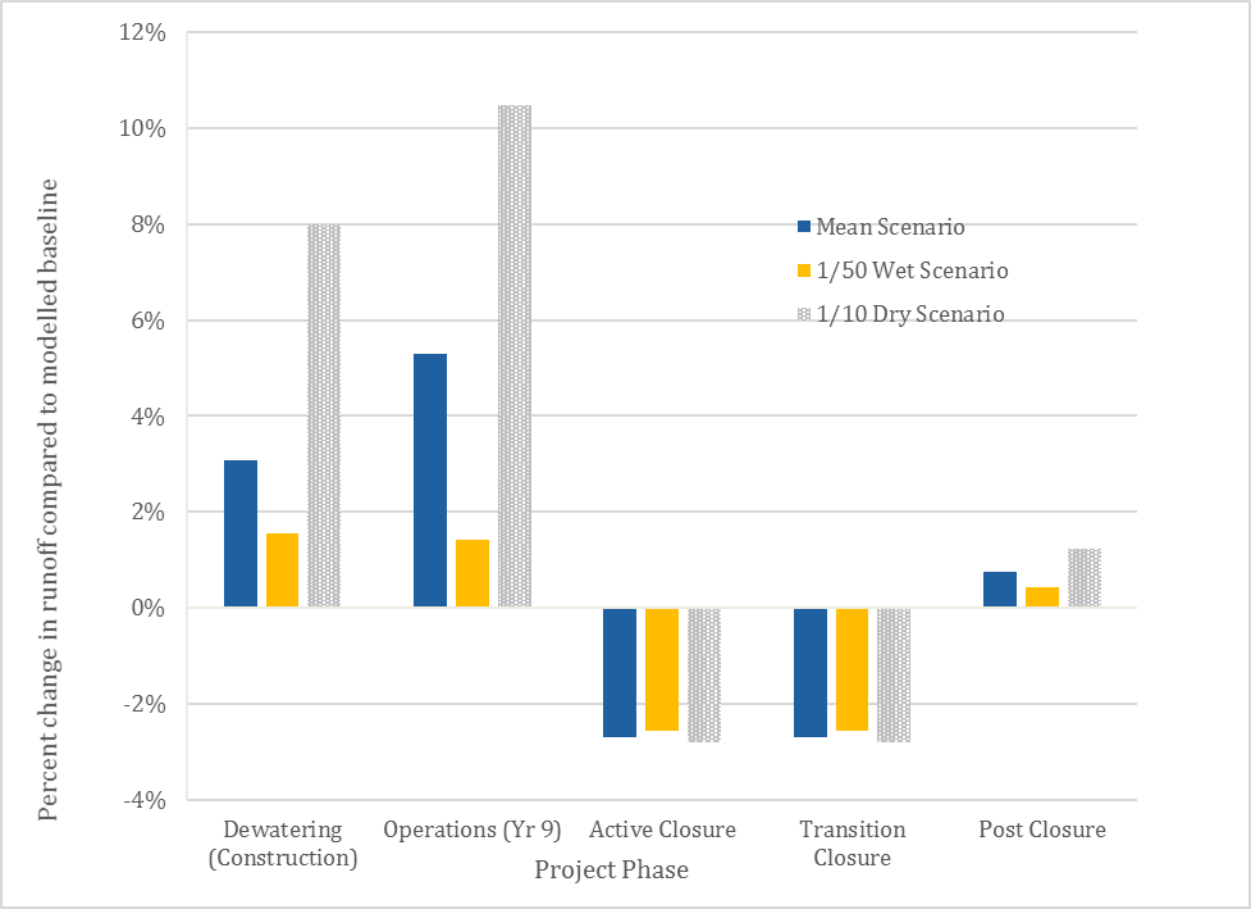


Figure 10-11: Predicted percent change in runoff relative to baseline in Finlayson Creek (KZ-26)

During construction, flows in Finlayson Creek at KZ-15 are predicted to increase by between 5.5% and 17.5% in response to increased flows in Geona Creek during this phase. The increase at KZ-15 is less pronounced in lower Finlayson (KZ-26) where flows are only predicted to increase between 1.5% and 8.0%.

During operations, flows in Finlayson Creek at KZ-15 and KZ-26 will generally be higher. During a mean precipitation year, flows are predicted to increase by 5% on average with some variation throughout the year; 14% at KZ-15 and between 2% to 8% at KZ-26. The increase in flow is more pronounced during a dry scenario year and less during a wet year. The increase in flow in Finlayson Creek during operations is in contrast to a decrease in Geona Creek because of the water management strategy that will release a portion of compliant water from the Lower Water Management Pond directly into Finlayson Creek above KZ-15, circumventing lower Geona Creek.

During active closure, flows in Finlayson Creek are predicted to decrease from baseline in the range of 8% at KZ-15 and 3% at KZ-26 due to cessation of open pit dewatering. Once the pit is filled (i.e., after the closure transition phase) flows in Finlayson will return to near baseline conditions (Figure 10-10 and Figure 10-11).

Surface Water Quality in Geona Creek and Finlayson Creek

Substances may be released in concentrations that could result in sublethal effects to aquatic biota under prolonged exposure, in receiving waters as a result of construction, operation or decommissioning activities (including discharge of mine water). Sublethal effects include (but are not limited to) altered growth, reproduction effects and other life processes. Since water quality guidelines or objectives for the protection of aquatic life are developed in consideration of the most sensitive organism (which varies depending on the water quality parameter), the discussion below applies to fish, benthic invertebrates, periphyton and aquatic plants.

A detailed discussion of Project effects on surface water quality is provided in the Surface Water Quality and Quantity chapter (Chapter 8). For the purposes of evaluating potential effects on aquatic habitat, water quality predictions included in Appendix D-6 (Surface Water Quality Model Report) were screened against the pWQOs presented in Appendix D-7. The analysis focussed on the Geona Creek receiving environment (KZ-37), but also considered Finlayson Creek (KZ-15) and South Creek (Figure 10-7). Parameters that presented potential pWQO exceedances during any of the Project phases, or constituents that are typically of potential concern due to their use in mine processes (e.g., nitrogen compounds, cyanide) are discussed in the following sections. Summary statistics of the low flow water quality predictions for Geona Creek receiving environment (KZ-37) during the construction, operation and active closure phases are presented in Table 10-6. Low flow water quality predictions were used for the effects assessment as they represent a reasonable worst case scenario. Table 10-7 summarizes the low flow water quality predictions for Finlayson Creek (KZ-15).

Table 10-6: Low Flow Water Quality Predictions in Geona (KZ-37), Year -1 through Year 13

	WQO (mg/L)	Minimum (mg/L)	Mean (mg/L)	Maximum (mg/L)	Frequency of WQO Exceedances (%)
Nitrite	0.06	0.000	0.014	0.045	0
Nitrate	3	0.002	0.609	1.954	0
Ammonia	*	0.003	0.087	0.251	0
Phosphorus	*	0.001	0.012	0.023	14.4**
Fluoride	0.12	0.021	0.078	0.135	8.9
Cyanide	0.005	3.05E-05	3.99E-04	6.58E-04	0
Selenium	*	0.0002	0.0011	0.0033	0.6

Note: Year -1 to 0 = Construction Phase; Year 1 to 10 = Operation Phase; Year 11 to 13 = Active Closure Phase

* WQO determined by an equation (pH, temperature, hardness or sulphate dependent) or baseline conditions

** There is no guideline or WQO for phosphorus, predictions are compared to a trigger range

Table 10-7: Low Flow Water Quality Predictions in Finlayson Creek (KZ-15), Year -1 through Year 13

	WQO (mg/L)	Minimum (mg/L)	Mean (mg/L)	Maximum (mg/L)	Frequency of WQO Exceedances (%)
Nitrite	0.06	0.000	0.005	0.014	0
Nitrate	3	0.001	0.219	0.521	0
Ammonia	*	0.002	0.031	0.074	0
Phosphorus	*	0.000	0.004	0.016	1.7**

	WQO (mg/L)	Minimum (mg/L)	Mean (mg/L)	Maximum (mg/L)	Frequency of WQO Exceedances (%)
Fluoride	0.12	0.038	0.079	0.128	6.7
Cyanide	0.005	3.05E-05	3.99E-04	6.58E-04	0
Selenium	*	0.0002	0.0009	0.0016	0

Note: Year -1 to 0 = Construction Phase; Year 1 to 10 = Operation Phase; Year 11 to 13 = Active Closure Phase

* WQO determined by an equation (pH, temperature, hardness or sulphate dependent) or baseline conditions

** There is no guideline or WQO for phosphorus, predictions are compared to a trigger range

Nitrogen Compounds

Nitrite and Nitrate

Mine blasting activities are a source of nitrogen compounds, including ammonia, nitrite, and nitrate, that can enter the receiving environment. These compounds have the potential to directly affect aquatic organisms, although nitrate is also an important plant nutrient and can stimulate primary production, potentially resulting in eutrophication if loading rates are high.

Nitrogen compounds are generally only of concern during the operations phase because their primary source is through the use of explosives. This will cease at closure and nitrogen concentrations found in receiving waters are expected to decrease accordingly.

Low flows predictions for Geona Creek are presented in Table 10-6 as a reasonable worst case scenario and nitrite and nitrate concentrations are expected to be lower during average and high flows. Under all of the scenarios modelled, nitrate and nitrate concentrations are predicted to meet the relevant CCME guidelines at KZ-37.

Ammonia

In aquatic environments, ammonia is present in two forms: ionized ammonium (NH_4^+), and un-ionized ammonia (NH_3). The term "total ammonia" is used to describe the sum of ammonia (NH_3) and ammonium (NH_4^+) concentrations. Ammonium does not easily cross fish gills and has been found to be less bioavailable than the un-ionized form. The un-ionized form (NH_3) can cross from water into fish, and once inside, a portion converts to the ionized form (NH_4^+), which can cause cellular damage (Levit, 2010). Both pH and water temperature affect the form of ammonia (NH_3) in water. Higher pH and higher temperatures result in a higher proportion of the total ammonia being present in its un-ionized form (NH_3).

The Canadian water quality guideline for the protection of aquatic life in freshwater is 0.019 mg/L (or ppm) for ammonia in its un-ionized form (NH_3) (CCME, 2010). The equation below is used to calculate the fraction of total ammonia (NH_3) that is un-ionized based on pH and water temperature:

$$f = \frac{1}{\left[10^{\left(0.0902+\left(\frac{2729.92}{T}\right)-pH\right)}+1\right]}$$

where: *f = fraction of total ammonia that is un-ionized*

T = temperature in K = temperature in °C + 273.15

The monthly median observed lab pH and temperature were used to develop the ammonia site pWQO. Lab pH was used rather than field pH as it was more alkaline and conservative in establishing the water quality objectives (WQO). Table 10-6 summarizes the low flow water quality predictions for ammonia at KZ-37 (Geona Creek receiving environment) during construction, operation and active closure phases. Predictions are further detailed in Appendix D-6, along with the associated pWQOs. Low flows predictions are presented here as a reasonable worst case scenario and ammonia concentrations are expected to be lower during average and high flows. The model results show that even if pH and temperature conditions deviate from baseline resulting in a greater fraction of un-ionized ammonia, it is still very unlikely that the CCME guideline will be exceeded during any of the Project phases (including transition closure and post-closure periods). Consequently, no exceedances are predicted in Geona Creek under median and high flows or downstream in Finlayson Creek under low, median or high flow conditions.

Phosphorus

Phosphorus is an essential nutrient for all living organisms; it plays a major role in biological metabolism, and when compared to other macronutrients required by biota, phosphorus is the least abundant and commonly the first nutrient to limit biological productivity (CCME, 2004). Currently, no national environmental quality guidelines exist for phosphorus, because the protocol for the Derivation of Guidelines for the Protection of Aquatic Life (CCME, 1991). The approach recommended by CCME (2004) is to compare predicted values with a trigger range (determined from the ecosystem trophic category) and to the baseline concentrations (up to a 50% increase in phosphorus concentrations above the baseline level is deemed acceptable), shown in Table 10-8.

Table 10-8: Total Phosphorus Trigger Ranges for Canadian Lakes and Rivers

Trophic Status	Canadian Trigger Ranges Total Phosphorus (mg/L)
Ultra-oligotrophic	<0.004
Oligotrophic	0.004 – 0.010
Mesotrophic	0.010 – 0.020
Meso-eutrophic	0.020 – 0.035
Eutrophic	0.035 – 0.100
Hyper-eutrophic	> 0.100

*Based on CCME (2004)

Table 10-6 shows the low flow water quality predictions for total phosphorous levels in the Geona Creek receiving environment (KZ-37), during the construction, operation and active closure phases. The percent exceedance shown is relative to the upper limit of the trophic category associated with the KZ-37 baseline values. While monthly predictions occasionally exceed a 50% increase with respect to KZ-37 baseline and/or the upper limit of the trigger range under low (14% of monthly predictions) or median (3% of monthly values) flow scenarios (no exceedances are expected under high flows), it should be noted that KZ-37 water quality predictions are largely driven by KZ-18 concentrations (60% of the load – see Appendix D-6). When phosphorus predictions are compared

to the upper limit of the trophic category associated with the KZ-18 baseline values or to the calculated 50% increase in KZ-18 baseline values, only one monthly exceedance is noted under low flow conditions. The annual average baseline phosphorus value is 0.008 mg/L at KZ-37 versus 0.030 mg/L at KZ-18.

Downstream in Finlayson Creek, using the same approach of comparing water quality predictions to the upper limit of the trophic category associated with the KZ-15 baseline values or to the calculated 50% increase in KZ-15 baseline values results in occasional exceedances (Table 10-7). However, predicted phosphorus values remain relatively low and only result in exceedances because baseline values at KZ-15 are very low (annual average of 0.004 mg/L).

A series of studies of laboratory cultures of algae and natural marine phytoplankton populations from the 1930s to the 1950s (Redfield, 1958) led to a concept that algae, under reasonably good growth conditions, will have an elemental composition with relatively defined atomic ratios. These ratios have become known as the Redfield ratios. For N to P, this ratio is about 15:1 to 16:1. “Natural systems in which the atomic ratio of other elements to P is greater than the Redfield ratio are often assumed to be systems in which algal growth or biomass is ultimately limited by P or at least that algal growth rates in such systems will be greatly reduced” (Correll, 1999). Other studies found that that phosphorus limitation was relieved at N:P molar ratio < 10:1 and that the optimal N:P supply ratio for most phytoplankton species was between 11:1 and 20:1 (Hecky et al., 1988). No predictions are available for total nitrogen (obtained from the sum of nitrate, nitrite, and total Kjeldahl nitrogen (TKN)) but a study by Rus et al. (2012) found that TKN constitutes an average of 40% of total nitrogen in surface water samples. Using the nitrite and nitrate low flow predictions at KZ-37 in combination with an assumed TKN proportion of 40%, total nitrogen is expected to range between 0.004 and 3.3 mg/L (average value of 1.039 mg/L) at KZ-37 during the construction, operation and active closure phases. Applying the Redfield ratio of 16:1 to the estimated average total nitrogen value of 1.039 mg/L, growth would be limited by nitrogen for phosphorus levels above 0.065 mg/L, while it will be limited by phosphorus for phosphorus values below 0.065 mg/L. All of the monthly predictions for phosphorus are below this value, and therefore, nitrogen is not anticipated to be limiting in this system, although water temperature, and light are other important growth limiting factors. In the case of Geona Creek, generally cold water temperature plays a key role in limiting productivity. In particular, elevated phosphorus levels predicted to occur during winter months are not a concern for eutrophication due to the minimal rates of primary production at lower water temperatures and reduced sunlight.

During the transition closure and post-closure phases (Year 14 to Year 36), once active water treatment has stopped, phosphorus concentrations at KZ-37 and KZ-15 could also exceed the trigger range or increase in baseline concentrations thresholds. However, Geona Creek and Finlayson Creek are low productivity, cold water systems, and are continually flushed; therefore, it is not anticipated that predicted phosphorus concentrations will result in excessive primary productivity that could be detrimental to aquatic resources and habitat.

Fluoride

The current CCME interim guideline for fluoride is 0.12 mg/L, and was derived by applying a safety factor of 0.01 to the lowest acceptable adverse effect level reported (CCME, 2002).

Table 10-6 summarizes the low flow water quality predictions for fluoride at KZ-37 (Geona Creek receiving environment) during construction, operation and active closure phases, and predictions are further detailed in Appendix D-6. Low flows predictions are presented here as a reasonable worst case scenario and fluoride concentrations are expected to be lower during average and high flows. The maximum fluoride concentration predicted to occur under low flow conditions is 0.135 mg/L (September, Year 9).

Under median or high flows water quality predictions, marginal fluoride guideline exceedances are expected to occur at KZ-37 during the construction phase, but very infrequently (see Appendix D-6). Downstream in Finlayson Creek (KZ-15), occasional fluoride guideline exceedances are also predicted to occur occasionally (Table 10-7). Even though some of the predicted concentrations exceed the CCME interim guideline, no adverse effects on aquatic resources are anticipated for the following reasons:

- The local natural fluoride levels are important in assessing the toxicological effects, because local populations may already be adapted to fluoride exposure (Sigler et al., 1972; Fleiss, 2011). Since background concentrations are naturally elevated in Geona and Finlayson Creeks (annual baseline average of 0.07 mg/L (or 58% of guideline value) at KZ-37 and of 0.08 mg/L (or 67% of guideline value) at KZ-15), local populations of fish and invertebrates are likely acclimatized to fluoride exposure;
- The aquatic toxicity of fluoride is influenced by environmental factors such as temperature, hardness, pH, salinity, and the presence of ion-exchange materials (CCME, 2002; Fleiss, 2010). Several conditions in Geona Creek contribute to reducing fluoride toxicity:
    - Fluoride toxicity increases with increasing water temperature (CCME, 2002). Relatively cold temperatures are therefore favourable;
    - Fluoride toxicity is negatively correlated with water hardness (CCME, 2002). Predicted hardness values at KZ-37 range between 50 mg/L and 284 mg/L at low flows during the construction, operation, and active closure phases. These elevated hardness values will therefore have an ameliorating effect;
    - Fluoride toxicity increases with a downshift in pH (Fleiss, 2010). The average lab pH value in Geona Creek (KZ-9) is 7.9, which is slightly alkaline and therefore favourable; and
    - The presence of cations such as calcium, magnesium, and potentially selenium, or anions such as chloride, all of which are found in Geona Creek in varying concentrations, can reduce the toxicity of fluoride (CCME, 2002).
- The CCME guideline is interim only and likely overprotective, since it uses a safety factor of 0.01. Criteria in other jurisdictions are generally higher (Fleiss 2010). For example, British

Columbia uses a hardness-dependent criterion for short-term exposure, which is calculated according to the following equation (BC MoE, 2011):

$$WQC = 0.01 * (-51.73 + 92.57\ log_{10}\ (hardness))$$

where water quality criteria (WQC) and hardness are in mg/L.

Using the predicted hardness range at KZ-37 during low flow conditions (minimum equal to 50 mg/L, maximum equal to 284 mg/L, average equal to 212 mg/L), the WQC for Geona Creek would range between 1.06 and 1.75 mg/L (average of 1.64 mg/L). No exceedances of the BC WQC are therefore predicted at KZ-37 under any flow conditions and during any Project phase.

During the transition closure and post-closure phases, once active water treatment has stopped, the maximum fluoride monthly value at KZ-37 is predicted to occur in March of years 26 through 36 (0.13 mg/L). This value is only marginally over the guideline and for the reasons outlined above, predicted fluoride concentrations during the transition and post-closure periods are not expected to result in adverse effect to aquatic life.

Cyanide

Cyanide is a parameter of interest in terms of receiving water quality because sodium cyanide is used as a reagent in the process plant as a lead circuit depressant.

The CCME guidelines for Protection of Aquatic Life (PAL) guideline of 0.005 mg/L for free cyanide (primary toxic form) was adopted as the pWQO for the Project. Because sample preservation and analytical problems may make monitoring for free cyanide unreliable, particularly in waters affected by mine wastes (CCREM, 1987), the measurement of weak-acid-dissociable (WAD) and total cyanide is recommended (CCREM, 1987) and the guideline is applied to WAD cyanide.

Table 10-6 summarizes the low flow water quality predictions for WAD cyanide in the Geona Creek receiving environment (KZ-37) for the construction, operation and active closure phases. Further details are provided in Appendix D-6. WAD cyanide concentrations at KZ-37 under all flow scenarios and throughout all Project phases are expected to be well below the CCME PAL guideline of 0.005 mg/L. No exceedances are predicted to occur downstream in Finlayson Creek either (Table 10-7).

Selenium

Potential effects associated with selenium in aquatic environments require evaluation that differs from other metals because chronic effects of selenium may occur following incorporation into the food chain, biotransformation to organic forms (seleno-amino acids) and transfer through the food chain (Janz, 2012). Because overall productivity and the characteristics of food chains differ substantially among aquatic systems, incorporation of aqueous selenium into the food chain, and transfer through the food chain, is highly site-specific. For example, overall primary productivity and the composition of the food chain both play a significant role in determining the assimilation of

selenium up the food chain. Dissolved sulphate competes with dissolved selenate (which is likely the dominant form of selenium in flowing watercourses such as Geona Creek and Finlayson Creek) for uptake by aquatic primary producers such that selenium assimilation by primary producers is substantially modified (reduced) with increasing aqueous sulphate concentrations. Therefore, the selenium pWQOs should consider the local sulphate concentration.

The approach pursued for the development of a sulphate-dependent site specific selenium water quality objective involved characterizing these relationships as a function of sulphate concentrations using both literature data and laboratory test work (which employed site water). Minnow Environmental was contracted to lead the development of the selenium SSWQO in collaboration with Nautilus Environmental. Further details of this work can be found in Appendix A of Appendix D-7, which presents the technical memorandum that outlines their methods and findings.

Water quality predictions for the Geona Creek receiving environment (KZ-37) during the construction, operation and active closure phases were compared to the selenium SSWQO and only once exceedance is predicted to occur (March of year -1; 0.0033 mg/L) under low, median or high flow conditions. This maximum value is likely associated with sediment mobilization from construction activities. Low flow results are presented in Table 10-6 and further details can be found in Appendix D-6. No selenium exceedances are predicted to occur in Finlayson Creek (KZ-15) under any flow scenarios or any Project phase (Table 10-7).

The single SSWQO exceedance in Geona Creek is not of concern for aquatic organisms because of its relatively short duration (one month), the timing of its occurrence (fall/winter where fish use of the system is minimal and benthic invertebrate are on a dormancy or diapause state) and the fact that the exceedance is for the total fraction. The dissolved fraction (bioavailable to aquatic organisms) is likely substantially lower, because the exceedances are likely associated with high sediment loads during construction or decommissioning activities.

Water Quality in South Creek

Low, median, and high flow water quality predictions were produced for South Creek (KZ-13), to estimate potential changes in water quality resulting from Fault Creek, South and Southwest diversion into the South Creek drainage. All modelled water quality parameters are predicted to remain below their respective SSWQO under all flow scenarios (see Appendix D-6 Surface Water Quality Model Report). No adverse effects to aquatic life in South Creek are therefore expected to result from the Project activities.

Water Temperature

Riparian vegetation plays a key role in aquatic habitats as it provides LWD and shade that regulates water temperature. Clearing riparian vegetation for access road upgrades near watercourse crossing's and riparian areas located within the Project footprint reduces or eliminates this temperature regulating effect.

Changes to stream temperature can directly affect the physical and biological properties of a watercourse. For Arctic grayling, the optimal temperature range for spawning and rearing is between

7.0°C and 12°C and between 4.0°C and 9.0°C for incubation (BC MOE, 2001). Table 10-9 shows the mean monthly temperatures observed in Fault Creek, Geona Creek and upper Finlayson Creek. June, July and August mean temperatures in Geona Creek fall within the optimal range for Arctic grayling.

Table 10-9: Mean Monthly Water Temperature (°C)

Month	Fault Creek (KZ-2)	Geona Creek (KZ-9)	Finlayson Creek below Geona Creek confluence (KZ-15)	Finlayson Creek above Geona Creek confluence (KZ-16)
May-15	2.0	3.5	3.8	3.7
Jun-15	4.3	8.1	8.0	8.2
Jul-15	6.5	10	9.9	10
Aug-15	5.7	8.4	8.4	8.8
Sep-15	2.5	3.6	3.7	3.7
Oct-15	0.65	0.85	0.88	0.71
Nov-15	0.48	0.35	0.38	0.25
Dec-15	0.47	0.33	0.35	0.24
Jan-16	0.40	0.31	0.34	0.24
Feb-16	0.38	0.32	0.33	0.24
Mar-16	0.38	0.32	0.34	0.24
Apr-16	0.42	0.38	0.53	0.32
May-16	1.8	1.4	3.0	2.4
Jun-16	4.9	9.9	9.2	9.7
Jul-16	7.1	11	11.0	11
Aug-16	6.1	9.0	8.9	9.1
Sep-16	2.9	4.1	4.3	4.3
Oct-16	0.67	1.0	0.46	N/A

Current canopy cover in Geona Creek riparian areas is quite limited. As such, the potential temperature regulating effect of riparian areas is already reduced. Construction and operation activities such as water withdrawal and diversion, as well as water discharge may alter base flows that may result in changes to stream temperature. Additionally, water storage such as in the ABM open pit and water management ponds could result in higher water temperatures. However, upper Geona Creek where the mine infrastructure will be developed, has substantial natural pond habitat. Despite this the system there remains within temperature ranges suitable for grayling, and in fact is relatively cool during the summer months (Table 10-8). This is likely a reflection of the elevation of the site and groundwater input in the creek. Given the mean temperatures shown in Table 10-9, it is not expected that Project activities will cause changes in water temperature that will fall outside of the optimal range for Arctic grayling.

Stream Sediments Chemistry and Particle Size Distribution

Sediments may act as sinks or sources for trace pollutants, and Project-related activities could contribute to precipitation and binding of certain elements to stream sediments or to the release of naturally occurring elements from sediments to water.

Incremental fine sediment loading in a stream could result from increased sediment loading, and is known to potentially affect both stream morphology and aquatic biota. Changes in flow patterns resulting from Project activities could also cause a change in particle size distribution, where slower water velocities are associated with a greater proportion of fines and faster water velocities are associated with larger sediment particle size.

10.4.1.3 Benthic Invertebrates, Periphyton and Aquatic Plants

Benthic Invertebrate Community

Changes in benthic invertebrate communities and populations could result from direct habitat loss in upper Geona Creek, increased TSS and sedimentation, change in water velocity, change in water temperature or from changes in water quality. These mechanisms were described in Section 10.4.1.2 above.

Habitat in upper Geona Creek will be lost, but new habitat will be created as part of the fish habitat compensation (offsetting) measures (see Section 10.4.2.2 and Appendix E-4). Benthic invertebrates from the east tributary (KZ-18) flowing into Geona Creek at KZ-9, will continue to drift into Geona Creek and be available as a food source for fish downstream.

The effects of increased TSS loading on benthic invertebrates include physical habitat change due to the scouring of stream beds and the dislodgement of organisms, smothering of benthic communities, alteration of microhabitat within interstitial space in substrate and abrasion of respiratory surfaces and interference of food uptake for filter feeders (Birtwell, 1999). Deposition resulting from increased sediment loading can result in a change in stream sediment particle size distribution, with a greater proportion of fine sediment typically being less suitable for benthic invertebrates.

The velocity of the water is fastest just below the surface, and slowest on the top and along the bottom due to friction with the air and substrate. As the water flows over rocks and substrate, a protective boundary layer, about 1 to 4 mm thick, is formed where the velocity of the current slows. The flattened body type of some benthic macroinvertebrates allows them to live in this boundary layer and not be carried away by the current. Other invertebrates have developed strategies, such as living under rocks, spinning nets and making anchors to remain in the current, while taking advantage of the available nutrients. Large pulses of water or sudden increases in velocity can scour the river bottom, disturbing the benthic community.

Abundance and Diversity of Periphyton Communities

Periphyton is a valuable biological monitoring tool to assess potential effects of changes in water quality. The predicted changes in water quality for key constituents were discussed in the water quality section (subsection of Section 10.4.1.2).

Chlorophyll a

Determining chlorophyll *a* concentrations provides a measure of algae biomass and thus, the primary productivity of a given location. Spatial or temporal changes in chlorophyll *a* can indicate Project-related effects, particularly relative to the release of nutrients (nitrogen compounds, phosphorus) in the receiving waters. Small increases in primary productivity (periphyton/plant) can have a modest stimulatory influence on secondary producers (benthic invertebrates) and fisheries. Large increases in primary productivity can change the community of primary producers (periphyton/plant) and can result in a secondary decrease in DO (concentration and cycling) resulting in modification of benthic invertebrate community (e.g., replacement of intolerant with tolerant forms) and decrease in fish habitat quality, plus potential tertiary effects of lower DO/redox on metal speciation.

Change in chlorophyll *a* could be in an adverse direction if primary productivity decreases or increases to such an extent as to cause eutrophication; however, it is also possible that the change is beneficial if primary productivity is increased slightly.

Sublethal Effects

Substances may be released in receiving waters as a result of construction, operation or decommissioning activities (including discharge of mine water), in concentrations that could result in sublethal effects to fish under prolonged exposure. Sublethal effects include (but are not limited to) altered growth, reproduction effects and effects on other life processes.

Because water quality guidelines or objectives for the protection of aquatic life are developed in consideration of the most sensitive organism (which varies depending on the water quality parameter), the discussion of chronic effects of decreased water quality is presented in Section 10.4.1.2 applies to fish, benthic invertebrates, periphyton and aquatic plants.

Table 10-10 provides a summary of the identified potential effects on the subcomponents of the aquatic ecosystems and resources VC.

Table 10-10: Identified Potential Project Effects for Aquatic Ecosystems and Resources

Subcomponent	Potential Effect	Project Phase
Fish (Arctic grayling)	Changes in Arctic grayling population CPUE or condition factor	Construction, operations, closure
	Sublethal Effects to Fish	Construction, operations, closure
Aquatic habitat	Changes to habitat availability, distribution and connectivity	Construction, operations, closure, post closure
	Changes in TSS	Construction, operations, closure

Subcomponent	Potential Effect	Project Phase
	Changes in surface water quantity	Construction, operations, closure
	Changes in surface water quality	Construction, operations, closure, post-closure
	Changes in water temperature	Construction, operations, closure
	Changes in stream sediment chemistry and particle size distribution	Construction, operations, closure
Benthic invertebrates, periphyton and aquatic plants	Change in benthic invertebrate community	Construction, operations, closure
	Change in abundance and diversity of periphyton communities	Construction, operations, closure
	Change in Chlorophyll *a*	Construction, operations, closure
	Sublethal effects	Construction, operations, closure

10.4.2 Mitigation Measures

This section discusses mitigation measures that BMC will implement to eliminate, minimize and/or reduce Project effects resulting from interactions between the aquatic ecosystems and resources VC and Project activities.

A Fish and Aquatic Habitat Management Plan (FAHMP) has been developed (Section 18.9) to minimize Project-wide fisheries and aquatic habitat effects during construction, operation and closure of the Project. This plan complements the FOP (Appendix E-4), Surface Water Management Plan (SWMP) (Section 18.4) and Sediment and Erosion Control Plan (SECP) (Section 18.6). The Hazardous Materials Management Plan (HMMP) (Section 18.3) and Spill Contingency Plan (SCP) (Section 18.5) will also aid in minimizing any effects from the Project on aquatic resources. Furthermore, a conceptual fish and fish habitat monitoring plan has also been developed to quantify and monitor the effects that result from Project development and operations and measure the efficacy of the offsetting measures developed. Monitoring is further supported by Kaska Dena Management Practices with a particular focus on maintaining stream flows and forest cover (DKI, 2010).

Specific mitigations for the aquatic ecosystems and resources subcomponents are presented in the sub-sections below. Depending on the predicted effectiveness of the mitigation measures (i.e., the degree to which the mitigation measure is expected to eliminate the effect), a determination is made as to whether there is a residual effect (Table 10-10). If there is an expected residual effect, the significance of the effect is evaluated in Section 10.4.3.

The mitigation strategies outlined below are also echoed in the Kaska Dena Management Practices with an emphasis on maintaining fish populations throughout Kaska Traditional Territory by reducing road density, limiting in-stream work to particular seasons, and compensating for loss of fish habitat (DKI, 2010).

10.4.2.1 Fish (Arctic grayling)

The increase in fish mortality risk will be mitigated by the implementation of the FAHMP (Section 18.9) and FOP (Appendix E-4). The FOP includes fish salvage and a strategy to minimize salvage requirements. The SECP (Section 18.6) will reduce risk associated with elevated TSS and turbidity. The timing of instream work will be chosen to minimize risk to fish, and the implementation of the HMMP (Section 18.3) and SCP (Section 18.5) will minimize risks associated with accidental substance release into receiving waters.

Aqueous geochemical effects to fish, benthic invertebrates, periphyton and aquatic plants will be mitigated through careful control of Project discharge water quality. Appendix D-8 outlines the development of site specific receiving WQOs. Mitigation measures to ensure these site specific receiving WQOs are met are also described in Section 8.4.2. These measures will be further complemented by the SWMP (Section 18.4), SECP (Section 18.6), HMMP (Section 18.3) and SCP (Section 18.5).

Residual effects to fish (Arctic grayling) are anticipated due to changes or alterations to habitat, but no sublethal residual effects to fish are expected following application of mitigations measures (Table 10-11).

10.4.2.2 Aquatic Habitat

Changes to aquatic habitat availability, distribution and connectivity will be mitigated by the implementation of the FOP (Appendix E-4). The offsetting measures in the FOP involve habitat replacement in lower Geona Creek and modifications to culverts on Finlayson Creek (at the Robert Campbell Highway) to improve fish passage. These measures require construction activities that could further affect aquatic habitat and thus a number of specific mitigate measures have been developed to minimize further effects and are described in the FOP and include:

- Erosion and sediment control;
- Fish salvage and strategy to minimize salvage requirements;
- Instream construction timing windows (instream construction will be avoided, when practicable, during grayling spawning and incubation period mid-May to late June); and
- Geochemical control of construction materials for in-stream works.

Changes in TSS as well as stream sediment chemistry and particle size distribution will be mitigated by the implementation of the SECP (Section 18.6). The main objectives of the SEC Plan are to:

- Control run-off;
- Minimize erosion on exposed slopes and substrates; and
- Prevent input of silt or sediment into watercourses during all phases of the Project.

Discharge will have to meet MMER and standards placed in the WUL for TSS.

Changes in surface water quantity and temperature will be mitigated by the implementation of the SWMP (Section 18.4). The SWMP describes strategies and provides guidance for the control of water from the Project during mine construction, operations, closure and reclamation and post closure. The objective of the SWMP is to manage site water collection, conveyance, storage, treatment, and release, in support of Process Plant water requirements while mitigating environmental effects to downstream waters.

There are no anticipated residual effects on water temperature and total suspended solids after implementation of mitigation measures. However, residual effects are anticipated to occur in regard to water quantity and water quality because they will be different from baseline conditions, which can also result in changes in stream sediment chemistry, particle size distribution. Mitigation measures are summarized in Table 10-11.

10.4.2.3 Benthic Invertebrates, Periphyton and Aquatic Plants

Mitigation measures for aqueous geochemical effects on fish, benthic invertebrates, periphyton and aquatic plants are discussed above in Section 10.4.2.1. Change in surface water quantity, change in TSS, and change in water temperature and their effects on benthic invertebrates will be mitigated by implementation of the SWMP (Section 18.4), FAHMP (Section 18.9), SECP (Section 18.6), SCP (Section 18.5) and HMMP (Section 18.3). Mitigation measures are summarized in Table 10-11.

However, even with mitigation measures in place changes in habitat components (water quantity and quality) are expected as a result of the Project. Therefore, residual effects on benthic invertebrates, periphyton and aquatic plants communities have been identified, but no sublethal effects are anticipated to remain after the implementation of mitigation measures.

Table 10-11: Proposed Key Mitigation Measures for Aquatic Ecosystems and Resources

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Fish (Arctic grayling)				
Changes in Arctic grayling population CPUE or condition factor	Construction, operations, closure	Implementation of Fisheries Offsetting Plan Implementation of Fisheries and Aquatic Habitat Management Plan Implementation of Surface Water Management Plan (including water treatment) Implementation of Hazardous Materials Management Plan and Spill Contingency Plan	Medium	Yes
Sublethal effects to fish	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	High	No

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Aquatic habitat				
Changes in habitat availability, distribution connectivity	Construction, operations, closure, post-closure	Implementation of Fisheries Offsetting Plan.	High	Yes
Changes in total suspended solids (TSS)	Construction, operations, closure	Implementation of Sediment and Erosion Control Plan.	High	No
Change in surface water quantity	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	High	Yes
Change in surface water quality	Construction, operations, closure, post-closure	Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	High	Yes
Change in water temperature	Construction, operations, closure	Implementation of Surface Water Management Plan.	High	No
Change in stream sediments chemistry and particle size distribution	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment). Implementation of Sediment and Erosion Control Plan.	High	Yes
Benthic Invertebrates, Periphyton and Aquatic Plants				
Change in benthic invertebrate community	Construction, operations, closure	Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Sediment and Erosion Control Plan. Implementation of surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Medium	Yes
Change in abundance and diversity of periphyton communities	Construction, operations, closure	Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Sediment and Erosion Control Plan. Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	High	Yes
Change in Chlorophyll *a*	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	High	Yes

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Sublethal effects to benthic Invertebrates, aquatic plants or algae	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	High	No

10.4.3 Residual Effects and Significance Determination

The significance of residual effects as a result of the Project on aquatic ecosystems and resources are summarized in Table 10-12.

10.4.3.1 Fish (Arctic grayling)

Changes to Arctic grayling population CPUE or condition factor resulting from the Project activities could be in a beneficial or adverse direction. Project activities are likely to affect Arctic grayling population in an adverse direction initially while offsetting measures detailed in the FOP are anticipated to enhance fish use and increase the productive capacity of the Geona/Finlayson systems, thereby resulting in an overall beneficial direction with respect to Arctic grayling population size in the Finlayson Creek watershed. The magnitude is low because changes are expected to be within natural variability of baseline conditions at a minimum in Geona Creek while improving fish passage at the Finlayson culverts should result in a substantial increase in fish population numbers and use above the culverts. The geographic extent is limited to the site (Geona Creek and Fault Creek) and the duration is long-term as it will extend over the construction, operation and closure phases. The frequency of the potential adverse effects on fish mortality risk is continuous (e.g., continuous use of industrial equipment); potential beneficial effects would be continuous as well. The effects are reversible in the short-term (less than 5 years). However, the probability of the effect occurring is unlikely as fish will be isolated or removed from upper Geona Creek before proceeding with construction activities that would put these fish at risk. The fish subcomponent of the aquatic ecosystems and resources VC has high economic and social context, given the First Nation traditional use of the regional area for fishing. Overall, the effect is not significant.

10.4.3.2 Aquatic Habitat

Changes in habitat availability, distribution and connectivity are in the adverse direction as Project activities will result in habitat loss, however offsetting measures detailed in the FOP will create new valuable habitat in lower Geona Creek and re-connect large tracts of creek habitat in the Finlayson watershed which should result in an overall beneficial effect. The magnitude is moderate due to habitat loss in the upper Geona Creek reaches which removes the productive capacity of this section of the creek while habitat replacement offsetting proposed for lower Geona Creek (as described in the FOP – Appendix E-4) should at a minimum maintain the overall productive capacity of Geona Creek. The geographic extent is limited to the site and the duration is in the far future as some of the habitat losses and associated offsetting measures will be permanent. The frequency is continuous and some of the changes will be irreversible. The probability of the effect occurring is very likely.

Habitat availability, distribution and connectivity has neutral environmental and socio-economic context, as it is considered to have some resilience to accommodate change, as well as due to its potential indirect effects on fish populations, which are highly valued by local First Nations. Overall, the effect is not significant.

Changes in surface water quantity are adverse, and the magnitude is low to moderate in Geona Creek and South Creek and low in Finlayson Creek with flows not exceeding a 20% change from baseline and/or staying within the natural variability of the system for mean scenario years. All three waterways are naturally responsive to rainfall events and subject to relatively high extreme flows at freshet. Therefore, the flows during the construction and operation phases are not expected to have an impact on the system as they will remain within the natural variability of the system while water management infrastructure (i.e., Water Management Ponds) and strategies will temper extreme high or low flows. The slightly lower flows expected in South Creek at closure are also not expected to substantially impact the aquatic habitat of South Creek or its resources. South lakes may shrink slightly due to the predicted lower flows but are expected to still be able to support the low numbers of fish in the system. The geographic extent is local and duration is long term as changes could occur over all Project phases, as site hydrology will not return to conditions close to baseline until year 26, when the outflow of ABM lake begins and contribute flow to Geona Creek, thereby reconnecting Fault Creek and the other south diversion areas to Geona Creek. The frequency is continuous and the effect is reversible in the long term. This has neutral environmental and socio-economic context and the probability of the effect occurring is very likely. Overall, the effect is not significant.

Changes in surface water quality are adverse with a potential increase in concentrations of certain parameters, but the magnitude is low for most parameters (that will not exceed their respective pWQOs) and for those that will, exceedances are of moderate magnitude (less than ten times the pWQO). More specifically, nitrogen compounds are all predicted to remain below their respective objectives in Geona and Finlayson Creeks under all flow scenarios and during all Project phases. For phosphorus, there is no guideline, but rather a trigger range or baseline concentration approach because it is nontoxic. Some of the predicted phosphorus monthly values are expected to exceed these thresholds but because there are no toxicity concerns associated with phosphorus and because Geona and Finlayson Creek are low productivity systems, it is not anticipated that predicted phosphorus concentrations will result in excessive primary productivity. Occasional fluoride and selenium exceedances in Geona and Finlayson Creeks are alleviated by a number of ameliorating factors and in the case of fluoride, the guideline for the protection of aquatic life is very conservative. Cyanide is predicted to remain below its objective during all Project phases and under all flow scenarios. The geographic extent of changes in surface water quality is local as some changes could be observed in Finlayson Creek and the duration is in the far future as some changes are predicted to last into the post-closure period. The frequency is sporadic as pWQO exceedances are predicted to occur on an occasional basis and the effect is reversible in the short term. The probability of the effect occurring is likely and the surface water quality measurable parameter has neutral environmental and socio-economic context, as it is considered to have some resilience to accommodate change, as well as due to its potential indirect effects on fish populations, which are highly valued by local First Nations. Overall, the effect is not significant.

Changes in stream sediment chemistry and particle size distribution could be either adverse or beneficial since sediments may act as sinks or sources for trace pollutants, and Project-related activities could either contribute to precipitation and binding of certain elements to stream sediments or to the release of naturally occurring elements from sediments to water. Changes in flow patterns resulting from Project activities could cause a change in particle size distribution, where slower water velocities are associated with a greater proportion of fines and faster water velocities are associated with larger sediment particle size. The magnitude is expected to be low (within natural variability of baseline conditions) and the geographic extent local. The duration is long term as changes could occur over all Project phases, the frequency is continuous, and the effect is reversible in the short term. This measurable parameter has low environmental and socio-economic context and the probability of the effect occurring is likely. Overall, the effect is not significant.

In summary, residual effects on fish and fish habitat are not significant because fish habitat will not be altered chemically, biologically, or in a way that results in an adverse change in the ecological function of that habitat, and such that natural recruitment would not re-establish the community to its original composition density after closure. Physical changes to fish habitat will occur in upper Geona Creek during mine construction but measures have been developed (and are described in the FOP) to offset that impact including habitat replacement and enhancement and re-connection of habitat. Overall, with the FOP offsetting measures fish habitat will not be altered in such a way as to cause an adverse change in the distribution or abundance of a fish species or community that is dependent upon that habitat. Finlayson Creek habitat re-connection proposed in the FOP however should provide a positive change to distribution and abundance of Arctic grayling in the watershed. Residual effects on fish habitat productivity are not significant because after mitigation and offsetting measures are implemented no alteration or disruption of habitat resulting in a loss of productive capacity is anticipated for Geona or South Creek and while an increase in productive capacity is anticipated for Finlayson Creek

10.4.3.3 Benthic Invertebrates, Periphyton and Aquatic Plants

Changes in benthic invertebrate community are adverse if diversity, abundance, richness or %EPT decrease, however it is also possible that the change is neutral if some species are replaced by others that are better adapted to altered creek conditions while endpoint metrics remain unchanged. The magnitude is low as changes are expected to be within natural variation of baseline conditions (baseline conditions were found to fluctuate from year to year, possibly in response to climatic conditions). The geographic extent is local, and duration is long-term, as changes could occur over all Project phases. The frequency is continuous and the effect is reversible in the short-term (less than 5 years), as the typical life span of benthic invertebrates is 1 to 3 years (Canadian Aquatic Biomonitoring Network, no date). The probability of the effect occurring is likely and the benthic invertebrate community some unique economic and social attributes, indirectly as food source for fish which are highly valued by local First Nations. Overall, the effect is not significant.

Change in abundance and diversity of periphyton communities are adverse if diversity and abundance decrease, however it is also possible that the change is neutral if some species are replaced by others that are better adapted to altered creek conditions while endpoint metrics remain unchanged. The magnitude is low as changes are expected to be within natural variability of baseline

conditions. The geographic extent is local, and duration is long-term, as changes could occur over all Project phases. The frequency is continuous and the effect is reversible in the short-term (less than 5 years). The probability of the effect occurring is likely and periphyton has low environmental and socio-economic context. Overall, the effect is not significant.

Change in chlorophyll *a* are adverse if primary productivity decreases or increases to such an extent as to cause eutrophication, however it is also possible that the change is beneficial if primary productive is increase slightly. The magnitude is low as changes are expected to be within natural variability of baseline conditions. The geographic extent is local, and duration is long-term, as changes could occur over all Project phases. The frequency is continuous and the effect is reversible in the short-term (less than 5 years). The probability of the effect occurring is likely and chlorophyll *a* has low environmental and socio-economic context. Overall, the effect is not significant.

In summary, residual effects on benthic invertebrates and periphyton are considered not significant because it is not anticipated that any Project-related activity will impair the ability of the watercourses to sustain aquatic life at levels that were similar to Project pre-development.

Table 10-12: Project Effects Significance Assessment for Aquatic Ecosystems and Resources

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Fish (Arctic grayling)									
Changes in Arctic grayling population CPUE or condition factor	Adverse/Beneficial	Low	Site	Long term	Regular/Continuous	Reversible Short term	High	Likely	Not significant
Aquatic Habitat									
Changes in habitat availability, distribution connectivity	Adverse/Beneficial	Moderate	Site	Far future	Continuous	Irreversible	Neutral	Very Likely	Not significant
Change in surface water quantity	Adverse	Moderate to Low	Local	Long term	Continuous	Reversible Long term	Neutral	Very likely	Not significant
Change in surface water quality	Adverse	Moderate to Low	Local	Far future	Sporadic	Reversible Long term	Neutral	Likely	Not significant
Change in Stream Sediments Chemistry and Particle Size distribution	Adverse/Beneficial	Low	Local	Long term	Continuous	Reversible Short term	Low	Likely	Not significant
Benthic invertebrates, periphyton and aquatic plants									
Change in benthic invertebrate community	Adverse/Neutral	Low	Local	Long term	Continuous	Reversible Short term	Neutral	Likely	Not significant
Change in abundance and diversity of periphyton communities	Adverse/Neutral	Low	Local	Long term	Continuous	Reversible Short term	Low	Likely	Not significant
Change in Chlorophyll *a*	Adverse/Beneficial	Low	Local	Long term	Continuous	Reversible Short term	Low	Likely	Not significant

Note: Criteria definitions are provided in Table 10-2 and Table 10-3.

10.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for Aquatic Ecosystems and Resources follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. The following Project residual effects have been identified for aquatic ecosystems and resources and are considered through the CEA:

- Changes in Arctic grayling population CPUE or condition factor;
- Changes in habitat availability, distribution and connectivity;
- Change in surface water quality;
- Change in stream sediment chemistry and particle size distribution;
- Changes in benthic invertebrate community;
- Changes in abundance and diversity of periphyton communities; and
- Changes in chlorophyll *a*.

10.5.1 Cumulative Effects Characterization

For past, present, and future projects and activities to be considered the following conditions must be met:

- There is information available to identify if the project or activity results in a demonstrable or measurable effect on the VC;
- The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
- The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for VC are identified through the screening in Table 10-13. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

Table 10-13: Cumulative Effects Screening for Aquatic Ecosystems and Resources

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Quartz Mining and Exploration				
Fyre Lake Property (*Pacific Ridge Exploration)*	No	N/A	N/A	No
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/ Veris Group*)	No	N/A	N/A	No
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	No	N/A	N/A	No
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	N/A	N/A	No
The Yukon Base Metal Project *(Overland Resources Ltd.)*	No	N/A	N/A	No
Wolverine Mine (*Yukon Zinc Corp.)*	No	N/A	N/A	No
Roads, Access Roads and Trails				
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	N/A	N/A	No
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	N/A	N/A	No
Other Activities				
Single/Group Trapline Concessions	No	N/A	N/A	No
Outfitting Concessions	No	N/A	N/A	No
Campgrounds	No	N/A	N/A	No

As indicated in Table 10-13 above, no projects or activities have been identified to overlap with Project residual effects in type of effect, in time, and in space. Therefore, no potential cumulative effects have been identified for aquatic ecosystems and resources. No further assessment is required.

10.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the effectiveness of recommended mitigation measures;

- Identify unexpected environmental effects; and
- Implement additional mitigation measures if required, as per adaptive management plans.

The conceptual aquatic monitoring program is described below.

10.6.1 Aquatic Environmental Program

Aquatics resource monitoring is ongoing as part of the pre-development environmental baseline programs for the Project. Historical aquatic resource surveys were also completed in 1994 and 1995 to support the IEE, and from 2002 to 2016 under the WUL QZ97-026-01 biennual aquatic monitoring program. Sampling as required under the conditions of WUL QZ97-026 will continue until the licence expires in September 2018. Thereafter sampling will occur every two years under the new WUL for the Project, except in years when BMC is required to undertake Environmental Effects Monitoring (EEM) under the *Metal Mining Effluent Regulations* (MMER). The EEM program occurs in three year cycles. In the years that EEM sampling is required, components of it that are also required under the current or future WUL (i.e., benthic invertebrate sampling program) will be undertaken as per protocols under the MMER – EEM program and the study design that will be developed to comply with the regulation. Additional strategies will be developed to monitor the outcome of offsetting measures described in the FOP.

The following describes the proposed monitoring programs for the Project that includes the current ongoing aquatic sampling program as required under WUL QZ97-026-01 with additional stations added where deemed appropriate to increase the number of reference and exposure sites. The programs described below will commence during Project construction phase and continue during the construction, operation and closure phases of the Project.

Reporting of the aquatic resource monitoring program described below will be submitted on a biennial basis to the Yukon Water Board as part of the annual report and every three years to Environment and Climate Change Canada for the EEM study results. Aquatics monitoring results will be compared to the AMP thresholds (i.e., population size, density, quality) and discussed in the Water Licence reports.

10.6.2 Benthic Invertebrate Monitoring Program

BMC will carry out a benthic invertebrate monitoring program every two years (except in years when benthic invertebrate sampling under the MMER-EEM program is required) in July/August, during construction, operation and closure, as follows:

- Three replicates samples will be taken by a Hess sampler equipped with a 250 µm mesh net;
- Samples will be preserved with 10% formalin solution and identified to the lowest possible taxon (usually genus) and counted;
- Stream information collected at the time of benthos collection will include: velocity, depth, temperature, substrate conditions and riparian conditions;

- Routine water quality sampling will be carried out during benthic invertebrate sampling program; and
- Proposed sample locations include: KZ-9, KZ-15, KZ-16, KZ-17, KZ-18, KZ-21, KZ-26 and KZ-37.

BMC will carry out a benthic invertebrate metal tissue program every two years in July/August during construction, operation and closure, as follows:

- One composite sample will be collected of sufficient size to allow low detection limits in invertebrate tissues for heavy metals and selenium. Collection equipment will be kick nets, Hess sampler, or other suitable equipment;
- Samples will be preserved with 10% formalin; and
- Proposed sample locations include: KZ-15, KZ-16, KZ-18, KZ-7, KZ-26 and KZ-37.

10.6.3 Sediment Monitoring Program

Sediment sampling methods will be consistent with the requirements of the current WUL (and previous sampling efforts) to enable meaningful comparison of results. Suitable areas of fine substrate from the active channel (relatively more sand and silt, less coarse material) will be sought out by the field crew once on site. Sediment samples will be collected biennially in the late summer/early fall in concert with benthic invertebrate collection. Samples will be stored in coolers and shipped to an accredited laboratory for particle size analysis, metals and pH analysis. Details with respect to particle size distribution will be evaluated along with any trends in metal concentrations over time at each of the sites.

BMC will carry out a sediment monitoring program every two years in July/August, during operation and closure, as follows:

- Three replicate samples of fine sediment will be taken from within the active channel of the stream, using an aluminum or Teflon scoop or a glass sampling jar;
- The samples will be dried and screened, using sieve sizes at American Society for Testing and Materials (ASTM) mesh numbers 10, 20, 40, 60, 100, 140 and 270, and the fraction weights recorded;
- A sub-sample, composed of material which passes through the 230 mesh sieve, will be analysed for metals by a 33 element ICP scan and total organic carbon (TOC);
- A routine water quality sample will be taken at the same time the sediment sampling is carried out; and
- Proposed sample locations include: KZ-7, KZ-9, KZ-15, KZ-16, KZ-17, KZ-18, KZ-21, KZ-26 and KZ-37.

10.6.4 Fisheries Monitoring Program

A fish sampling program will be conducted on an annual basis to monitor fish use in Geona, Finlayson and South Creeks (systems that will be influenced by Project development). East Creek will serve as a reference site. Fish sampling methods will include electrofishing, minnow trapping, beach seining, angling and visual observations. All fish captured will be identified and enumerated, measured for fork length (mm) or total length, weighed, observed for abnormalities, and released at the location of capture. Results will be reported as CPUE to enable spatial and temporal comparisons as well as provide a semi-quantitative assessment. Additional supporting information that will be collected includes: physical description and photo documentation of sampling locations, in situ water parameters (temperature, DO, conductivity), as well as weather conditions at time of sampling.

Arctic grayling spawning surveys in Geona and Finlayson Creek will be conducted on ground and via aerial reconnaissance. Surveys will focus on habitat most likely to support grayling spawning based on knowledge gleaned from 2015-16 habitat investigations (Appendix E-3). Surveys will occur post-freshet (i.e., mid-May – early June) and once water temperatures are increasing and in the 4^{o}C range (temp range that generally trigger grayling to spawn) or higher.

As discussed in Section 18.9 and presented in Appendix E-4, BMC has developed a preliminary FOP, which includes development of offsetting measures to replace habitat lost to mine development and a measure to re-connect habitat in Finlayson Creek that is currently isolated by culverts that impede fish passage. The fish monitoring plan described above will also serve to monitor the success of the offsetting measures which are designed to maintain a viable population of Arctic grayling in Geona Creek, re-establish spawning habitat in Geona Creek that will be lost to Project development, and re-connect Finlayson Creek fish habitat by modifying the culverts at the Robert Campbell Highway that are currently considered a barrier to fish passage.

With respect to the proposed culvert modification, fish sampling will be conducted immediately upstream and downstream of the culverts as it has been done in previous years, to verify the effectiveness of the modifications once completed. Additional sampling methods will also be employed to determine passage system efficacy and is described in Section 18.9.

10.6.5 Fish Tissue Sampling

The fish tissue sampling program monitoring heavy metals and selenium will be continued as per the existing water licence requirements. Sampling will be conducted every two years during July/August, during operations and closure, at Finlayson Creek stations KZ-15, KZ-16, KZ-18 and KZ-26. The target species will be slimy sculpins, which are known to inhabit Finlayson Creek and are relatively sessile. Samples will be frozen as soon as practicable after capture and sent to an accredited laboratory for analysis.

10.6.6 Metal Mining Effluent Regulations - Environmental Effects Monitoring

Federal effluent regulations for the metal mining industry (Metal Mining Effluent Regulations of the *Fisheries Act*) came into effect in June 2002 and were last updated in May 2016 (Government of

Canada, 2016). These regulations, administered under the federal *Fisheries Act*, apply to mining and milling operations that discharge effluent(s) at a rate greater than 50 m^3/day. The MMER outline requirements for routine effluent monitoring, acute lethality testing, and EEM. The objective of EEM is to determine whether mining activity is causing an effect on fish, benthic invertebrate communities and/or the use of fisheries resources (based on mercury accumulation in fish tissues). Once the Project becomes subject to the MMER (i.e., when the operation begins discharging effluent at more than 50 m^3/day), BMC must initiate a sublethal toxicity testing program (initially at a quarterly frequency for at least the first two years, followed by semi-annual sampling thereafter) on two plant species, one invertebrate and fish embryo, and submit a study design for undertaking an EEM program for fish and benthic invertebrates within one year. The study design must also be submitted at least 6 months prior to conducting the program. The study design will follow guidance provided by the "Metal Mining Technical Guidance for EEM" (Government of Canada, 2016). With respect to aquatic resource monitoring, BMC will be required to undertake studies every 3 years to monitor effects from mining operations on the fish and benthic invertebrate communities downstream of its effluent discharge point. The annual Fish Monitoring Program described above will serve to support the requirements under EEM, but an EEM specific study on fish will have to be developed for each 3-year cycle. However, with respect to benthic invertebrates, the biennial monitoring program is consistent with WUL requirements; however, the EEM program will need to be slightly more intensive and robust. Therefore, in years that the WUL benthic sampling program described above align with EEM only the EEM program will be conducted.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

11 TERRAIN AND SOILS 11-1

11.1 ASSESSMENT APPROACH 11-1
11.1.1 Selection of Subcomponents and Measurable Parameters 11-1
11.1.2 Criteria for Assessing Significance 11-2
11.2 ASSESSMENT BOUNDARIES 11-5
11.3 EXISTING CONDITIONS 11-7
11.3.1 Regional Setting 11-7
11.3.2 Glacial History 11-8
11.3.3 Surficial Geology 11-8
11.3.4 Permafrost Conditions 11-12
11.3.5 Terrain Analysis 11-12
11.3.6 Ground Conditions at Sites of Proposed Facilities 11-15
11.3.7 Soil Development 11-21
11.3.8 Metals in Soil 11-22
11.3.9 Soil Nutrients 11-22
11.4 PROJECT-SPECIFIC EFFECTS 11-22
11.4.1 Effects Characterization 11-22
11.4.2 Mitigation Measures 11-26
11.4.3 Residual Effects and Significance Determination 11-30
11.5 CUMULATIVE EFFECTS 11-32
11.5.1 Cumulative Effects Characterization 11-32
11.6 EFFECTS MONITORING 11-33

LIST OF TABLES

Table 11-1: Terrain and Soils VC Subcomponents and Measurable Parameters 11-2
Table 11-2: Terrain Significance Criteria Definition 11-3
Table 11-3: Soils Significance Criteria Definition 11-4
Table 11-4: Study Areas for Terrain and Soils 11-7
Table 11-5: Interaction Matrix for the Terrain and Soil VC 11-23
Table 11-6: Identified Potential Project Effects for the Terrain and Soil VC 11-25
Table 11-7: Proposed Mitigation Measures for Terrain and Soil VC 11-29
Table 11-8: Project Effects Significance Assessment for Terrain and Soil VC 11-31
Table 11-9: Cumulative Effects Screening for Terrain and Soils VC 11-32

LIST OF FIGURES

Figure 11-1: Terrain and Soil Study Area 11-6
Figure 11-2: Surficial Geology Project Area 11-10
Figure 11-3: Surficial Geology along Tote Road/Proposed Access Road and Finlayson Lake Airstrip ... 11-11
Figure 11-4: Slope Angle Map 11-13
Figure 11-5: Terrain Analysis 11-14
Figure 11-6: Site Investigations and Approximate Permafrost Boundary Sheet 1 of 2 11-17
Figure 11-7: Site Investigations and Approximate Permafrost Boundary Sheet 2 of 2 11-18

11 TERRAIN AND SOILS

This chapter provides an overview of the existing terrain and soils conditions and assessment of the potential Project effects on terrain and soils. Terrain and soils are closely interrelated and are considered as a single Valued Component (VC) for the Project, as they are vital to the landscape and ecosystems that support aquatic, biophysical, and human environments.

Project activities for Project development and operations have the potential to affect the terrain and soil VC. Site preparation and clearing will alter the quantity and quality of underlying soil resources, as well as possibly result in changes to local terrain. Yukon residents place value on terrain and soils as integral aspects of ecosystems. This chapter outlines the potential effects, measures to mitigate these effects, and determines if there are any overall significant residual effects from the Project on the terrain and soil VC.

11.1 ASSESSMENT APPROACH

The terrain and soils EA will generally follow the methods outlined in Chapter 5.

Desk-based research was conducted to identify Kaska knowledge, uses, interests, and values related to terrain and soils; however, none was available from publicly available secondary sources. Ongoing future Traditional Knowledge (TK) data collection efforts as well as consultation and engagement activities within the Ross River Dena Council, as representatives of the Kaska First Nation, may result in additional information and understanding on this issue.

11.1.1 Selection of Subcomponents and Measurable Parameters

The terrain and soils subcomponents and measurable parameters are provided in Table 11-1.

Yukon residents place value on terrain and soils as integral aspects of ecosystems. Terrain stability was selected as a subcomponent not only due to this concern from Yukoners, but also as it is a key aspect of the mine design. Changes in terrain stability, as a result of the Project, may cause events that affect other VCs.

The Project may affect the volume of ecologically functioning soil available, as well as soil quality. In addition, availability of suitable soils for reclamation is directly relevant to the development of an effective closure and reclamation plan.

Table 11-1: Terrain and Soils VC Subcomponents and Measurable Parameters

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Terrain and Soils	Terrain	Terrain stability	Change in terrain stability to result in a greater area of unstable terrain conditions compared to existing conditions	Threshold is set to avoid introduction of new terrain hazards in the area
	Soils	Topsoil Quantity	Permanent loss of soil under Project footprint does not exceed 25% of maximum extent of the Project Footprint	Threshold is set to evaluate area permanently lost under Project components and ensure majority of soil quantity potentially lost to Project components during operations is salvaged and used for reclamation
		Topsoil Quality	Comparison of topsoil quality to regulatory guideline values	CCME Guidelines 2007 (Canadian Soil Quality Guidelines for Protection of Human Health)

The potential effects on terrain will be evaluated by comparing the existing terrain conditions to predicted changes to terrain stability from mine development and operations. The assessment of the predicted changes will take into consideration potential for permafrost thaw and increased risk of terrain hazards as a result of clearing. The potential effects considered for soils include the changes to soil properties that may affect availability and suitability of soils for reclamation activities.

11.1.2 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and

- Environmental and socio-economic context: the ability of the VC to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for terrain and soils are presented in Table 11-2 and Table 11-3.

Table 11-2: Terrain Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
	Adverse	VC would change for the worse
Magnitude	Low	Minor change in terrain stability relative to existing conditions (i.e., within baseline range of the assessment)
	Moderate	Terrain stability changes from stable to potentially unstable
	High	Terrain stability changes to unstable
Geographic Extent	Site	Effect limited to the Project Footprint
	Local	Effect extending beyond the Project Footprint but within the regional area
	Regional	Effect extending across the regional study area
	Beyond Regional	Effect that extends beyond the regional study area, across Yukon or beyond
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent Project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)

Criteria	Definition	
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Economic and Social Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

Table 11-3: Soils Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
	Adverse	VC would change for the worse
Magnitude	Low	**Topsoil quantity**: Some soil is permanently lost under Project Footprint but the loss is equal to or less than 10% of the maximum extent of the Project Footprint **Topsoil quality**: Changes to soil metal and non-metal concentrations are within the natural variability and below Yukon soil quality standards under the *Environment Act* or site-specific target concentrations where existing concentrations exceed Yukon soil quality standards
	Moderate	**Topsoil quantity**: Some soil is permanently lost under Project Footprint and the loss is greater than 10% but equal to or less than 25% of the maximum extent of the Project Footprint **Topsoil quality**: Changes to soil metal and non-metal concentrations that are above the limits of natural variation but below Yukon soil quality standards under the *Environment Act* or site-specific target concentrations where existing concentrations exceed Yukon soil quality standards
	High	**Topsoil quantity**: Some soil is permanently lost under Project Footprint and the loss is greater than 25% of the maximum extent of the Project Footprint **Topsoil quality**: Changes to soil metal and non-metal concentrations that are above Yukon soil quality standards under the *Environment Act* or site-specific target concentrations where existing concentrations exceed Yukon soil quality standards
Geographic Extent	Site	Effect limited to the Project Footprint
	Local	Effect extending beyond the Project Footprint but within the local study area
	Regional	Effect extending across the regional study area
	Beyond Regional	Effect that extends beyond the regional study area, across Yukon or beyond
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent Project phases or into post-closure phase (11 to 25 years)

Criteria	Definition	
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Economic and Social Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

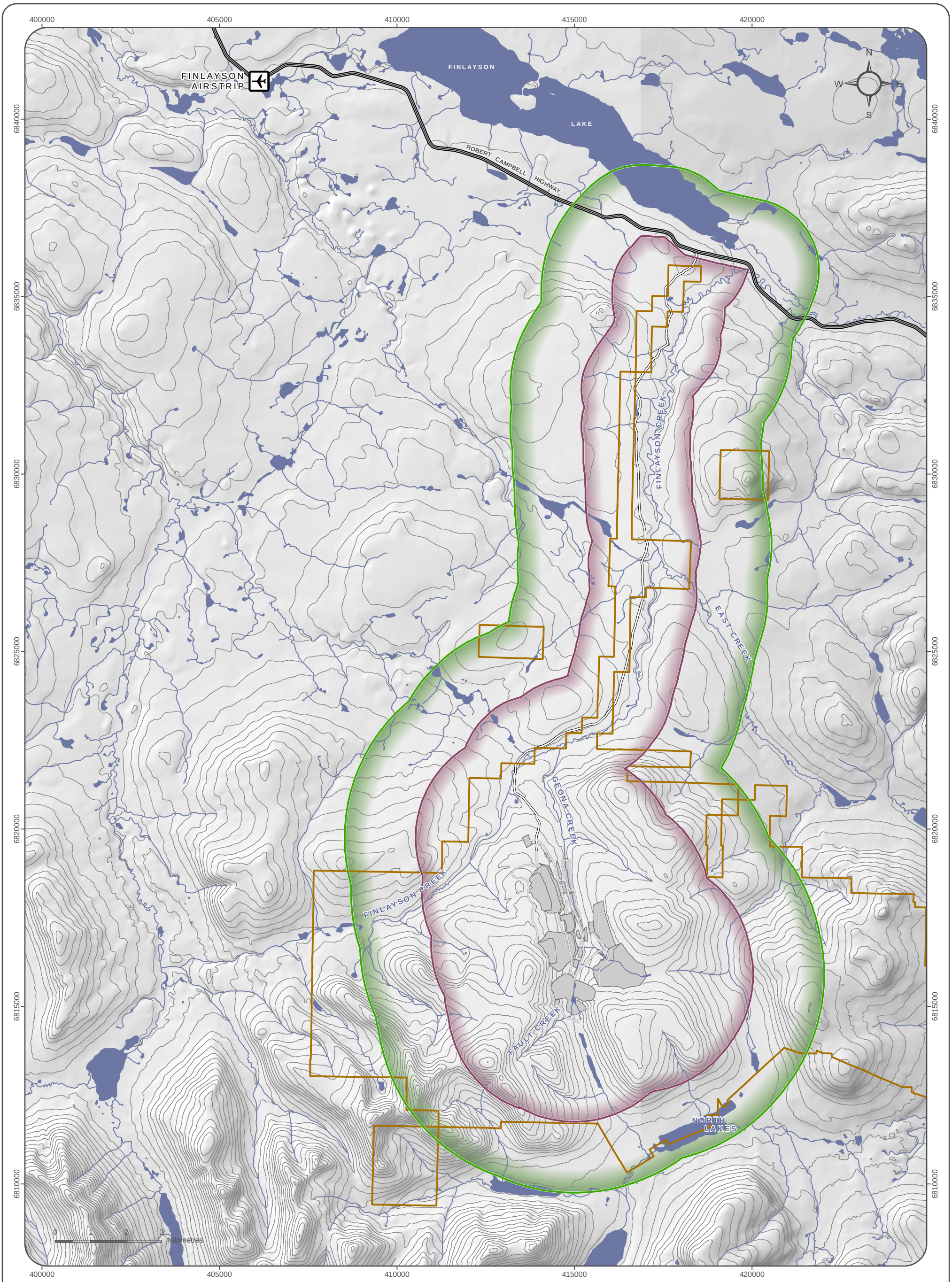
A significant effect is considered to occur if it is adverse, of high magnitude and extends across the regional study area, or is adverse, of high magnitude within the local study area and occurs over the long term.

11.2 ASSESSMENT BOUNDARIES

The local and regional study areas (LSA and RSA) for terrain and soils are described in Table 11-4 and are shown in Figure 11-1.

The LSA encompasses the entire Project Footprint which includes all mine features and clearing areas, including the Access Road and Finlayson Lake airstrip. The total area of the LSA is 12,440.5 ha, while the Project Footprint including infrastructure and mine features is 655.6 ha.

The RSA encompasses the LSA and a 2 km buffer surrounding the LSA.



Finlayson Lake Airstrip Location

Local Study Area

Regional Study Area

Location of Proposed Mine Infrastructure

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Tote Road/Proposed Access Road

Proposed Mine Road

Contour (40 m interval)

Watercourse

Waterbody

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KUDZ ZE KAYAH PROJECT

FIGURE 11-1

TERRAIN AND SOIL STUDY AREA

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Table 11-4: Study Areas for Terrain and Soils

Study Area	Terrain and Soils Specific Study Area Description
Local Study Area	The local study area encompasses all the Project infrastructure, including the Access Road and the Finlayson Lake airstrip.
Regional Study Area	The regional study area includes a 2 km buffer around the LSA.

The temporal boundaries below are used for the assessment of Project effects on terrain and soils:

- **Construction Phase**: approximately 2-year period including site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: approximately 10-year period including open pit and underground mining and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as closure phase): approximately 3-year period for decommissioning, reclamation and closure; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required; the phase is split into two periods: a transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.

11.3 EXISTING CONDITIONS

This section presents a summary of existing environmental conditions as they relate to the terrain and soils VC. The characterization of the existing environment serves as the baseline against which the effects of the Project are assessed. The description of the existing environment has been focussed on those components of the environment that may be affected by the Project.

The description of the existing environment for the terrain and soils VC is based on the review of existing literature and the results of the historic and current field programs conducted for the Project. The following sections provide the summary descriptions of the field programs with the detail provided in the various reports describing the baseline conditions including Appendix C-2 (Mill Site Area Geotechnical Characterization); Appendix C-3 (Kudz Ze Kayah Prefeasibility Study - Geotechnical Site Characterization Summary); Appendix C-4 (Kudz Ze Kayah Prefeasibility Study - Class A Storage Facility Stability Assessment); Appendix C-6 (Kudz Ze Kayah Prefeasibility Study - Updated Design Class B, C and Overburden Stockpile); Appendix E-5 (Findings of Terrain Analysis), as well as the Vegetation and Soils (including TEM) baseline report (Appendix E-6).

11.3.1 Regional Setting

Elevation within the Project area ranges from 1,000 masl at the beginning of the Tote Road (at the Robert Campbell Highway) to 2,040 masl at the southwestern extent of the Geona Creek catchment. The Tote Road gradually climbs through a gently rolling plateau that is networked with small creeks and wetland complexes. East of the road is a large steep sided ravine in which Finlayson

Creek lies. Once the road crosses the Finlayson Creek (approximately 17.5 km) it climbs into the Pelly Mountain Range foothills which are characterized by rounded glaciated mountains.

The Project is situated within the upper Geona Creek valley, which is surrounded by larger steeper sided mountain slopes. A series of shallow wetlands occur along Geona Creek due to historical beaver dams in the valley bottom. Side valleys east of the Geona Valley are relatively broad and 'U-shaped". Tributaries such as Fault Creek, are high velocity streams that have incised the mountain slopes depositing sediment into Geona Creek (Appendix E-6).

The Project area is within the Extensive Discontinuous Permafrost Zone (Yukon Permafrost Network, 2016). Permafrost is commonly encountered under the organic layers that cover the Geona and upper Finlayson valleys. Permafrost is typically located under poorly drained areas, in cool aspects and upper elevations. Permafrost related ground movement or solifluction is apparent on upper to middle elevation slopes.

11.3.2 Glacial History

The landscape covering the Project was formed by past glacial and interglacial activity that occurred during the Quaternary period over the last 2 million years. The most recent ice advances include the Reid glaciation that occurred at least 200,000 years ago and the McConnell glaciation that occurred 25,000 to 17,000 years ago, which shaped the surface features and deposits of the area. Late glacial deposition of glaciofluvial sediment and melt out till is common in the Finlayson valley area (Bond, 2000).

The mountains immediate to the Project are rounded; exposed bedrock shows striations caused by the wear of glacial movement. One sharp edged peak, that is located at the head of Fault Creek, may have existed above the ice cap. It is more characteristic of the taller peaks of the Saint Cyr range of the Pelly Mountains, found south of the Project.

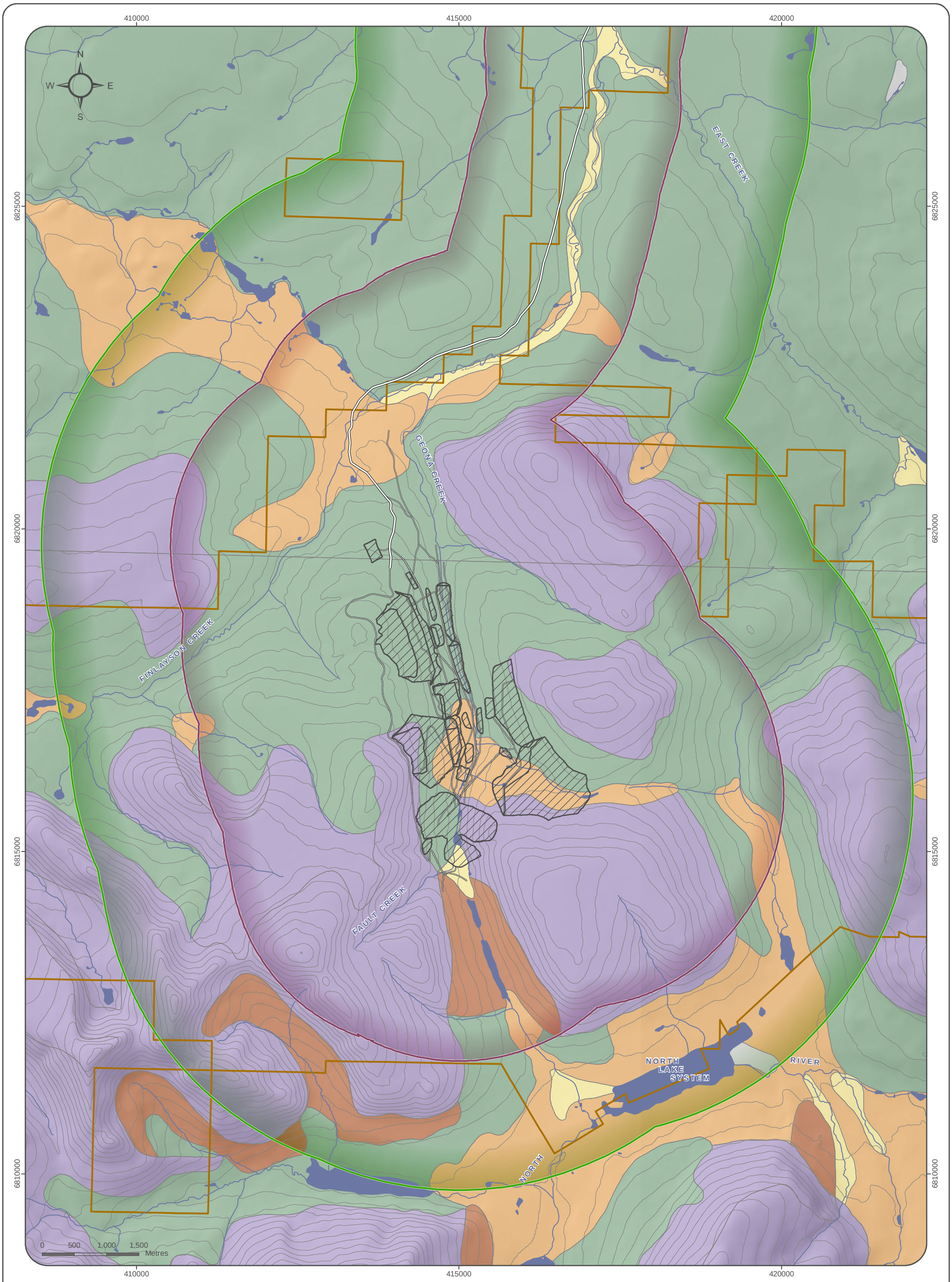
11.3.3 Surficial Geology

Glacial, periglacial (ice related), and fluvial processes are the main processes that have been involved in the creation of landforms and are the origin of surficial deposits in the Project area (Norecol, Dames & Moore Ltd., 1996). The main surficial deposits in the area are as follows:

- Alluvial deposits – geologically recent and result from water processes reworking the sediments deposited during the last ice age.
- Glaciofluvial deposits – the result of water processes from the melting of glaciers and ice sheets. The valley bottoms are infilled generally with sand and gravel deposits from alluvial and glaciofluvial processes to depths of up to 20 m. There are some glaciofluvial deposits on the west side of Geona Creek near the confluence with Finlayson Creek where a deposit in excess of 40 m thick is present.
- Glacial till deposits – the result of the direct glacial action. These silty sand and gravel deposits overlie much of the area, ranging in thickness from less than 1 m to up to 10 m. The thickness of these deposits generally decreases with increasing elevation.

- Colluvium deposits – the result of frost loosening of bedrock which is then transported by debris and avalanche flows to the base of steep slopes.
- Organic material – generally less than 0.5 m thick overlies colluvium and glacial till deposits.

Surficial geology maps for the LSA and RSA based on information from the Yukon Geological Survey are presented in Figure 11-2 and Figure 11-3.



Surficial Material

- Colluvium
- Fluvial Active
- Glaciofluvial
- Morainal
- Organic
- Bedrock

- Local Study Area
- Regional Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse

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FIGURE 11-2

SURFICIAL GEOLOGY PROJECT AREA

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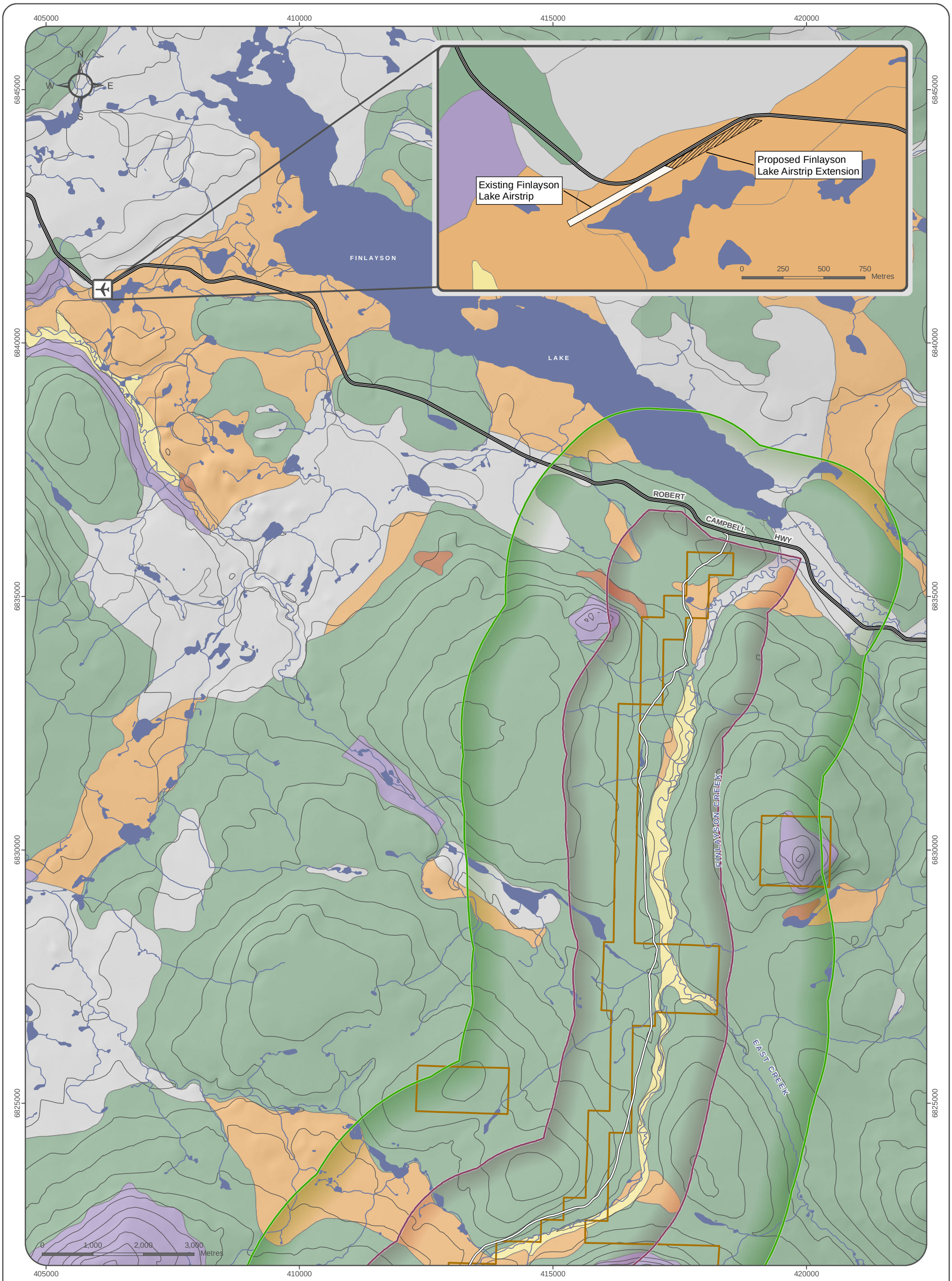

Surfical Material

- Colluvium
- Fluvial
- Glaciofluvial
- Morainal
- Organic
- Bedrock
- Local Study
- Regional Study
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Waterbody
- Tote Road/Proposed Access Road
- Contour (40 m interval)
- Watercourse

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FIGURE 11-3
SURFICIAL GEOLOGY ALONG TOTE ROAD/PROPOSED ACCESS ROAD AND FINLAYSON LAKE AIRSTRIP

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11.3.4 Permafrost Conditions

Permafrost is present on north and west facing slopes, especially above 1,400 masl elevation, although permafrost has been observed as low as 1,250 masl. Permafrost related ground movement or solifluction is present on slopes steeper than about 4H:1V (Norecol, Dames & Moore Ltd., 1996).

Site investigations, comprising test pitting and boreholes, were carried out at the site in 1995 and 1996. Additional site investigations, including test pitting, boreholes and installation of thermistors was carried out by Knight Piésold in 2015 and 2016 (Knight Piésold Ltd., 2016a).

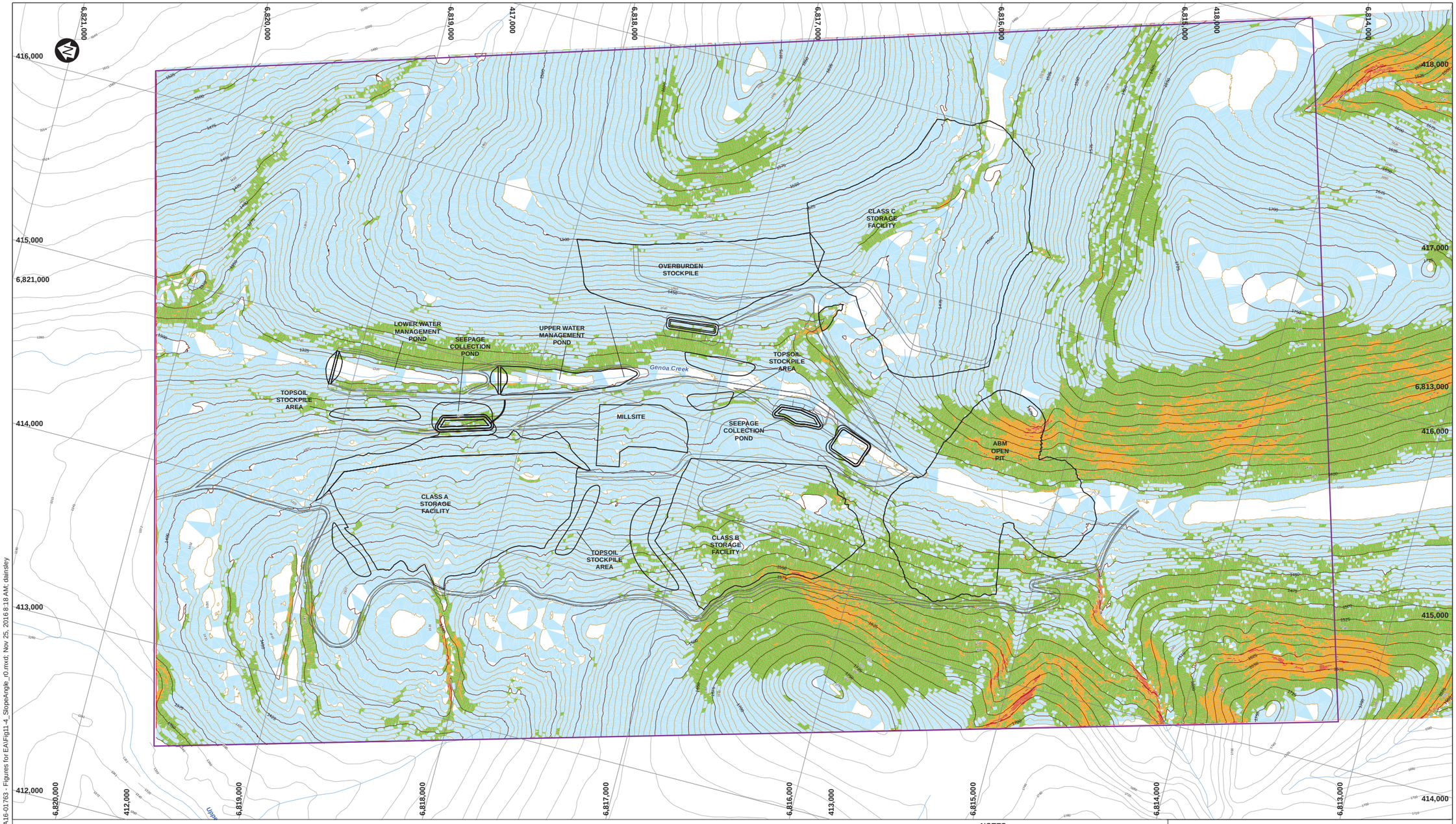
The 1995/1996 field program found 35 test pits that encountered permafrost; a further 40 test pits observed ice lenses and ice segregation, which was interpreted as an active layer rather than permafrost. Permafrost was not identified in any of the 2016 thermistors, however frozen soil and ice were encountered in samples at ~1.5 m and 5.0 m from a drill hole within the Class C Storage Facility footprint. Additionally, a monitoring well installed in the Class A Storage Facility area was discovered to be frozen in the bedrock at ~6 m below ground surface (Knight Piésold Ltd., 2016a).

11.3.5 Terrain Analysis

Knight Piésold completed a terrain analysis of the Project area (Appendix E-5). From this analysis, slope angles in the Project Footprint were determined to generally be classed as gentle (Figure 11-4). The steepest terrain is in the southwest part of the Project Footprint where the slopes are predominantly moderately inclined and locally moderately steep. Moderately steep to steep slopes occur along two gullies upslope from the site of the ABM open pit, and a band of moderate slopes occurs at the toe of the east side of the Geona Creek Valley.

The terrain analysis identified a range of landforms in the Project Footprint including hummocky moraines, kames, kettles, eskers, pro-glacial meltwater corridors, glaciofluvial terrace, solifluction lobes, patterned ground (stripes) and thaw lakes (Figure 11-5). The findings of the 1995/1996 and 2016 test pits were used to confirm aspects of the terrain analysis.

The predominantly hummocky nature of the glaciated topography and the absence of glacial flutings (low linear ridges) supports the concept of the area representing ice-contact glaciofluvial deposits (kames) and associated Ablation Till. Both of these geological materials were deposited when glacier ice stagnated and melted. Ablation Till and kames are predominantly cohesionless soils, which nonetheless, have some fines. Within the vicinity of the ABM open pit a few small eskers were identified as well as a glaciofluvial terrace at the east side of the Geona Creek valley floor. These units usually are comprised of sands and gravels with only minor fines.



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LEGEND

GENERAL

- CONTOUR (5 M)
- CONTOUR (20 M)
- RIVER/CREEK
- STUDY AREA
- PROPOSED MINE FACILITIES

SLOPE ANGLE

- 0 - 5% (PLAIN: 0 - 3 DEGREES)
- 6 - 26% (GENTLE: 4 - 15 DEGREES)
- 27 - 49% (MODERATE: 16 - 26 DEGREES)
- 50 - 70% (MODERATELY STEEP: 27 - 35 DEGREES)
- >70% (STEEP: >35 DEGREES)

0 0.1 0.2 0.4 0.6 0.8 1 1.2 km

ISSUED FOR INFORMATION

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	24NOV'16	ISSUED FOR INFORMATION	JEH	KK	LJG

NOTES:

1. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 9N.

2. THE CONTOUR DATA IS 5 METRES LIDAR CONTOURS INSIDE THE STUDY AREA AND 20 METRES GEOYUKON CONTOURS OUTSIDE THE STUDY AREA. (HTTP://MAPSERVICES.GOV.YK.CA/GEOYUKON).

3. THIS MAP IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 24X36 ("D" SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

4. FACILITIES TAKEN FROM A PROJECT GENERATED ARRANGEMENT PLAN DATED NOVEMBER 16, 2016.

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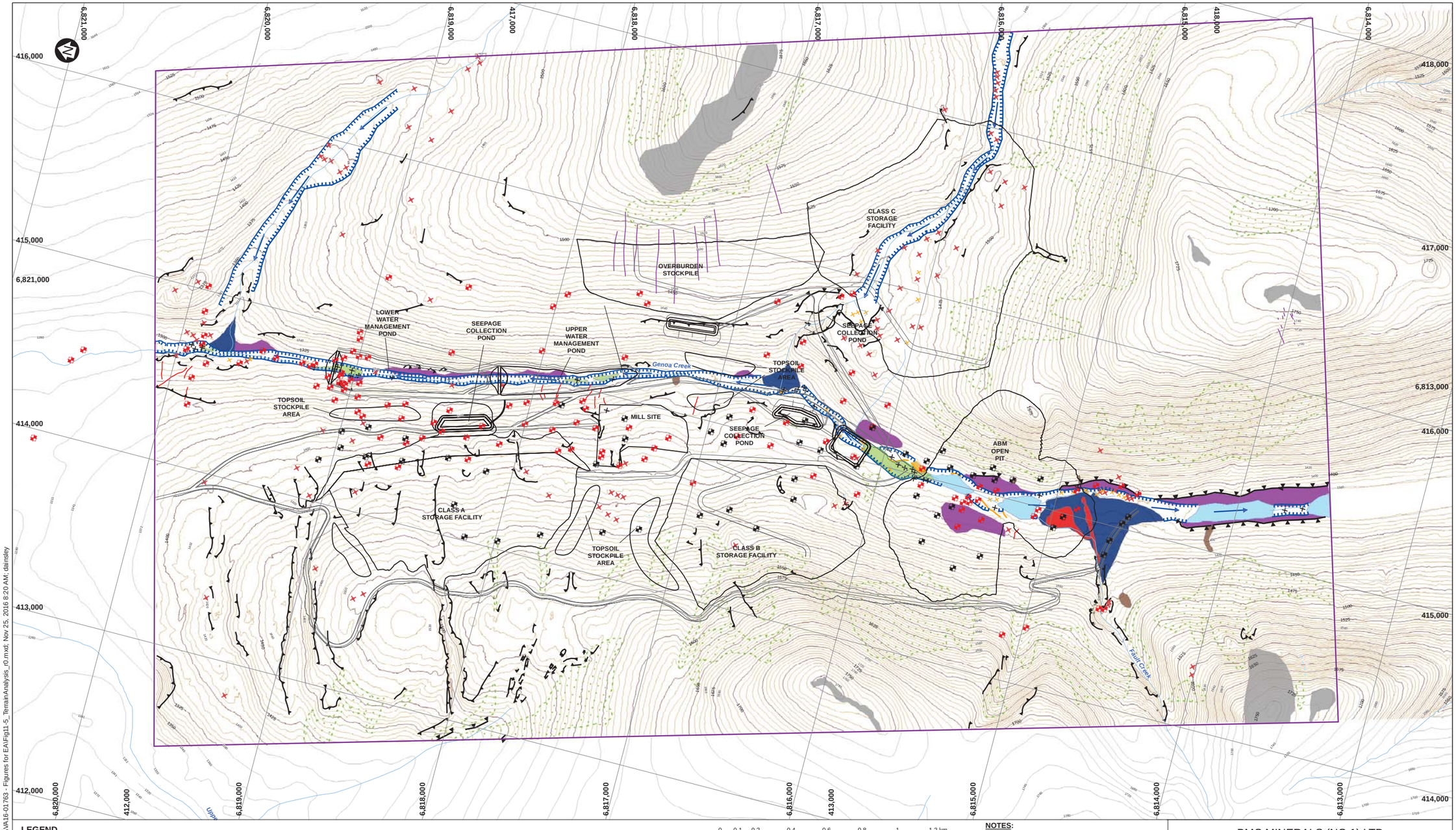
KUDZ ZE KAYAH PROJECT

SLOPE ANGLE MAP

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-640/2	VA16-01763

FIGURE 11-4 REV 0



LEGEND

GENERAL
- TESTPIT 2016
- TESTPIT PRIOR TO 2016
- CONTOUR (5 M)
- CONTOUR (20 M)
- RIVER/CREEK
- STUDY AREA
- PROPOSED MINE FACILITIES

TERRAIN FEATURES
- CONVEX SLOPE BREAK
- CONCAVE SLOPE BREAK
- STRIPES
- MELTWATER CORRIDOR
- ORGANIC SWAMP
- ALLUVIAL FAN
- LAKE DEPOSIT
- COLLUVIAL APRON
- GLACIOFLUVIAL TERRACE
- BEDROCK KNOLL OR RIDGE

TERRAIN HAZARDS
- GULLY EROSION
- RECENT DEBRIS FLOOD DEPOSIT
- RECENT DEBRIS SLIDE
- DEBRIS SLIDE
- THERMAL EROSION
- THAW LAKE
- SOLIFLUCTED SLOPE

LANDFORMS
- ESKER
- KAME
- KETTLE

0 0.1 0.2 0.4 0.6 0.8 1 1.2 km

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	24NOV16	ISSUED FOR INFORMATION	JEH	KK	LJG

ISSUED FOR INFORMATION

NOTES:

1. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 9N.

2. THE CONTOUR DATA IS 5 METRES LIDAR CONTOURS INSIDE THE STUDY AREA AND 20 METRES GEOYUKON CONTOURS OUTSIDE THE STUDY AREA. (HTTP://MAPSERVICES.GOV.YK.CA/GEOYUKON).

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4. FACILITIES TAKEN FROM A PROJECT GENERATED ARRANGEMENT PLAN DATED NOVEMBER 16, 2016.

BMC MINERALS (NO.1) LTD

KUDZ ZE KAYEH PROJECT

TERRAIN ANALYSIS MAP

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-640/2	VA16-01763

FIGURE 11-5 REV 0

0 0.1 0.2 0.4 0.6 0.8 1 1.2 km

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Three pro-glacial meltwater corridors (meltwater channels formed in front of a retreating ice sheet) were delineated in the mapping; a north-south corridor along Geona Creek and two west northwest oriented corridors, which intersect the Geona Creek corridor from the east. It is interpreted that glaciofluvial sands and gravels occur along these corridors. Along the Geona Creek Meltwater Corridor, the glaciofluvial deposits are overlain by lake deposits and organic swamp deposits as well as alluvium deposited by Geona Creek. Three alluvial fans have developed at the confluence of tributary drainage lines with Geona Creek. Bedrock outcrops primarily in hill-top settings (Appendix E-5).

Although the terrain is predominantly gently inclined, the terrain analysis highlighted local geohazards including four debris slides on moderate slopes adjacent to Geona Creek. These landslides may have been caused in part by permafrost degradation. One relict debris slide and four recent debris slides were mapped on the moderate to moderately steep slopes of the Fault Creek gully in the southwest part of the Project Footprint. The gully terminates in a broad alluvial fan, approximately 700 m wide. 1995 ortho-imagery shows evidence of a recent debris flood on this fan; the fan and debris flood deposit extend into the footprint area of the proposed ABM open pit (Appendix E-5).

The terrain analysis confirmed permafrost and periglacial processes across the Project Footprint with permafrost distribution partly controlled by slope aspect with the sheltered north-facing slopes being the most prone to having permafrost (see Figure 11-6 and Figure 11-7) (Knight Piésold, 2016b). Extensive areas of solifluction were mapped on the upper and middle slopes. Solifluction comprises seasonal downslope creep of the active layer. The footprints of the proposed ABM open pit, the three proposed waste storage facilities, and one of the proposed Topsoil Stockpile areas all extend into the areas of solifluction. Stripes extend down slope into the footprint area of the proposed Overburden Stockpile. These features are likely to be preferential flowpaths for near-surface water. Thaw lakes on the Geona Creek Valley floor and thermal erosion on the lower slopes on the west side of the valley provide local evidence of permafrost degradation. The 1995/1996 site investigations found permafrost to be more extensive along the portion of the drainage line in the north part of the LSA where the valley floor has a northerly aspect (Appendix E-5).

11.3.6 Ground Conditions at Sites of Proposed Facilities

11.3.6.1 Class A and B Storage Facilities

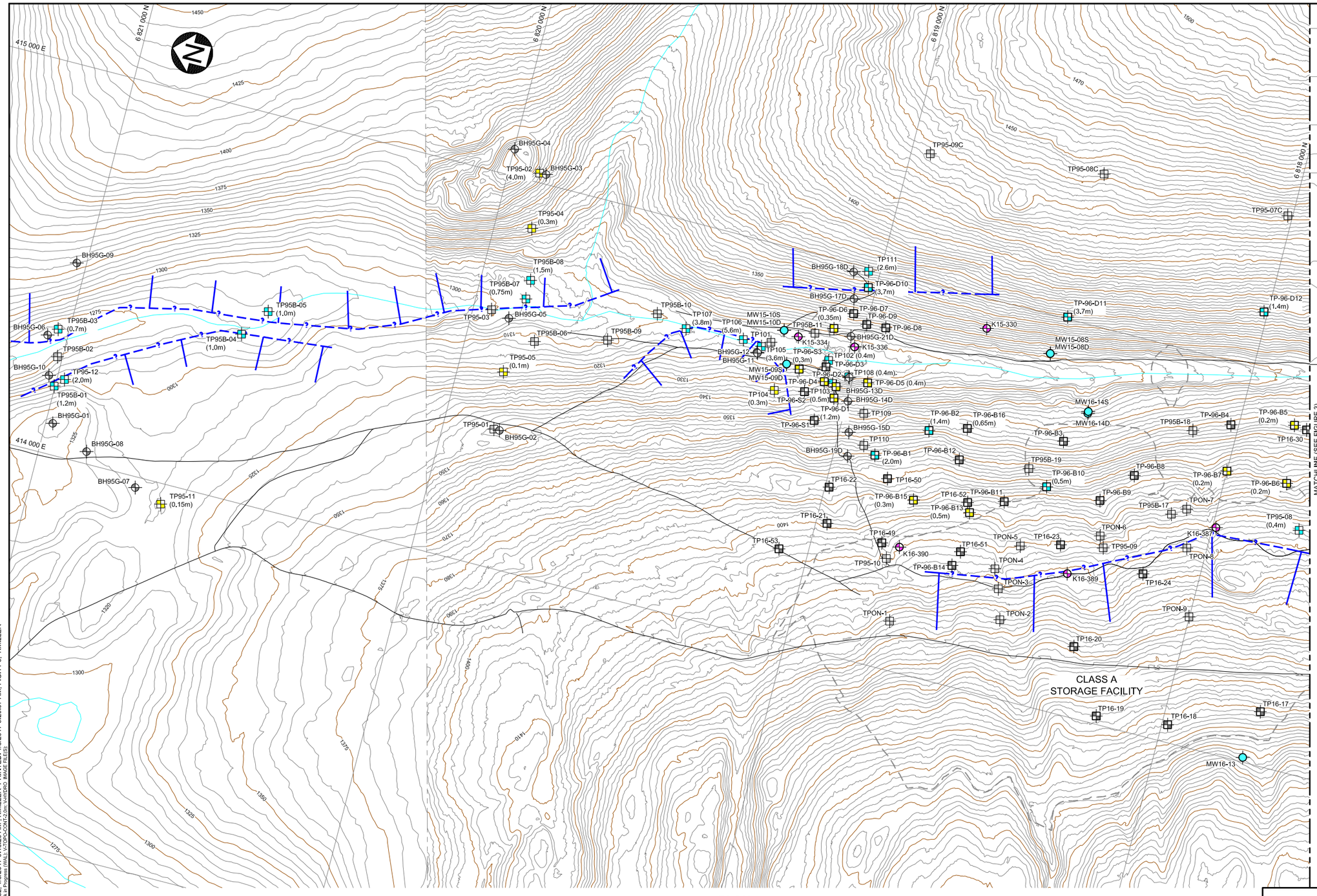
The Class A and B Storage Facilities are located on the western slopes of the Geona Creek valley. The terrain analysis indicates the surficial geology in the area to be mainly Ablation Till, with kames within the footprints of the facilities. The Ablation till is composed of loose to compact silty sandy gravel with cobbles, with occasional localized pockets of fine-grained silts and clays, and was found to be locally frozen in the test pits undertaken in the toe area of the north part of the footprint of the Class A Storage Facility. 2016 test pits within the footprint of the Class A Storage Facility, encountered weathered bedrock within 1 m of ground surface. Highly weathered bedrock was encountered within 1 m of ground surface, locally, in previous test pits undertaken at the sites of

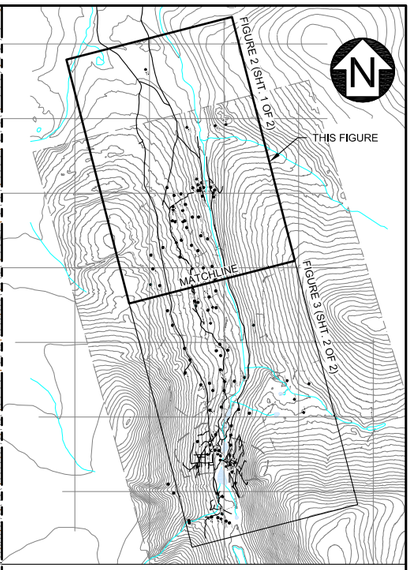
the Seepage Collection ponds down slope from the site of the Class B Storage Facility (Appendix E-5).

Frozen ground conditions at 1.7 m and 3.3 m were observed in test pits downgradient of the ROM pad area and in another on the northern side of the Class B Storage Facility. A test pit within the ROM pad area also showed evidence of ice lenses (Knight Piésold, 2016b).

The glacial soils in the footprint areas of the Seepage Collection Ponds, which are proposed to be sited down slope from each Storage Facility, have been found to include slightly less fines. Local kame deposits were identified at the site of the Class B Seepage Collection Pond, and the south part of the footprint of the Class B Seepage Collection Pond impinges on an organic swamp.

The terrain analysis identified soliflucted slopes in the upslope (west) part of the footprint of the Class B Storage Facility. Two solifluction lobes impinge on the southwest part of the footprint of the Class A Storage Facility. The material encountered in Test Pit TP 16-18 into the toe of one of the lobes comprised sand and gravel with some clay and trace cobbles and boulders. The upslope portion of the footprint of the southern Topsoil Stockpile Area crosses a solifluction lobe. Possible thermal erosion features were mapped down slope and to the east of the site of the Class A Storage Facility. Gully erosion was mapped, locally, in the south part of the footprint of the Class B Storage Facility.





KEY PLAN
NTS

LEGEND:

- GROUNDWATER MONITORING WELL (TETRA TECH)
- GEOTECHNICAL DRILLHOLE (KNIGHT PIESOLD)
- PREVIOUS DRILLHOLE (GOLDER)
- TEST PIT (KNIGHT PIESOLD)
- TEST PIT (GOLDER)
- (1.8m) TEST PIT THAT ENCOUNTERED PERMAFROST & DEPTH
- (0.7m) TEST PIT THAT ENCOUNTERED ACTIVE LAYER & DEPTH
- PERMAFROST LINE (GOLDER 1995)
- TRAIL

NOTES:

1. COORDINATE GRID IS UTM NAD 83 9N.
2. TOPOGRAPHIC DETAIL BASED ON INFORMATION PROVIDED BY BMC FEBRUARY 02, 2016.
3. CONTOUR INTERVAL IS 2 METRES.
4. ALL ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

PLAN
SCALE A

SCALE A: 100 50 0 100 200 300 400 500 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	03JAN'17	ISSUED WITH TRANSMITTAL	JAS	KJM	LJG

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SITE INVESTIGATIONS AND APPROXIMATE PERMAFROST BOUNDARY SHEET 1 OF 2

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-640/2	VA17-00001

FIGURE 11-6 REV 0

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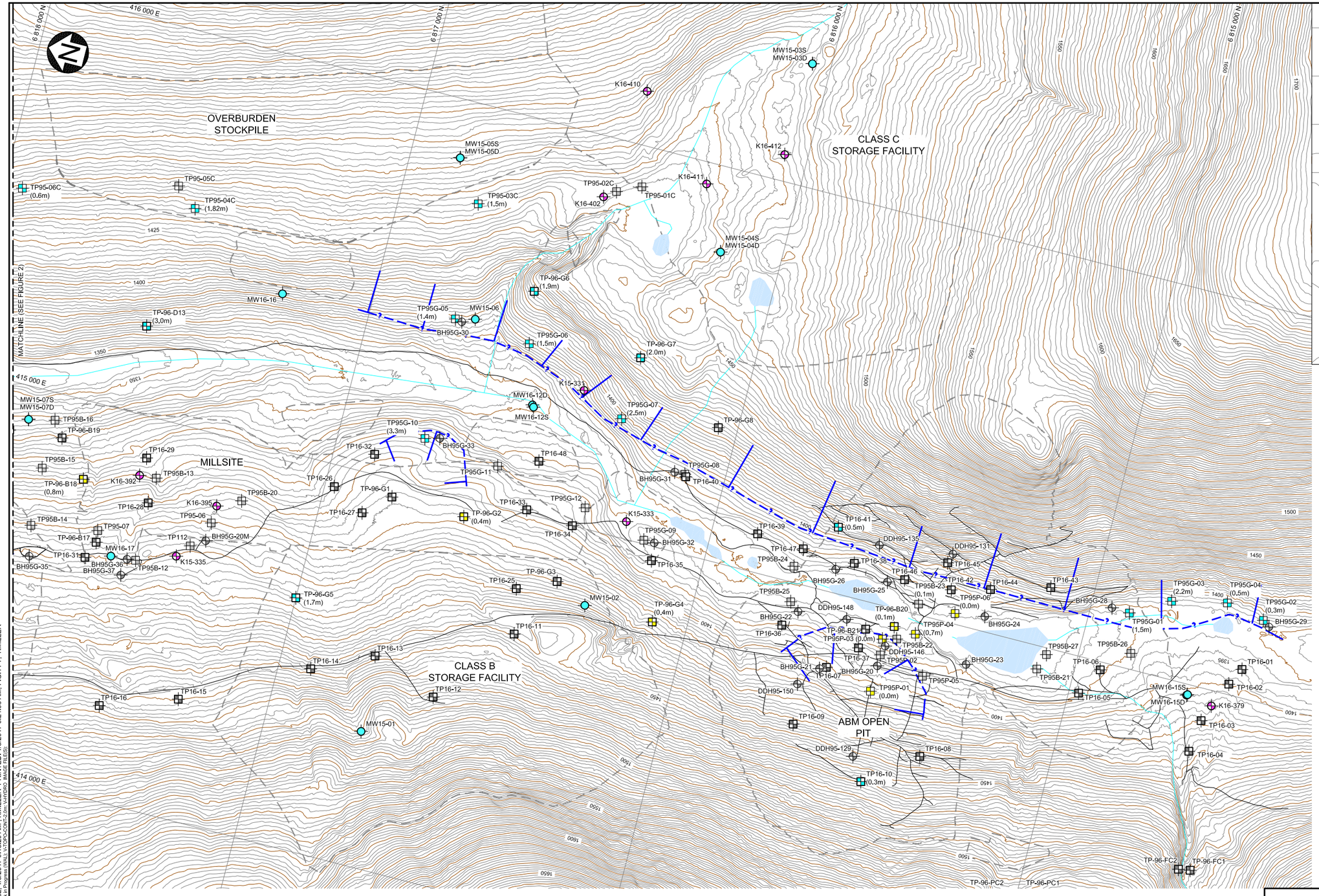

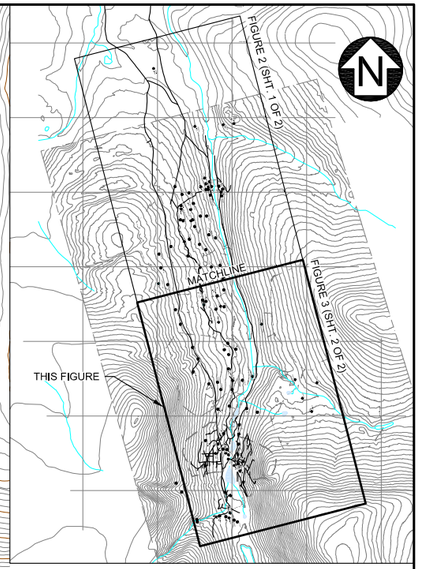

KEY PLAN
NTS

LEGEND:

- GROUNDWATER MONITORING WELL (TETRA TECH)
- GEOTECHNICAL DRILLHOLE (KNIGHT PIESOLD)
- PREVIOUS DRILLHOLE (GOLDER)
- TEST PIT (KNIGHT PIESOLD)
- TEST PIT (GOLDER)
- (1.8m) TEST PIT THAT ENCOUNTERED PERMAFROST & DEPTH
- (0.7m) TEST PIT THAT ENCOUNTERED ACTIVE LAYER & DEPTH
- PERMAFROST LINE (GOLDER 1995)
- TRAIL

NOTES:

1. COORDINATE GRID IS UTM NAD 83 9N.
2. TOPOGRAPHIC DETAIL BASED ON INFORMATION PROVIDED BY BMC FEBRUARY 02, 2016.
3. CONTOUR INTERVAL IS 2 METRES.
4. ALL ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

PLAN
SCALE A

SCALE A 100 50 0 100 200 300 400 500 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	03JAN'17	ISSUED WITH TRANSMITTAL	JAS	KJM	LJG

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KUDZ ZE KAYAH PROJECT

SITE INVESTIGATIONS AND APPROXIMATE PERMAFROST BOUNDARY SHEET 2 OF 2

Knight Piésold CONSULTING

P/A NO. VA101-640/2

REF NO. VA17-00001

FIGURE 11-7

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11.3.6.2 Class C Storage Facility

The Class C Storage Facility is located in a small valley offshoot along the east slopes of the Geona Creek valley at the southern end. The terrain analysis shows the surficial geology of the site to be Ablation Till; limited existing site investigation information confirms this interpretation. Two test pits taken in 1995 encountered silty sand with gravel and minor cobbles and boulders. (Appendix E -5).

A meltwater corridor oriented towards the west-northwest crosses the footprint of the proposed facility. It is interpreted that glaciofluvial sands and gravels occur along this corridor and that the glaciofluvial sands and gravels extend beneath the footprint of the Seepage Collection Pond. These deposits were not ground-proofed in the previous site investigation. Abundant kames and kettles were mapped on the lower slopes adjacent to the drainage line especially on the south side of the valley. These landforms are characteristic of ice-contact glaciofluvial deposits. The particle size distribution of these soils is likely to be somewhat similar to that of the Ablation Till.

The 1995 test pits undertaken at the footprint of the proposed facility did not encounter permafrost. Test pits undertaken in 1995 in Ablation Till soils to the northwest did, however, encounter permafrost. Hole K16-410 drilled on the northern side of the Class C Storage Facility encountered frozen soil and ice at approximately 1.5 and 5 m depth (Knight Piésold Ltd., 2016b). It is interpreted that slope aspect has a significant control on the permafrost distribution and it is expected that permafrost is more widespread on north-facing slopes in the south part of the footprint of the proposed facility.

An extensive area of solifluction was mapped on the upper north-facing slopes in the vicinity of the site of the proposed facility. The area of solifluction extends into the proposed footprint, in particular in the west portion.

11.3.6.3 Overburden Stockpile

Overburden stripped from the ABM open pit excavation is required (in part) for closure, and will be placed in a stockpile along the valley's east slope, north of the Class C Storage Facility. Test pits from 1995 encountered clayey silt and sand with gravel and minor cobbles and boulders, which is interpreted to be Ablation Till.

Permafrost was encountered in 3 of the 4 test pits undertaken in the vicinity of the site of the proposed facility in the 1995 site investigation. Upslope from the site of the proposed Overburden Stockpile site, there is a bedrock knoll at an elevation of approximately 1,700 masl. The terrain analysis identified a narrow band of solifluction in the upper colluvial slopes. Stripes extend down slope from the toe area of the soliflucted slopes and extend across much of the footprint area of the proposed facility. Stripes typically comprise loose very coarse soils and can be seasonal preferential flow paths for near-surface water within the active layer.

11.3.6.4 ABM Open Pit

A pro-glacial meltwater corridor oriented towards the north passes through the central portion of the footprint of the ABM open pit. It is interpreted that glaciofluvial sands and gravels occur along this corridor. The glaciofluvial deposits are overlain by lake deposits and organic swamp deposits, locally, as well as alluvium deposited by Geona Creek. The lake deposits are expected to comprise silts and fine sands. The alluvial deposits can be subdivided into channel deposits and overbank flood plain deposits (Appendix E-5).

An active fluvial fan intersects the meltwater corridor in the south part of the footprint of the ABM open pit. The 1995 ortho-imagery shows evidence of a recent debris flood on the fan. The mapped extent of the debris flood deposit is shown on Figure 11-5.

The surficial geology on the valley side slopes at the site of the ABM open pit is interpreted to predominantly comprise Ablation Till. Three small eskers were mapped along the toe slopes of the valley in the vicinity of the site of the ABM open pit. A glaciofluvial terrace was mapped on the valley floor immediately to the north of the footprint of the ABM open pit. Colluvial apron deposits have been identified at the toes of the valley side slopes at the site of the ABM open pit.

Permafrost was encountered in the 1995/96 site investigations especially in the finer grained alluvial, organic swamp and colluvial apron soils. Ice lenses with a width of approximately 25 cm and a thickness of approximately 10 cm were observed in an alluvial flood plain deposit comprising organic silt and sand with trace gravel. Several thaw lakes were identified in an organic swamp on the north side of the footprint of the ABM open pit. A possible thermal erosion feature was mapped in the vicinity of the west margin of the footprint area of the ABM open pit. These thaw lakes and thermal erosion features are interpreted as local evidence of permafrost degradation.

An area of solifluction was mapped on the slopes in the east part of the footprint area of the ABM open pit. Test Pits TP16-43 and TP16-45 encountered partly frozen cohesionless soil to approximately 1.0 m depth, interpreted as a solifluction deposit. Test Pit TP16-41, undertaken in the north part of the footprint of the ABM open pit, encountered partly frozen organic silt with some sand and trace cobbles to 0.5 m depth. This material is also a possible solifluction deposit. The west margin of the ABM open pit footprint also extends into an area of soliflucted slopes. Test Pit TP16-10 in the west end of the ABM open pit footprint encountered permafrost at 0.3m depth.

11.3.6.5 Operations Water Management Ponds

The Operations Water Management Ponds are to be located on the Geona Creek valley floor, which is interpreted to be a pro-glacial meltwater corridor filled with sands and gravels. The glaciofluvial deposits encountered in the 1995/1996 test pitting investigations comprised silty sand with some gravel and trace cobbles. The glaciofluvial deposits are overlain by organic swamp deposits and alluvium deposited by Geona Creek. The organic swamp deposits were found to be up to approximately 5.4 m thick.

The terrain analysis shows that the surficial geology on the valley side slopes in the vicinity of the sites of the Operations Water Management Ponds generally comprises Ablation Till. Colluvial Aprons have been mapped at the toe of the east side of the valley (Appendix E-5).

Permafrost was encountered in the majority of the 1995/1996 tests pits undertaken on the valley floor in the vicinity of the sites of the Operations Water Management Ponds with depths of frozen soils between 0.9 m and 5 m; and ice content between 5 to 40% (Knight Piésold Ltd., 2016a). Ice lenses were identified in the finer-grained organic swamp and flood plain soils. The extensive presence of permafrost in this area is partly attributed to valley floor having a northerly aspect in this part of the site. Possible thaw lakes were identified in the footprint areas of both the Lower and Upper Water Management Ponds.

11.3.6.6 Process Plant Facility

The terrain analysis shows the surficial geology at the site of the Process Plant predominantly comprises Ablation Till. Permafrost was generally not encountered in the overburden soils in the test pits undertaken at the site of the site. However, frozen silty sand to sandy silt with some gravel that included approximately 1 to 2 mm-thick ice lenses was encountered in Test Pit TP 96-B18. A possible thaw lake was mapped in the northeast corner of the footprint of the site. Possible thermal erosion features extend down slope from the northeast corner of the footprint of the site towards Geona Creek (Appendix E-5).

Weathered bedrock was encountered in most of the test pits undertaken at the site of the Process Plant Facility. It is interpreted that bedrock is shallowest in the northwest part of the footprint where weak to very weak highly weathered bedrock was encountered at 1.2 to 1.8 m depth.

11.3.7 Soil Development

During 2015 and 2016, ecosystem surveys were undertaken in the Project area. A total of 32 soil samples were taken in the LSA, which were analyzed for metals, nutrients, pH, and texture (Appendix E-6). In general, the soils in the LSA are acidic sandy loams, and are low in macronutrients. Organics occur on gentle slopes and valley bottoms in association with fens and bogs found along drainages.

The most common Soil Order encountered during the ecosystem survey were Cryosols. Cryosols are soils that overlay shallow permafrost (less than 2 m below the surface) especially on the north aspects in Spruce/Feathermoss forests and in the valley bottoms where thick organic layers insulate mineral soils from solar radiation. The other orders of mineral soils encountered with in the study area were Dystric Brunisols found on south facing mountain slopes and old alluvial plains. Regosols are young soils with a poorly developed B horizon. Regosols are mainly located in the alpine, where soils evolve slowly or in floodplain corridors where there is repeated disturbance by high water events.

11.3.8 Metals in Soil

The Project area is known to be a mineralized site and can be expected to have naturally elevated soil concentrations of a range of metals relative to typical background levels. Soil metal and nutrient profiles were collected to assess the magnitude and extent of metal concentrations that occur in the LSA. This baseline will help in monitoring potential changes in metal concentration in the environment as Project development, operations, and closure take place. Knowledge of both nutrient and metal parameters within Project area soils will aid in evaluating the potential use of soils for reclamation and closure activities.

The soil samples collected in the baseline study were analyzed using CCME soil guidelines for industrial sites. Of the CCME soil guidelines for metals (19), four exceeded the guidelines including arsenic, copper, selenium, and zinc. The arsenic guideline was exceeded at eight out of 19 sites. The mean arsenic concentration among the 19 samples was 17 mg/kg (standard deviation of 18 mg/kg), exceeding the guideline of 12 mg/kg. Copper, zinc, and selenium exceeded the guidelines at three, two, and one site, respectively (Appendix E-6). Further details of the metals in soil are discussed in Section 12.3.5.

Distribution of the higher metal concentrations did not appear to be related to the location of the sample with the deposit.

11.3.9 Soil Nutrients

Soil nutrients can vary widely from site to site; even within a short distance, soil characteristics can differ immensely. Nutrients were measured to give an overall indication of soil fertility. As expected, soils in the LSA are, in general, nutrient poor and acidic (Appendix E-6).

11.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on the terrain and soils VC as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

11.4.1 Effects Characterization

In order to focus the effects assessment, the first step is to identify any potential interactions between Project activities and the terrain and soils VC. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1, or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions - *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects*; and

2 – Higher risk interactions - *it is reasonably foreseeable that residual effects may result.*

The results of the interactions screening are presented in Table 11-5.

Table 11-5: Interaction Matrix for the Terrain and Soil VC

Project Activity	Terrain Stability	Soil Quantity and Quality
Construction		
Tote Road upgrade to access road	0	2
Finlayson Lake airstrip upgrade	0	2
Site preparation and clearing	2	2
Site grading, including soil and overburden removal and stockpiling	2	2
Off site traffic (construction equipment and materials delivery)	0	0
On site traffic	0	1
ABM open pit development (including dewatering and Fault Creek diversion)	2	2
Infrastructure construction	2	2
Waste handling	0	1
Water use and management	1	1
Power generation	0	1
Worker transport	0	0
Construction camp operation	0	1
Workforce, procurement and hiring	0	0
Operations		
ABM open pit operations (including blasting and dewatering)	2	2
Underground operations	0	0
Ore processing	1	2
On site traffic	0	1
Off site traffic (highway)	0	0
Finlayson Lake airstrip operations	0	1
Storage facilities management (Class A, B, and C)	2	2
Progressive reclamation of storage facilities	1	1
Water use (potable and non-potable)	0	0
Mine water management and treatment (including effluent discharge)	0	0
Waste management	0	1
Power generation	0	1
Worker transport	0	1
Camp operation	0	1
Workforce, procurement and hiring	0	0

Project Activity	Terrain Stability	Soil Quantity and Quality
Closure		
Processing plant decommissioning and site reclamation	2	2
ABM lake filling	2	2
Final storage facilities reclamation	1	1
Support infrastructure removal and site reclamation	1	1
Water management and treatment (including effluent discharge)	1	1
On site traffic	0	0
Off site traffic	0	0
Access road reclamation	1	1
Workforce, procurement and hiring	0	0

11.4.1.1 Terrain Stability Effects

Project related activities, such as site preparation and clearing (including vegetation); site grading (including soil and overburden removal and stockpiling); infrastructure construction activities including road building; pit dewatering and blasting may change the existing slope stability in the Project area. Changes in slope geometry (e.g., caused by erosion) can also cause slope instability. Slope instability may lead to geohazards (i.e., landslides or debris flows).

The shallow and intermittent nature of the permafrost in the LSA may thaw after vegetation is removed and contribute to instability.

The greatest effects on terrain stability will be experienced during construction, but will also occur during operations (from loading of storage facilities, topsoil storage areas and the Overburden Stockpile). During closure terrain stability may also be affected by road decommissioning, re-contouring of landforms, and by re-distribution of surficial materials and soil. The effect of some activities on terrain stability may extend into the future. For example, road construction may alter natural drainage pathways by changing overland water-flow patterns, and lead to the creation of new seepage areas, slumps, or gullies several years after the end of mining activity.

11.4.1.2 Effects on Soil Quantity

The primary soil quantity effect is loss of ecologically functioning soil. During construction and ongoing development of infrastructure during operations, 655.6 ha of land will be covered under the footprint of facilities such as the ABM open pit, waste storage facilities, overburden and topsoil stockpiles, process plant facility, water diversion, and management structures and associated roads. Most ecological functions of the soil will be temporarily diminished in these areas.

Progressive reclamation efforts will restore ecological functionality over time to a substantial portion of disturbed land categorized as temporarily lost during construction and operations. The majority of the area covered during construction and operations will be reclaimed during or after

mining activity. However, approximately 34 ha of land will be permanently lost under the footprint of the ABM lake, which accounts for 5% permanent loss from the overall Project Footprint.

11.4.1.3 Effects on Soil Quality

Degradation of soil quality may occur throughout all phases of the Project by compaction, contamination, erosion, and other physical, chemical, or biological changes. The following text outlines some of the processes that lead to the degradation.

Soil compaction is typically caused by surface traffic and handling. Compaction affects the composition and function of the soil, as well as decreasing infiltration and may result in increased surface runoff, soil erosion, and have detrimental effects on soil productivity. The largest change in compaction will take place during construction, with a smaller effect during operations and then increasing again due to reclamation activities during closure.

Soil contamination due to aerial deposition by metal-laden dust particles (e.g., from blasting, crushing and transportation of mineral materials) is associated with mining. The results from air quality modelling indicated no exceedances of the Yukon Ambient Air Quality Standards for any of the Project phases (Chapter 6 and Appendix E-1).

Disturbance during construction can lead to erosion of soils, which may not only affect the quantity, but also the quality of the soil. Stripping of the soil and stockpiling can also lead to soil degradation due to the soil being handled several times. As well, stockpiles can develop anoxic conditions leading to degradation of the soil available for reclamation.

11.4.1.4 Summary

Table 11-6 provides a summary of the identified potential effects from the above section that are carried forward for consideration of mitigation measures.

Table 11-6: Identified Potential Project Effects for the Terrain and Soil VC

Subcomponent	Potential Effect	Project Phase
Terrain Stability	Increase in geohazards due to temporarily increased slope instability	Construction, operations, closure
Soil Quantity	Loss of soil under infrastructure footprint	Construction, operations, closure
Soil Quality	Degradation of soil quality	Construction, operations, closure

11.4.2 Mitigation Measures

11.4.2.1 Mitigation Measures for Terrain Stability

Several approaches will be used to mitigate potential effects of the Project on terrain stability (Appendix C-6). Many of them are related to mine design to help eliminate risks and include approaches such as:

- Removal of material to bedrock (including permafrost lenses) beneath the Class A and B Storage Facilities and the Process Plant Facility;
- Installation of compacted glacial till to provide a low permeability seepage barrier beneath Class A and B Storage Facilities;
- Grading waste storage facilities to collect and convey water away from facility;
- Construction of buttress at Class A Storage Facility for confinement at the downstream slope of the facility;
- Assessing the volume of material on waste rock storage facilities to not affect stability;
- Construction of storage facilities with nominal slopes of 3H:1V (Class B and Class C Storage Facilities) for long-term physical stability and to allow for recontouring for closure and reclamation;
- Planning of progressive reclamation to help ensure slope stability;
- Reduction of catchment areas by decreasing the lateral extents of each facility along the valley slopes;
- Containment of Class C waste rock volume in the side-valley northeast of the ABM open pit, confining the pile along the northeast and south slopes;
- Utilizing the guidelines for the Dump Stability Rating (DSR) scheme, a semi-quantitative method for assessing the relative potential pile stability and recommending the appropriate level of pile investigation and design; and
- Capping of waste storage facilities such to promote stability and prevent erosion.

Construction and operational approaches may also include:

- Identification of temporary run-off and erosion controls for construction (such as run-off collection channels, settlement ponds, and sediment control devices such as silt fences); and
- Trial sections in the field during the initial stages of development to monitor rock fill pile stability and foundation performance.

Procedures in the Sediment and Erosion Control Plan (Section 18.6) will aid in terrain stability.

Mitigation and Monitoring Plans are a key part of the mitigative measures as well, particularly for terrain stability:

- Geotechnical monitoring (Section 11.6) identifies monthly and annual inspections of facilities and relative terrain. This monitoring can be adapted depending upon results.
- Sediment and Erosion Control Plan (Section 18.6): establishment of an erosion monitoring system at the beginning of Construction will help verify proper implementation and effectiveness of mitigation measures. If monitoring data indicate that the employed mitigation methods are not adequately controlling soil erosion, adaptive management measures directed towards identification and implementation of a new or modified mitigation approach.

11.4.2.2 Mitigation Measures for Soil Quantity

The main objective of this mitigation is to minimize the area of land on which Project development will eliminate or severely compromise the ecological function of soil. The Project has been designed to minimize land-clearing to the areas only necessary for Project development. This has been done through Project design, where the mine infrastructure will be localized to the Geona Creek valley and the proposed upgrades to the Tote Road will largely follow the existing alignment. The Project footprint was also minimized by the proposed use of the Finlayson Lake airstrip rather than construct a new one (as originally proposed by Cominco). Other key mitigation measures include soil salvage and stockpiling during construction and reclamation and re-vegetation of disturbed areas.

11.4.2.3 Mitigation Measures for Soil Quality

Degradation to soil may be caused by compaction, contamination, storage, transport, and erosion.

Reclamation methods that reduce equipment traffic during soil redistribution and placement will be utilized to lessen compaction of soil in stockpiles and reclaimed areas. For example, where practicable, instead of a dozer, a backhoe will be used to distribute topsoil cover in the reclaimed areas. Ripping will be used in areas where surficial soils are excessively compacted.

Contamination of surficial soil horizons with metals transported by dust is predicted to be minor (Chapter 6).

Dust abatement and mitigation of air quality mitigation measures (Section 18.11.2) will aid in maintaining the soil quality available for reclamation. Soils will be monitored for changes in metal concentrations during operations and during the initial stages of closure and effects will be mitigated by remediation during mine closure, if required.

Mitigation measures that help reduce unpaved road dust include application of surface treatments, such as surface wetting. At the proposed Project, unpaved Access Road and mine roads, exposed surfaces, and stockpiles will be watered to mitigate dust. Proposed restrictions on traffic speeds (Traffic and Access Management Plan, Section 18.12) will further reduce dust generation.

During salvage operations, mitigation against soil degradation by having multiple topsoil storage areas, will focus on minimizing the number of times the soil is moved, reducing vehicle traffic over the stockpile surface, and avoiding handling soils when they are too dry or too wet.

Reduction of stockpile erosion will be accomplished by covering stockpiles with plastic sheeting or tarps, or establishing vegetative cover, to prevent erosion (as noted in Section 18.6.2).

Potential effects on VC and identified mitigation measures are summarized in Table 11-7.

Table 11-7: Proposed Mitigation Measures for Terrain and Soil VC

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measures (high, medium, low)	Residual effect identified? (Yes/No)
Terrain Stability				
Increase in geohazards due to temporarily increased slope instability	Construction, operations, closure	Mine design to minimize risk including: • Slope stabilization techniques in areas characterized by highly erodible soils or long, steep slopes • Construction of waste storage facilities involving considerations related to base foundation (excavation to bedrock, removal of permafrost lenses); nominal slopes 3H:1V for Class B and Class C and 4H:1V for Class A (for long-term physical stability and allowing recontouring for closure and reclamation) Soil erosion and control measures Geotechnical and soil erosion monitoring	High	Yes
Soil Quantity				
Loss of soil under component footprint	Construction, operations, closure	Minimize land clearing to the areas necessary for Project Footprint Soil salvage, storage and stockpiling	Medium	Yes
Soil Quality				
Degradation of Soil Quality	Construction, operations, closure	Dust suppression techniques Soil stockpiling techniques that conserve soil quality Minimizing the number of times the soil is moved, reducing vehicle traffic over stockpile surface, and avoiding handling soils when they are too dry or too wet Erosion monitoring and prevention program Reclamation methods that reduce equipment traffic during soil redistribution and placement	Medium	Yes

11.4.3 Residual Effects and Significance Determination

11.4.3.1 Terrain Stability

Through mine design and planning, construction in unstable or erodible terrain has been minimized. However, construction of the infrastructure required for the Project may affect the stability of some of the terrain. The overall magnitude of Project effects on terrain stability will be moderate as the occurrence of a geohazard event could possibly alter the landscape from stable to potentially unstable. However, the geographic extent will be localized to the LSA. The geomorphological changes associated with the increased instability will be permanent, yet over time the land will re-establish its equilibrium; the duration is long term, lasting through construction, operations, and closure. The effect is seen to be reversible, as the land may return to baseline levels following a period of time. The economic and social context is valued as neutral, as the VC is considered to have some resilience to change. Taking all of the mitigation and design features into account, the probability of a geohazard risk is assessed to be unlikely. Even though the initial magnitude of an event could be high, it is expected that equilibrium will be re-established, and overall the effect of Project development on terrain stability is expected to not be significant.

11.4.3.2 Soil Quantity

The maximum area of soil covered under the Project Footprint before reclamation will be 655.6 ha. Of this amount, it is expected that majority of that footprint will be reclaimed, and after a period time return to its baseline biological function. Following mine closure, the ABM lake will remain in place, thus creating a residual loss of soil of 34 ha. This represents 0.3% of the entire LSA and 5% of the total Project Footprint disturbed during construction and operations.

The loss of soil reflects a low magnitude (permanent loss of an area of soil equal to 5% of total Project Footprint); and the geographic extent is limited to within the Project Footprint. The loss will extend into the far future and will be continuous, as well as being irreversible. The probability of this loss is very likely. However, due to the small size of covered land, as well as nutrient poor soils within the existing area of land, the overall effect of permanent soil loss associated with the Project is considered not significant.

11.4.3.3 Soil Quality

Even with mitigation measures in place, soil degradation is likely to occur as a result of the Project. The magnitude of the Project-related effects on soil quality is expected to be moderate. The effects will be localized, restricted to the Project Footprint, yet will be long term. The frequency of the effects leading to soil degradation will be sporadic throughout the Project life, and most effects would be considered to be reversible in the long term. The probability of the degradation taking place is likely, yet overall will be considered not significant due to the relative small areas of soil affected and the generally low capacity of the soils. The significance of residual effects as a result of the Project on terrain and soil VC are summarized in Table 11-8.

Table 11-8: Project Effects Significance Assessment for Terrain and Soil VC

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Probability	Significance (Significant/ Not significant)
Increase in geohazards due to temporarily increased slope instability	Adverse	Moderate	Local	Long term	Sporadic	Reversible long term	Neutral	Unlikely	Not significant
Loss of soil under Project Footprint	Adverse	Low	Site	Far future	Continuous	Irreversible	Neutral	Very Likely	Not significant
Degradation of soil quality in reclaimed areas	Adverse	Moderate	Site	Long term	Sporadic	Reversible long term	Neutral	Likely	Not significant

Note: Criteria definitions are provided in Table 11-2 and Table 11-3.

11.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for terrain and soils follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. The following Project residual effects have been identified for terrain and soils and are considered through the CEA:

- Increase in geohazards due to temporarily increased slope instability;
- Loss of soil under Project Footprint; and
- Degradation of soil quality in reclaimed areas.

11.5.1 Cumulative Effects Characterization

For past, present, and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the project or activity results in a demonstrable or measurable effect on the VC;
2. The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for VC are identified through the screening in Table 11-9. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

Table 11-9: Cumulative Effects Screening for Terrain and Soils VC

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Fyre Lake Property (*Pacific Ridge Exploration*)	No	N/A	N/A	No
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/ Veris Group*)	No	N/A	N/A	No
Pelly Explorations (*BMC Minerals (No.1) Ltd.*)	No	N/A	N/A	No
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	N/A	N/A	No

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
The Yukon Base Metal Project *(Overland Resources Ltd.)*	No	N/A	N/A	*No*
Wolverine Mine (*Yukon Zinc Corp.)*	No	N/A	N/A	*No*
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	N/A	N/A	*No*
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	N/A	N/A	*No*
Single/Group Trapline Concessions	Yes	No	N/A	*No*
Outfitting Concessions	Yes	No	N/A	*No*
Campgrounds	No	N/A	N/A	*No*

Note: If "No" is indicated for a condition the remaining conditions are indicated as N/A (not applicable) as all conditions must be met for potential cumulative effect to be identified.

As indicated in Table 11-9 above, no projects or activities have been identified to overlap with Project residual effects in type of effect, in time, and in space. Therefore, no potential cumulative effects have been identified for terrain and soils. No further assessment is required.

11.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

The proposed monitoring for the terrain and soils is summarized as follows:

- Geotechnical inspections will be undertaken by an engineer licensed to practice in the Yukon on an annual basis during operations for all storage facilities and water management infrastructure. Physical inspections of all storage facilities and water management infrastructure will be conducted on a monthly basis during operations by site personnel. The frequency of inspections will be reduced during closure as identified by the engineer of record. All geotechnical inspections will be reported as part of annual reports for the Water Licence and Quartz Mining License. The results of the geotechnical inspections will be

compared against the AMP thresholds (i.e., physical stability, ground temperatures, elevation survey results)

- The Sediment and Erosion Control Plan (Section 18.6): main objectives are to control run-off; minimize erosion on exposed slopes and substrates; and prevent inputs of silt or sediment into watercourses during all phases of the Project. Establishment of an erosion monitoring system at the beginning of construction will help verify proper implementation and effectiveness of mitigation measures. If monitoring data indicate that the employed mitigation methods are not adequately controlling soil erosion, adaptive management measures directed towards identification, and implementation of a new or modified mitigation approach.
- Metals in Atmospheric Dust (Section 12.6): The sampling program will be conducted prior to construction, after development, and once every three years through to closure with data tracked over time to determine if there are any changes in metal concentrations resulting from the Project.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

12 VEGETATION COVER AND COMPOSITION 12-1

12.1 ASSESSMENT APPROACH 12-1
12.1.1 Regional Setting 12-1
12.1.2 Selection of Subcomponents and Measurable Parameters 12-2
12.1.3 Criteria for Assessing Significance 12-5
12.2 ASSESSMENT BOUNDARIES 12-6
12.3 EXISTING CONDITIONS 12-9
12.3.1 Regional Context and Terrestrial Ecosystem Mapping 12-9
12.3.2 Wetland and Riparian Ecosystems 12-10
12.3.3 Rare Plants 12-11
12.3.4 Invasive Plants 12-12
12.3.5 Metals in Soils and Vegetation 12-15
12.3.6 Forest Productivity and Timber Volumes 12-17
12.4 PROJECT-SPECIFIC EFFECTS 12-18
12.4.1 Effects Characterization 12-18
12.4.2 Mitigation Measures 12-37
12.4.3 Residual Effects, Consequence, and Significance Determination 12-41
12.5 CUMULATIVE EFFECTS 12-45
12.5.1 Cumulative Effects Characterization 12-45
12.6 EFFECTS MONITORING 12-46
12.6.1 Soil and Plant Tissue Monitoring Program 12-46

LIST OF TABLES

Table 12-1: Preliminary Vegetation Subcomponents and Measurable Parameters 12-3
Table 12-2: Vegetation Cover and Composition Significance Criteria Definition 12-5
Table 12-3: Proposed Study Areas for Vegetation Cover and Composition 12-6
Table 12-4: Rare Plants Identified in Yukon's Southeast Region and May Exist in the LSA 12-11
Table 12-5: Soil Metal Concentrations Compared to CCME Guidelines 12-15
Table 12-6: Vegetation Metal Concentrations from 1997, 2015, and 2016 Samples Compared to Uncontaminated Worldwide Background Ranges 12-17
Table 12-7: Interaction Matrix for Vegetation Cover and Composition 12-19
Table 12-8: Potential Project Effects on Vegetation Cover and Composition 12-21
Table 12-9: Summary of Predicted Ecosystems on Post-Mining Landforms by Main Project Facility 12-25
Table 12-10: Change in Wetland and Riparian Ecosystems within the LSA 12-30
Table 12-11: Change in Old Growth Forest within the LSA 12-32

Table 12-12: Identified Potential Project Effects for Vegetation Cover and Composition 12-37
Table 12-13: Proposed Mitigation Measures for Vegetation Cover and Composition.....12-40
Table 12-14: Thresholds for Project Effects on Wetland and Riparian Ecosystems 12-41
Table 12-15: Thresholds for Project Effects on Old Growth Forest Ecosystems 12-42
Table 12-16: Project Effects Significance Assessment for Vegetation Cover and Composition 12-44
Table 12-17: Cumulative Effects Screening for Vegetation Cover and Composition 12-45
Table 12-18: Soil and Plant Monitoring Programs.....12-49

LIST OF FIGURES

Figure 12-1: Regional and Local Study Areas for Vegetation Cover and Composition 12-8
Figure 12-2: Rare Plant Survey Transects and Plots 12-13
Figure 12-3: Locations of Observed Invasive Plant Species 12-14
Figure 12-4: Predicted Ecosystems on Post-Mining 12-28
Figure 12-5: Riparian and Wetland Interaction with Project Footprint.....12-31
Figure 12-6: Old Growth Forest Interaction with the Project Footprint.....12-33
Figure 12-7: Extent of Dust Deposition During Operations 12-36
Figure 12-8: Soil Monitoring Sites.....12-48

LIST OF PHOTOGRAPHS

Photo 12-1: Ecosite 01-FEsWiFm (Subalpine fir-scrub birch-willow-feather moss) 12-22
Photo 12-2: Ecosite 11-EsLi (Scrub birch-lichen) 12-22
Photo 12-3: Ecosite 23-EsWiEmni (Scrub birch-willow-crowberry).....12-23
Photo 12-4: Ecosite 35-WiEqFbGr (Willow-horsetail-forbs-grass).....12-23
Photo 12-5: Ecosite 42-CaaqSp (Water sedge) 12-24
Photo 12-6: Wetland Ecosystem (Wetland B south of ABM open pit).....12-24

12 VEGETATION COVER AND COMPOSITION

This chapter provides an overview of the existing vegetation conditions and assessment of the potential Project effects on vegetative cover and composition. Vegetation cover and composition was selected as a Valued Component (VC) due to its fundamental importance to the health and wellbeing of the biophysical and human environment, as well as having high cultural and First Nations value. Vegetation cover and composition contribute to the overall biophysical system and are an interconnected component of aquatic habitat, wildlife habitat, and the hydrological system.

Project activities for Project construction, operation, and closure have the potential to affect the vegetation cover and composition. Site preparation and clearing will directly alter the vegetation cover and composition through the loss of vegetation cover. Additionally, dust deposition from the different stages of the Project development has potential to indirectly affect the vegetation surrounding the Project. Yukon residents place value on vegetation cover and composition as an essential aspect of the biophysical system. This chapter outlines potential effects, measures to mitigate these effects, and determine if there are any overall significant residual effects from the Project on the vegetation cover and composition.

12.1 ASSESSMENT APPROACH

The vegetation cover and composition effects assessment generally follows the methods outlined in Chapter 5 and relies on results from the terrestrial ecosystem mapping (TEM) (Appendix E-6), and air dispersion modelling (Appendix E-1). The TEM forms the basis for assessment of the spatial extent of change and composition to the vegetation communities resulting from the Project.

The assessment considered species or ecosystem features that have ecological, social or cultural values, and that may be sensitive to Project activities. The assessment of potential effects on traditional use species relied on Kaska Traditional Knowledge (TK) and Traditional Land Use (TLU) gathered from desk-based, secondary sources (Appendix F-3).

The authors respect Kaska First Nation (Kaska) as stewards of the land, their traditional knowledge, and the sacred law of the land (A'IE). The effects assessment (EA) incorporates Kaska management principles in the vegetation assessment and mitigation plans wherever practicable.

12.1.1 Regional Setting

The Project is located in the northern foothills of the Pelly Mountains on the Yukon Plateau, on the east side of the divide between the Pelly River and Liard River drainage basins. The Project area is located in the Finlayson Creek/River drainage, which forms part of the Liard Basin. Elevations in the area range from about 1,300 to 2,000 metres above sea level (masl). The area has a typical northern interior climate. Summers are cool and short, whereas winters are long and very cold. The frost-free period is generally 40 to 60 days (some valley bottom stations report 70 to 90 days), although frost can occur in any month. Mean annual temperatures range from about 0 to -5°C. The mean annual precipitation is estimated at 612 mm; approximately 322 mm falling as rain from May through early October, and 290 mm falling as snow.

The study area is within the Extensive Discontinuous Permafrost Zone (Yukon Permafrost Network, 2016). Permafrost is commonly encountered on north and west facing slopes above 1,400 masl, however, has been encountered as low as 1,250 masl (Knight Piésold Ltd., 2016). Active permafrost layers are encountered in the Geona valley under thick insulating organic layers. Permafrost related ground movement or solifluction is apparent on steep (4H:1V) upper elevation slopes (Knight Piésold Ltd., 2016).

The Tote Road passes mostly through open white and black spruce forest. Feathermoss is the main ground cover with a well-developed shrub understory; sedge or sphagnum tussocks are common in the frequent wetlands and black spruce stands.

The proposed Project lies in a U-shaped subalpine valley with mountains along the east and west sides. The rounded mountain tops and upper slopes are in the alpine zone. The alpine vegetation mat is composed of low growing dwarf shrubs with various graminoids, forbs, and mosses. Middle mountain slopes are dominated by willow and scrub birch with sparse distribution of subalpine fir. The lower slopes are open white spruce and subalpine forests dominated by willows and scrub birch. The valley bottom features a fen complex with several beaver-created wetlands linked along Geona Creek.

12.1.2 Selection of Subcomponents and Measurable Parameters

Five subcomponents were selected for the assessment of vegetation cover and composition based on the likelihood and occurrence within the Project area. Criteria used in the selection of the five subcomponents include:

- Likely presence in the Project area;
- Abundance and distribution in the Project area;
- Sensitivity to Project activities;
- Socio-economic and cultural values; and
- Conservation status.

The vegetation cover and composition subcomponents and measurable parameters are provided in Table 12-1.

Table 12-1: Preliminary Vegetation Subcomponents and Measurable Parameters

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Vegetation Cover and Composition	Wetland and riparian ecosystems	Change in spatial extent based on mapped ecosite units and wetland classification from baseline condition	Low = 0-10%; Moderate = 10-25%; High = >25%.	North American Conservation Council (Canada) (NAWCC) Strategic Plan for conservation of wetland productivity, which is linked to waterfowl productivity. Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010) and Andrén (1994). Kaska land management practices for conserving important wetlands habitat based on cultural and ecological importance (Dena Kayeh Institute, 2010).
	Old growth forest	Change in spatial extent based on mapped ecosite units and species structural stage from baseline condition	Low = 0-10%; Moderate = 10-25%; High = >25%.	As for wetlands, thresholds for conservation of important vegetation are linked to wildlife habitat. Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010) and Andrén (1994). Kaska land management practices for conserving important habitats (Dena Kayeh Institute, 2010).
	Rare plants	Change in probable rare ecosites that would be most suitable for rare plant species	No loss of rare plants.	Prohibition under the *Species At Risk Act*. Currently only Baikal Sedge listed. Kaska land management practices for conserving important habitats (Dena Kayeh Institute, 2010). BMC responsible mining philosophy.
	Invasive plants	Occurrence of new invasive plant populations from baseline conditions	Low = zero to two times the number of invasive plants surveyed at baseline. Moderate = two to four times the number of invasive plants surveyed at baseline. High = > four times the number of invasive plants surveyed at baseline.	Yukon Invasive Species Council strategy (https://www.yukoninvasives.com/strategy.html).
	Metal concentrations in traditionally used plants or wildlife browse plants	Metal concentrations in local plant tissues and soils	Soil: CCME Guidelines (Canadian Soil Quality Guidelines for Protection of Human Health).	No guidelines are specific for vegetation. Soil metals are used as thresholds.

Measurable parameters can provide management or scientific evidence of ecosystem quality, and reliable evidence of trends or changes in quality and abundance. Measurable parameters were selected to enable the quantitative measurement of potential Project and cumulative effects and compare conditions that are predicted to exist during construction and operations with baseline

conditions. The assessment of potential effects on traditional use species relied on Kaska input pertaining to their TK/TLU (Appendix F-3).

Wetlands were chosen as a subcomponent since they have high diversity and provide habitat for many species of wildlife. Kaska place high value in wetlands since they support fish, wildlife, and waterfowl and help purify water (Dena Kayeh Institute, 2010, p.16). Kaska traditionally and currently use wetlands to support trapping, hunting, fishing, and plant collecting activities, connected to Kaska trails and adjacent to habitation locations (Dena Kayeh Institute, 2010, p.16). Kaska land management practice framework integrates with the Canadian Wetland Classification and National Wetland Working Group systems for describing wetlands (Dena Kayeh Institute, 2010).

Ecological thresholds for wetland are related to conservation of waterfowl productivity as defined in the North American Waterfowl Management Plan (NAWMP, 2012). The North American Wetland Conservation Council (Canada) Strategic Plan 2010-2020 (NAWCC, n.d.) includes objectives for conservation of wetland productivity. Kaska land management practices work towards conserving wetland habitats for their support of a high diversity of species (Dena Kayeh Institute, 2010). The wetlands thresholds for the Project are therefore linked to habitat loss thresholds for birds and wildlife that use this habitat, with a focus on waterfowl. The following threshold values were chosen to assess the magnitude of effect for loss of vegetation for birds and small mammal species: low – 0 to 10%; moderate – 10 to 25%; high – greater than 25%. Swift and Hannon (2010) performed a review of critical thresholds associated with habitat loss; they concluded that most studies that documented empirical thresholds fell near the range of 10 to 30% habitat cover. This was consistent with a proposed range of 10 to 30% habitat cover by Andrén (1994).

Old growth forest was chosen as a subcomponent due to its importance to wildlife productivity and cultural and ecological value to the Kaska as key habitat (Dena Kayeh Institute, 2010). Old growth forests are fairly rare in boreal regions and are defined as such due to their age, diversity, and complexity that creates important habitat for various wildlife species (Lesica et al., 1991; Burton et al., 1999). Old growth forest ecological thresholds were the same as those used for wetlands due to the linkage with habitat required to support wildlife as discussed above.

Rare plants have high ecological value due to their vulnerability to extirpation. This value is formalized through many legislative, policy, and non-governmental initiatives ranging from the international Convention of Biological Diversity, to the federal *Species at Risk Act*, Yukon's commitment to sustainability in the Yukon *Environment Act*, Kaska land management practices as a Kaska priority (Dena Kayeh Institute, 2010), and BMC's commitment to environmental responsibility (Appendix A-4). Rare plants have not been identified in the Project area. However, they are still considered a valued subcomponent. To conserve rare species, the threshold has been set at no loss, to raise awareness and provide initiative for mitigation measures to be taken (e.g., relocation, propagation, or protection) if a rare plant species is encountered in the Project Footprint.

Vegetation and soil metals were chosen as a valued subcomponent due to the potential for metal accumulation to affect wildlife that consume the vegetation and humans that consume the vegetation and wildlife.

12.1.3 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long-term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and
- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for vegetation cover and composition are presented in Table 12-2.

Table 12-2: Vegetation Cover and Composition Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
	Adverse	VC would change for the worse
Magnitude	Low	Defined by thresholds in Table 12-1; increase over background but below guidelines
	Moderate	Defined by thresholds in Table 12-1; occasional exceedance of guidelines
	High	Defined by thresholds in Table 12-1; continual exceedance of guidelines
Geographic Extent	Site	Effect limited to the Project Footprint
	Local	Effect extending beyond the Project Footprint but within the local study area

Criteria	Definition	
	Regional	Effect extending across the regional study area
	Beyond Regional	Effect that extends beyond the regional study area
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long-term	Effect lasting through any two concurrent Project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long-term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

A significant effect is considered to occur if it is adverse, of high magnitude and extends across the regional study area, or is adverse, of high magnitude within the local study area and occurs over the long-term.

12.2 ASSESSMENT BOUNDARIES

The local and regional study areas (LSA and RSA) for vegetation cover and composition are described in Table 12-3. Figure 12-1 shows the LSA and RSA boundaries.

Table 12-3: Proposed Study Areas for Vegetation Cover and Composition

Study Area	Vegetation Study Area Description
Local Study Area (LSA)	The vegetation local study area is centered on the proposed Project Footprint and includes a 3 km buffer around the Project Footprint. The vegetation local study area also includes the Access Road and 1.5 km buffer on either side of the existing road alignment.

Study Area	Vegetation Study Area Description
Regional Study Area (RSA)	Based on ecoregions defined for Yukon Territory, the Project is situated in the Pelly Mountains ecoregion and the Access Road is located in the Yukon Plateau North ecoregion. The vegetation regional study area encompasses both of these ecoregions but is limited to the extent of game management subzone 10-07 due to the direct relationship between ecosystem composition and wildlife. Rare plant species that are known to exist in the southeast section of Yukon were considered for rare plant surveys.

Temporal boundaries are defined to include all Project phases within which effects are expected to occur. The Project phases considered in the vegetation EA include the following:

- **Construction Phase**: will last approximately two years and includes site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground development and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as closure phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required.

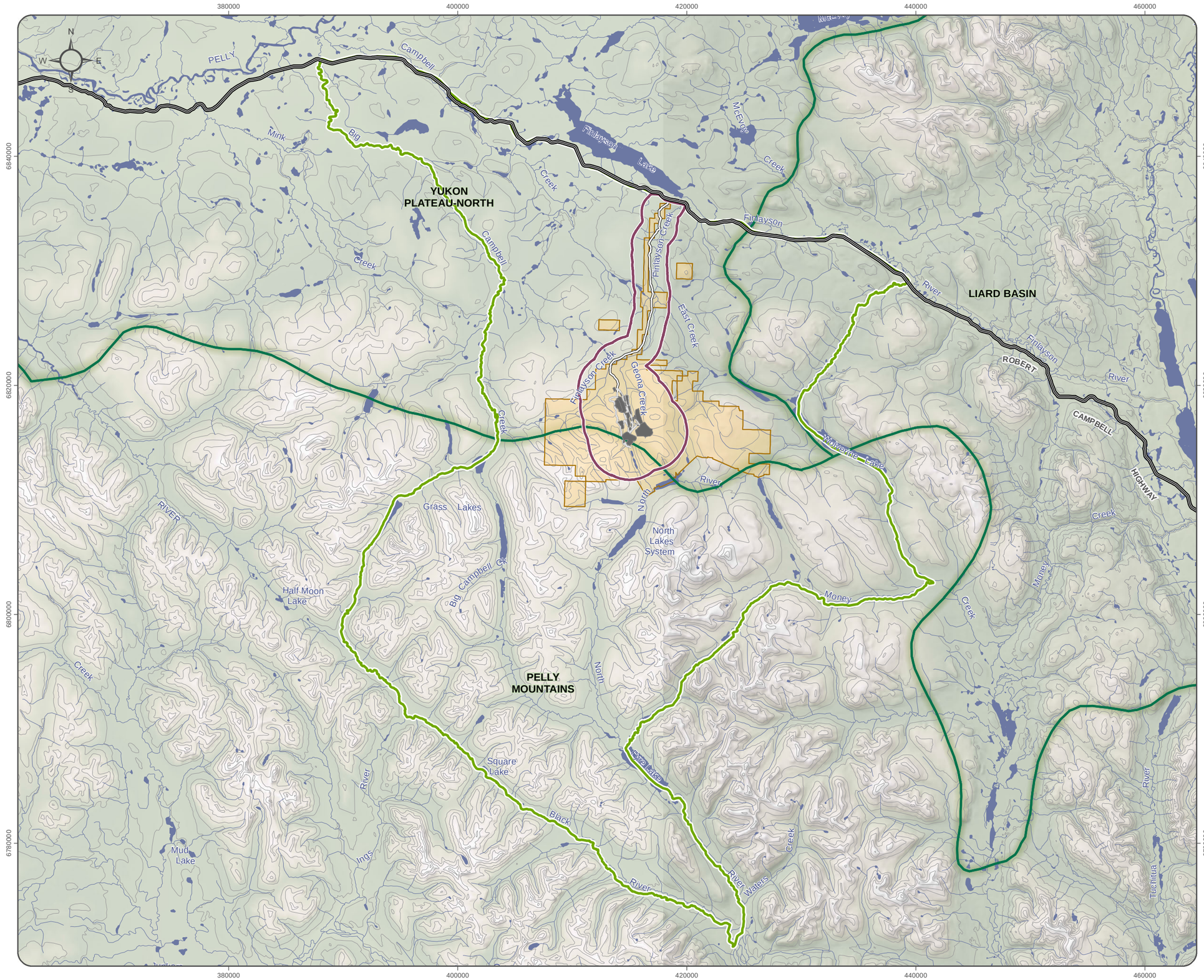

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FIGURE 12-1

REGIONAL AND LOCAL STUDY AREAS FOR VEGETATION COVER AND COMPOSITION

JANUARY 2017

- Local Study Area
- Regional Study Area (Game Management Subzone 10-07)
- Ecoregion Boundary
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Watercourse
- Waterbody

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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12.3 EXISTING CONDITIONS

This section presents a summary of existing environmental conditions as they relate to the vegetation cover and composition. This characterization of the existing environment serves as the baseline against which the effects of the Project are assessed. The description of the existing environment has been focussed on those components of the environment that may be affected by the Project.

The description of the existing environment for vegetation cover and composition presents a compilation and review of historical information and the results of the 2015 and 2016 field programs. The following sections provide the summary of the field programs with the detail provided in the Vegetation Baseline Report (Appendix E-6).

The 2015-16 baseline report provides information on existing vegetation communities present in the LSA of the Project. It includes terrestrial ecosystem descriptions and mapping, and survey results for rare plants, invasive plants, baseline metal concentrations in soils and vegetation, wetland assessments, and forest productivity and timber volume estimates. This baseline will inform the reclamation program, future vegetation monitoring initiatives, wildlife habitat suitability, and form a basis to assess effects of the proposed Project development. The baseline report combines historical information from surveys completed during the initial Project assessment and licensing process in the 1990s, and information collected during the re-initiation of Project baseline surveys in 2015 and 2016 to support re-assessment and re-licensing.

12.3.1 Regional Context and Terrestrial Ecosystem Mapping

There are five ecozones recognized in Yukon: Southern Arctic, Pacific Maritime, Taiga Plain, Boreal Cordillera, and Taiga Cordillera. Boreal and Taiga are the dominant units. The Project is located in the Boreal Cordillera Ecozone. Ecoregions represent smaller areas of ecozones, characterized by distinctive physiography and ecological responses to climate, as expressed by the development of vegetation, soil, water, and fauna (Smith et al., 2004). The Project is situated in a transitional climatic zone bordering on three different ecoregions (Figure 12-1): Yukon Plateau-North to the north, Liard Basin to the east, and Pelly Mountains Ecoregion to the south (Smith et al., 2004). The Tote Road is mainly within the Yukon Plateau-North Ecoregion. The Project Footprint is within the northern portion of the Pelly Mountains Ecoregion.

The Project area and associated infrastructure is primarily situated in the subalpine bioclimatic zone, from an elevation of 1,300 masl to approximately 1,550 masl, with the open pit anticipated to extend to the lower range of the alpine zone. At higher elevations, dwarf shrubs, graminoids, and herbs dominate; boreal forests are more prevalent at lower elevations.

The most common species found within the study area include scrub birch (*Betula glandulosa*), willow (*Salix* spp.), subalpine fir (*Abies lasiocarpa*), and open stands of white spruce (*Picea glauc*a) at lower subalpine elevations. Along either side of the first 17 km of the Tote Road, a mixed forest of white and black spruce (*Picea mariana*) exists. The forests are composed of mainly mature trees (greater than 100 years); some of the white spruce encountered are older (greater than 160 years) and are likely survivors of historic fires.

The riparian systems within the LSA are of two basic types: slow flowing creek/fen complexes with associated wetlands, or faster flowing creeks confined to deep valleys with definitive floodplains, such as Finlayson Creek. The riparian systems associated with slow flowing creeks contain organic substrates derived from sphagnum mosses and graminoids. Acid tolerant plants such as Labrador tea (*Rhododendron groenlandicum*), bog blueberry (*Vaccinium uliginosum*), and cloudberry (*Rubus chamaemorus*) grow amongst the moss hummocks. The second type of riparian system has a rocky substrate; sediment is composed mostly of gravel, cobbles and boulders. The vegetation associated with this system is tall willows, balsam popular (*Populus balsamifera*), and white spruce on upper terraces.

The Terrestrial Ecosystem Map for the study area is presented in Terrestrial Ecosystem Map Report, which is included as Appendix A of the Baseline Vegetation Report (Appendix E-6). The total area mapped was 97 km^2, of which 46 km^2 surrounds the Project area, and 51 km^2 is along the Tote Road. The mapped area is at a scale of 1:23,000. Of the 97 km^2, the Boreal High (BOH) bioclimate zone represents 43.9% (49.6 km^2), the Boreal Subalpine (BOS) zone represents 35.3% (39.9 km^2) and the Alpine (ALP) zone represents 20.8% (23.5 km^2). There are 27 core vegetation communities (7 alpine, 9 boreal subalpine, 11 boreal high) that were derived from 126 vegetation associations gleaned from aerial photographs and fieldwork.

12.3.2 Wetland and Riparian Ecosystems

During the 2015 baseline study, creeks and wetlands were surveyed by Contango Strategies Ltd. to assess the potential for passive and semi-passive water treatment for the Project (Appendix E of the Vegetation Baseline Report). These types of treatment systems, known as constructed wetland treatment systems (CWTS), can improve water quality through microbial and other natural biological processes. Therefore, vegetation, sediment and associated beneficial microbes in wetlands were explored in the context of water chemistry ranges naturally present at the Project area.

The CWTS site assessment focussed on natural wetland and creek areas at the Project. Sampling locations were selected based on the presence of potentially beneficial wetland plants, information from long-term monitoring, in situ measurements, and other visible features that suggested the location might inform strategies for water quality improvement by CWTS. A subset of wetlands was selected for characterization, rather than a broad-scale assessment of all wetlands within the Project area. Eleven areas were sampled during the wetlands assessment. Details on methods and samples taken during the CWTS site assessment can be found in the report Site Assessment for Treatment Wetlands at Kudz Ze Kayah in Appendix E of the Vegetation Baseline Report. The CWTS study concluded that the Project area has several natural ponds, wetlands, and aquatic vegetation in creeks. It is therefore expected to be conducive to the implementation of CWTS.

Wetland classification information is discussed further in the Terrestrial Ecosystem Map Report, included as Appendix A of the Baseline Vegetation Report.

In the 1996 Initial Environmental Evaluation (IEE), vegetation categories were reported near wetlands; however, no specific information was included on the number or type of wetlands within

the Project area, nor was the percentage of land covered by wetlands calculated (Norecol, Dames & Moore Ltd., 1996).

12.3.3 Rare Plants

To determine if one of the Yukon's species of vascular plants is rare, the Yukon Conservation Data Centre (YCDC) assigns a rank to the plant using the NatureServe conservation status system method. Based on these ranks, YCDC compiles lists of plants that are of global conservation concern, federally listed under the *Species at Risk Act*, or of specific conservation concern in Yukon (YCDC, 2016). The YCDC publishes a Track List, which is publicly available and regularly updated for all species of conservation concern with conservation status ranks. It also publishes a Watch List for species where there is not enough information to determine conservation concern (YCDC, 2016). The 2016 version of these lists contained 127 plant species in the Track List and 195 plant species in the Watch List.

Through careful review of the list of rare plants known to be present in the southeast region, and in discussion with YCDC personnel, it was determined that nine rare plant species could possibly exist in the LSA (Table 12-4). The field method used for the rare plant surveys was the line transect protocol established by the Alberta Native Plant Council (ANPC, 2012). The ecosystems in the LSA that were most likely to host rare plants were wetlands, old talus deposits, and moist alpine meadows.

Table 12-4: Rare Plants Identified in Yukon's Southeast Region and May Exist in the LSA

Rare Plant	Yukon Rank	Associated Habitat
Parry's Arnica, also known as Nodding Leopardbane (*Arnica parryi*)	SH – last reported 1944	Alpine meadows, steep ravines and ledges
Northern Beech Fern *(Phegopteris connectillis)*	S1/S2	Moist alpine cliffs and rocky areas
Leafy Thistle (*Cirsium foliosus*)	S2	Moist soil, grasslands, meadows, edges, and openings in boreal forest, riverbanks
Mount Sheldon Ragwort (*Senecio sheldonensis*)	S2/S3 – last reported 1970	Subalpine meadows, wet to moist meadows, and forest openings in montane to alpine zones
Spiny-spored Quillwort (*Isoetes echinospora*)	S2/S3	Silty lake or pond margins, often submerged, granitic gravel/cobbles
Maritime Quillwort (*Isoetes maritima)*	S2/S3	Shallow water, lakes and streams, granitic gravel/cobbles
Water Mudwort (*Limosella aquatica*)	S2/S3	Semi-aquatic, mud or wet sand adjacent to wetlands or slow moving water
Common River Grass (*Scolochloa festucacea*)	S1	Shallow waters or wet marshes
Blunt-leaf Pondweed (*Potamogeton obtusifolius*)	S1	Small, shallow lakes and ponds

Note: NatureServe designates conservation status as follows:
Geographic scale of assesment: G = Global, N = National, S = Subnational.

Rank: 1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, 5 = secure, X = presumed extinct or extirpated, H = historical - possibly extinct or extirpated, NR = status has not yet been assessed, U = unrankable with present information (YCDC, 2015). All rankings presented in the above table relate ONLY to the Yukon.

The 1995 baseline study focussed on the characterization and distribution of major vegetation types and did not present any data on rare plants (Norecol, Dames & Moore Ltd., 1996). No rare plants were found during the 2015 and 2016 transect surveys or through incidental observations while performing other field work. Figure 12-2 shows the locations of the transects and plots for the rare plant surveys.

Although it is possible rare plants may exist, observations were not made nor expected as the area does not have unique landscape features such as hot springs, limestone, or alkaline wetlands that are known to be associated with rare plants in the southeast region. It cannot be concluded that no rare plants exist within the LSA, only that they were not detected in the areas selected for surveys.

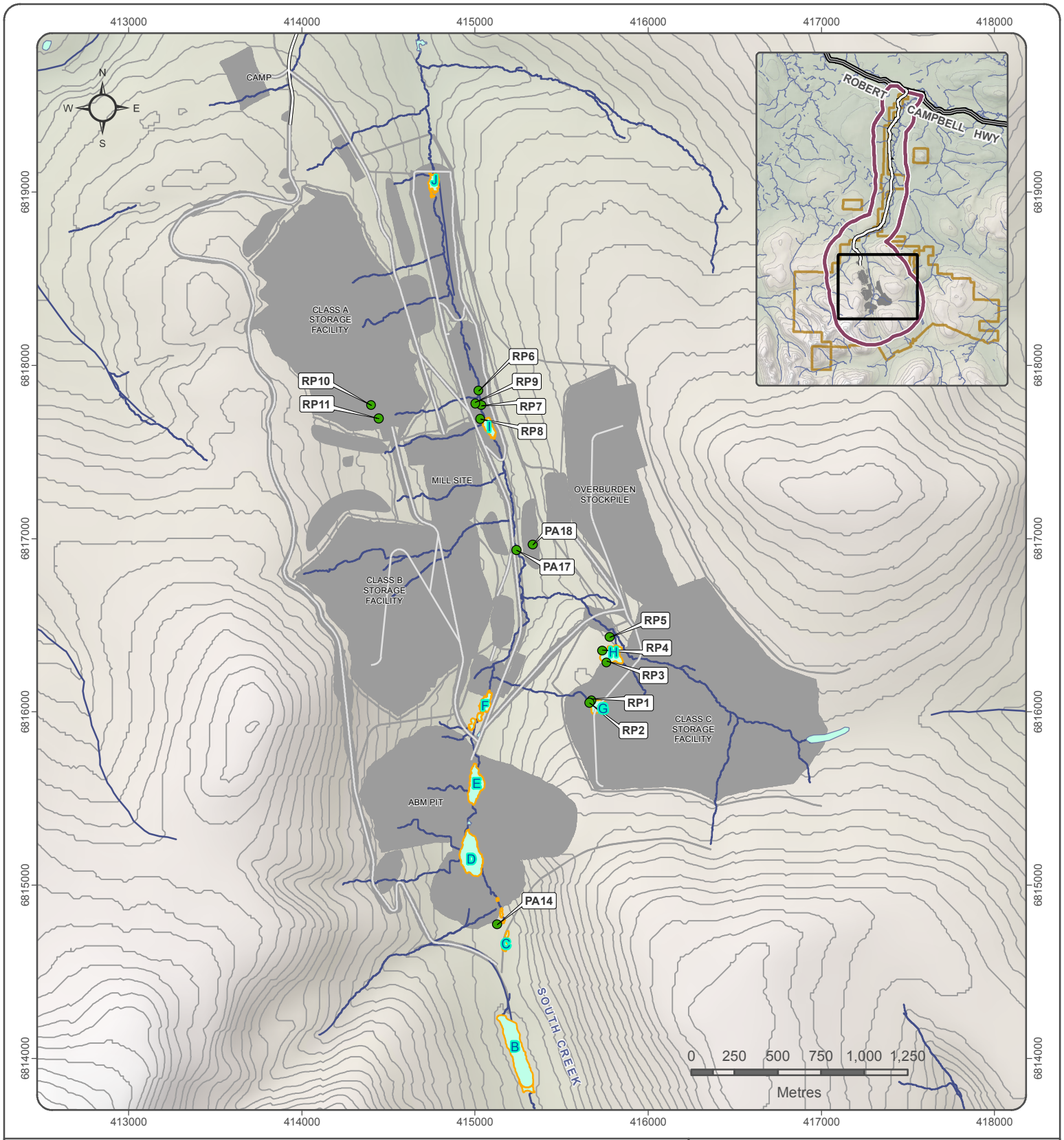
12.3.4 Invasive Plants

According to the Yukon Invasive Species Council (YISC), there are 154 introduced plant species in Yukon, but only 20 are considered invasive (YISC, 2016). Non-native species are typically introduced to a new environment from highway right-of-ways, agricultural properties, and people inadvertently transporting seeds (Line et al., 2008). A baseline inventory of invasive plants was conducted at the property to determine the current existence and extent of any invasive plant species, locations of infestation, and vectors of transportation/spread. Survey efforts for invasive species concentrated on the Tote Road, and other locations around the Project area with recent or historically disturbed ground or soil.

Ten non-native species were detected during the 2015 and 2016 invasive species surveys. Most observations were made along the Tote Road, particularly near the gatehouse and associated laydown area. Smooth brome (*Bromus inermis)*, narrow-leaf hawksbeard (*Crepis tectorum*), and oxeye daisy (*Leucanthemum vulgare*) were the most invasive non-native species present. Pineapple weed (*Matricaria discoidea*), alsike clover (*Trifolium hybridum*), perennial ryegrass (*Lolium perenne*), common timothy (*Phelum pretense*), field pennycress (*Thlaspi arvense*), and herb-sophia (*Descurainia sophia*) are less aggressive, non-native species that were also observed. One of Yukon's most invasive plants, white sweet clover (*Melilotus albus*), was not identified during the 2015 surveys but was observed in 2016. Figure 12-3 shows the locations of observed invasive plants during the 2015 and 2016 surveys.

Only one invasive species observation was made within the proposed Project Footprint. Smooth brome was found in the proposed open pit area in 2015. This area was cleared early in 2016 for exploration trail building and the plant was not found again during the 2016 surveys. It is possible the grass was introduced through a seed-mix used by Cominco to revegetate disturbed areas (Dorothy Dick, pers. comm.).

No information on invasive plants was included in the 1996 baseline study for the Project. Detailed recommendations for the management of current invasive plants and prevention of additional infestations are presented in the management plans in Chapter 18. An invasive species management plan was implemented for the exploration project during the 2016 exploration field season.



- Rare Plant Transect Location
- Rare Plant Perimeter Survey
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Mine Infrastructure Footprint
- Local Study Area
- Waterbody
- Watercourse
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (20 m interval)

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FIGURE 12-2

RARE PLANT TRANSECTS AND PLOTS

JANUARY 2017

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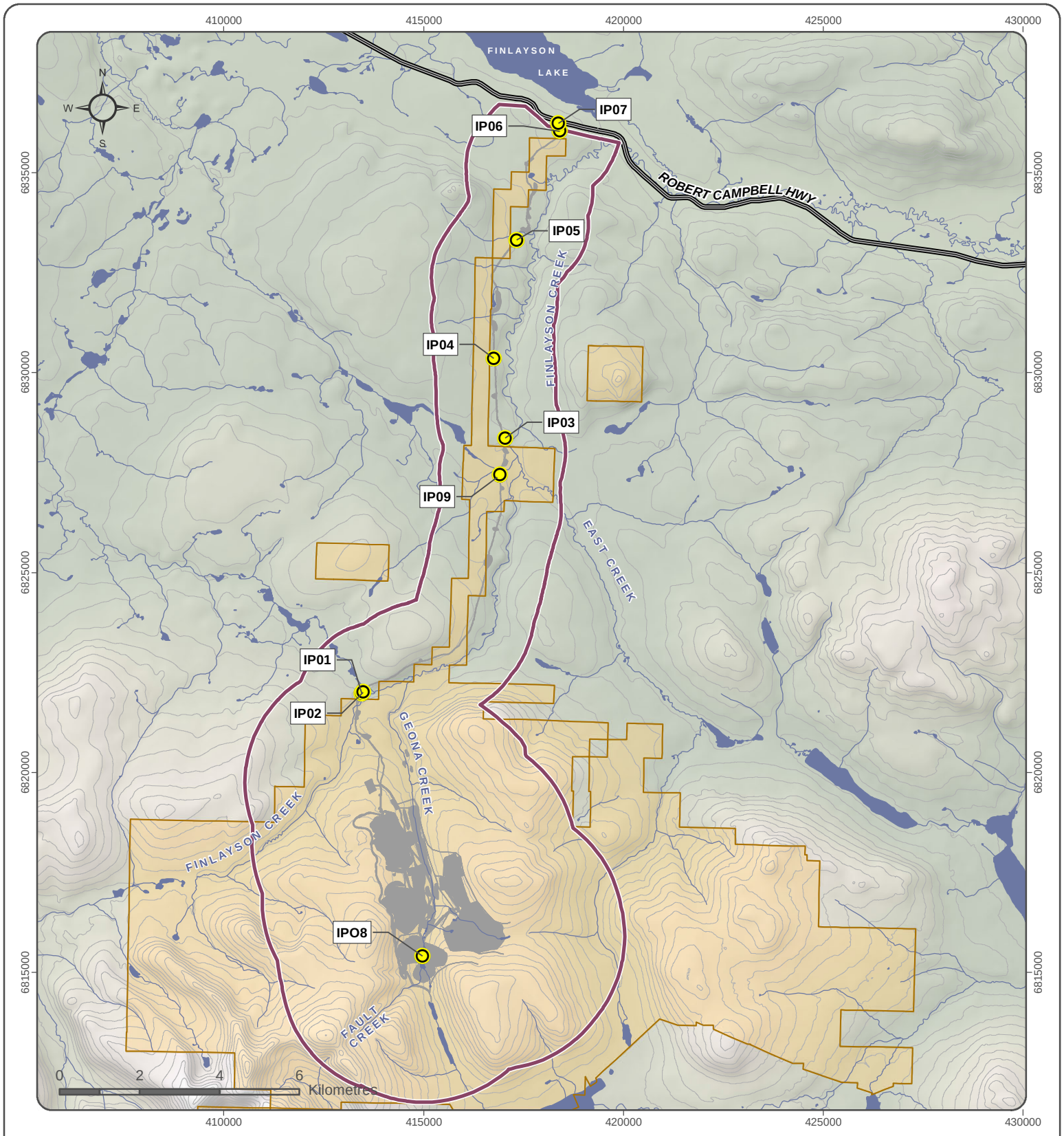

- Location of Observed Invasive Plant
- Local Study Area
- Location of Proposed Mine Infrastructure Fotprint
- BMC Minerals (No.1) Ltd. Claim Areas
- Waterbody
- Contour (40 m interval)
- Watercourse

KUDZ ZE KAYAH PROJECT

FIGURE 12-3
LOCATION OF OBSERVED INVASIVE PLANT SPECIES

MARCH 2017

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12.3.5 Metals in Soils and Vegetation

The determination of metal concentrations in soils and vegetation in the Project area provides a baseline data set, which will help in monitoring changes in metal concentrations in the environment as Project development and operations proceed. Furthermore, knowledge of metal concentrations in soils within the Project area will aid in evaluating the potential use of soils for reclamation and closure activities.

Metals in vegetation can be ingested by wildlife and could accumulate in animal tissues, entering the food web and transferring to other trophic levels. The plant species chosen for sampling in this study are known to be consumed by wildlife; therefore, metal analysis of plant tissues gives a baseline for what levels wildlife may be ingesting through their food source.

Soil and vegetation tissue samples were collected at 32 locations in the LSA. Metal concentrations in soil samples were compared to Canadian Council of Ministers of the Environment (CCME) soil guidelines for metal concentrations at industrial sites (Table 12-5). Of all the metals in which guidelines have been established (i.e., 19), four exceeded the guidelines including arsenic, copper, selenium, and zinc. The arsenic guideline was exceeded at 16 out of 32 sites. Copper, zinc, and selenium exceeded the guidelines at three, two, and one site, respectively. Metal concentrations in soils were not characterized during the 1996 baseline study performed by Norecol, Dames & Moore Ltd.

Table 12-5: Soil Metal Concentrations Compared to CCME Guidelines

Element	Units	CCME Industrial Guideline	Sites Exceeding CCME Guideline	Min	Max	Mean	Standard Deviation	95th Percentile
Aluminum	mg/kg	-	-	7,570	27,300	13,605	4,392	25,430
Antimony	mg/kg	40	none	<0.10	1.78	0.38	0.30	1.21
Arsenic	mg/kg	12	PA01, PA02, PA04, PA06, PA09, PA10, PA15, PA20, PA45, PA51, PA52, PA55, PA57, PA58, PA59, PA72	2.39	96	17	18	71
Barium	mg/kg	2,000	none	54	838	170	141	591
Beryllium	mg/kg	8	none	<0.40	0.61	0.26	0.26	0.59
Bismuth	mg/kg	-	-	0.13	1.03	0.27	0.16	0.71
Cadmium	mg/kg	22	none	0.09	7.84	0.91	1.42	4.89
Calcium	mg/kg	-	-	1,370	19,900	5,269	3,542	16,215
Chromium	mg/kg	87	none	15	80	37	16	79
Cobalt	mg/kg	300	none	4.41	38	14	7.20	32
Copper	mg/kg	91	PA02, PA16, PA17	3.52	192	40	37	145
Iron	mg/kg	-	-	14,500	58,100	30,993	11,455	56,340
Lead	mg/kg	600	none	10	72	28	17	70
Lithium	mg/kg	-	-	5.90	23	14	4.09	23
Magnesium	mg/kg	-	-	2,510	21,200	7,721	3,834	17,020

Element	Units	CCME Industrial Guideline	Sites Exceeding CCME Guideline	Min	Max	Mean	Standard Deviation	95th Percentile
Manganese	mg/kg	-	-	112	1,320	572	288	1,282
Mercury	mg/kg	50	none	<0.05	0.14	<0.05	--	--
Molybdenum	mg/kg	40	none	0.63	9.11	1.89	1.54	6.11
Nickel	mg/kg	89	none	9.96	71	32	15	68
Phosphorus	mg/kg	-	-	439	3,930	1,061	638	2,775
Potassium	mg/kg	-	-	439	4,540	1,340	961	4,133
Selenium	mg/kg	2.9	PA02	<0.5	6.52	<0.5	--	--
Silver	mg/kg	40	none	<0.05	1.45	0.28	0.38	1.44
Sodium	mg/kg	-	-	<100	159	<100	--	--
Strontium	mg/kg	-	-	9.24	72	24	16	67
Thallium	mg/kg	1	none	0.06	0.43	0.15	0.08	0.35
Tin	mg/kg	300	none	0.15	1.14	0.47	0.23	0.97
Titanium	mg/kg	-	-	122	1,350	606	344	1,323
Uranium	mg/kg	300	none	0.66	9.50	1.77	1.65	6.12
Vanadium	mg/kg	130	none	19	122	51	26	122
Zinc	mg/kg	360	PA16, PA20	28	784	161	141	593
Zirconium	mg/kg	-	-	<0.5	4.98	1.37	1.19	4.50

* 95th percentile is equivalent to maximum concentration

In 2015, a total of 40 vegetation samples were collected from six different vegetation types: willow (*Salix* spp.), grass (Graminoids), grass roots, horsetail (*Equisetum* spp.), lowbush cranberry (*Vaccinium vitis-idaea*), and bog blueberry (*Vaccinium uliginosum*). In 2016, a total of 33 vegetation samples were collected from four different vegetation types: willow, lichen (*Cladina stellaris*), horsetail, and bog blueberry. The species selected for sampling were based on the dietary preferences of moose, caribou, small mammals, birds, and Kaska harvest species (Appendix F-3). In a study by Wein and Freeman (1995), traditional plants most collected by Yukon First Nations include low bush cranberry, blueberry, crowberry, Labrador tea, and balsam fir, Willow is also gathered, but less frequently (Wein and Freeman, 1995). The key metals of concern analysed in a study by Receveur et al. (1998) of traditional foods in Yukon included arsenic, mercury, cadmium, and lead.

Different parts of the plant were sampled to determine where metals had accumulated within the plant, depending on what part of the plant was being consumed. Berry samples were collected from the cranberry and blueberry plants, leaves and buds were collected from the willow, stems and roots were analyzed from grass species, leaves were collected from the lichen, and stalks were sampled from the horsetail plant. These species were chosen as representatives of groups of traditionally used plants. There are no guidelines for metal concentrations in plant tissues.

Arsenic, mercury, chromium, titanium, vanadium, and uranium had concentrations below the detection limit in all vegetation samples except grass roots. Beryllium and bismuth were below the detection limit for all vegetation types.

Metal concentrations in vegetation were also evaluated in 1997, based on a small set of vegetation samples. Results showed that concentrations of most metals detected in the LSA were within the range of worldwide background concentrations for similar vegetation types. Cadmium and zinc concentrations in some species exceeded the upper limits found at natural sites (Kabata-Pendias, 2011). In riparian vegetation, concentrations of aluminum, cadmium, copper, lead, selenium, and zinc were generally lower from samples at Lower Finlayson Creek, and higher in samples from Geona Creek. Sedges contained higher levels of aluminum than other species, while willows had the highest levels of zinc (Norecol, Dames & Moore Ltd., 1997). Only six metals were analyzed in the vegetation samples.

Table 12-6 compares the results of the vegetation samples from 2015 and 2016 to those collected in 1997. It also compares 1997, 2015, and 2016 results to background concentrations in plants from background sites worldwide. No information was provided regarding what plant species the background range was collected from.

Table 12-6: Vegetation Metal Concentrations from 1997, 2015, and 2016 Samples Compared to Uncontaminated Worldwide Background Ranges

Units (µg/g)	Aluminum	Cadmium	Copper	Lead	Selenium	Zinc
Worldwide Background Range	No data	< 1	2 – 30	0.1 – 5	0.1 – 2	15 – 150
Project Vegetation						
Sedges						
1997	43 – 1,810	< 0.2 – 1.6	5.7 – 13	< 0.3 – 2.1	0.4 – 1.5	155 – 212
2015	3.5 – 1,420	0.02 – 3.4	2.1 – 9.1	0.2 – 9.7	< 0.05 – 0.4	15 – 266
2016	No data	No data	No data	No data	No data	No data
Horsetail						
1997	30 – 108	2.8 – 5.1	8.7 – 12	< 0.3 – 0.4	0.2 – 1.5	47 – 60
2015	1.9 – 5.2	0.03 – 2.0	2.6 – 7.3	0.02 – 0.2	0.1 – 0.4	22.1 – 112
2016	2.8 – 6.1	0.2 – 0.9	4.1 – 7.4	0.03 – 0.07	0.05 – 7.7	27 – 62
Willow						
1997	4 – 31	0.5 – 9.6	3.5 – 9.6	< 0.3 – 1.2	< 0.2 – 1.0	124 – 467
2015	3.7 – 123	1.3 – 19	2.5 – 5.8	0.01 – 0.2	< 0.05 – 0.4	40 – 699
2016	4.0 – 25	2.1 – 22	1.9 – 5.6	0.02 – 0.4	< 0.05 – 1.8	71 – 1,010
Berry						
1997	19 – 165	1.4 – 1.8	7.2 – 8.1	0.3 – 1.2	< 0.2 – 0.6	70 – 128
2015	< 0.2 – 0.31	0.04	0.5 – 0.7	< 0.002	< 0.01	2.6 – 2.8
2016	0.7 – 0.9	0.05 – 0.1	0.5 – 0.7	< 0.002 – 0.008	< 0.01	2.9 – 4.5
Lichen						
2016	20.9 - 84.4	0.09 - 0.34	0.6 - 1.4	0.09 - 0.26	<0.05 - 0.8	14 - 44

12.3.6 Forest Productivity and Timber Volumes

Stand density and volume estimates give an indication of possible timber quantity and carbon storage potential within the LSA. These two parameters can be used as a preliminary assessment for firewood harvest potential, and to determine whether firewood harvest is feasible given the quantity of standing timber and site conditions for access. The stand density and volume estimates also contribute to the understanding of existing wildlife habitat in the LSA.

During the 2015 and 2016 baseline study, timber plots were located along the existing Tote Road at the lower elevations where there was adequate forest cover (greater than 10%). A variable size or prism sweep method was used to select trees to measure. There were seventeen timber plots with a total of 77 trees measured over the 2015 and 2016 field seasons. This is a small sample size, but adequate to determine average volumes per forested polygon. Many of the polygons selected for timber measurements had very few trees per hectare, which reduced variability in tree size. Most polygons were less than 200 stems per hectare with a maximum stem count per hectare of approximately 312. Volume was calculated using the metrics recorded in the timber plot samples. The method used is a basic timber inventory meant to show relative wood volumes associated with each forested polygon in the study area.

In general, the trees measured are of poor timber quality. Sinuous stems are common due to active permafrost. White spruce, the ideal commercial species, are mature to old and exhibit signs of pathology. The black spruce is mainly small and spindly with little volume yield. The subalpine fir is in better condition than the spruce, but sparser on the ground and considered poor firewood.

No timber estimates were provided by Norecol, Dames & Moore Ltd. during the IEE conducted in 1996. A forest cover map does exist for the area created by the YG Forest Management Branch. This cover map is at a scale of 1:50,000 and only identifies the leading tree species, structure stage, and forest type coverage via polygon areas.

12.4 PROJECT-SPECIFIC EFFECTS

This section assesses the potential effects on vegetation cover and composition as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

12.4.1 Effects Characterization

In order to focus the effects assessment (EA), the first step is to identify any potential interactions between Project activities and Vegetation cover and composition. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1 or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects; and
2 – Higher risk interactions- it is reasonably foreseeable that residual effects may result.

The results of the interactions screening are presented in Table 12-7.

Table 12-7: Interaction Matrix for Vegetation Cover and Composition

Project Activity	Wetland and Riparian Areas	Old Growth Forest	Rare Plants	Invasive Plants	Metal concentrations in vegetation and soils
Construction					
Tote Road upgrade to Access Road	1	1	1	1	1
Finlayson Lake Airstrip upgrade	0	0	0	1	1
Site preparation and clearing	2	2	2	1	1
Site grading, including soil and overburden removal and stockpiling	2	1	2	1	1
Off site traffic (construction equipment and materials delivery)	0	0	0	2	1
On site traffic	0	0	0	1	1
ABM open pit development (including dewatering and Fault Creek diversion)	2	2	2	0	2
Infrastructure construction	2	2	2	1	1
Waste handling	1	0	0	0	0
Water use and management	1	0	0	0	0
Power generation	0	0	0	0	0
Worker transport	0	0	0	2	1
Construction camp operation	0	0	0	0	1
Workforce, procurement and hiring	0	0	0	0	0
Operations					
ABM open pit operations (including blasting and dewatering)	0	0	0	0	2
Underground operations	0	0	0	0	0
Ore processing	0	0	0	0	2
On site traffic	0	0	1	0	1
Off site traffic (highway)	0	0	0	2	1
Finlayson Lake airstrip operations	0	0	0	2	0
Storage facilities management (Class A, B, and C)	2	0	2	1	2
Progressive reclamation of storage facilities	0	0	0	1	0
Water use (potable and non-potable)	0	0	0	0	0
Mine water management and treatment (including effluent discharge)	2	0	0	0	0
Waste management	0	0	0	0	0
Power generation	0	0	0	0	0
Worker transport	0	0	0	2	1
Camp operation	0	0	0	0	0
Workforce, procurement and hiring	0	0	0	0	0

Project Activity	Wetland and Riparian Areas	Old Growth Forest	Rare Plants	Invasive Plants	Metal concentrations in vegetation and soils
Closure [1]					
Processing plant decommissioning and site reclamation	1	0	0	0	1
ABM lake filling	0	0	0	0	0
Final storage facilities reclamation	0	0	0	0	1
Support infrastructure removal and site reclamation	0	0	0	0	1
Water management, treatment and discharge	1	0	0	0	0
On site traffic	0	0	0	0	1
Off site traffic	0	0	0	1	1
Access Road reclamation	1	0	0	1	1
Workforce, procurement and hiring	0	0	0	0	0

[1] Closure interactions occur during the active and transitional stages of closure as infrastructure is decommissioned, facilities reclaimed, and wetlands are constructed and maintained.

12.4.1.1 Overall Vegetation Community Changes

Project effects on vegetation cover and composition were primarily assessed using quantitative analysis based on spatial change in area from baseline conditions to reflect Project activities. The basis for quantifying vegetation cover and composition changes was derived from the 1:23;000 TEM that was developed for the LSA (Appendix E-6). Baseline conditions for the selected subcomponents were intersected with the potential disturbance areas to derive the amount of directly affected area. Direct effects resulting from Project disturbance are presented in Table 12-8. The most predominant ecosites that fall within the Project Footprint are exhibited in Photos 12-1 to 12-6.

The methods for assessing environmental effects on vegetation described above is in keeping with the Kaska land management framework which includes determining the percentage of forest cover removal and seral classes to assess level of effects on watersheds (Dena Kayeh Institute, 2010, p.18).

In addition to these direct Project interactions, the following indirect interactions were identified for vegetation cover and composition:

- Potential effect to vegetation metal concentrations as a result of fugitive dust from Project activities;
- Potential effect from groundwater table changes around the ABM open pit; and
- Potential change to vegetation composition as a result of altering soil moisture regimes.

Table 12-8: Potential Project Effects on Vegetation Cover and Composition

Ecosite[1]	Baseline Area in LSA (ha)	Percent of LSA (%)	Directly Impacted Ecosite (ha)	Percent of Ecosite Loss in LSA (%)	Post Closure Reclamation Ecosite (ha)	Ecosite Area Change (ha)	Percent of LSA Ecosite Change Post Closure (%)
Alpine Bioclimate Zone (>1,550 masl)							
01-EsWiDsLu	621.8	5%	15.3	2.5%	0.0	-15.3	-2%
13-EsGrLi	252.7	2%	6.6	2.6%	0.0	-6.6	-3%
21-HeCxLi-k	330.0	3%	0.0	0.0%	0.0	0.0	0%
21SZ-EsDsGr-w	322.0	3%	0.0	0.0%	0.0	0.0	0%
31SZ-SireCxMo	439.2	4%	11.4	2.6%	0.0	-11.4	-3%
33-WiFbCx	95.7	1%	0.0	0.0%	0.0	0.0	0%
TA	399.6	3%	4.1	1.0%	0.0	-4.1	-1%
Boreal Subalpine Bioclimate Zone (1,330-1,550 masl)							
01-EsWiFm	1084.1	9%	83.3	7.7%	104.2	20.8	2%
01-FEsWiFm	867.5	7%	123.3	14.2%	0.0	-123.3	-14%
11-EsLi	506.0	4%	49.5	9.8%	104.5	55.0	11%
22S-EsFmLi	295.6	2%	2.8	1.0%	32.3	29.5	10%
23-EsWiEmni	850.9	7%	203.3	23.9%	214.8	11.5	1%
31-RhEsFmLi	857.1	7%	25.8	3.0%	28.0	2.2	0%
35-WiEqFbGr	160.4	1%	31.0	19.3%	16.3	-14.6	-9%
36SZ-GrFbMo	143.8	1%	9.4	6.5%	0.0	-9.4	-7%
42O-CaaqSp	18.3	0%	6.7	36.7%	7.0	0.3	2%
48OZ-CxGrFbMo	171.5	1%	9.3	5.4%	0.0	-9.3	-5%
Wetland	21.9	0%	6.5	29.8%	3.6	-2.9	-13%
Boreal High Bioclimate Zone (900-1,300 masl)							
01-SwWiFbFm	1058.9	8%	17.7	1.7%	63.1	45.5	4%
11-AKnGr	90.8	1%	1.3	1.5%	0.0	-1.3	-1%
15S-EsCl-x	241.6	2%	6.2	2.6%	0.0	-6.2	-3%
25-SwEsDsFmCl	1052.9	8%	10.7	1.0%	0.0	-10.7	-1%
28SK-SwBEqFm	97.0	1%	0.0	0.0%	0.0	0.0	0%
35-SbSwRhFm	1180.5	9%	12.6	1.1%	0.0	-12.6	-1%
40-SbRhFmCl	688.3	6%	10.8	1.6%	0.0	-10.8	-2%
41-WiCaaqMo	228.8	2%	1.0	0.5%	0.0	-1.0	0%
46SK-BWiFb	32.3	0%	0.5	1.5%	0.0	-0.5	-1%
52O-EsCaaqSp	290.3	2%	4.3	1.5%	0.0	-4.3	-1%
56SZ-CxFbAuco	81.2	1%	1.9	2.3%	0.0	-1.9	-2%

[1] Ecosite codes and descriptions are located in Appendix E-6.

Photo 12-1: Ecosite 01-FEsWiFm (Subalpine fir-scrub birch-willow-feather moss)

Photo 12-2: Ecosite 11-EsLi (Scrub birch-lichen)

Photo 12-3: Ecosite 23-EsWiEmni (Scrub birch-willow-crowberry)

Photo 12-4: Ecosite 35-WiEqFbGr (Willow-horsetail-forbs-grass)

Photo 12-5: Ecosite 42-CaaqSp (Water sedge)

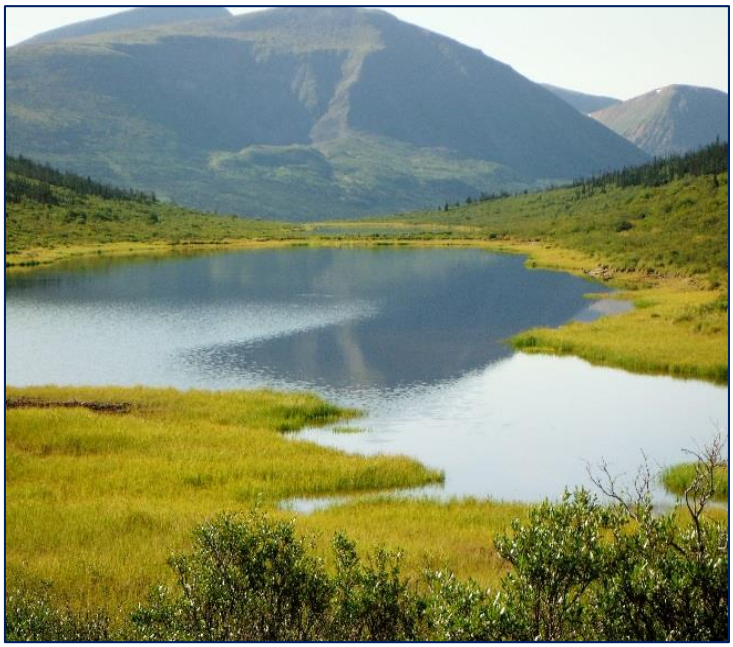


Photo 12-6: Wetland Ecosystem (Wetland B south of ABM open pit)

Through progressive reclamation and final reclamation, vegetation communities will be re-established. Post-closure target ecosystems on the post-mining landforms were based on estimated moisture, nutrient, slope, elevation, and aspect. The conceptual reclamation plan includes the preliminary species selected for revegetation (Appendix H-1). Figure 12-4 shows the predicted ecosystems on the Project footprint in post-closure. Figure 12-4 presents the predicted ecosystems that will be reclaimed on the post-mining landforms after revegetation and the likely wildlife species that the vegetation communities will support.

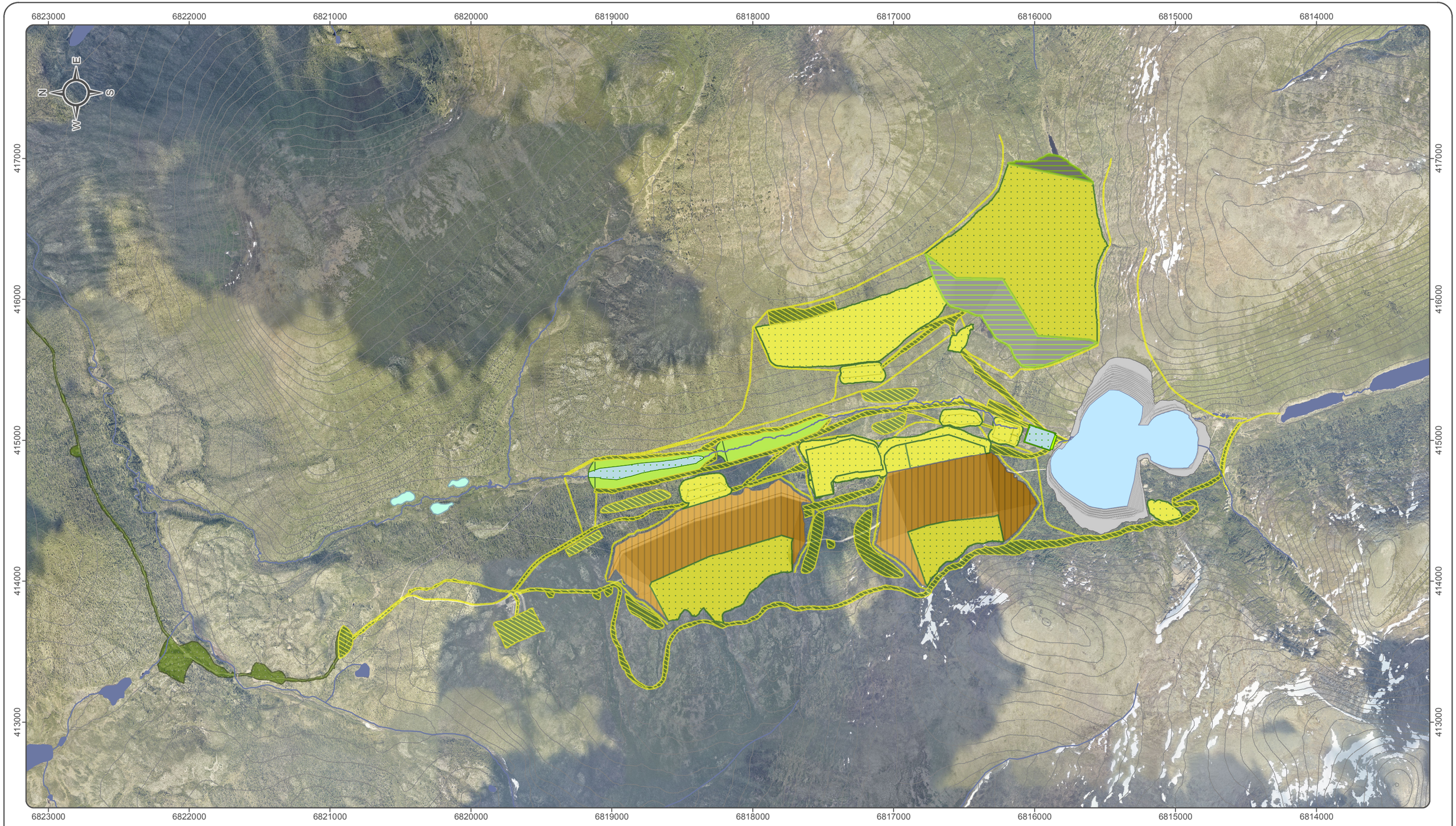
Post-mining landforms generally have lower nutrients and are drier since the facilities are constructed with coarse, benign rock from mining or till without organics. The soil and overburden stripped and stockpiled during construction loses nutrients while it is stored for reclamation. The resulting slopes are usually well drained and will likely require addition of soil amendments during revegetation to restore nutrients. Revegetated ecosystems are predicted to be mainly grasses and forbs and ultimately shrublands typical of fast draining, low nutrient soils in the subalpine. Some subalpine fir planting is proposed to reclaim some forest ecosystems. Wetlands will be restored in the valley bottom post-closure in the areas of the Operations Water Management Ponds. Additional ponds will be established as a part of the aquatic closure plan downstream of the Operations Water Management Ponds.

Table 12-9: Summary of Predicted Ecosystems on Post-Mining Landforms by Main Project Facility

Facility Sub-Area	Area (ha)	Target Ecosite # / Nutrient-Moisture Regime	Short-term Target Revegetation Treatment and Rationale	Long-term Target Post-Mine Vegetation Association	Estimated Post-Mine Habitat Suitability
Class A Facility					
Top	32.9	Subalpine 23/Poor-Mesic	Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Plant scrub birch seedlings. Research planting with native *Vaccinium spp.* (blueberry and lowbush cranberry) if final overburden pH, nutrients, and soil moisture are favourable to restore grizzly habitat.	Scrub birch-willow-crowberry	Caribou rut, moose post-rut, grizzly bear, wolf, small mammals, upland game birds
Slopes	53.9	Subalpine 11/Poor-Subxeric	Low growing species to allow for monitoring physical and chemical stability of facility. Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Research to restore lichens and mosses in Biological Soil Crusts.	Scrub birch-lichen	Moose post-rut, wolf
Class B Facility					
Top	16.0	Subalpine 23/Poor-Mesic	Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Plant scrub birch seedlings. Research planting with native *Vaccinium spp.* (blueberry and lowbush cranberry) if final overburden pH, nutrients, and soil moisture are favourable to restore grizzly habitat.	Scrub birch-willow-crowberry	Caribou rut, moose post-rut, grizzly bear, wolf, small mammals, upland game birds

Facility Sub-Area	Area (ha)	Target Ecosite # / Nutrient-Moisture Regime	Short-term Target Revegetation Treatment and Rationale	Long-term Target Post-Mine Vegetation Association	Estimated Post-Mine Habitat Suitability
Slopes	50.7	Subalpine 11/Poor-Subxeric	Low growing species to allow for monitoring physical and chemical stability of facility.	Scrub birch-lichen	Moose post-rut, wolf
			Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Research to restore lichens and mosses in Biological Soil Crusts.		
Class C Facility					
Top	65.3	Subalpine 23/Poor-Mesic (70%)	Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Plant scrub birch seedlings.	Scrub birch-willow-crowberry	Caribou rut, moose post-rut, wolf, ptarmigan, voles, mice
	28.0	Subalpine 31/Poor-Subhygric (30%)		Fir-scrub birch-feathermoss-lichen	
Slopes	32.3	Subalpine 22/Poor-Submesic	Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Research to restore lichens and mosses in Biological Soil Crusts.	Scrub birch-feathermoss-lichen	Caribou rut, moose post-rut, wolf
Overburden Stockpile					
Slope	46.1	Subalpine 23/Poor-Mesic	Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize. Plant scrub birch seedlings.	Scrub birch-willow-crowberry	Moose post-rut, wolf
ABM Open Pit					
	0.0	Flooding	No revegetation.	ABM lake	Waterfowl
Operations Water Management Ponds					
Constructed Wetland	1.6	Subalpine 42/Poor-Hygric	Engineered design and species selection based on water treatment requirements. Full design will be completed during operations.	Carex spp	Waterfowl, passerines, moose, grizzly bear, small mammals
Operations water management ponds	6.5	Subalpine 42/Poor-Hygric (30%)	Locally-collected willow staking.	Willow-horsetail-forbs-grass	Waterfowl, passerines, moose, grizzly bear, small mammals
	15.2	35/Rich-Subhygric (70%)	Supplement organics.		
Water collection ponds	18.7	Subalpine 23/Poor-Mesic	Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize.	Scrub birch-willow-crowberry	Moose, small mammals, passerines
Process Plant and Ancillary Facilities					
Process plant and ore pads	35.9	Subalpine 23/Poor-Mesic	Scarify. Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize.	Scrub birch-willow-crowberry	Moose, small mammals, passerines

Facility Sub-Area	Area (ha)	Target Ecosite # / Nutrient-Moisture Regime	Short-term Target Revegetation Treatment and Rationale	Long-term Target Post-Mine Vegetation Association	Estimated Post-Mine Habitat Suitability
Other disturbed areas	39.5	Subalpine 01/Medium-Mesic	Contour and scarify where needed. Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize.	Subalpine fir-scrub birch-willow-feathermoss	Moose, small mammals, passerines
Access Road Right-of-Way					
Access Road and site roads	121.7	Boreal and Subalpine 01/Medium-Mesic	Scarify. Grasses and forbs. Seed with commercial and locally collected native seed mix, fertilize.	White spruce-willow-forbs-feathermoss in Boreal High Scrub birch-willow-feathermoss in Subalpine	Caribou, moose, small mammals (including bats), passerines



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AEG

1:25,000 (when printed on 11 x17 inch paper)

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PREDICTED POST-MINING ECOSYSTEM VEGETATION ASSOCIATIONS
(only dominat vegatation shown)

- Fir-Scrub birch-Willow-Feathermoss
- White Spruce Willow-forbs-Feathermoss
- Scrub Birch-lichen
- Scrub birch-Feathermoss-Lichen
- Scrub birch-Willow-crowberry
- Willow-Horsetail-Forbs-Grass
- Bare Rock
- ABM Lake @ 1380 masl
- Constructed Wetland
- South Constructed Wetland, Footprint
- Fish Habitat Compensation Pond
- Waterbody

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 12-4

PREDICTED ECOSYSTEMS ON POST-MINING LANDFORMS

JANUARY 2017

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12.4.1.2 Wetland and Riparian Ecosystems

Assessment of the Project effects on wetland and riparian ecosystems was measured by calculating the direct loss of area resulting from the Project Footprint. Project-related activities such as site preparation and clearing (including vegetation); site grading (including soil and overburden removal and stockpiling); infrastructure construction activities (including road building and foundation development); storage facility management and open pit development may affect the baseline wetland and riparian conditions in the LSA. The most likely effects resulting from these Project related activities will result in direct loss in area of wetland and riparian ecosite communities.

Most of the effects on wetland communities will occur during the construction phase resulting from stripping and clearing the open pit, storage facilities, and infrastructure areas. During the construction phase three fish habitat ponds will be created downstream of the Lower Water Management Pond as a part of the Fisheries Offsetting Plan (FOP). These ponds are being constructed to offset fish habitat loss and will also offset wildlife habitat lost from the open pit development. The total area of the three ponds will be 2.0 ha with an estimated shoreline length of 1,210 m which will cause a reduction in ecosites 25-White spruce-Scrub birch-Dwarf shrub-Feathermoss-Cladina and 31-Labrador tea-Scrub birch-Feathermoss-Lichen but have a beneficial effect on wetland and riparian ecosystems.

There will be the temporary loss of wetlands, partially compensated for by development of the fish habitat compensation ponds during operations. It should be noted that there are wetlands throughout the LSA and RSA that will provide alternative habitat for migratory birds during the operations phase of the project. The wetlands in the Project Footprint were not found to provide any unique habitat for listed species and are not legally protected.

The main effects on riparian ecosystems will result from direct loss of stream-related ecosites that intersect the Project Footprint. The construction phase will likely have the most notable effects as this is when major land clearing activities are scheduled to occur. More specifically ecosystem loss resulting from the stripping and clearing the open pit, storage facilities, infrastructure areas, and the diversion of water around the Project will be the majority of the impact to the riparian ecosystem. Riparian ecosystems within the Project Footprint include mostly ecosite 35-Willow-Horsetail-Forb-Grass (BOS) with a fraction of ecosite 41-Willow-*Carex aquatilis*-moss (BOH). The expected disturbed area for these two ecosites is 31.0 ha and 1.0 ha, respectively.

Indirect losses of riparian and wetlands just south of the open pit are also expected due to the groundwater drawdown cone from mining and dewatering the ABM open pit. During operations, Fault Creek will be diverted to South Creek to maintain flows; however, the shallow groundwater in the overburden aquifer will drop by approximately a metre in the area of the uppermost pond and wetland (refer to Section 9.4.3 for further discussion on groundwater effects). Following closure, Fault Creek will be rerouted into the Geona Creek valley to fill the open pit and then flow to Geona Creek after the pit is filled. As a result, flows in the South Creek drainage will drop to approximately 89% of their baseline flows and rebound to approximately 90% of their baseline flows once the pit is filled. The resulting effects on the wetlands and riparian areas of the South Creek are difficult to

predict. For the purposes of this assessment, it is estimated that the flow changes and reductions will result in a loss of 10% of wetland and riparian vegetation in this area.

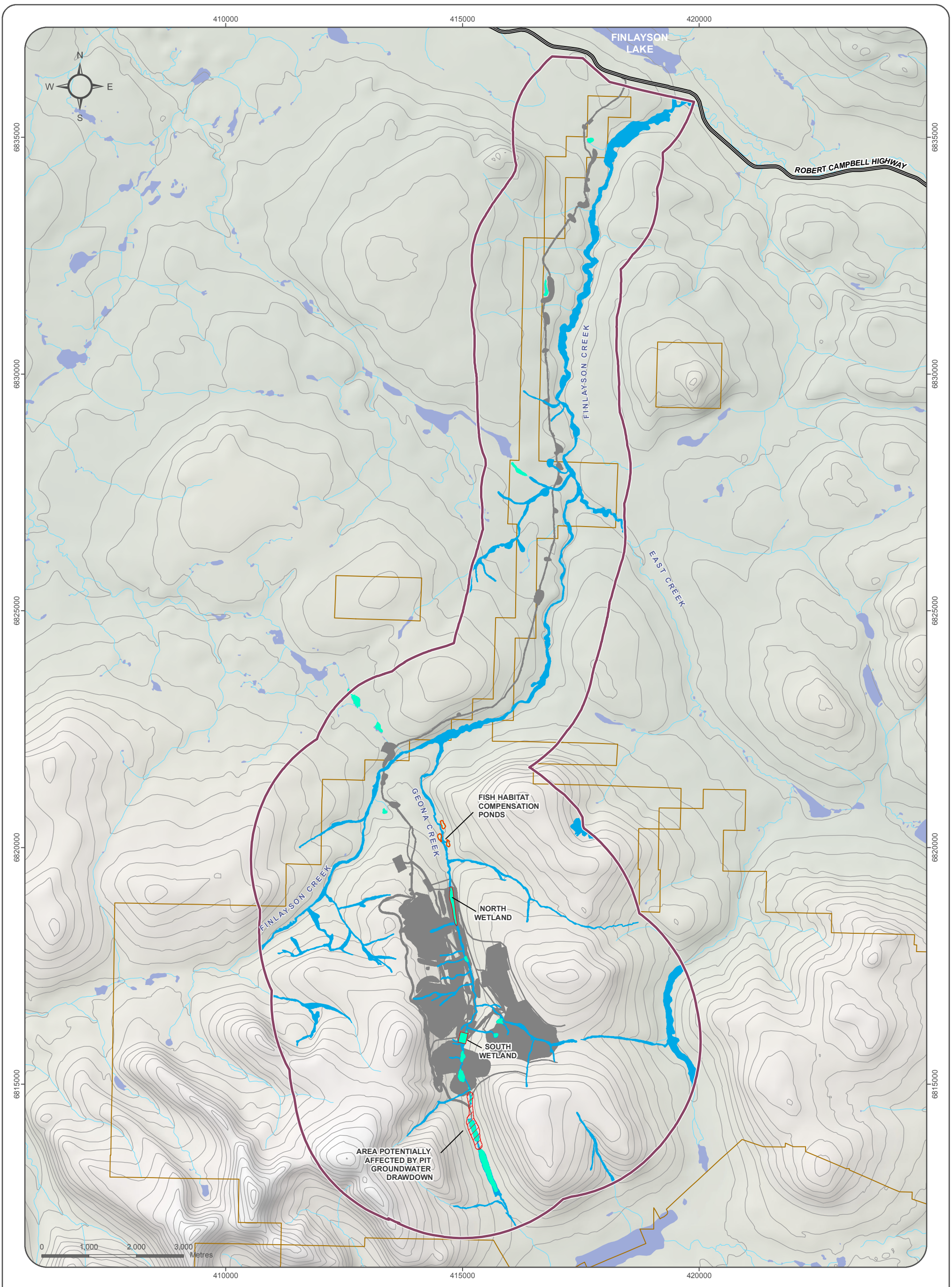
The magnitude of the potential effects was quantified by relating the direct and indirect loss of the specified ecosite to the total ecosite area with in the LSA and evaluating the effect against the determined threshold criteria. Table 12-10 shows the relative change for the respective ecosites. Wetlands and riparian ecosites have not been totalled because they are ecologically distinct. It should also be noted that there is a time delay before the ecosite gain is realized so the magnitude of effects considers both the maximum disturbance during operations until it reclamation is complete post-closure.

Figure 12-5 shows the location of wetlands and riparian areas relative to the Project Footprint and highlights proposed constructed ponds for the fish habitat offset program, the location of likely post-closure constructed wetlands, and the areas that are predicted to be affected by the open pit groundwater drawdown.

Table 12-10: Change in Wetland and Riparian Ecosystems within the LSA

Ecosystem Type	Baseline Area Within LSA[1] (ha)	Direct Ecosite Loss[2] (ha)	Ecosite Gain from Fish Habitat Offset[3] (ha)	Total Ecosite Change Operations (%)	Ecosite Gain from Reclamation[4] (ha)	Total Ecosite Change Post-Closure (%)
Wetland	21.9	6.0	1.8	-19.2	3.3	-4.1
Total riparian (ecosites 35 and 41)	372.1	31.0	0.2	-8.3	18.2	-3.4
35-Willow-Horsetail-Forb Grass (BOS)	138.3	30.0	0	-19.3	18.2	-8.5
41-Willow-Carex aquatilis-moss (BOH)	233.8	1.0	0.2	-0.5	0	-0.5

[1] Area of ecosite prior to any construction
[2] Area of ecosite lost to the Project Footprint, including Access Road
[3] Area of wetlands and riparian vegetation from fish habitat creation
[4] Area of wetlands reclaimed post-closure



Wetland

Riparian Ecosystem

Constructed Replacement Riparian and Wetland Ecosystems

Riparian and Wetland Ecosystems Potentially Affected by Pit Groundwater Drawdown

Local Study Area

Location of Proposed Mine Infrastructure Footprint

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Watercourse

Contour (40 m interval)

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FIGURE 12-5

RIPARIAN AND WETLAND INTERACTION WITH PROJECT FOOTPRINT

JANUARY 2017

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12.4.1.3 Old Growth Forest

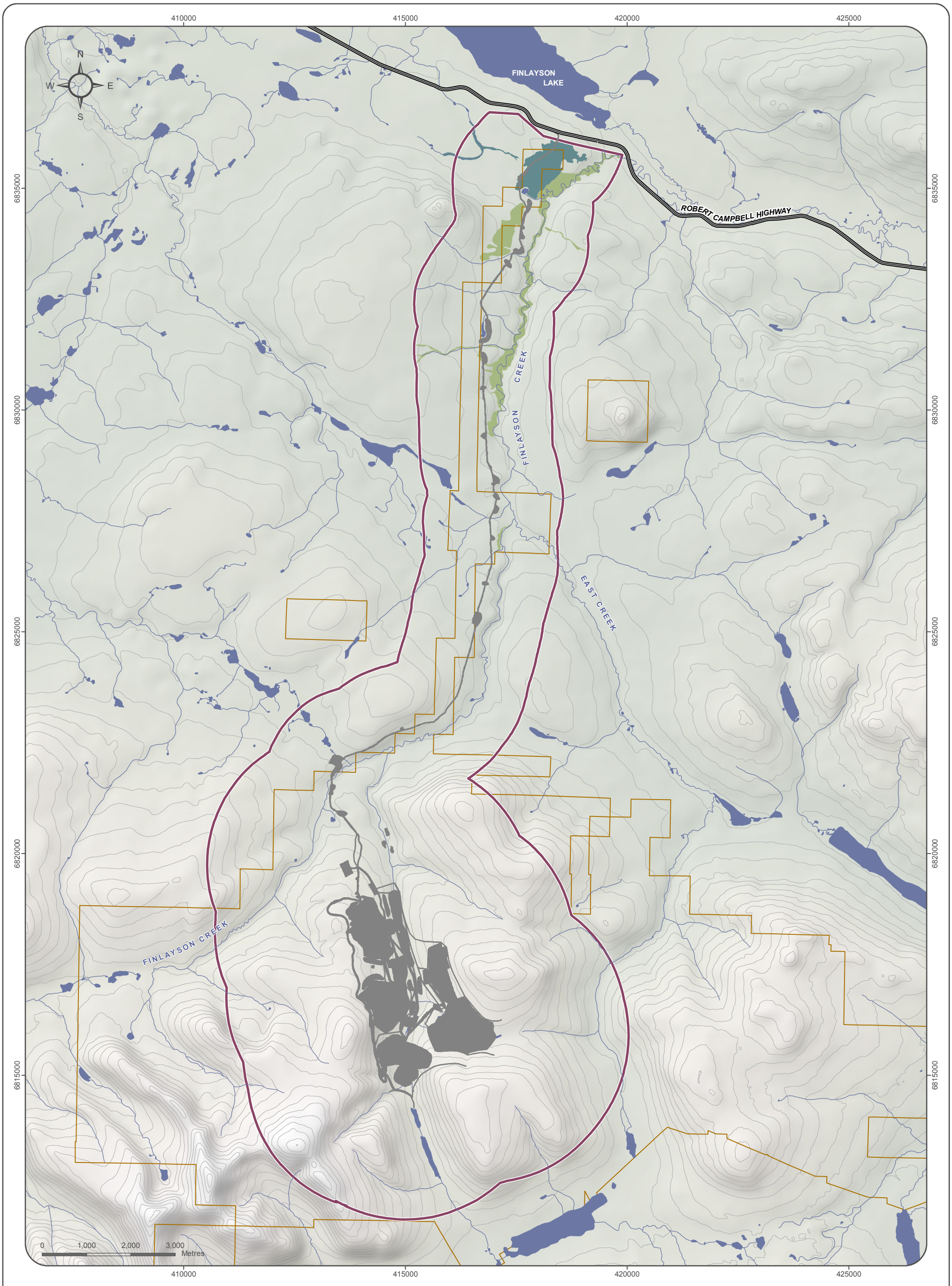
The primary effect to old growth forest will be the direct loss of area through the construction and operations phases. Project activities, such as site preparation and clearing (including vegetation), site grading (including soil and overburden removal and stockpiling), infrastructure construction activities including road building, pit dewatering and blasting will affect the old growth forest in the LSA. Although there are no major re-alignments planned for the Access Road, there will be a small area of loss of old growth black and white spruce where they occur along the Access Road to the extent of the BOH.

Old growth forest in the LSA was assessed using the Project specific TEM in conjunction with the Project disturbance footprint. TEM polygons containing old growth forest (i.e., structural stage 7) and whose leading species were either white spruce, black spruce, or subalpine fir were selected as the old growth ecosystems. Areas of direct disturbance were calculated where these polygons directly intersected with the Project disturbance. Table 12-11 shows the area with respect to each species that will likely be removed. Figure 12-6 shows the location of old growth forest areas relative to the Project Footprint.

Table 12-11: Change in Old Growth Forest within the LSA

Old Growth Tree Species	Baseline Area Within LSA[1] (ha)	Direct Old Growth Forest Loss[2] (ha)	Total Old Growth Change Post-Closure (%)
White Spruce (Sw)	164.4	1.7	-1.0
Black Spruce (Sb)	8.9	0.0	0.0
Total	**173.3**	**1.7**	**-1.0**

[1] Area of old growth forest prior to any construction
[2] Area of old growth forest lost to the Project Footprint, including Tote Road upgrade



Old Growth Forest by Species

- Black Spruce(Sb)
- White Spruce (Sw)
- Local Study

- Location of Proposed Mine Infrastructure Footprint
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

- Waterbody
- Watercourse
- Contour (40 m interval)

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KUDZ ZE KAYAH PROJECT

FIGURE 12-6

OLD GROWTH FOREST INTERACTION WITH PROJECT FOOTPRINT

DECEMBER 2016

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12.4.1.4 Rare Plants

Project related activities, such as site preparation and clearing (including vegetation), site grading (including soil and overburden removal and stockpiling), infrastructure construction activities including road building, pit dewatering and blasting, and storage facility management were identified as having the greatest potential effect on rare plant ecosystems. These listed activities are planned for the construction and operations phase and comprise the largest amount of surface disturbance for the Project. The storage facilities are designed to be cleared and reclaimed systematically in stages as the Project is executed over the ten-year life. There could be some indirect effects from closure phases resulting from additional surface disturbance and dust generation. Transect and wetland surveys conducted in 2015 and 2016 did not identify any rare plant species within the Project area and as a result no known areas of occurrence were identified as overlapping the Project disturbance footprint. However, based on the YCDC track list and communication with the YCDC, nine plant species were identified that could possibly exist within the LSA (YCDC, 2015; Table 12-4); therefore, a chance find procedure is included in the management plans (Chapter 18) to identify rare species if they are encountered when clearing wetland areas or near cliffs.

12.4.1.5 Invasive Plant Species

Introduction of invasive plant species can arise from newly exposed disturbance as well as seeds and vegetation inadvertently transported to site on the undercarriages of vehicles, equipment, work boots, or on work clothes from off site locations. Invasive plant species spread rapidly and outcompete native species resulting in potential changes to the overall vegetation community and the wildlife species communities that the vegetation supports (YISC, 2016). BMC has already implemented an invasive plant management plan for the exploration program and will continue this program throughout the life of the Project.

The Project can continue to affect native vegetation through the introduction of invasive species with increased activities throughout the construction, operations, and closure phases. Specific activities within these phases includes: Tote Road upgrade to Access Road, site preparation and clearing, off site traffic (construction equipment and materials delivery), worker transport, and site grading (including soil and overburden removal and stockpiling). The amount of area cleared at any given time will be limited to reduce the potential for invasive species establishment which occurs most frequently on disturbed ground.

12.4.1.6 Metal Concentrations in Traditional Use and Wildlife Browse Plants

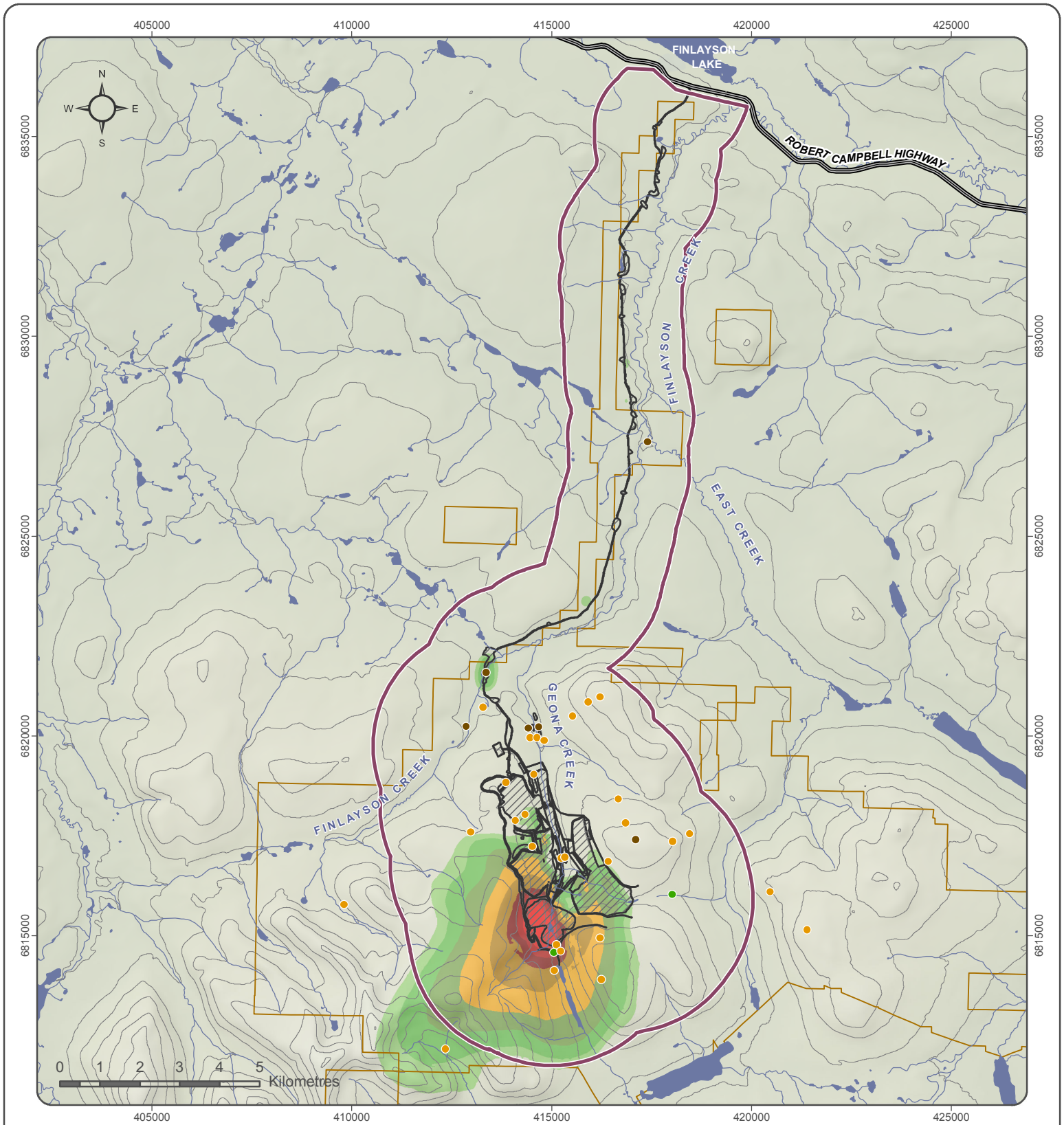
Project related activities occurring in the construction and operation phases may cause a potential effect on metal concentrations in plants used for traditional purposes and wildlife browse. More specifically, the construction activity of pit development and operation activities of open pit operations, ore processing, and storage facilities operations will generate dust that will disperse in the prevailing wind currents and settle on soil and vegetation and can be absorbed or transported into the plant. Figure 12-7 shows the results of the dust dispersion model (Appendix E-1) for the operations phase when there is maximum dust generation. Based on the modelling, the open pit

blasting is the primary source of dust and dust dispersion patterns spread some to the east, but mostly to the southwest due to the prevailing northeast winds. This model predicts a reasonable worst case scenario that includes the conservative assumption that all equipment will be operating at once (which will not occur during the life of the Project) and that blasts are at the surface (which will only occur during a portion of the construction period). Atmospheric transport of dust is also expected from the Class A and Class B Storage Facilities, the ROM Pad, and Low Grade Ore Pad.

Vegetation metal concentrations are typically affected by airborne dust accumulation on plant tissue and the surrounding soils. Metals are a necessary micronutrient for plants, but at high concentrations can impair plant growth (Csavina et al., 2011). Lichens and mosses in particular are more sensitive to airborne metals and road dust (Walker and Everett, 1987; Farmer, 1993). Road dust also has the potential to reduce plants that prefer acidic environments (Walker and Everett, 1987).

Effects of metals in vegetation on wildlife varies widely depending on the plant species being consumed, foraging range, quantity of plant material consumed, climate, and the wildlife species (Roggeman et al., 2013).

The Project is a proposed polymetallic operation that can result in dispersion of mineralized dust; therefore, there is the potential for the Project to be a source of various heavy metals that could adversely affect surrounding vegetation and indirectly human, and wildlife health. However, the risk of metals reaching detrimental concentrations is considered to be low because the operation is not located near an urban centre (i.e., receptors are distant). The majority of metals and metalloids in airborne emissions from the Project will be from road dust. In addition, the wildlife (i.e., receptors) browsing on vegetation surrounding the Project have large ranges and are unlikely to consume nearby vegetation in quantities that would cause detrimental effects to the wildlife or any humans consuming these animals (Roggeman et al., 2013).



TSP Deposition Annual Average (µg /m²/Day)

- 213 - 400
- 400 - 500
- 500 - 700
- 700 - 1,000
- 1,000 - 1,800
- 1,800 - 3,500
- 3,500 - 6,500
- 6,500 - 13,500
- 13,500 - 27,500
- 27,500- 55,600

- Baseline Vegetation Sample
- Baseline Soil Sample
- Baseline Vegetation and Soil Sample
- Location of Proposed Mine Infrastructure Footprint
- Local Study Area
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Waterbody
- Watercourse
- Contour (100 m interval)

KUDZ ZE KAYAH PROJECT

FIGURE 12-7

EXTENT OF DUST DEPOSITION DURING OPERATIONS

JANUARY 2017

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12.4.1.7 Summary

Table 12-12 provides a summary of the identified potential effects from the above section that are carried forward for consideration of mitigation measures.

Table 12-12: Identified Potential Project Effects for Vegetation Cover and Composition

Subcomponent	Potential Effect	Project Phase
Wetland and Riparian Ecosystems	Loss of wetland and riparian ecosystems	Construction, operations, closure, post-closure
Old Growth Forest	Loss of old growth forest	Construction, operations, closure, post-closure
Rare Plants	Loss of rare plants	Construction, operations
Invasive Plants	Invasive plants outcompeting native vegetation	Construction, operations, closure, post-closure
Metal concentrations in Traditional Use and Wildlife Browse Plants	Metal increase in traditional use plants or wildlife browse	Construction, operations

12.4.2 Mitigation Measures

12.4.2.1 Wetland and Riparian Ecosystems

The main objective of the planned mitigation for the Project is to minimize the area cleared for Project activities which will directly affect or compromise wetland complexes and riparian ecosystems. This will be achieved by the Project design which considers minimizing land clearing to the areas only necessary for Project development. An alternatives assessment was conducted for tailings and waste rock management (Section 4.15.4). The preferred alternative is for the major storage facilities to avoid permanently flooding the Geona valley (which was the original design by Cominco) in order to reduce the permanent loss of wetland and riparian ecosystems. This change in design has substantially reduced the effects to wetland and riparian ecosystems that would have occurred under the previously approved Cominco design. This objective is in keeping with the goals of the Kaska land management framework. For wetlands less than 500 ha in size, Kaska management practices suggest that riparian buffers be set on a site specific basis (Dena Kayeh Institute, 2010). The Project design and proposed management practices for sediment and erosion control (Section 18.6) are in keeping with the Kaska framework where practicable. Wetlands affected by Project development are all less than 500 ha. Site-specific protective riparian buffers of 30 m adjacent to fish bearing waterbodies and 15 m adjacent to non-fish bearing waterbodies, where practicable, have been included in the Project design and will be discussed further with Kaska for final design (Section 18.7.3.3).

As discussed in Section 12.4.1.2, construction of three fish habitat ponds at construction will minimize effects to wetland function from Project development. Overall, the Project will meet the federal goal of conserving long-term waterfowl populations (NAWMP, 2014) given losses of wetland function are temporary during the operations as well as wetlands in the surrounding LSA and RSA provide alternate habitat.

In addition to Project design (i.e., not having submerged tailings permanently stored in the valley) progressive reclamation and reclamation at closure will be the main mitigative actions used to address the potential effects on wetland and riparian ecosystems. Reclaiming lost ecosystems with similar ecosites as much as practicable will be implemented to further reduce potential residual effects. Additionally, mitigation and monitoring plans will be a key part of the mitigative measures for wetland and riparian ecosystems. In particular:

- Sediment and Erosion Control Plan (Section 18.6): Includes control measures during vegetation and soil stripping, taking into consideration slope stability and the proximity to sensitive habitats, to reduce sediment from entering riparian areas, wetlands, and fish habitat. Additionally, disturbed areas will be revegetated to stabilize riparian zones as soon as practicable; and
- Wildlife Protection Plan (Section 18.7): Establish "no-clearing" buffer zones around riparian areas (i.e., creeks and ponds) to prevent sedimentation of aquatic habitats and minimize disturbance to wildlife movement corridors, where practicable.

12.4.2.2 Old Growth Forest

Old growth forest is very difficult to reclaim on a disturbed area as it can take hundreds of years to re-establish which is difficult to measure and quantify relative to the disturbance. Therefore, a project design that avoids or minimizes disturbance of old growth forest is the only practical mitigation measure. The majority of old growth forest exists along the Tote Road in the BOH bioclimate zone. The alignment for the Access Road upgrade was designed to minimize new disturbance, which also minimizes disturbance of old growth forest. Reclamation may ultimately re-establish conifer forest; however, this mitigation measure is too long-range (i.e., greater than 140 years) to be applicable in this assessment of effects.

12.4.2.3 Rare Pants

The likelihood of rare plants being disturbed from Project development is low given rare plants were not found during baseline studies and ecosystems that contain these species are limited at the Project footprint. To reduce the chance of disturbance of rare plants, a chance find procedure will be implemented with particular attention in likely areas of rare plant occurrence during the construction phase and clearing activities during operations. Rare plant habitat is often associated with cliff areas, wetland complexes, and riparian zones, which are less common in landscape mosaics. In addition, information for recognition and identification of rare plants will be included in the induction program and clearing protocols for equipment operators.

12.4.2.4 Invasive Plant Species

Mitigation measures for invasive species have been established for prevention and control measures as part of the KZK Exploration Project and will continue to be implemented during construction and operations of the mine. Species that are known to spread quickly will receive extra effort in management to reduce the potential risk. Specific measures to prevent the establishment and spread

of invasive species are described in the Invasive Species Management Plan (Section 18.8.1) specific activities outlined in the plan include:

- Minimize disturbance of the natural vegetation and exposure of soils around the Project Footprint;
- Allow disturbed and reclaimed areas to revegetate naturally to the extent practicable to reduce the risk of introducing invasive plant species to the area;
- Re-use salvaged soil for reclamation to promote successful regeneration of the natural seed bank;
- Collection and use of local seeds for reclamation;
- If and when necessary, procurement of seeds will be done from reputable seed suppliers with quality control programs;
- Transplant seedling to disturbed ground to encourage quick regeneration of ground cover and reduce likelihood of invasive species colonization;
- If concerns of an invasive species infestation are immediate, establish a vegetation cover as soon as practicable after ground disturbance using a native grass seed mix;
- Where practicable, limit vehicle use to existing roads and trails (included in BMC's ATV policy, Appendix A-11) to limit additional ground disturbance and therefore potential introduction of invasive species;
- Ensure equipment, vehicles, and personnel clothing are free of invasive plants prior to entering the Project by way of a check station at the Access Road gatehouse. Check station will include information on invasive species, instructions for proper disposal, and a disposal bin;
- All new equipment/vehicles entering Project area, will need to be weed free prior to site access; and
- Ensure employees are briefed on proper invasive species prevention strategies during induction.

The prevention measures above will be supplemented with a monitoring and control program. Disturbed areas will be regularly checked and invasive species removed. If preventative measures are unsuccessful at stopping the spread of invasive plants to the Project operations area site, BMC will take action to control the spread and removal of the invasive species. BMC commits to using Yukon recommended invasive plant management methods. Further details of the control program are presented in Section 18.8.

12.4.2.5 Metal Concentrations in Traditional Use and Wildlife Browse Plants

The main mitigative measures to reduce the potential for increased metal concentration in plants used for traditional purposes and wildlife browse will be through the Air Quality Management Plan (Section 18.11). The objectives of the air quality management plan include:

- Minimize fugitive dust;
- Minimize emissions of and exposure to gaseous contaminants; and
- Minimize emissions of greenhouse gases during all phases of the Project.

The most applicable objectives are minimizing fugitive dust and minimizing the emissions and exposure of gaseous contaminants. Fugitive dust will be managed by:

- Constructing closures around crushing and material handling facilities;
- Progressive reclamation of storage facilities; and
- Watering of roads and exposed surfaces.

A vegetation and soil monitoring plan will be implemented to track the effects of dust deposition relating to the mine area and Access Road. The monitoring plan is scheduled to be conducted every three years starting in the construction phase and will track change in soil metal concentrations from baseline conditions. If soil metals exceed guidelines or are consistently higher than baseline concentrations, then additional mitigations measures will be taken to reduce emissions. A vegetation tissue metal monitoring program would also be implemented at that time to determine the extent (if any) plants are incorporating metals from the soils into their roots, stems, and/or leaves.

12.4.2.6 Summary of Mitigation Measures

Potential effects on VC and identified mitigation measures are summarized in Table 12-13 and discussed further below.

Table 12-13: Proposed Mitigation Measures for Vegetation Cover and Composition

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (High, Medium, Low)	Residual effect identified? (Yes/No)
Loss of wetland and riparian ecosystems	Construction, operations, closure, post-closure	Reclamation; construct wetland and riparian areas during construction (part of fish habitat offsets) and at closure (part of water treatment)	Medium	Yes
Loss of old growth forest	Construction, operations, closure, post-closure	Limit initial Project disturbance of old growth forest through design	Medium	Yes

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (High, Medium, Low)	Residual effect identified? (Yes/No)
Loss of rare plants	Construction, operations	Additional, focussed rare plant survey prior to construction; information to recognize and identify rare plants will be included in the induction program and in clearing protocols for equipment operators	High	No
Invasive plants outcompeting native vegetation	Construction, operations, closure	Continuation of invasive species management plan	High	Yes
Metal increase in traditional use plants or wildlife browse	Construction, operations	Implementation of air quality management plan	Medium	Yes

12.4.3 Residual Effects, Consequence, and Significance Determination

Residual effects were brought forward for the assessment of the significance as defined by the criteria described in Section 12.1.3. The significance of residual effects resulting from the Project on vegetation cover and composition are summarized in Table 12-16.

12.4.3.1 Wetland and Riparian Ecosystems

The percentage of wetland and riparian zones estimated to be lost, including both direct and indirect loss, was used to determine the magnitude of effect. Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 12-14.

Table 12-14: Thresholds for Project Effects on Wetland and Riparian Ecosystems

Magnitude of Effect	Ecosystem Loss Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

Referring to Table 12-10, the percentages of wetland ecosite loss equates to 19.2% during operations and into transition closure and 4.1% post-closure resulting in a moderate magnitude effect. Riparian ecosystem loss equates to 8.3% during operations and into transition closure and 3.4% post-closure resulting in a low magnitude effect. It should be noted that direct habitat loss was calculated including the Access Road upgrade footprint and all site disturbance footprints from construction to closure with pipelines and diversion ditches buffered to five metres.

Loss of wetland and riparian ecosystems in the valley bottom around the Project Footprint will be mitigated with the creation of ponds. There will be some effect on the wetlands in the creek to the

south of the Project Footprint from the groundwater drawdown cone around the open pit. The resulting residual effect is considered not significant because the effect will be moderate (10 to 25% change) in magnitude. Estimated loss is 19.2% or 4.2 ha of wetland and, 8.3% or 30.8 ha of riparian areas during operations. Effects will be local, long-term (from construction through to post-closure), continuous, reversible over the long-term (greater than 5 years), with neutral context (important as wetlands, but not unique or rare in the region). It is very likely that this residual effect will occur with low uncertainty in the assessment because the wetlands and riparian areas are directly in the footprint of the Project.

12.4.3.2 Old Growth Forest

Table 12-15 lists the magnitude thresholds for the effects. Referring back to Table 12-11, the percentage of old growth forest loss equates to a low magnitude effect resulting from clearing for the Tote Road upgrade. It should be noted that direct habitat loss was calculated including the Tote Road upgrade and all site disturbance footprints from construction to closure with pipelines, diversion ditches, and site access roads buffered to five metres.

Table 12-15: Thresholds for Project Effects on Old Growth Forest Ecosystems

Magnitude of Effect	Ecosystem Loss Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

Loss of small amounts of old growth black and white spruce forests are expected as a result of the upgrade of the Tote Road to an Access Road. The right-of-way will be revegetated post-closure, but there are no other mitigations that can replace old growth forest. The resulting residual effect is considered not significant because the effect will be low (<10% change) in magnitude (loss of 1.7 ha), be site-specific (only in the footprint), far future (effect lasts greater than 140 yrs), continuous, reversible in the long-term, with neutral context (important, but more old growth exists in the immediate vicinity and regionally). It is very likely that this residual effect will occur with low uncertainty in the assessment.

12.4.3.3 Invasive Plant Species

The magnitude of the potential effect of invasive plants is defined by the spread of invasive plants within the LSA compared to baseline conditions. Success of invasive plant control programs vary widely (Kettenring and Adams, 2011). Based on the expected high level of clearing and transportation activity on and off site for construction and operation and effective implementation of the invasive plant control program, it is estimated that invasive species will increase two to four times baseline levels. This is categorized as a moderate magnitude effect. The effect is expected to be just at site, long-term, continuous, reversible long-term, with neutral context. It is likely that this residual effect will occur with medium uncertainty in the assessment, resulting in an overall rating of not significant.

12.4.3.4 Metal Concentrations in Traditional Use and Wildlife Browse Plants

Metal concentrations could increase in soils and vegetation surrounding the mine resulting from the spread of metal laden dust. Mitigation measures include minimizing dust sources from the Project following the air quality management plan. The effect is expected to be low in magnitude (soil concentrations increase somewhat over background), be local (in the LSA), long-term, continuous, reversible in the short term (less than 5 yrs), with neutral context (important for locals but not exclusive hunting or gathering grounds). It is likely that this residual effect will occur with medium uncertainty in the assessment, resulting in an overall rating of not significant.

Table 12-16: Project Effects Significance Assessment for Vegetation Cover and Composition

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance (Significant/ Not significant)
Wetland and Riparian Ecosystems									
Loss of wetland and riparian ecosystems	Adverse	Moderate	Local	Long-term	Continuous	Reversible long-term	Neutral	Very likely Low uncertainty	Not significant
Old growth forest									
Loss of old growth forest	Adverse	Low	Site	Far future	Continuous	Reversible long-term	Neutral	Very likely Low uncertainty	Not significant
Invasive plant species									
Increase in invasive plants	Adverse	Moderate	Site	Long-term	Continuous	Reversible long-term	Neutral	Likely Medium uncertainty	Not significant
Vegetation metals									
Metal increase in traditional use plants or wildlife browse	Adverse	Moderate	Local	Long-term	Continuous	Reversible short term	Neutral	Likely Medium uncertainty	Not significant

Note: Criteria definitions are provided in Table 12-2.

12.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for vegetation cover and composition follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. The following Project residual effects have been identified for vegetation cover and composition and are considered through the CEA:

- Loss of wetland and riparian ecosystems;
- Loss of old growth forest;
- Invasive plant species; and
- Metal increase in traditional use plants or wildlife browse.

12.5.1 Cumulative Effects Characterization

For past, present, and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the project or activity results in a demonstrable or measurable effect on the VC;
2. The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for vegetation cover and composition are identified through the screening in Table 12-17. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

As indicated in table below, no projects or activities have been identified to overlap with Project residual effects in type of effect, in time and in space. Therefore, no potential cumulative effects have been identified for vegetation cover and composition. No further assessment is required.

Table 12-17: Cumulative Effects Screening for Vegetation Cover and Composition

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Fyre Lake Property (*Pacific Ridge Exploration)*	No	N/A	N/A	No

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Grew Creek (*Golden Predator Corp.*)	No	N/A	N/A	No
Ketza River Mine *(Ketza Group/ Veris Group*)	No	N/A	N/A	No
Pelly Explorations (*BMC Minerals (No.1) Ltd.*)	No	N/A	N/A	No
Selwyn Project *(Selwyn Chihong Mining Ltd)*	No	N/A	N/A	No
The Yukon Base Metal Project *(Overland Resources Ltd.)*	No	N/A	N/A	No
Wolverine Mine (*Yukon Zinc Corp.)*	No	N/A	N/A	No
Geotechnical Investigation and Quarry Pit Development *(Transportation Engineering Branch)*	No	N/A	N/A	No
Finlayson Winter Trail *(Inconnu Lodge Limited)*	No	N/A	N/A	No
Robert Campbell Highway Traffic	No	N/A	N/A	No
Single/Group Trapline Concessions	Yes	No	N/A	No
Outfitting Concessions	Yes	No	N/A	No
Campgrounds	No	N/A	N/A	No

Note: If "No" is indicated for a condition the remaining conditions are indicated as N/A (not applicable) as all conditions must be met for potential cumulative effect to be identified.

12.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

12.6.1 Soil and Plant Tissue Monitoring Program

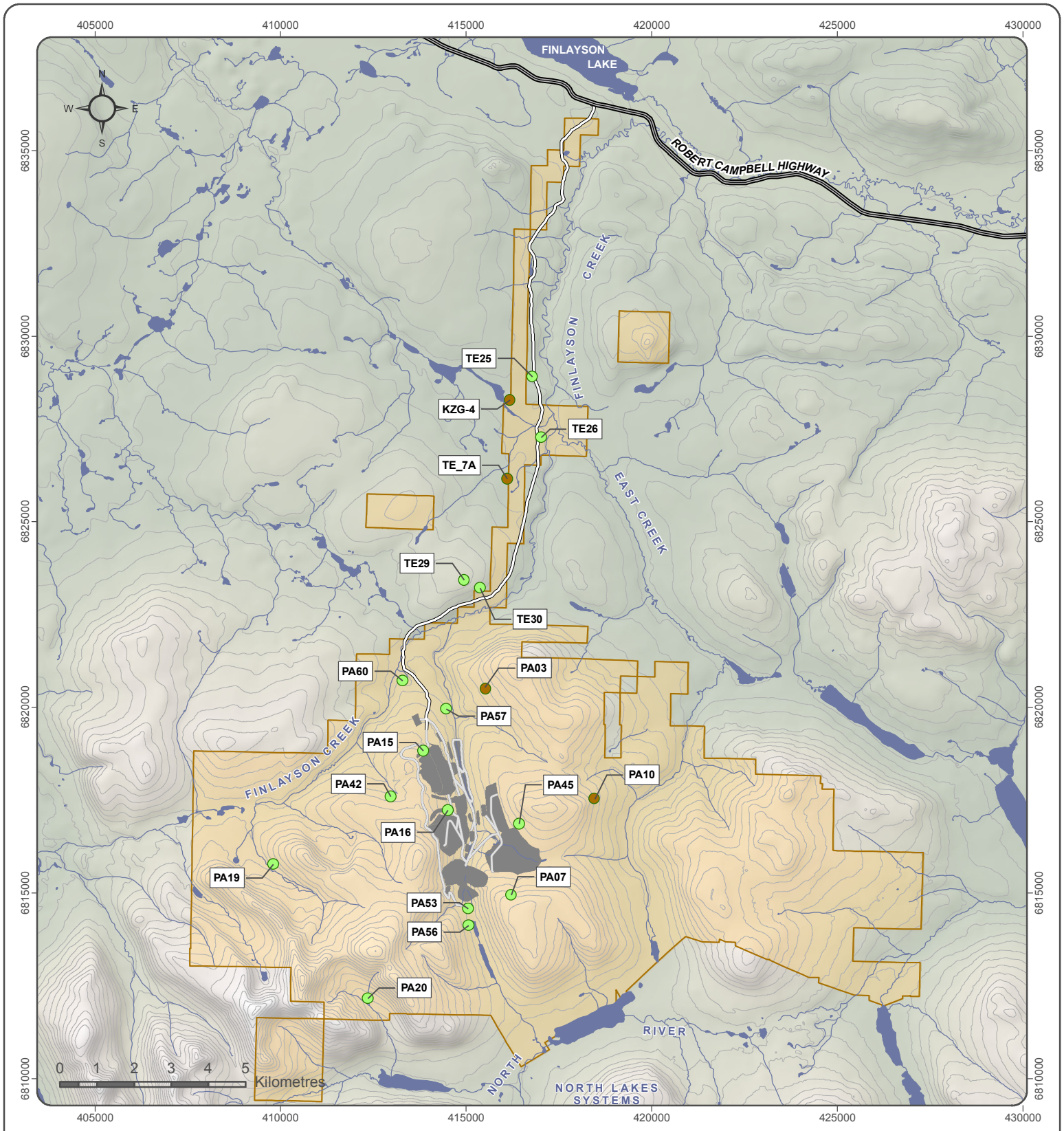
The Project does not include a smelter and concentrates are handled within a closed facility and transported enclosed in trailers. Therefore, potential sources of atmospheric metals are from

residual ore dust from blasting, open haul trucks going to the crusher, the live ore stockpile, tailings dust from the Class A Storage Facility where the material has dried but is not yet covered, and earthmoving activities in an area with naturally higher mineralization. Potential sources of metals in vegetation from water sources are limited to the closure period for constructed wetlands. The water management program controls and treats any contact water prior to release to the environment during operations and closure.

To track potential metals in atmospheric dust from these sources, the monitoring program will initially collect soil samples at exposure and control sites. The sampling program will be conducted prior to construction, after development, and once every three years through to closure with data tracked over time to determine if there are any changes in metal concentrations resulting from the Project. Sample locations are shown on Figure 12-8. The sampling locations were selected with consideration to three general dust dispersion sources (pit blasting, on site facilities, and access road) along with the prevailing wind direction and results from the air quality modelling. The sample design establishes five monitoring points related to each general dispersion source and four control sites outside the zone of influence. Sampling will be done by collecting at least three replicate soil samples at each site. The sampling program will be consistent and robust enough to statistically identify spatial and temporal trends. Results will be compared with soil quality Canadian Council of Ministers of the Environment (CCME) guidelines for industrial sites and with previous sample results. If results indicate metals are approaching guidelines, additional mitigations may be employed through the adaptive management plan and a vegetation sampling program may be added to if necessary.

In addition, a soil and vegetation metal monitoring program will commence with installation of constructed wetlands in order to monitor the efficacy of the constructed wetland at treating water as well as to ensure that metals are not accumulating to any significant degree in vegetative matter of any species. For wetlands, soils will be tested for nutrients, metals, and microbes. The wetlands are designed to create metal compounds in the soil and root systems that are not bioavailable. The monitoring program will be used to ensure that metals are not accumulating significantly in the vegetative matter. If there is significant increase in vegetation metal concentrations beyond background, then the wetland system will be modified to minimize wildlife access.

A summary of the Project soil and plant tissue monitoring program is provided in Table 12-18.



- Soil Monitoring Location
- Soil Monitoring Control Location
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Waterbody
- Watercourse
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)

KUDZ ZE KAYAH PROJECT

FIGURE 12-8

SOIL MONITORING SITES

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12.6.1.1 Invasive Plants

Invasive plants will be controlled and removed from site following measures described in Section 18.8). Prevention is a key component of the program including routine inspections of vehicles and employees for invasive plants and seeds. The annual monitoring program will inspect Project areas that have a higher risk of introduction of invasive plants (i.e., Access Roads and Laydowns).

12.6.1.2 Rare Plants

A chance find procedure will be followed for rare plants, similar to the chance find procedure for heritage resources. Information for recognition and identification of rare plants will be included in the induction program and clearing protocols for equipment operators. The most likely locations for rare plants are in rare ecosystems near cliffs and wetlands. As presented in Appendix E-6, potential rare plant species include Parry's Arnica, also known as Nodding Leopardbane (*Arnica parryi*); Northern Beech Fern (*Phegopteris connectillis*); Leafy Thistle (*Cirsium foliosus*); Mount Sheldon Ragwort (*Senecio sheldonensis*); Spiny-spored Quillwort (*Isoetes echinospora*); Maritime Quillwort (*Isoetes maritima*); Water Mudwort (*Limosella aquatica*); Common River Grass (*Scolochloa festucacea*); Blunt-leaf Pondweed (*Potamogeton obtusifolius*).

A summary of the Project monitoring program is provided in Table 12-18.

Table 12-18: Soil and Plant Monitoring Programs

Program	Purpose and Methodology	Frequency
Dust Dispersal Monitoring for Soil Metal Concentration	To detect changes in metal concentration in soils compared to baseline, controls, and CCME industrial guidelines.	Prior to construction, after development, and once every three years to closure
Wetland Efficiency	To ensure that metals are not accumulating to any significant degree in vegetative matter of any species that could be harmful to wildlife.	Annually
Invasive Plants Prevention	Inspect vehicles and equipment coming onto the Project area are clean and free of invasive plants and seeds.	Ongoing
Invasive Plants Control and Monitoring	Revisit sites where invasive plants have been previously located and other high risk sites, and conduct control measures as required. Record number of invasive plants and species at each site. Photo-document sites from set viewpoint at each site.	Annually
Rare Plants Chance Find Procedure	To identify and manage rare plants if encountered during clearing.	During land clearing

The proposed monitoring for vegetation cover and composition is summarized as follows:

- No specific monitoring program is proposed for old growth forests, or rare plants. Vegetation cover and composition will be indirectly monitored through the reclamation plan that monitors the success of the revegetation program and the constructed wetlands;

- Invasive plants will be monitored and removed on a regular basis following the invasive plant management plan to prevent the spread of invasive plants; and

Dust deposition on soil will be monitored periodically to determine the distribution and extent of change. If the extent of change is high magnitude, then additional monitoring would be conducted on traditionally used plants and wildlife browse.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

13 WILDLIFE AND WILDLIFE HABITAT 13-1

13.1 ASSESSMENT APPROACH 13-1
13.1.1 Regional Setting 13-1
13.1.2 Selection of Subcomponents and Measurable Parameters 13-2
13.1.3 Criteria for Assessing Significance 13-10
13.2 ASSESSMENT BOUNDARIES 13-12
13.3 EXISTING CONDITIONS 13-16
13.3.1 Caribou 13-16
13.3.2 Moose 13-19
13.3.3 Grizzly Bear 13-21
13.3.4 Grey Wolf 13-23
13.3.5 Wolverine 13-23
13.3.6 Collared Pika 13-23
13.3.7 Bats 13-26
13.3.8 Cliff-Nesting Raptors 13-26
13.3.9 Passerines (Olive-sided Flycatcher) 13-27
13.3.10 Waterfowl 13-29
13.3.11 Bumble Bees 13-29
13.4 PROJECT-SPECIFIC EFFECTS 13-30
13.4.1 Effects Characterization 13-30
13.4.2 Mitigation Measures 13-76
13.4.3 Residual Effects, Consequence, and Significance Determination 13-90
13.5 CUMULATIVE EFFECTS 13-113
13.5.1 Cumulative Effects Characterization 13-113
13.5.2 Cumulative Effects Mitigation Measures 13-120
13.5.3 Cumulative Effects Significance Assessment 13-121
13.6 EFFECTS MONITORING 13-123

LIST OF TABLES

Table 13-1: Rationale for Selection of Wildlife Subcomponents 13-2
Table 13-2: Species Known or Likely to Occur in the LSA, but not Selected as Subcomponents 13-5
Table 13-3: Wildlife Subcomponents, Measurable Parameters, Threshold Criteria, and Threshold Rationale 13-7
Table 13-4: Wildlife and Wildlife Habitat Significance Criteria Definition 13-11
Table 13-5: Study Areas for Wildlife and Wildlife Habitat 13-13
Table 13-6: Interaction Matrix for the Wildlife and Wildlife Habitat Subcomponents 13-31

Table 13-7: Summary of Finlayson Caribou Herd Rut Habitat Changes 13-38
Table 13-8: Summary of Finlayson Caribou Herd Post Calving Habitat Changes 13-39
Table 13-9: Summary of Caribou Habitat Loss 13-40
Table 13-10: Moose Post Rut Habitat Suitability Effects 13-48
Table 13-11: Moose Late Winter Habitat Suitability Effects 13-48
Table 13-12: Summary of Moose Habitat Loss 13-49
Table 13-13: Change in Grizzly Bear Denning Habitat Due to Project Effects in the RSA 13-54
Table 13-14: Change in Collared Pika Habitat Quality Due to Project Effects in the LSA 13-59
Table 13-15: Change in Little Brown Bat Habitat Quality Due to Project Effects in the LSA 13-63
Table 13-16: Change in Cliff-Nesting Raptor Habitat Quality Due to Project Effects in the LSA 13-67
Table 13-17: Change in Olive-sided Flycatcher Nesting Habitat Quality Due to Project Effects in the LSA 13-70
Table 13-18: Change in Waterfowl Habitat Quality Due to Project Effects in the LSA 13-73
Table 13-19: Identified Potential Project Effects for the Wildlife and Wildlife Habitat 13-75
Table 13-20: Proposed Mitigation Measures for Finlayson Caribou Herd 13-80
Table 13-21: Proposed Mitigation Measures for Moose 13-81
Table 13-22: Proposed Mitigation Measures for Grizzly Bear 13-84
Table 13-23: Proposed Mitigation Measures for Grey Wolf 13-85
Table 13-24: Proposed Mitigation Measures for Wolverine 13-85
Table 13-25: Proposed Mitigation Measures for Collared Pika 13-86
Table 13-26: Proposed Mitigation Measures for Bats 13-87
Table 13-27: Proposed Mitigation Measures for Cliff-Nesting Raptors 13-87
Table 13-28: Proposed Mitigation Measures for Olive-sided Flycatcher 13-89
Table 13-29: Proposed Mitigation Measures for Waterfowl 13-90
Table 13-30: Thresholds for Project Effects to Caribou Abundance 13-91
Table 13-31: Significance of Residual Effects – Finlayson Caribou Herd 13-92
Table 13-32: Thresholds for Project Effects to Moose Abundance 13-93
Table 13-33: Significance of Residual Effects – Moose 13-94
Table 13-34: Thresholds for Project Effects to Suitable Grizzly Bear Denning Habitat 13-95
Table 13-35: Significance of Residual Effects – Grizzly Bear 13-96
Table 13-36: Thresholds for Project Effects to Wolf Abundance 13-97
Table 13-37: Significance of Residual Effects – Wolf 13-98
Table 13-38: Thresholds for Project Effects to Wolverine Abundance 13-99
Table 13-39: Significance of Residual Effects – Wolverine 13-100
Table 13-40: Thresholds for Project Effects to Suitable Collared Pika Habitat 13-101
Table 13-41: Significance of Residual Effects – Collared Pika 13-102
Table 13-42: Thresholds for Project Effects to Suitable Bat Habitat 13-103
Table 13-43: Significance of Residual Effects – Bats 13-104
Table 13-44: Thresholds for Project Effects to Suitable Cliff-Nesting Raptor Habitat 13-105
Table 13-45: Significance of Residual Effects – Cliff-Nesting Raptors 13-106
Table 13-46: Thresholds for Project Effects to Suitable Olive-sided Flycatcher Nesting Habitat 13-107
Table 13-47: Significance of Residual Effects – Passerines (Olive-sided Flycatcher) 13-108
Table 13-48: Thresholds for Project Effects to Suitable Waterfowl Habitat 13-109

Table 13-49: Significance of Residual Effects – Waterfowl....13-110
Table 13-50: Significance of Residual Effects – Bumble Bee 13-112
Table 13-51: Residual Effects on Wildlife and Wildlife Habitat 13-113
Table 13-52: Cumulative Effects Screening for Wildlife and Wildlife Habitat 13-114
Table 13-53: Proposed Cumulative Effects Mitigation Measures for Wildlife and Wildlife Habitat ..13-120
Table 13-54: Cumulative Effects Significance Assessment for Wildlife and Wildlife Habitat 13-122
Table 13-55: Wildlife Monitoring Programs 13-124

LIST OF FIGURES

Figure 13-1: Regional and Local Study Areas for Caribou 13-14
Figure 13-2: Regional and Local Study Areas for Wildlife 13-15
Figure 13-3: Finlayson Caribou Herd Seasonal Distribution and Habitat Ranges 13-18
Figure 13-4: Moose Observations and Wildlife Key Areas....13-20
Figure 13-5: Grizzly Bear Observations 13-22
Figure 13-6: Small Mammal Survey Sites and Bat Detectors 13-25
Figure 13-7: Bird Site Survey Locations 2015-2016 13-28
Figure 13-8: Finlayson Caribou Herd Rut Habitat Suitability: Home Range and Regional Study Area .13-41
Figure 13-9: Finlayson Caribou Herd Rut Habitat Suitability: Local Study Area and Project Mine Footprint 13-42
Figure 13-10: Finlayson Caribou Herd Post Calving Habitat Suitability Home Range and Study Area ..13-43
Figure 13-11: Finlayson Caribou Herd Post Calving Habitat Suitability Local Study Area and Proposed Mine Footprint 13-44
Figure 13-12: Moose Post Rut Habitat Suitability....13-50
Figure 13-13: Moose Late Winter Habitat Suitability 13-51
Figure 13-14: Grizzly Denning Habitat Suitability 13-55
Figure 13-15: Collared Pika Habitat Suitability within the Local Study Area 13-61
Figure 13-16: Little Brown Bat Habitat Suitability within the Local Study Area 13-65
Figure 13-17: Cliff-Nesting Raptor Nesting Habitat Suitability within the Local Study Area 13-68
Figure 13-18: Olive-sided Flycatcher Habitat Suitability within the Local Study Area....13-71
Figure 13-19: Waterfowl Habitat Suitability within the Local Study Area 13-74
Figure 13-20: Wildlife Cumulative Effects Assessment Areas and Project Activities 13-119

13 WILDLIFE AND WILDLIFE HABITAT

This chapter provides an overview of the existing wildlife conditions and assessment of the potential Project effects on wildlife and wildlife habitat. Wildlife and wildlife habitat was selected as a VC due to its fundamental importance to the health and function of the biophysical and human environment, as well as wildlife's high cultural and value to the Kaska Nation. The assessment of wildlife is linked to the assessment of vegetation cover and composition (Chapter 12) as well as the assessment of the socio-economic VCs (Chapter 15).

13.1 ASSESSMENT APPROACH

The wildlife effects assessment (EA) will generally follow the methods outlined in Chapter 5 and relies on results from the terrestrial ecosystem mapping (Appendix E-6), habitat suitability mapping (Appendix E-8), air dispersion modelling (Appendix E-1), noise modelling (Appendix E-2), and water quality modelling (Appendix D-7).

The authors respect Kaska as stewards of the land, their traditional knowledge, and the sacred law of the land (A'IE). The EA incorporates Kaska management principles in the wildlife assessment and mitigation plans wherever practicable.

13.1.1 Regional Setting

The Project is located in the Yukon Plateau-North Ecoregion; part of the Canadian Boreal Cordillera Ecozone. The upper Geona Creek valley, where the Project is situated, is in a transitional zone bordering three different ecoregions: Yukon Plateau-North, Liard Basin and Pelly Mountains. Elevations in the local study area (LSA) range from approximately 1,300 masl to 2,000 masl. The area has a typical northern interior climate. Summers are cool and short, whereas winters are long and very cold. Mean annual temperatures range from about 0 to -5°C. The mean annual precipitation is estimated at 612 mm; approximately 322 mm falling as rain from May through early October, and 290 mm falling as snow (Appendix D-2).

The Tote Road passes mostly through open white and black spruce forest. Feathermoss is the main ground cover with a well-developed shrub understory; sedge or sphagnum tussocks are common in the frequent wetlands and black spruce stands.

The proposed Project lies in a U-shaped subalpine valley with mountains along the east and west sides. The rounded mountain tops and upper slopes are in the alpine zone. The alpine vegetation mat is composed of low growing dwarf shrubs with various graminoids, forbs, and mosses. Middle mountain slopes are dominated by willow and scrub birch with sparse distribution of subalpine fir. The lower slopes are open white spruce and subalpine forests dominated by willows and scrub birch. The valley bottom features a fen complex with several beaver-created wetlands linked along Geona Creek.

Due to the topographic range and heterogeneous landscape there exists a wide array of habitat types that support numerous wildlife species. Notable wildlife species in the Project area include the

Finlayson caribou herd (FCH), moose, grizzly bear, black bear, wolf, red fox, wolverine, marten, mink, hoary marmot, collared pika, muskrat, river otter, beaver, bats, and several raptor, waterfowl and songbird species. The lakes and wetlands in or near the Project provide breeding and migratory habitats for waterfowl and shorebirds.

13.1.2 Selection of Subcomponents and Measurable Parameters

All wildlife, including birds, were considered as candidate species for selection as subcomponents for the EA. Several criteria were used to narrow down the selection of wildlife subcomponents for the EA. For example, wildlife species that have cultural and/or economic value were given high priority based on their importance to the Kaska Nation, as indicated in desk-based research results (Appendix F-3). The area in and around the proposed Project is understood to be important to members of the Kaska Nation for purposes of hunting of caribou, moose, and sheep. Other criteria that were used to assess each species was the likelihood for each species to interact with the Project, species at risk, species that have unique habitat requirements, species known to be sensitive to disturbance, and species identified by stakeholders as important based on engagement records (Appendix B for consultation records).

Table 13-1 presents the wildlife subcomponents selected for assessment, their conservation status, the reasons for their selection, and the stakeholder group expressing an interest in the species.

Table 13-1: Rationale for Selection of Wildlife Subcomponents

Subcomponent	Species/Population	Conservation Status	Reasons for Selection	Group Expressing Interest
Finlayson Caribou Herd	Northern Mountain population of woodland caribou (*Rangifer tarandus caribou*)	Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Special Concern (COSEWIC, 2014a)	*Species at Risk Act* (SARA) - subsection 79 (2); Kaska cultural keystone species for hunting and cultural purposes (Dena Kayeh Institute, 2010); High cultural value, strong regional interest; Calving and rut habitat, and migration corridors are a conservation concern for Environment Yukon	Ross River Dena Council (RRDC) Elders and Kaska members (Appendices B-3 and F-3); Yukon Government; Focal species in the Kaska land management practices (Dena Kayeh Institute, 2010); Federal Government

Subcomponent	Species/Population	Conservation Status	Reasons for Selection	Group Expressing Interest
Moose	*Alces alces*	Not at Risk; assumed secure	Kaska cultural keystone species for hunting and cultural purposes (Dena Kayeh Institute, 2010); High cultural value, strong regional interest; Primary harvest species in the region; Yukon Environment	RRDC Elders and Kaska members (Appendices B-3 and F-3); Yukon Government; Focal species in the Kaska land management practices (Dena Kayeh Institute, 2010)
Grizzly Bear	Western population of grizzly bear (*Ursus arctos*)	Special Concern (COSEWIC, 2012)	SARA - subsection 79 (2); Species sensitive to disturbance; Potential for human–bear conflict	RRDC Elders and Kaska members (Appendices B-3 and F-3); Yukon Government; Federal Government
Wolverine	*Gulo gulo*	Special Concern (COSEWIC, 2014b)	SARA - subsection 79 (2); Species sensitive to disturbance; Representative species for furbearers of cultural importance to the Kaska for cultural and trapping purposes [such as marten, beaver, muskrat, mink, porcupine, squirrel, gopher]	RRDC and Kaska members (Appendices B-3 and F-3); Federal Government
Grey Wolf	*Canis lupus*	Not at Risk (COSEWIC, 1999)	Important predator-prey relationship with FCH and moose in the region; Representative species for furbearers of cultural importance to the Kaska for cultural and trapping purposes (such as fox and lynx)	RRDC and Kaska members (Appendices B-3 and F-3)
Collared Pika	*Ochotona collaris*	Special Concern (COSEWIC, 2011)	SARA - subsection 79 (2); Habitat specialist; Sensitive to disturbance; Representative species for small mammals of cultural importance to the Kaska for cultural and trapping purposes (such as groundhog/marmot, squirrel, gopher)	Yukon Government; Federal Government

Subcomponent	Species/Population	Conservation Status	Reasons for Selection	Group Expressing Interest
Little Brown Bat	*Myotis lucifugus*	Endangered (COSEWIC, 2013)	SARA - subsection 79 (2); Habitat specialist; Unknown population status in Yukon	Yukon Government; Federal Government
Cliff-Nesting Raptors	Golden eagle, gyrfalcon, peregrine falcon	Special Concern (COSEWIC, 2007b)	SARA - subsection 79 (2); Kaska focal species (Dena Kayeh Institute, 2010); Habitat specialist; Gyrfalcon and peregrine falcon are specially protected wildlife in Yukon *Wildlife Act*	Yukon Government; Federal Government
Passerine birds	Olive-sided flycatcher (*Contopus cooperi*)	Threatened (COSEWIC, 2007a)	SARA - subsection 79 (2); Kaska focal species (Dena Kayeh Institute, 2010); Protected by the *Migratory Birds Convention Act*; Representative species for passerines	Yukon Government; Federal Government
Waterfowl	Ducks, swans, geese, waterbirds	Varies by species	SARA - subsection 79 (2), for those species at risk; Kaska focal species (Dena Kayeh Institute, 2010); Protected by the *Migratory Birds Convention Act*	Yukon Government; Federal Government
Bumble bees	Gypsy cuckoo bumble bee (*Bombus bohemicus*), western bumble bee (*Bombus occidentalis mckayi*)	Gypsy cuckoo bumble bee – endangered (COSEWIC, 2014c); western bumble bee – special concern (COSEWIC, 2014d)	SARA - subsection 79 (2), for those species at risk	Yukon Government

Table 13-2 presents the other wildlife species that are known to exist in the LSA, but were not selected as subcomponents for this EA, as well as a rationale for their exclusion and the level of interaction they have with the Project. Reasons why these species were excluded include: not likely to interact with the Project in high numbers (i.e., Stone sheep, mule deer); not considered at risk (i.e., black bear); not identified as species of concern by stakeholders; not abundant in the LSA; and/or not sensitive to disturbance.

Table 13-2: Species Known or Likely to Occur in the LSA, but not Selected as Subcomponents

Subcomponent	Species/ Population	Conservation Status	Potential Interaction with the Project	Reason for Exclusion
Stone Sheep	*Ovis dalli stonei*	Not assessed; assumed secure	Occurs in regional study area (RSA) occasionally	No spatial or temporal overlap with Wildlife Key Area (WKA) – limited interaction Sheep populations and Kaska harvest occur south of the Project in the North Lakes and Liard headwaters regions from the ethnographic report (Appendix F-3), Yukon Government (YG) and baseline wildlife studies (Appendix E-8)
Black Bear	*Ursus americanus*	Not at Risk (COSEWIC, 1999)	Occurs along Access Road; unlikely to occur near Project Footprint in upper Geona Creek valley	Limited interaction in the proposed Project Footprint; mitigation for grizzly bear should mitigate potential effects on black bear
Mule Deer	*Odocoileus hemionus*	Not assessed; assumed secure	Unlikely; has not been observed in the LSA or RSA	Uncommon in the area; Project is at northern extent of species range; species not at risk
Coyote	*Canis latrans*	Not assessed; assumed secure	Likely occurs along Access Road; no direct observations	Species not at risk; species adaptable to human disturbance
Red Fox	*Vulpes vulpes*	Not assessed; assumed secure	Occurs in the LSA; assumed to be distributed across entire RSA	Species not at risk; species adaptable to human disturbance
Canada Lynx	*Lynx canadensis*	Not at Risk (COSEWIC, 2001)	Occurs in the LSA; distribution unknown	Species not at risk; Project interaction expected to be minimal as lynx populations expected to remain stable
Snowshoe Hare	*Lepus americanus*	Not assessed; assumed secure	Occurs in the LSA; assumed to be distributed across entire RSA	Species not at risk; species adaptable to human disturbance
Hoary Marmot	*Marmota caligata*	Not assessed; assumed secure	Occurs in the LSA, dens located on mountain slopes in LSA	Species not at risk; mitigation for collared pika should mitigate effects on hoary marmot
Porcupine	*Erethizone dorsatum*	Not assessed; assumed secure	Occurs along Access Road; unlikely to occur near Project Footprint in upper Geona Creek valley	Species not at risk; species adaptable to human disturbance; limited interaction with Project Footprint
American Marten	*Martes americanus*	Not assessed; assumed secure	Occurs along Access Road; limited occurrence near Project Footprint in upper Geona Creek valley	Species not at risk; species adaptable to human disturbance; limited interaction with Project Footprint
Beaver	*Castor canadensis*	Not assessed; assumed secure	Limited occurrence in the LSA; distribution unknown	Species not at risk; no recent sign of beaver in the Project Footprint
Woodchuck	*Marmota monax*	Imperilled/vulnerable	May occur in LSA, according to CDC	Not observed in the LSA

Subcomponent	Species/ Population	Conservation Status	Potential Interaction with the Project	Reason for Exclusion
Northern Myotis	*Myotis septentrionalis*	Endangered	May occur in LSA, according to CDC	Represented by little brown myotis in the assessment
Wood Frog	*Lithobates sylvatica*	Not assessed; assumed secure	May occur in the LSA; distribution unknown; no observations made	Species not at risk; not been observed in the LSA
Bank Swallow	*Riparia riparia*	Threatened	May occur in LSA, according to CDC	Represented by olive-sided flycatcher in the assessment
Barn Swallow	*Hirundo rustica*	Threatened	Observed in LSA	Represented by olive-sided flycatcher in the assessment
Red-necked Phalarope	*Phalaropus lobatus*	Special concern	Observed in LSA	Represented by olive-sided flycatcher in the assessment
Rusty Blackbird	*Euphagus carolinus*	Special concern	May occur in LSA, according to CDC	Represented by olive-sided flycatcher in the assessment
Horned Grebe	*Podiceps auritus*	Special concern	May occur in LSA, according to Environment and Climate Change Canada	Represented by waterfowl in the assessment
Common Nighthawk	*Chordeiles minor*	Threatened	May occur in LSA, according to CDC	Represented by raptors in the assessment
Short-eared Owl	*Asio flammeus*	Special concern	May occur in LSA, according to CDC	Represented by raptors in the assessment
Western Bumble Bee	*Bombus occidentalis*	Special concern	Bumble bees observed in LSA	Represented by gypsy cuckoo bumblebee in the assessment

Quantitative metrics, such as thresholds, are needed to evaluate the magnitude of effects from Project activities on a particular species. Thresholds are ecological points at which a species' behaviour, population, distribution, or other characteristic abruptly changes (Dykstra, 2004; Swift and Hannon, 2010). Threshold criteria can vary depending on a species' cultural value, distribution, abundance, sensitivity, mobility, resilience, life history, interspecies relationships, and the parameters being measured. Thresholds are often theoretical, based on observations for other species or in other circumstances; nonetheless, they give a basis for predicting the magnitude of an effect. Legislation such as the Yukon *Wildlife Act*, *Migratory Birds Convention Act*, and the *Species at Risk Act*, as well as associated guidance and management documents, and scientific studies are all considered in determining the thresholds. Thresholds are defined for the measurable parameter, for which the effects on the species (subcomponents) is assessed. Measurable parameters often used in EA are percent change in suitable habitat, change in wildlife movement patterns or population distribution, road density (i.e., length of roads per square km), wildlife mortality, among others. The proposed measurable parameters and associated threshold criteria for the selected wildlife subcomponents used in this assessment are provided in Table 13-3.

Table 13-3: Wildlife Subcomponents, Measurable Parameters, Threshold Criteria, and Threshold Rationale

Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Finlayson Caribou Herd	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: <10% change in RSA moderate-high to high suitability rut or post calving habitat Moderate: >10% but <15% change in RSA moderate-high to high suitability rut or post calving habitat High: >15% change in RSA moderate-high to high suitability rut or post calving habitat	Environment Canada (2011); Andrén (1994); Swift and Hannon (2010)
	Change in wildlife movement Change in population distribution	Qualitative - no barriers to seasonal movement patterns	Professional opinion
	Change in wildlife mortality directly from Project activities (i.e., vehicle collisions and hunting)	No injuries or fatalities (unless required for human safety) directly attributed to the Project	Hegel (2013) BMC conservation philosophy[1]
	Health condition	Qualitative - no barriers to seasonal movement patterns	BMC conservation philosophy[1]
Moose	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: <10% change in RSA moderate-high to high suitability post rut or late winter habitat Moderate: >10% but <15% change in RSA moderate-high to high suitability post rut or late winter habitat High: >15% change in RSA moderate-high to high suitability post rut or late winter habitat	Environment Canada (2011); Andrén (1994); Swift and Hannon (2010)
	Change in wildlife movement Change in population distribution	Low: road density <0.2 km/km^2 Moderate: road density 0.2 to 0.4 km/km^2 High: road density >0.4 km/km^2	Beyer et al. (2013)
	Change in wildlife mortality directly from Project activities (i.e., vehicle collisions)	No injuries or fatalities (unless required for human safety) directly attributed to Project activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no barriers to seasonal movement patterns	BMC conservation philosophy[1]

Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
Grizzly Bear	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: <10% change in RSA moderate to high suitability denning habitat Moderate: >10% but <15% change in RSA moderate to high suitability denning habitat High: >15% change in RSA moderate to high suitability denning habitat	Environment Canada (2011); Andrén (1994); Swift and Hannon (2010)
	Change in wildlife movement and direct disturbance	High: road density >0.6 km/km^2	Beazley et al. (2004)
	Change in wildlife mortality directly from Project activities (i.e., vehicle collisions, dispatched for human safety)	No injuries or fatalities (unless required for human safety) directly attributed to mine activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no barriers to seasonal movement patterns	BMC conservation philosophy[1]
Grey Wolf	Prey availability	Low: if moderate rating for loss of suitable habitat either caribou or moose and low for the other, or low for both Moderate: if high rating for loss of suitable habitat either caribou or moose and low for the other, or moderate for both High: if high rating for either loss of suitable habitat caribou and moose and moderate for the other, or high for both	Hayes and Harestad (2000); Farnell (2009)
	Mortality	No injuries or fatalities (unless required for human safety) directly attributed to mine activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no barriers to seasonal movement patterns	BMC conservation philosophy[1]
Wolverine	Habitat Avoidance	High: road density >0.6 km/km^2	Beazley et al. (2004)
	Mortality	No injuries or fatalities (unless required for human safety) directly attributed to mine activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no barriers to seasonal movement patterns	BMC conservation philosophy[1]
Collared Pika	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: 0-10% in LSA high suitability habitat Moderate: 10-25% in LSA high suitability habitat High: >25% in LSA high suitability habitat	Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010); Andrén (1994); and others – see text below
	Health condition	Qualitative - no barriers to seasonal movement patterns	BMC conservation philosophy[1]
Little Brown Bat	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: 0-10% in LSA high suitability habitat Moderate: 10-25% in LSA high suitability habitat High: >25% in LSA high suitability habitat	Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010); Andrén (1994); and others – see text below

Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria	Threshold Rationale/Source
	Mortality	No injuries or fatalities (unless required for human safety) directly attributed to mine activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no observable deterioration of physical condition	BMC conservation philosophy[1]
Cliff-Nesting Raptors	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: 0-10% in LSA high suitability habitat Moderate: 10-25% in LSA high suitability habitat High: >25% in LSA high suitability habitat	Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010); Andrén (1994); and others – see text below
	Health condition	Qualitative - no observable deterioration of physical condition	BMC conservation philosophy[1]
Passerine birds (represented by Olive-sided Flycatcher)	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: 0-10% in LSA high suitability habitat Moderate: 10-25% in LSA high suitability habitat High: >25% in LSA high suitability habitat	Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010); Andrén (1994); and others – see text below
	Mortality	No injuries or fatalities (unless required for human safety) directly attributed to mine activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no observable deterioration of physical condition	BMC conservation philosophy[1]
Waterfowl	Change in suitable habitat from baseline conditions (including both direct and indirect habitat loss)	Low: 0-10% in LSA high suitability habitat Moderate: 10-25% in LSA high suitability habitat High: >25% in LSA high suitability habitat	Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010); Andrén (1994); and others – see text below
	Mortality	No injuries or fatalities (unless required for human safety) directly attributed to mine activity	BMC conservation philosophy[1]
	Health condition	Qualitative - no observable deterioration of physical condition	BMC conservation philosophy[1]
Bumble bees	Change in available habitat	Low: 0-10% in LSA Moderate: 10-25% High: >25% in LSA	Habitat thresholds for birds and wildlife are determined from work by Swift and Hannon (2010); Andrén (1994); and others – see text below

[1] BMC has a conservation philosophy demonstrated through its environmental, no hunting/no fishing, no firearms, and no feeding of animals policies presented in Appendix A.

Habitat disturbance thresholds for caribou were based on disturbance thresholds put forth in the reported entitled "Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou" (Environment Canada, 2011). The report determined that less than 10% disturbance of habitat was very likely to have a very low risk on woodland caribou populations and greater than 90% probability of sustained stable or positive growth. Given the conservative values of these

thresholds, they were also selected for moose and grizzly bear as part of this EA. A disturbance threshold of 10% is consistent with disturbance thresholds summarized in Swift and Hannon (2010) and Andrén (1994). The habitat disturbance thresholds used for caribou, moose and grizzly bear are more conservative than those used for birds and small mammals to ensure a high likelihood of the desired outcome and a very low level of risk is assumed for the large mammal species that are known to be more sensitive to disturbance.

For grizzly bear, the threshold is no mortality in line with BMC's conservation philosophy implied in BMC's policies (Appendix A) and reinforced through continual engagement with Kaska (Appendix B).

The habitat disturbance threshold criteria listed for collared pika, bats, cliff-nesting raptors, olive-sided flycatcher, and waterfowl were based on the following sources of literature. Swift and Hannon (2010) performed a review of critical thresholds associated with habitat loss; they concluded most studies that documented empirical thresholds for habitat loss fell near the range of 10%-30%. This was consistent with a proposed range of 10%-30% habitat cover by Andrén (1994). Furthermore, a wildlife EA for the Kerr-Sulphurets-Mitchell (KSM) Project, operated by Seabridge Gold Inc., considered the Project effect to have a low magnitude if the habitat was modified less than 25% (Rescan Environmental Services Ltd, 2013). The threshold level of 25% used in the KSM Project was based on literature by Hargis and Bissonnette (1997); Hargis et al. (1999); Potvin et al. (1999); and Poole et al. (2004).

The threshold values quantified for habitat loss for the Project should be considered more conservative as they include direct habitat loss from the Project, as well as indirect habitat loss, which includes all habitat in a 300 m buffer of the direct habitat loss, as well as a low magnitude effect if the habitat loss is less than 10%. Indirect effects for birds and smaller animals were assumed to occur in a 300 m buffer, which is a distance supported by an Arctic road study that showed plant and soil (i.e., available habitat) were affected up to 200 m to 300 m from roads (Forbes, 1992). The zone of effects has been shown to vary in numerous other road studies depending on species and road size and activity level; however, most effects occur within 30 to 100 m for dust, nutrients, and hydrological changes, and within 300 m for birds and medium sized mammals for forested areas with lower traffic volume roads as expected for the Project (Forman and Alexander, 1998; Biglin and Dupigny-Giroux, 2006; Summers et al., 2011). Small mammals and many bird species showed no effect in effects studies (Fahrig and Rytwinski, 2009); therefore, 300 m was considered a reasonable buffer zone for this assessment and even a conservative buffer for many small species.

13.1.3 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;

- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and
- **Environmental and socio-economic context**: the ability of the species to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for wildlife and wildlife habitat are presented in Table 13-4.

Table 13-4: Wildlife and Wildlife Habitat Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC would be an improvement
	Neutral	No change in VC
	Adverse	VC would change for the worse
Magnitude	Low	Threshold criteria defined in Table 13-3
	Moderate	Threshold criteria defined in Table 13-3
	High	Threshold criteria defined in Table 13-3
Geographic Extent	Site	Effect limited to the Project Footprint
	Local	Effect extending beyond the Project Footprint but in LSA
	Regional	Effect extending across the RSA
	Beyond Regional	Effect extending beyond the RSA
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project

Criteria	Definition	
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The VC is considered to have strong resilience to accommodate change
	Neutral	The VC is considered to have some resilience to accommodate change
	High	The VC is considered to have low resilience to accommodate change

A significant residual effect is considered to occur if it is adverse, of high magnitude and extends across the regional study area, or is adverse, of high magnitude in the local study area and occurs over the long term. For species of high environmental and/or socio-economic context, professional judgement was used to increase the level of significance if necessary (e.g., loss of critical habitat for an endangered species). In addition, if there was a high level of uncertainty in the effects, the level of significance was increased.

13.2 ASSESSMENT BOUNDARIES

The local and regional study areas (LSA and RSA) for wildlife and wildlife habitat are described in Table 13-5. Figure 13-1 shows the LSA and RSAs for the FCH, including their rutting and post calving ranges around the Project, as well as the entire herd range. Figure 13-2 outlines the LSA and RSAs used to assess the other wildlife species. The RSA is defined as Game Management Subzone (GMS 10-07) for species other than caribou. This subzone was defined as the RSA because it is the defined area that Yukon Government (YG) uses for large mammal management in the region. It has an area of 2,063 km^2. The LSA was delineated by a 3 km buffer around the Project Footprint, as well as a 1.5 km buffer around the existing Tote Road alignment, and encompasses an area of 124 km^2. The LSA was used to assess birds and smaller mammals since most of their habitat needs are met in the Geona Creek and Finlayson Creek watershed.

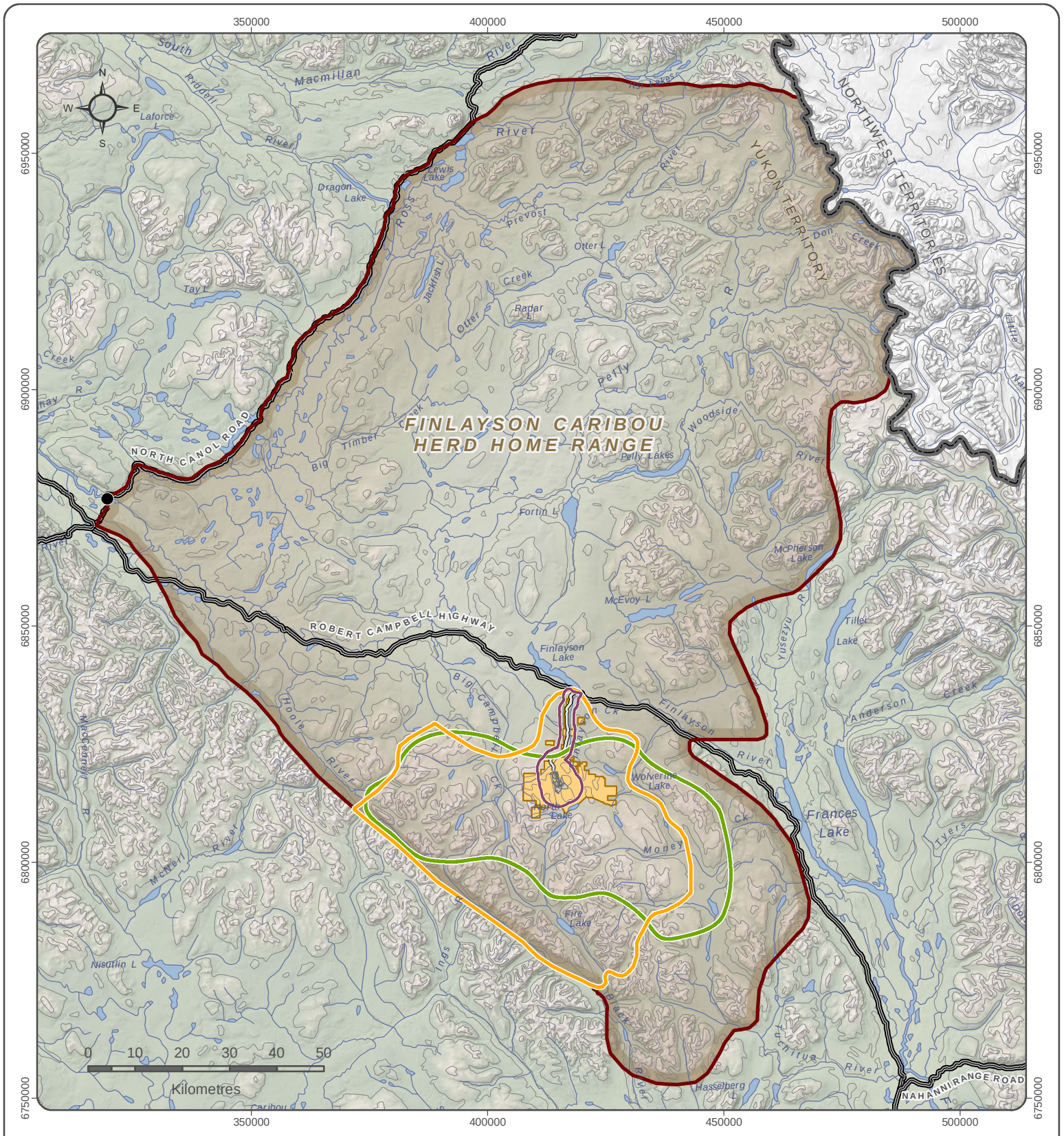
The temporal boundaries used in this assessment include all phases of the Project including:

- **Construction**: approximately 2-year period including site preparation and clearing and establishment of Project infrastructure;
- **Operations**: approximately 10-year period including open pit and underground development and ore processing;
- **Closure**: approximately 3-year period for decommissioning, reclamation and closure; and
- **Post-closure**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required; the phase is split into two periods: a transitional 13-year period during which the ABM open pit continues to fill, ending when the

ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.

Table 13-5: Study Areas for Wildlife and Wildlife Habitat

Subcomponents	Spatial Boundary	Specific Study Area Description
Finlayson Caribou Herd	LSA RSA - (1) rutting range, (2) post calving, (3) entire FCH range	LSA is the Project Footprint plus a 3 km radius around the mine and infrastructure, and 1.5 km on either side of the Tote Road; Three RSAs include (1) the rutting range around the Project, (2) post calving range around the Project, and (3) overall FCH range; and Consideration was also given to the FCH population in GMS 10-07.
Moose	LSA RSA	LSA is the Project Footprint plus a 3 km radius around the mine and infrastructure, and 1.5 km on either side of the Tote Road; and RSA is the YG management unit GMS 10-07.
Grizzly Bear	LSA RSA (1) 10 km radius centered on the proposed ABM open pit, RSA (2) game boundary GMS 10-07	LSA is the Project Footprint plus a 3 km radius around the mine and infrastructure, and 1.5 km on either side of the Tote Road; Two RSAs include (1) Denning surveys focused on a 10 km radius centered on the proposed ABM open pit where there's higher potential denning habitat; and RDA (2) Game management subzone GMS 10-07 for comparison with harvest data and to look at regional suitable growing and denning habitat.
Wolverine, Wolf, Bats, Collared Pika	LSA	LSA is the Project Footprint plus a 3 km radius around the mine and infrastructure, and 1.5 km on either side of the Tote Road which is the zone of influence for these species that includes Geona Creek and Finlayson Creek watersheds to the Robert Campbell Highway.
Cliff Nesting Raptors, Olive-sided Flycatcher, Waterfowl	LSA	LSA is the Project Footprint plus a 3 km radius around the mine and infrastructure, and 1.5 km on either side of the Tote Road which includes Geona Creek and Finlayson Creek watersheds to the Robert Campbell Highway; the northern range of bird species is known to breed in Central Yukon; control sites established outside the zone of influence in similar habitats as those surveyed in the LSA.



- Local Study Area
- Caribou Post Calving Study Area
- Caribou Rut Study Area
- Finlayson Caribou Herd Home Range
- Robert Campbell Highway
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

KUDZ ZE KAYAH PROJECT

FIGURE 13-1

REGIONAL AND LOCAL STUDY AREAS FOR CARIBOU

JANUARY 2017

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Wildlife Key Area data compiled by the Yukon Department of Environment. Publication Date: May 2009
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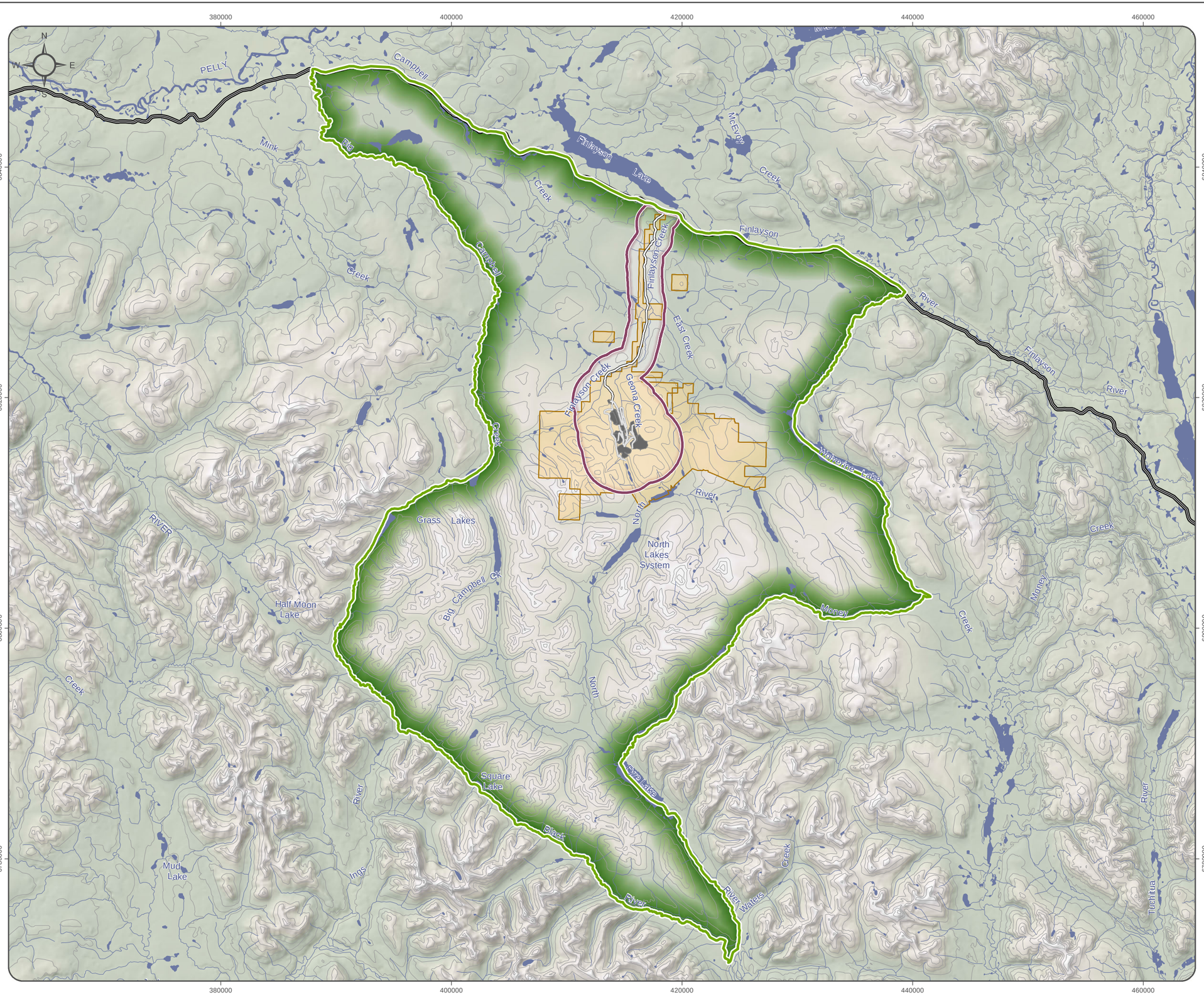

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 13-2
REGIONAL AND LOCAL STUDY AREAS FOR WILDLIFE

MARCH 2017

- Local Study Area
- Regional Study Area (Game Management Subzone 10-07)
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Robert Campbell Highway
- Watercourse
- Waterbody

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Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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13.3 EXISTING CONDITIONS

This section presents a summary of existing environmental conditions as they relate to the wildlife and wildlife habitat. This characterization of the existing environment serves as the baseline against which the effects of the Project are assessed. The description of the existing environment focused on those wildlife components of the environment that may be affected by the Project. The species selected as subcomponents are: Finlayson caribou herd (FCH); moose; grizzly bear; grey wolf; wolverine; collared pika; little brown bat; cliff-nesting raptors; waterfowl; and olive-sided flycatcher.

The description of the existing conditions for wildlife and wildlife habitat presents a compilation and review of existing information that was collected during the Initial Environmental Evaluation (IEE) (Norecol, Dames & Moore Ltd., 1996), desk based research, and the results of the 2015 and 2016 field programs. The following sections provide a summary of the baseline data that was collected for each valued subcomponent (species or animal group) assessed for the Project.

As the following sections provide only a summary, more detail regarding the methods and results of the field programs (for the valued subcomponents and other species) can be found in the Wildlife Baseline Report (Appendix E-8). The Wildlife Baseline Report provides further details on the historical and current knowledge of wildlife distribution and abundance in the Project LSA and RSA, including previously collected data from consultants and government agencies.

13.3.1 Caribou

The caribou that occupy the Project LSA and RSA are part of the FCH. This herd has a traditional home range of 23,000 km^2 distributed in east-central Yukon. The FCH is the most valued wildlife feature in the Project LSA as it is of ecological, economic and cultural importance to both the Kaska and resident and guided hunters in the region. The herd is part of the Northern Mountain caribou population (NMP) (*Rangifer tarandus caribou*), which has been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2014a) as a Species of Special Concern and listed as such under the *Species at Risk Act* (SARA) in 2005. The population status of the herd has been a concern for decades and subject to numerous YG studies, as well as a wolf control program between 1983 and 1989 (WCMPRC, 2011).

In 1982, YG surveyed the FCH and determined that the population was declining (WCMPRC, 2011). A recovery program was initiated in 1983 to determine if wolf predation and human harvest were responsible for the decline. From 1983 through 1989, the wolf population was reduced by 85%, and licensed and First Nation harvest of the herd was reduced. The recovery program resulted in the herd doubling its population to a maximum of 5,950 animals by 1990. By 1994, the wolf population had re-established itself and the FCH population began to decrease again. In 2007, the last late winter population census conducted for the FCH, determined that the population had decreased to approximately 3,077 animals. A late winter population census for the FCH is being planned by YG in collaboration with BMC for 2017.

The herd uses the uplands around the LSA in the spring, summer, and fall, and the lowlands of the Pelly River in winter (Norecol, Dames & Moore Ltd., 1996). The Project is located in key caribou rut

habitat (Department of Environment Map ID: ENV.WKA.104G Set 2). As part of the baseline study, three different surveys over 2015 and 2016 (late winter, post calving, and rut) were performed to assess the spatial and temporal distribution of FCH throughout the year in the LSA. Caribou were not assessed during their calving period as NMP caribou are widely dispersed in the mountains during this life cycle period as an anti-predation tactic. Hence, there is very little likelihood of interaction with Project during calving and there is no meaningful way to assess their distribution and behaviour during this period.

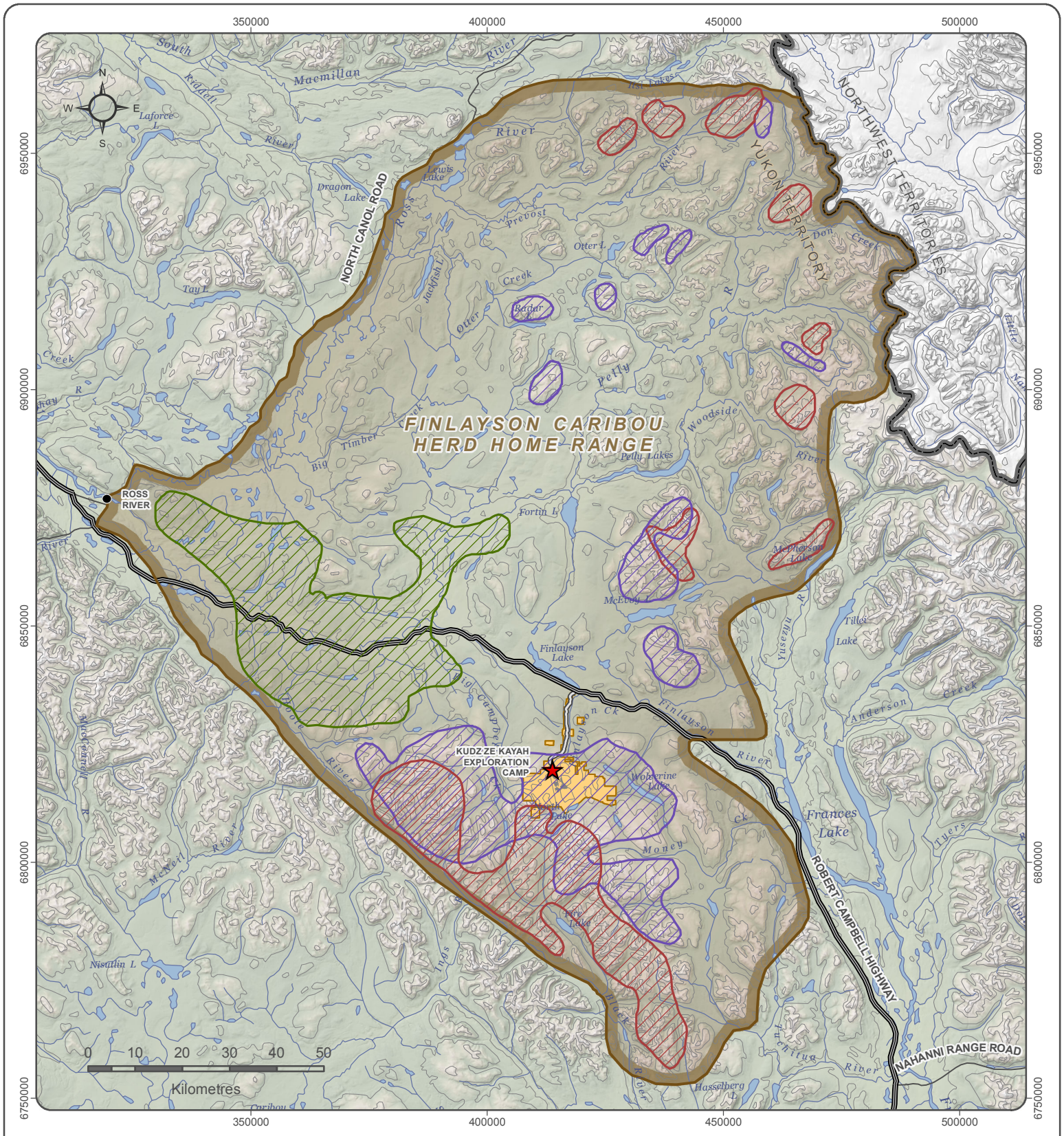
Kaska traditional knowledge (TK) indicates that there are a complex set of factors that determine the distribution of caribou including *snow cover, lichen abundance, moose, predation, direct and indirect disturbances, and forest succession* (Dena Kayeh Institute, 2010). In particular, the Finlayson area is known also for the open canopy spruce forests with lichens and mineral bearing lake overflows (Dena Kayeh Institute, 2010).

FCH surveys were conducted in the study boundaries agreed to with YG as defined in Figure 13-3. The 2015 late winter survey found a total of 19 caribou, compared to 142 during the 2016 late winter survey. One explanation for the difference in observations could be the low snow pack during the winter of 2016 near Finlayson Lake. The low snow pack in the northern half of the study area may have allowed the caribou to remain close to their post calving and rutting areas throughout the winter, rather than forcing the caribou further west to their traditional winter range near Pelly River.

The 2015 post calving survey found a total of 12 calves and 61 cows. The lower ratio observed in 2015 may have been a result of poor weather conditions during the survey. During the post calving survey, up to 90% of caribou observations are made on snow patches where the animals congregate to avoid the heat and insects; however, when the weather is cool and windy, the caribou do not need the snow patches. In 2015, the survey was conducted during cool, damp, and windy conditions making caribou observations more difficult to obtain. During the 2016 post calving survey, a total of 147 caribou were observed of which there were 103 cows, 18 calves, 11 immature bulls, 11 mature bulls, and 4 unclassified. For comparison, the total number of cows observed in 1995, 2015, and 2016 was 184, 61, and 103, respectively, and the total number of calves observed was 120, 12, and 18, respectively.

The 2015 rut survey observed a total of 712 caribou (449 cows, 123 calves, 62 immature bulls, and 78 mature bulls), suggesting that caribou are present in and adjacent to the LSA during the rutting period. Observations resulted in a recruitment rate of 27:100 and a bull to cow sex ratio of 31:100. The sex ratio is below average for this herd, and just above the management guideline of a minimum of 30 bulls per 100 cows to ensure all females are bred. The recruitment rate was higher than the long-term average for the herd, and only slightly higher than the stable recruitment rate of 25 calves per 100 adult cows.

Similar results were observed in the 2016 rut survey. In October 2016, a total of 660 caribou were observed in 60 groups with 27 calves per 100 cows and 39 bulls per 100 cows. These survey results clearly show that caribou are present in and adjacent to the LSA during the rutting period.



- Kudz Ze Kayah Exploration Camp
- Core Post Calving Range
- Core Rut Range
- Core Winter Range
- Community
- Tote Road/Proposed Access Road
- Robert Campbell Highway
- Secondary Road
- Contours (1000 m)
- Watercourse
- Waterbody
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

KUDZ ZE KAYAH PROJECT

FIGURE 13-3

FINLAYSON CARIBOU HERD SEASONAL DISTRIBUTION AND HABITAT RANGES

JANUARY 2017

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved. Wildlife Key Area data compiled by the Yukon Department of Environment. Publication Date: May 2009 Obtained from Geomatics Yukon. Datum: NAD 83; Projection: UTM Zone 9N

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13.3.2 Moose

Moose (*Alces alces*) are widely distributed in the LSA, and prefer shrub-dominated ecosystems near forest cover such as treeline edges, riparian or wetland complexes, and regenerating burn areas. In general, moose move to certain habitats corresponding to seasonal changes and life cycle needs (Environment Yukon, n.d.). They are regionally important as a subsistence food source for the Kaska, as well as sport hunting by Yukon resident hunters and guided non-resident hunters (Norecol, Dames & Moore Ltd., 1996).

Moose densities throughout Yukon range between 100 and 250 moose for every 1,000 km^2 of suitable habitat; however, densities in excess of 400 moose for every 1,000 km^2 have been recorded (Environment Yukon, n.d.). The current average Yukon-wide density of moose is about 155 moose per 1,000 km^2 (Czetwertynski et al., 2012). For the region around the Ross and Pelly Rivers, it was estimated in 1996 that moose density was "high" at 250 to 349 moose per 1,000 km^2 (Yukon Government, 1996). Norecol, Dames & Moore Ltd. (1996) concluded that the number of moose using the LSA ranged between 10 and 20 at various times of the year. Government data from 1991 indicated that the broad valley adjacent to the western and southern slopes of the North Lakes was estimated to have a density of greater than 1.5 moose per km^2. Areas near the Access Road were estimated to have densities of 0 to 0.75 moose per km^2 (Norecol, Dames & Moore Ltd., 1996).

During the 2015/2016 baseline studies, three surveys were completed to assess the distribution and abundance of moose at different seasonal periods of 2015 and early 2016. Two late winter and one post rut survey documented population levels of moose in the RSA (Section 13.2). The second post rut survey was conducted in November 2016. During the 2015 late winter survey, all moose observations were north of the Project Footprint and were primarily on flat or gently sloped terrain close to streams and habitat that contained shrub understory. In total, 31 moose were observed during the 2015 late winter survey. A total of 152 moose were counted during the 2016 late winter survey. Possible explanations for the difference in numbers may be the intensity level of surveys, fresh snowfall prior to the 2016 survey aiding in animal detection, and favourable weather and snowpack conditions in 2016. During the post rut survey, a total of 114 moose were observed. Moose were mainly found at higher elevations throughout the study area. More bull moose were observed above treeline than cows. Figure 13-4 shows the distribution of moose in the RSA from the 2015 and 2016 post rut and early winter surveys. The YG wildlife key area (WKA) for moose wintering habitat is also shown on the figure.

Ungulate use of the area around Finlayson Lake for wintering is supported by Kaska TK on habitat requirements. Kaska TK indicates shallow snow depth results in better access to food and less predation of ungulates which confirms why the winter range around Finlayson Lakes is repeatedly used by ungulates (Dena Kayeh Institute, 2010).

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FIGURE 13-4

MOOSE OBSERVATIONS AND WILDLIFE KEY AREAS

JANUARY 2017

- 2015 Late Winter Ungulate Survey Sighting (25)
- 2016 Late Winter Ungulate Survey Sighting (69)
- 2015 Post Rut Moose Survey Sighting (49)
- 2016 Post Rut Moose Survey Sighting (49)
- 2015 Caribou Rut Survey Sighting (11)
- 2016 Caribou Rut Survey Sighting (0)
- Incidental Sighting (23)
- Moose Key Area - Late Winter Range
- Regional Study Area (Game Management Subzone 10-07)
- Tote Road/ Proposed Access Road
- Proposed Mine Road
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

* Numbers in brackets represent the number of individuals

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Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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13.3.3 Grizzly Bear

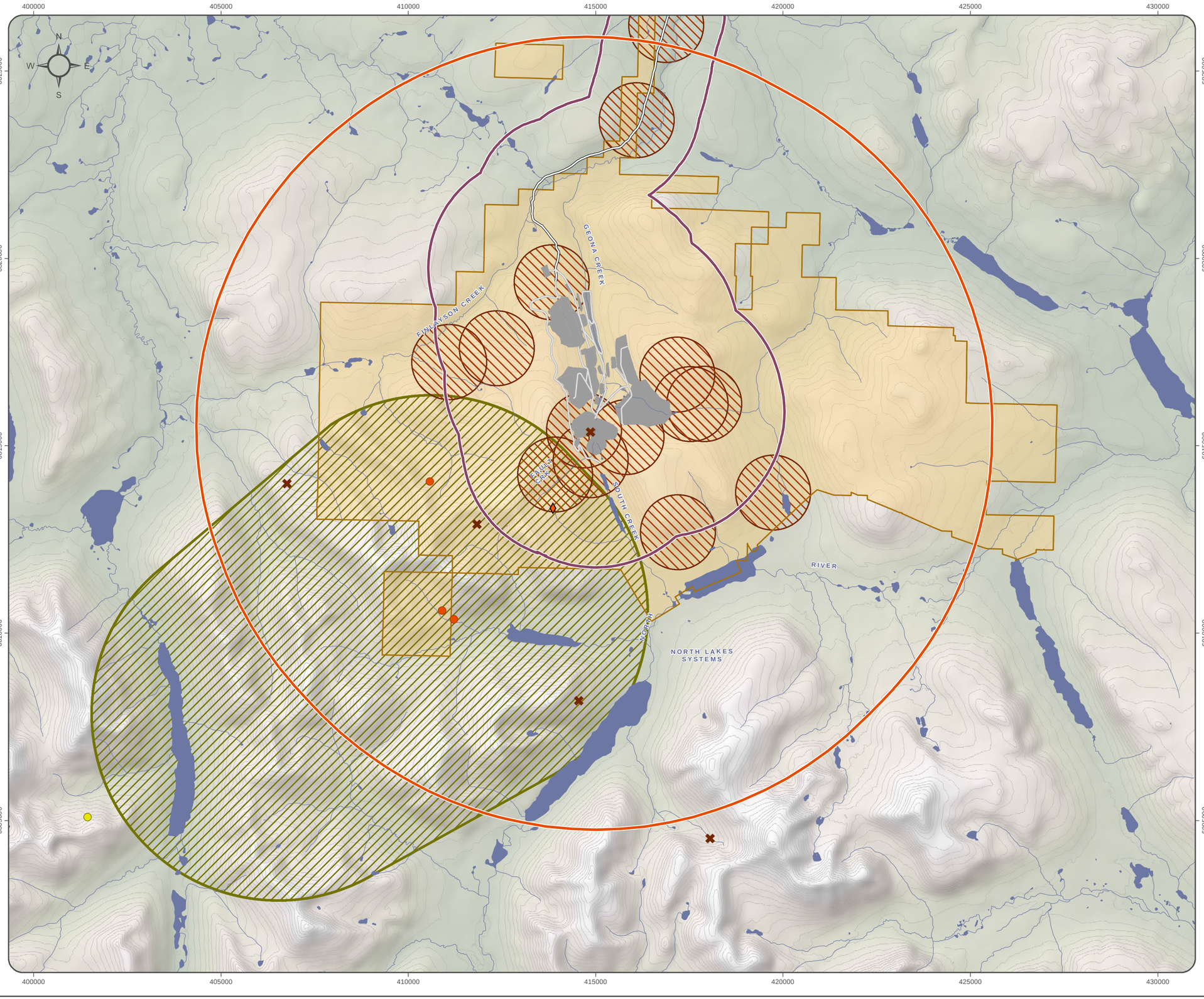
Grizzly bears (*Ursus arctos*) have large home ranges, preferring open valleys and subalpine regions, and may occur in all habitat types as they move through their range. Accurate densities for the LSA are unknown; however, Larsen et al. (1989) estimated densities in the Southern Lakes region of Yukon between 10 to 16 bears per 1,000 km^2, based on studies completed in that region. It is anticipated that the density of grizzly bears is higher in the east-central Yukon, compared to the Southern Lakes region, as there is less human effect on wilderness, fewer roads, and lower hunting pressure (Desrochers et al., 2002; Environment Yukon, 2005). Territorially, the Yukon Conservation Data Centre (YCDC) lists the grizzly bear as vulnerable in Yukon with a current estimated population of 6,000 to 7,000 (i.e., 12.4 to 14.5 bears per 1,000 km^2) (YCDC, 2015). Nationally, grizzly bears are listed as a COSEWIC Species of Special Concern and are listed in Schedule 3 of the federal *Species at Risk Act* (COSEWIC, 2012).

There is limited historical information on grizzly bear distribution or abundance in the LSA. However, grizzlies are known to occupy the subalpine valleys and alpine plateaus of the LSA and RSA where they feed on vegetation, berries, small mammals, and ungulates. Observations recorded in the 1995 Project camp log included one adult grizzly digging for ground squirrels in a basin 2 km south of the camp, and one grizzly in the uplands 2 km southeast of the camp. Incidental grizzly bear sightings recorded during the 1995 wildlife aerial surveys included a sow with two yearlings, a sow with a two-year old, and two individual sub-adults. No bear den sites were observed during the aerial surveys and none were reported during other project related work in the area (Norecol, Dames & Moore Ltd., 1996).

During the 2015 baseline surveys, three grizzly bear den surveys occurred over a three-week period from April 23 to May 15. One active bear den was discovered during the three surveys, located approximately 4.5 km southwest of the Project Footprint. The den entrance was located above treeline and had numerous bear tracks around it. During the final survey, multiple sets of grizzly bear tracks were observed near the den. Two individual sets of tracks were located in different areas, suggesting they were made by single bears in each case. These tracks also suggest there are more grizzly bears in the study area than just the sow and two cubs, who occupied the den found in May of 2015.

During the second of two den surveys in 2016, a second bear den was located approximately 4 km west from the proposed Project Footprint. This den location was near the location of the den that was discovered in 2015. Tracks of a sow and small cub were observed in a subalpine valley near the 2016 den location. A sow and sub-adult were also observed near this den location during the first den survey in 2016, suggesting they were likely denning in that general area as well.

Many incidental grizzly bear observations were made in the Project LSA during 2015 and 2016 as recorded in the camp wildlife log. During the 2016 field season, a total of 17 grizzly bear observations were recorded from May 10 to September 3. The locations of observations ranged from the boreal forest along the Tote Road to the alpine ridges surrounding the Project Footprint (Figure 13-5).



BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 13-5

GRIZZLY BEAR OBSERVATIONS

JANUARY 2017

- Grizzly Bear Sightings (Spring) (3)
- Grizzly Bear Sighting (Fall) (1)
- Spring Grizzly Bear Tracks (5)
- Spring Grizzly Bear Signs (1)
- Approximate Location of Incidental Sightings from Observation Log (14)
- Area in which 3 bear dens have been located (1)
- Local Study Area
- Bear Den Study Area
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse
- Waterbody
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

* Numbers in brackets represent the number of groups of this size range

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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13.3.4 Grey Wolf

Wolves (*Canis lupus*) in the general vicinity of the LSA were the subject of government studies in relation to their interaction with the FCH. A wolf control program was undertaken by YG between 1983 through 1989, and reduced the wolf population in the area by 85% (Norecol, Dames & Moore Ltd., 1996). After the cessation of control measures, the wolf population rebounded to near pre-control levels (Norecol, Dames & Moore Ltd., 1996).

The 1995 baseline study states that wolves and wolf sign were seen infrequently and notes two sightings of wolves occurring in the lower Geona Creek valley and northwest of the camp (Norecol, Dames & Moore Ltd., 1996). No species-specific surveys were undertaken for wolves during the 2015 and 2016 baseline studies; however, numerous incidental sightings occurred. Two wolf packs were observed during the late winter ungulate survey in 2015. One pack was observed 10 km west of the LSA, and the other pack was observed approximately 20 km southeast of the LSA. Additionally, many wolf tracks were observed throughout the LSA including the Tote Road, and were often associated with caribou tracks. In addition, six separate incidental wolf observations were made in the 2016 camp wildlife log. The observations were mostly made along the Access Road and along the Geona Creek valley.

13.3.5 Wolverine

Wolverines (*Gulo gulo*) are solitary predators that occupy home ranges hundreds of square kilometres (COSEWIC, 2014b). Large wilderness areas are essential to their survival, with populations declining due to an increase in transportation networks, agriculture areas, or human habitation. They have a broad ranging habitat from boreal forest to alpine ridges, and are one of the most reclusive animals in the boreal forest (Environment Yukon, 2015c). Wolverines were listed as a COSEWIC Species of Special Concern in 2014 (COSEWIC, 2014b). The YCDC lists the wolverine as vulnerable with no current population estimate for Yukon (Environment Yukon, 2015c; YCDC, 2015).

The 1995 baseline study reports that wolverines were observed in June 1995 west of the camp and tracks were observed north of the camp in April of the same year (Norecol, Dames & Moore Ltd., 1996). During the 2015 and 2016 baseline studies, no species-specific surveys were undertaken for wolverine; however, incidental sightings did occur. Incidental observations mostly consisted of tracks in alpine and subalpine habitats; one animal sighting did occur, which involved a wolverine being chased by a golden eagle (*Aquila chrysaetos*). Three incidental observations of wolverine were reported in the 2016 camp wildlife log. Each observation was recorded on a different day, which included an observation 1 km west of Rhyolite Peak in the alpine, and observations at km 22 and km 23 along the Access Road.

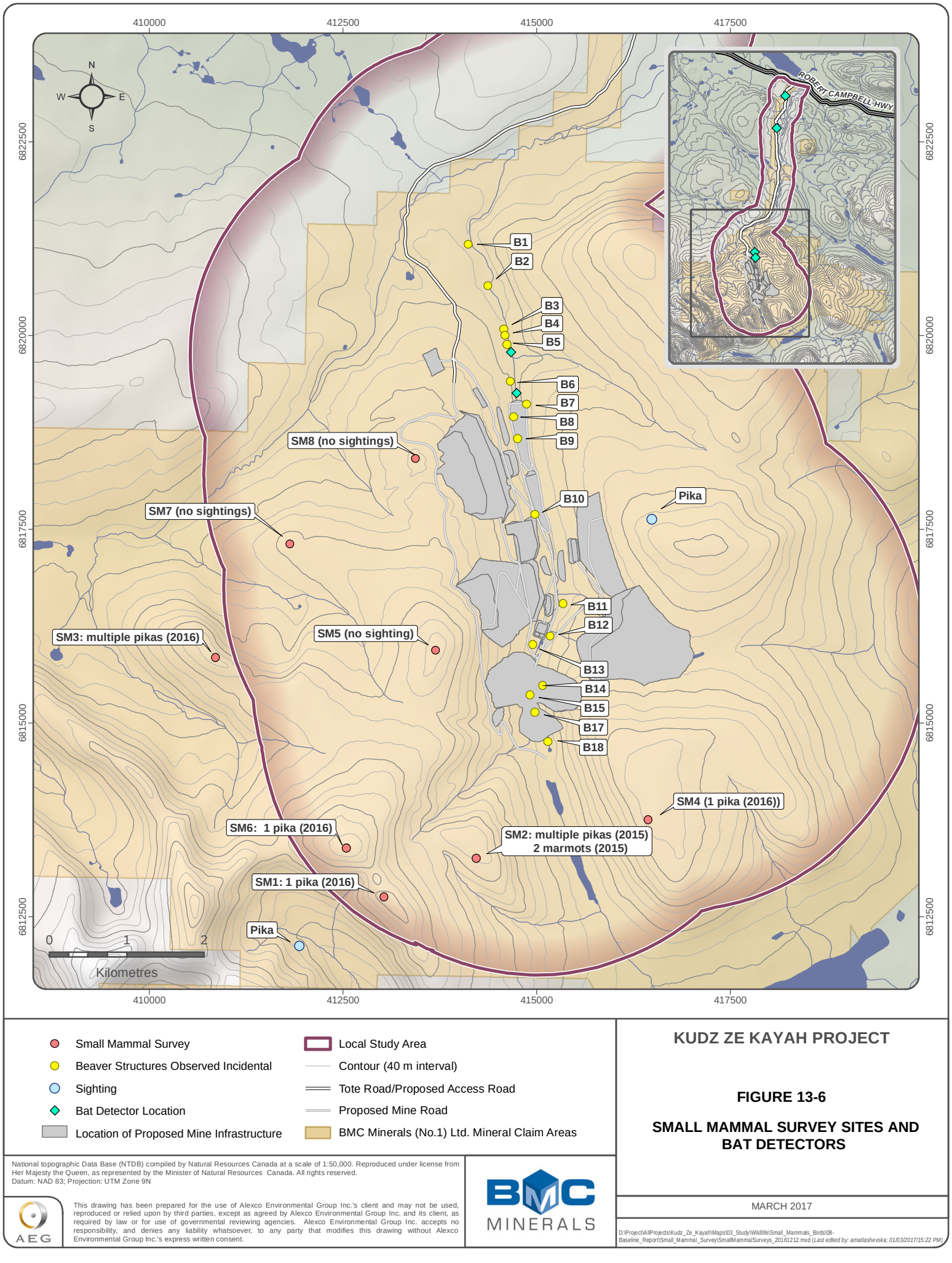
13.3.6 Collared Pika

The population of collared pika (*Ochotona collaris*) in Yukon is unknown; however, its distribution extends throughout most of Yukon, partially into the Northwest Territories, and into Alaska (COSEWIC, 2011a; Environment Yukon, 2015a). The collared pika was listed as Species of Special Concern by COSEWIC in 2011, because the potential negative effects of climate change to the

persistence of this species over the long term is substantial. The YCDC lists the collared pika as S3, or vulnerable (YCDC, 2015).

Prior to undertaking surveys in 2015, there appeared to be no regional or Project-derived information related to the distribution or abundance of collared pika and collared pika were not mentioned in the 1995 baseline study in the Project area (Norecol, Dames & Moore Ltd., 1996).

In 2015 and 2016, collared pika were observed on multiple mountains throughout the LSA (Figure 13-6). Pika focused surveys confirmed that collared pika are found south and west of the Project Footprint in their expected preferred habitat. Their preferred habitat is alpine sites that are steep and have exposed talus rock with low crevices that provide cover, adjacent to herbaceous meadows (Environment Yukon, 2015a). Most pika observations were vocalizations, although a small number of visual observations were also made. Given the frequency of observations made in 2015 and 2016, it is suspected that collared pika are present throughout the RSA at all high elevation sites with suitable habitat. Incidental observations of pika also occurred in 2015 and 2016 during the vegetation surveys.



- Small Mammal Survey
- Beaver Structures Observed Incidental
- Sighting
- Bat Detector Location
- Location of Proposed Mine Infrastructure
- Local Study Area
- Contour (40 m interval)
- Tote Road/Proposed Access Road
- Proposed Mine Road
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

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FIGURE 13-6

SMALL MAMMAL SURVEY SITES AND BAT DETECTORS

MARCH 2017

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13.3.7 Bats

Only three species of bats have been documented in Yukon, although it is suspected that others may exist but have not been detected yet (Slough and Jung, 2008). The three species known to exist are the little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and big brown bat (*Eptesicus fuscus*) (Jung et al., 2006; Slough and Jung, 2008). The little brown bat is the only species whose range overlaps the LSA (Environment Yukon, 2015b). The little brown bat is considered Endangered (COSEWIC, 2013), and the YCDC considers the little brown bat to be S1S3, critically imperiled and vulnerable (YCDC, 2015).

Little brown bats are often found feeding over water and along the edges of lakes and streams, but will also hunt in clearings and open forest. In Yukon, they are known to roost in human-made structures, rock crevices, tree cavities, and under tree bark, so locating active bat roost sites can be difficult (Environment Yukon, 2007). Males and females lead separate lives. Males live alone or in small colonies, often at higher elevations than females (but no more than 1,000 m). Females prefer to roost in larger colonies of up to several hundred bats (Environment Yukon, 2007). The little brown bat is migratory, arriving in Yukon between April and June and leaving between August and October. It is suspected they hibernate in southeast Alaska, but it is currently unknown. There are no known hibernating sites for bats north of Prince George, British Columbia (BC). In Yukon, the little brown bat occurs in relatively low densities, while population trends and wintering areas are unknown (Environment Yukon, 2007).

Historical survey data for bats (in particular, little brown bat) in the LSA do not exist. No recorded observations were made in the 1995 IEE (Norecol, Dames & Moore Ltd., 1996).

During the 2015 baseline field program, a survey for the presence of bats occurred using an Anabat model remote acoustic recorder unit. It was set up in a subalpine wetland at the north end of the proposed Project Footprint approximately 4 km north of the proposed ABM open pit. No bat calls were detected on the recording. It was suspected that no recordings were collected because the detectors were installed in subalpine habitat, which may be too high elevation for preferred bat habitat (i.e., greater than 1,000 masl).

In 2016, the detectors were installed at two different wetlands in boreal forest habitat along the Access Road (Figure 13-6). Both detectors were installed for 17 days and had successful recordings of bat vocalizations. It is suspected that the recordings were from the little brown bat, as the northern long-eared bat is only present in the extreme southeastern part of Yukon and has had very few observations, and the big brown bat has only been recorded twice in Yukon, both times in Teslin (1999 and 2007).

13.3.8 Cliff-Nesting Raptors

Based on the desktop analysis conducted in 2015, it was determined that high quality habitat for nesting raptors is not abundant in the LSA; however, raptors appear to be using what suitable habitat is available. This was confirmed during field surveys in 2015 and 2016. Raptors identified in the LSA included golden eagle (*Aquila chrysaetos),* bald eagle (*Haliaeetus leucocephalus*), gyrfalcon (*Falco*

rusticolus) and northern harrier (*Circus cyaneus*). One active and one inactive golden eagle nest were observed in 2015 and 2016 in the LSA. An active northern harrier nest was observed along Geona Creek in 2016 (Figure 13-7). Although suitable raptor habitat exists along the Access Road, no raptors were observed during the 2015 and 2016 field surveys. Two small unidentified raptor species were observed in the subalpine and alpine habitats above Geona Creek in June 2016. Two incidental observations of bald eagle were made in 2015: one observation was made southwest of the historical core shacks, and another observation was captured by a wildlife camera installed near North Lakes.

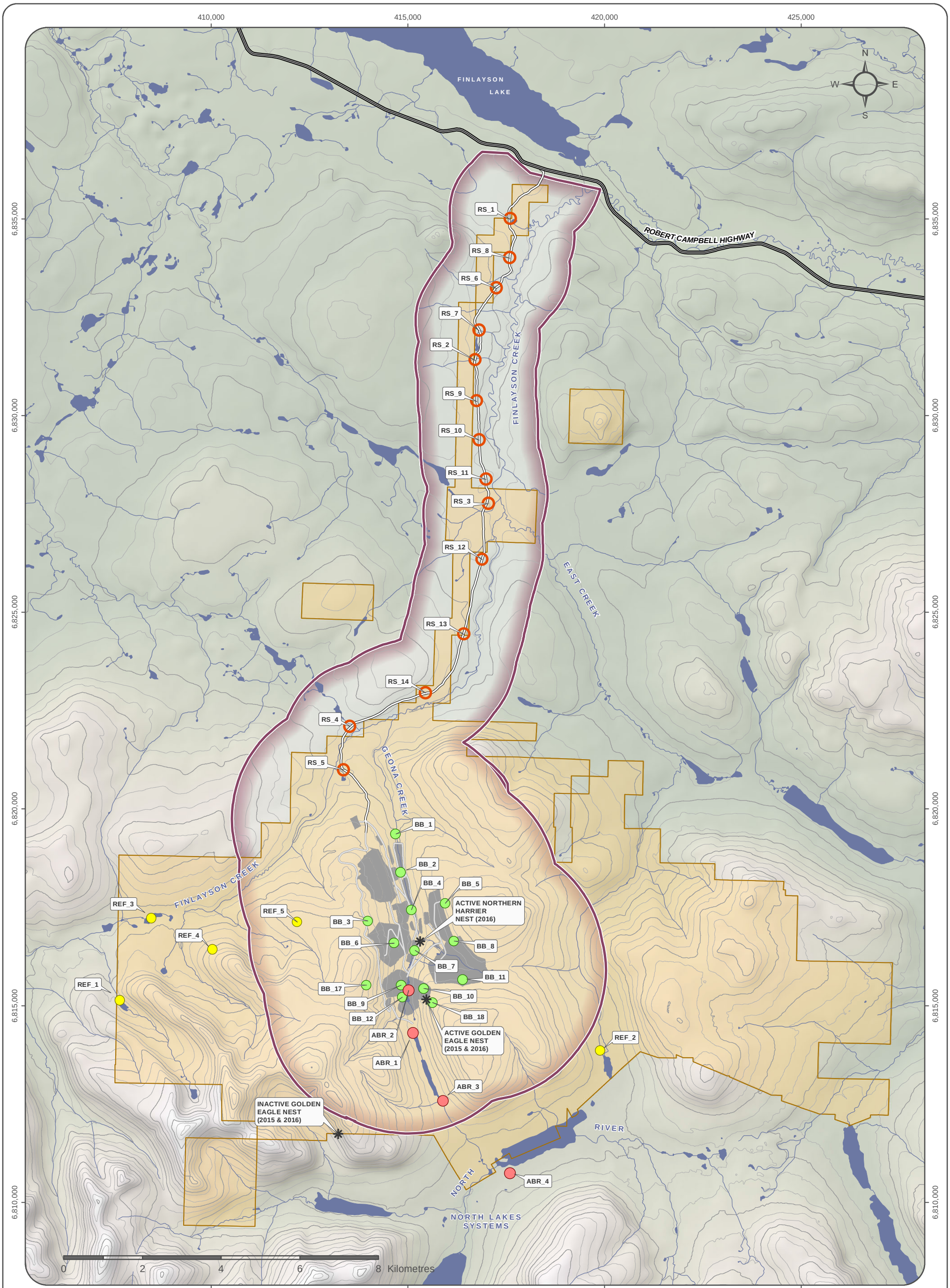
The 1995 baseline study reports multiple golden eagle observations, two bald eagle observations and a pair of gyrfalcons southeast of Wolverine Lake during a 1995 aerial survey (Norecol, Dames & Moore Ltd., 1996).

13.3.9 Passerines (Olive-sided Flycatcher)

The LSA contains a variety of habitats ranging from forested and riparian valleys to alpine peaks and meadows. Due to the diversity of habitats, a diverse assemblage of bird species also exists in the LSA. Directed point count surveys were performed in various habitats to record all passerine species present either in or near the proposed Project Footprint. Passerine species included the following general groups: flycatchers, shrikes and vireos, jays and crows, swallows, chickadees, kinglets, thrushes, waxwings, warblers, sparrows, blackbirds, and finches. Four main habitats were selected for point count surveys including mixed forest subalpine, alpine, riparian, and wetland. The greatest species richness was found in the subalpine forest and wetland habitats; alpine habitats showed the lowest species richness.

A total of 37 passerine species were observed during point count surveys conducted in 2015 and 2016 (Figure 13-7). Among those 37 species, four are reported as at risk according to COSEWIC: olive-sided flycatcher (*Contopus cooperi)*, bank swallow (*Riparia riparia)*, and barn swallow (*Hirundo rustica)* are considered Threatened, while rusty blackbird (*Euphagus carolinus*) is considered Special Concern. The most frequently observed species during the two years of baseline surveys were white-crowned sparrow (*Zonotrichia leucophrys*), American tree sparrow (*Spizella arborea*), and Wilson's warbler (*Cardellina pusilla*).

No breeding bird surveys were conducted for the Project in 1995, thus no previous background data exists for upland songbird populations in the LSA (Norecol, Dames & Moore Ltd., 1996).



- Tote Road Survey Location
- Wetland Survey Location
- Reference Habitat Survey Location
- Breeding Bird Survey Location
- Raptor Nest
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (40 m interval)
- Watercourse
- Waterbody
- Local Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

BMC MINERALS

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FIGURE 13-7

BIRD SITE SURVEY LOCATIONS 2015-2016

JANUARY 2017

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The olive-sided flycatcher was the most abundant at risk species. A total of four individuals were detected during the 2015 field surveys, nine individuals were detected during the 2016 field surveys, and 151 individuals were recorded during the Finlayson Lake breeding bird surveys from 1992 through 2014. In 2015, all four sightings occurred in the subalpine habitat where the proposed Project Footprint is planned. In 2016, six observations occurred in subalpine habitat either along the Access Road, in the Geona Creek valley, or near treeline on the slopes overlooking Geona Creek; the other three observations occurred in boreal forest habitat along the Access Road. These observations are consistent with typical olive-sided flycatcher habitat, which occurs in boreal and mixed forests from lowland areas to treeline, often at the edges of wetlands where dead trees provide singing and foraging sites (Sinclair et al., 2003).

13.3.10 Waterfowl

The LSA has limited habitat suitability for waterfowl (i.e., ducks, swans and geese) and other waterbirds (i.e., loons, grebes, gulls), due to the upland nature of the site. Besides the small, scattered wetlands throughout the LSA, there is limited lake and large open water habitat. Wetland surveys were conducted in the LSA as well as at reference wetlands outside the LSA. Predominant waterfowl using the wetlands in the LSA and reference wetlands were scaup (*Aythya* spp.) and goldeneye (*Bucephala* spp.*)*. Other waterfowl included green-winged teal (*Anas crecca)*, northern pintail (*Anas acuta*), mallard (*Anas platyrhynchos)*, bufflehead (*Bucephala albeola*) and red-breasted merganser (*Mergus serrator)*. Waterfowl nesting on the wetlands in the LSA include mallard, green-winged teal and northern pintail. Seven species of shorebird were observed in the LSA, of which six were suspected to be nesting: spotted sandpiper (*Actitis macularius)*, semipalmated plover (*Charadrius semipalmatus)*, lesser yellowlegs (*Tringa flavipes*), solitary sandpiper (*Tringa solitaria*), least sandpiper (*Calidris minutilla*), and American golden-plover (*Pluvialis dominica*). Red-necked phalarope (*Phalaropus lobatus*) are considered a species of Special Concern and were observed in 2015 and 2016 in the wetlands of the Geona Creek headwaters as well as reference wetlands.

The 1995 baseline study reported that wetlands in the upper Geona Creek valley were used during migration; however, no direct observations of waterfowl breeding were reported in 1995 (Norecol, Dames & Moore Ltd., 1996).

13.3.11 Bumble Bees

Bumble bees have been observed in the LSA; however, no formal studies were conducted. The two species of concern are the gypsy cuckoo bumble bee (*Bombus bohemicus*) and the western bumble bee (*Bombus occidentalis mckayi*). The gypsy cuckoo bumble bee is an obligate social parasite of the western bumble bee which means that the gypsy cuckoo bumble bee can only inhabit areas where the western bumble bee lives (COSEWIC, 2014c). The gypsy cuckoo bumble bee finds a nest of the western bumble bee (in old rodent holes or decaying logs), represses the host queen, and lays its eggs for the host workers to tend (COSEWIC, 2014c). Habitat exists throughout boreal forests and montane meadows for both species of bumble bee, but there are no confirmed specimens of the gypsy cuckoo in Yukon (COSEWIC, 2014c; COSEWIC, 2014d). Bumble bees feed on a wide range of flowering plant species (COSEWIC, 2014d).

13.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on wildlife and wildlife habitat as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

13.4.1 Effects Characterization

In order to focus the EA, the first step is to identify any potential interactions between Project activities and identified subcomponents for wildlife and wildlife habitat. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1 or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects; and*
2 – Higher risk interactions- *it is reasonably foreseeable that residual effects may result.*

The results of the interactions screening are presented in Table 13-6.

Table 13-6: Interaction Matrix for the Wildlife and Wildlife Habitat Subcomponents

Project Activity	Finlayson Caribou Herd	Moose	Grizzly Bear	Grey Wolf	Wolverine	Collared Pika	Little Brown Bat	Cliff-Nesting Raptors	Passerine Birds	Waterfowl
Construction										
Tote Road upgrade to Access Road	2	2	2	2	2	0	2	0	2	2
Finlayson Lake airstrip upgrade	2	2	2	2	0	0	1	0	2	2
Site preparation and clearing	2	2	2	2	2	2	0	2	2	2
Site grading, including soil and overburden removal and stockpiling	2	2	2	2	2	2	0	2	2	2
Off site traffic (construction equipment and materials delivery)	2	2	2	2	2	0	2	1	2	2
On site traffic	2	2	2	2	2	1	0	1	1	1
ABM open pit development (including dewatering and Fault Creek diversion)	2	2	2	2	2	2	0	2	2	2
Infrastructure construction	2	2	2	2	2	2	0	2	2	2
Waste handling	1	1	1	2	1	1	0	1	1	1
Water use and management	1	1	1	1	1	0	1	1	2	2
Power generation	0	0	0	0	0	0	0	0	0	0
Worker transport	1	1	1	1	1	0	1	1	1	1
Construction camp operation	1	1	1	1	1	0	0	1	1	1
Workforce, procurement and hiring	0	0	0	0	0	0	0	0	0	0
Operations										
ABM open pit operations (including blasting and dewatering)	2	2	2	2	2	2	0	2	2	2
Underground operations	1	1	1	1	1	1	0	1	1	1
Ore processing	1	1	1	1	1	1	0	1	1	1
On site traffic	2	2	2	2	2	1	0	1	2	2
Off site traffic (highway)	2	2	2	2	2	0	2	1	2	2

Project Activity	Finlayson Caribou Herd	Moose	Grizzly Bear	Grey Wolf	Wolverine	Collared Pika	Little Brown Bat	Cliff-Nesting Raptors	Passerine Birds	Waterfowl
Finlayson Lake airstrip operations	2	2	2	2	2	0	2	2	2	2
Storage facilities management (Class A, B, and C)	2	2	2	2	2	2	0	2	2	2
Progressing reclamation of storage facilities	2	2	2	2	2	2	0	1	2	2
Water use (potable and non-potable)	1	1	1	1	1	1	0	1	1	1
Mine water management and treatment (including effluent discharge)	1	1	1	1	1	0	1	1	2	2
Waste management	1	1	2	2	1	1	0	2	1	1
Power generation	0	0	0	0	0	0	0	0	0	0
Worker transport	1	1	1	1	1	0	1	0	1	1
Camp operation	1	1	2	1	1	0	0	0	1	1
Workforce, procurement and hiring	0	0	0	0	0	0	0	0	0	0
Closure										
Processing plant decommissioning and site reclamation	2	2	2	2	2	0	0	2	2	2
ABM lake Filling	1	1	1	1	1	0	0	1	1	2
Final storage facilities reclamation	1	1	1	1	1	1	0	1	1	1
Support infrastructure removal and site reclamation	1	1	1	1	1	0	0	1	1	1
Water management, treatment and discharge	1	1	1	1	1	0	1	1	1	1
On site traffic	2	2	2	2	2	1	0	1	1	1
Off site traffic	1	1	1	1	1	0	1	1	1	1
Access Road reclamation	1	1	1	1	1	0	1	1	1	1
Workforce, procurement and hiring	0	0	0	0	0	0	0	0	0	0

In addition to the direct Project interactions identified above, the following indirect interactions are identified for wildlife and wildlife habitat:

- Potential indirect effects as a result of changes to air quality;
- Potential indirect effects as a result of increased noise levels;
- Potential indirect effects as a result of changes to surface water quality; and
- Potential indirect effects as a result of effects on vegetation.

Project activities that are most likely to interact with and create a potential effect on wildlife include: mining of the ABM open pit; construction of processing facilities; construction of the camp infrastructure; upgrading of the existing Tote Road; construction of three storage facilities; construction of water management and treatment facilities; and an overall increase in human activity in the LSA. The phases of the Project that are considered to have a potential effect on wildlife are: construction, operations, closure, and post-closure.

The following discussion focuses on maximum adverse effects through construction and operations with closure and post-closure phases discussed through the mitigation sections and in the conceptual reclamation plan (Appendix H-1). The determination of residual effects and significance integrated all phases of the Project from construction through post-closure.

The Project activities listed above will interact with and potentially affect wildlife primarily by:

- Removing suitable habitat through site preparation and land clearing, which also reduces adjacent habitat effectiveness due to sensory disturbances (e.g., noise, visual, physical);
- Creating barriers to wildlife movement because of sensory disturbances or physical disturbances created by mine infrastructure, loss of habitat, or increase in human presence;
- Increasing the risk of mortality due to collisions with vehicles or increased harvest; and
- Deteriorating animal health caused from increased stress and excessive energy expenditures to avoid sensory disturbances, or direct interaction with impacted water or vegetation.

These potential effects are supported by Kaska TK (Appendix F-3) which is based on Kaska observations and insights from previous experiences with resources developments in their Traditional Territory, including Faro and Ketza Mines.

A key effect on wildlife from Project activity is the removal of suitable habitat through site preparation and land clearing, and reduction of adjacent habitat effectiveness due to sensory disturbances. Therefore, loss of suitable habitat was the primary focus of the assessment for most wildlife species. Habitat suitability maps were created to delineate high, moderate, and low quality habitat for each species based on well-defined habitat preferences found in the literature. The area loss of highly suitable habitat from direct and indirect sources was compared to a threshold found in the literature to quantify the magnitude of the habitat loss and contributes to determining the significance of the effect.

The areas of high, moderate, and low suitability habitat were delineated using spatial analysis in ArcGIS 10.4. The Terrestrial Ecosystems Map (TEM) in combination with watercourses, water bodies, and elevation data (Digital Elevation Model) were intersected and used to delineate appropriate areas of suitable habitat pertaining to each individual species. Where possible, the assessment of significance was supported in part, based on the loss of highly suitable habitat and was calculated by overlaying the overall disturbance Footprint of the Project with the derived habitat suitability index (Appendix E-8).

Direct loss of habitat includes either removal of the habitat due to clearing, or altering it in a way that it becomes unusable for the species. Indirect habitat loss is not the removal of habitat, but rather a reduction of the suitability of habitat that may result in species avoidance due to sensory disturbances such as noise, visual, or physical disturbances. Indirect habitat loss was delineated by a 300 m buffer surrounding the area of direct habitat loss, and was calculated for the following species: caribou, moose, grizzly bear, collared pika, bats, olive-sided flycatcher, cliff-nesting raptors, and waterfowl.

When calculating total habitat loss for the habitat suitability rankings, indirect habitat loss was weighted as 50% equivalent to direct habitat loss. Therefore, 3 km^2 of indirect habitat loss is equivalent to 1.5 km^2 of direct habitat loss. This equivalency was used because the indirect habitat would still be present but it was assumed to be used less. Furthermore, the desirability of use of the indirect habitat impacts increases as the distance from the direct habitat loss increases. Therefore, an average use of 50% of the area experiencing indirect effect was assumed across the entire buffer. This assumption allows for a calculation of total habitat loss to fairly assess thresholds and is a broad enough assumption that accommodates the variety of indirect responses observed for a number of species. Numerous studies show reduced use of habitat in the zones of influence, but do not show complete avoidance (Forman and Alexander, 1998; Fahrig and Rytwinski, 2009). Therefore, an average of 50% reduced use is considered reasonable and conservative for most species. Direct and indirect habitat losses are presented for transparency.

It should be noted that the values quantified for loss of habitat (both direct and indirect) may be overestimated because they represent the maximum area of disturbance in the LSA (i.e., worst-case scenario). These values do not account for the fact that progressive reclamation will occur on disturbed areas that are no longer needed for Project activities; therefore, reclaiming habitat as the Project proceeds. These reclaimed areas are likely to be used as habitat during closure and post-closure, albeit the suitability of the habitat may not be as high. Habitat at the ABM open pit will be permanently lost.

The following sections present predicted effects for each valued subcomponent. It should be noted that the subcomponents selected in a few cases, were selected to represent a broad group of similar wildlife. For example, collared pika was chosen as a representative species for small mammals, cliff-nesting raptors for other raptors, olive-sided flycatcher for passerines, and wolverine and wolf were chosen as representative species for furbearers. When the effects are noted for one representative species, it should be interpreted that the type and level of the effects for that species are assumed to be similar for all species in that group.

It should also be noted that the Section 13.4.1 focuses on potential effects with some discussion of mitigations. Full mitigation measures are then discussed in Section 13.4.2. Finally, the residual effects after mitigation and the resulting assessment of significance of effects are presented in Section 13.4.3.

13.4.1.1 Caribou

Project Interactions

Potential effects on caribou include direct and indirect habitat loss, disruption of movement corridors, direct mortality, and health effects from stressors and environmental contaminants. These are discussed below and quantified where practicable.

Northern Mountain Population (NMP) caribou make use of climax habitat (Bergerud, 1978), which offers little in the way of mitigating effects through enhancement. This is to say that caribou use habitat where the plant communities have changed over time to be in balance with the physical environment (i.e., climax) so they will make limited use of newly created or enhanced habitat. NMP caribou habitat management is therefore more about conservation than management. Woodland caribou are generally held well below the forage resource limits of carrying capacity by predation (Bergerud, 1980, 1988, 1996; Bergerud and Elliot, 1986; Farnell et al., 2008). In other words, without predation, the available food in their range would support a larger population than exists.

Based on surveys completed around the Project to date, the rutting period is when most interaction by caribou with the Project consistently occurs, with some interaction with post calving habitat. Therefore, this EA focuses on rut and post calving habitat. There is also expected to be interaction with caribou along the Access Road along Genoa Creek during the post rut/early winter period as caribou move from adjacent alpine rutting grounds to their lowland winter range along the Pelly River. Interactions are also expected in the winter range of the Pelly River lowlands with scheduled flights and activity at the Finlayson Lake airstrip.

General Indirect Effects on Habitat

Some potential indirect impacts to caribou are noise, human presence, linear disturbance, and dust deposition. In addition, movement corridor avoidances have been documented reducing habitat use in response to disturbances at distances of 250 m to 14 km (Dyer et al., 2001; Polfus et al., 2011; Boulanger et al., 2012). The distance of the response varies by species (e.g., mountain versus woodland versus barren-ground), terrain, vegetation types, and intensity and frequency of disturbance. Much of this research is based on the boreal population of woodland caribou or barren-ground caribou whose ecology differs from NMP woodland caribou (Fuller and Keith, 1981; Bradshaw et al., 1995; Mallory and Hillis, 1998; Gray, 1999; Dzus, 2001; McLoughlin et al., 2003). Boreal caribou are sensitive to stresses caused by human encroachment and are declining throughout most of their range (Ferguson and Gauthier, 1992; Bradshaw et al., 1995; Rettie and Messier, 1998; Dyer et al., 2001; Oberg, 2001; Vors and Boyce, 2009). Conversely, NMP caribou occur in diverse multiple predator-prey systems, exhibit gregarious behaviour, and make extensive use of open, upland habitats. There is less known about potential adverse effects to NMP caribou from anthropogenic disturbance and results from research on boreal or barren-ground caribou in other parts of Canada may not be entirely applicable to NMP caribou.

A study performed on the Atlin herd of northern woodland caribou found the zone of influence (ZOI) around the town of Atlin, B.C. (population 350) was 9 km in winter and 3 km in summer (Polfus et al., 2011). The study also found a high use road had a ZOI of 2 km in both summer and winter, a low use road 1 km in both summer and winter, and a mine had ZOI of 0.25 km in winter and 2 km in summer. Avoidance was linked to the seasons and the magnitude of the activity (e.g., busy roads were avoided by 2 km, less travelled roads were avoided by 1 km) (Polfus et al., 2011). While caribou avoided roads similarly across seasons, the ZOI around the mine and town differed across seasons. Weir et al. (2007) examined a mine project in Newfoundland that is comparable to the proposed Project, providing relatively comparable information regarding caribou distribution before and after mine construction, and before and during mine operation. They detected up to 36% reduction in caribou distribution within 4 km of the mine site during late winter (Weir et al., 2007).

Rut

There is evidence that caribou will abandon rutting grounds when exposed to frequent and intense aerial and ground-based mining exploration activity (Farnell, 2000). This can have a short-term impact on caribou calf survival in the following year, resulting in a negative population level response. Therefore, intense human activity on rutting grounds should be limited in rutting areas during the breeding season (September 28 to October 10) (Farnell, 2000).

Post Calving

For population level effects to occur, adult mortality would have to increase and/or calf recruitment decrease. A possible scenario for this effect would be increased predation, particularly on newborn or young calves, due to displacement of animals from preferred habitats such as calving and probably more importantly, post calving areas.

Another possibility is energetic stress due to disturbance that can cause the caribou to move to suboptimal habitats and result in increased energy expenditure. During post calving, caribou would need to expend more energy if they are displaced by airplanes or mine operations from habitat with snow patches that they use for insect relief. The results of numerous studies on caribou during the post calving season suggest that during warm summers, insects have a marked effect on caribou behavior and group dynamics by decreasing the amount of time spent feeding and increasing energy expenditure, thus limiting summer nutrition and body condition (White et al., 1975; Roby, 1978; Downes et al., 1986; Messier et al., 1988; Nixon and Russell, 1990). Caribou have a limited time span during summer for growth and building new fat reserves for coming winter. Females need to compensate for energy costs of gestation and lactation (Gerhart, 1995) and males have to build body reserves for the rut (Kelsall, 1968; Skoog, 1968). Constraints (e.g., human activity) on the ability of caribou to feed optimally during this period of high forage quality and availability could have a negative effect on their body condition (White et al., 1975).

Caribou tend to aggregate into large groups in the alpine during afternoon and evenings on hot windless summer days in response to biting insects during post calving (mid-June and July). Consequently, even single negative stimuli from a human caused effect (e.g., aircraft overflight) can have a bearing on numerous individuals. Body condition of females in turn effects their probability of becoming pregnant in fall and calf survival the following year (Gerhart, 1995).

Ion and Kershaw (1989) found that during warm weather months, caribou move into alpine areas and were frequently observed to utilize late-lying snow patches. The availability of snow patches varies among mountain ranges because of regional climatic and topographical effects. Snow patches occur in the mountains in the region of the LSA. In some mountain ranges, there are very few snow patches -- in these cases, snow patches provide limited habitat for caribou. Human activity at these limited sites could be detrimental if caribou are displaced.

Habitat Suitability

A habitat suitability index (HSI) model was prepared to predict habitat selection of the FCH for the rut and post calving periods. The data used to create the habitat suitability maps were collected over the last 30 years by YG biologists and recent survey data collected by Alexco Environmental Group Inc. (AEG) in 2015 and 2016 (Appendix E-8). In addition, expert knowledge was gathered through interviews with several individuals from Environment Yukon, AEG, and other consultants regarding caribou habitat usage. The HSI model variables chosen to determine habitat preference were vegetation cover, elevation, slope, and aspect. The classes in each variable were ranked based on their significance for caribou during the post calving and rut period. Satellite and telemetry data were combined and used to calibrate the model variables, while the aerial survey data were used to evaluate the effectiveness of the model. The resulting rut habitat suitability maps are presented in Figure 13-8 and Figure 13-9; and the post calving habitat suitability maps are presented in Figure 13-10 and Figure 13-11. Summaries of the quantity of habitat suitable for rut and post calving that will be affected by the Project are presented in Table 13-7 and Table 13-8, respectively.

Based on data from the habitat suitability maps, the percentage of moderately high and high valued habitat across the FCH range for rut and post calving is 17% (357,715 ha) and 11% (229,567 ha), respectively. Within the indirect ZOI (the rut and post calving study areas surrounding the LSA), percentage of moderately high and high value habitat for rut and post calving is 4.5% (4,771 ha) and 3.3% (2,778 ha), respectively. The proposed Project Footprint that directly overlaps with moderately high and high rut habitat is 777 ha, or less than 1% of the same quality habitat in the rut ZOI. Post calving habitat directly affected by Project infrastructure is 118 ha, or approximately 0.14% of the same quality habitat available in the post calving ZOI.

Table 13-9 presents a condensed summary of estimated caribou habitat loss at maximum disturbance during operations. Project development is estimated to result in a direct and indirect loss of 3.0% of the moderately high and highly suitable caribou rut habitat. Project development is estimated to result in a direct and indirect loss of 1.8% of the moderately high and highly suitable post calving habitat. In all, this would equate to less than a 1% loss of suitable rut or post calving habitat in the entire FCH home range.

Table 13-7: Summary of Finlayson Caribou Herd Rut Habitat Changes

FCH Home Range Habitat Suitability Index Study Area				
Habitat Suitability Index*	Number of Cells**	Area (ha)	Percent of FCH home range (HSI)	
Nil	47,008	2,938	0%	
Very Low	10,110,325	631,895	31%	
Low	13,294,756	830,922	41%	
Moderate	3,420,620	213,789	11%	
Moderately High	3,083,798	192,737	9%	
High	2,639,640	164,978	8%	
Rut Habitat Suitability Index (Caribou Rut ZOI from AEG 2015-2016 survey)				
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of FCH home range (HSI)	
Nil	7,456	466	16%	
Very Low	166,764	10,423	2%	
Low	763,176	47,699	6%	
Moderate	684,855	42,803	20%	
Moderately High	806,453	50,403	26%	
High	908,059	56,754	34%	
Indirectly Affected Habitat (based on LSA 3 km buffer around mine site and 1.5 km buffer around road)				
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of FCH home range (HSI)	Percent of Rut ZOI
Nil	57	4	0.1%	1%
Very Low	18,413	1,151	0.2%	11%
Low	56,740	3,546	0.4%	7%
Moderate	29,584	1,849	0.9%	4%
Moderately High	31,860	1,991	1.0%	4%
High	44,481	2,780	1.7%	5%
Directly Affected Suitability Caribou Habitat from Project Feature Footprint				
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of FCH home range (HSI)	Percent of Rut ZOI
Very Low	68	4	0.0%	0.0%
Low	1,007	63	0.0%	0.1%
Moderate	2,434	152	0.1%	0.4%
Moderately High	9,104	569	0.3%	1.1%
High	3,320	208	0.1%	0.4%

* Classifications of nil, very low and low are not located in the Project footprint

** Cell size 25 m x 25 m (625 m^2)

Table 13-8: Summary of Finlayson Caribou Herd Post Calving Habitat Changes

FCH Home Range Habitat Suitability Index Study Area				
Habitat Suitability Index*	Number of Cells**	Area (ha)	Percent of FCH home range (HSI)	
Nil	7,486,866	467,929	23%	
Very Low	16,205,085	1,012,818	50%	
Low	3,588,769	224,298	11%	
Moderate	1,636,904	102,307	5%	
Moderately High	1,621,049	101,316	5%	
High	2,052,016	128,251	6%	
Post Calving Habitat Suitability Index (Caribou Post Calving ZOI from AEG 2015-2016 survey)				
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of FCH home range (HSI)	
Nil	208,446	13,028	3%	
Very Low	1,264,139	79,009	8%	
Low	609,162	38,073	17%	
Moderate	485,006	30,313	30%	
Moderately High	521,512	32,595	32%	
High	824,417	51,526	40%	
Indirectly Affected Habitat (based on LSA 3 km buffer around mine site and 1.5 km buffer around road)				
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of FCH home range (HSI)	Percent of Post Calving ZOI
Nil	20,296	1,269	0.27%	9.7%
Very Low	68,287	4,268	0.42%	5.4%
Low	28,047	1,753	0.78%	4.6%
Moderate	20,063	1,254	1.23%	4.1%
Moderately High	17,738	1,109	1.09%	3.4%
High	26,704	1,669	1.30%	3.2%
Directly Affected Suitability Caribou Habitat from Project Feature Footprint				
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of FCH home range (HSI)	Percent of Post Calving ZOI
Nil	87	5	0.0%	0.0%
Very Low	1,114	70	0.0%	0.1%
Low	6,942	434	0.2%	1.1%
Moderate	5,902	369	0.4%	1.2%
Moderately High	1,789	112	0.1%	0.3%
High	99	6	0.0%	0.0%

* Classifications of nil, very low and low are not located in the Project footprint

** Cell size 25 m x 25 m (625 m^2)

Table 13-9: Summary of Caribou Habitat Loss

Suitability Ranking	Baseline Conditions for FCH Home Range[1] (km^2)	Baseline Conditions for FCH ZOI[2] (km^2)	Direct Habitat Loss in Project Footprint[3] (km^2)	Indirect Habitat Loss in LSA[4] (km^2)	Total Habitat Change in FCH Home Range[5] (%)	Total Habitat Change in FCH ZOI[5] (%)
Rut Habitat of Moderately High and High Suitability	3,577	1,072	7.8	47.7	-0.9%	-3.0%
Post Calving Habitat of Moderately High and High Suitability	2,296	841	1.2	27.8	-0.7%	-1.8%

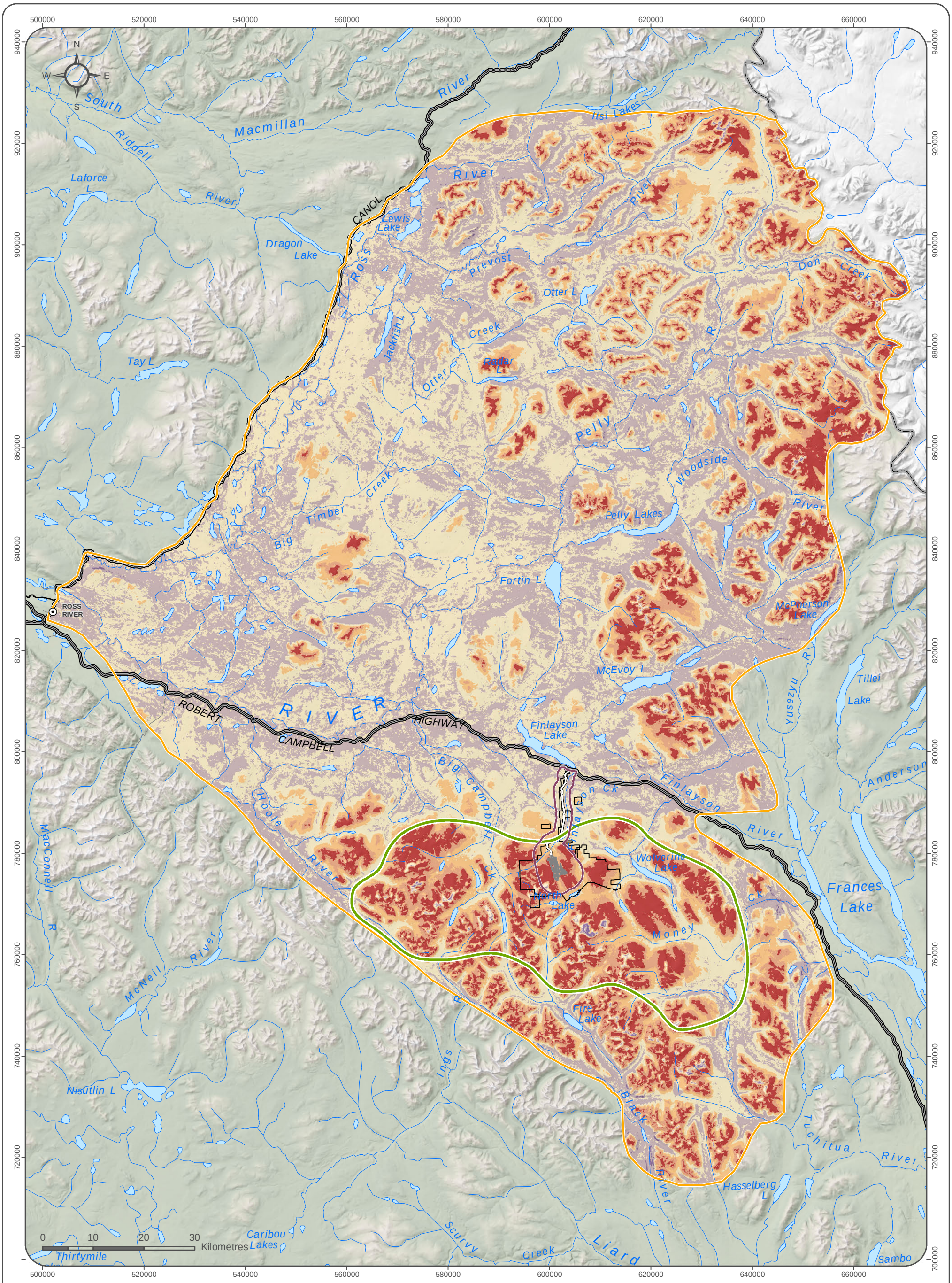
[1] Amount of habitat prior to any construction in the FCH home range

[2] Amount of habitat prior to any construction in the rut habitat range for the FCH in the Project region or ZOI

[3] Area of direct habitat lost to the Project Footprint, including Access Road

[4] Area of indirect habitat lost located in the LSA

[5] Percent change after direct and 50% of indirect habitat loss



HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area (Indirect Zone of Influence)
- Caribou Rut Study Area
- Finlayson Caribou Herd Home Range
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Mine Infrastructure

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KUDZ ZE KAYAH PROJECT

FIGURE 13-8

FINLAYSON CARIBOU HERD RUT HABITAT SUITABILITY: HOME RANGE AND REGIONAL STUDY AREA

JANUARY 2017

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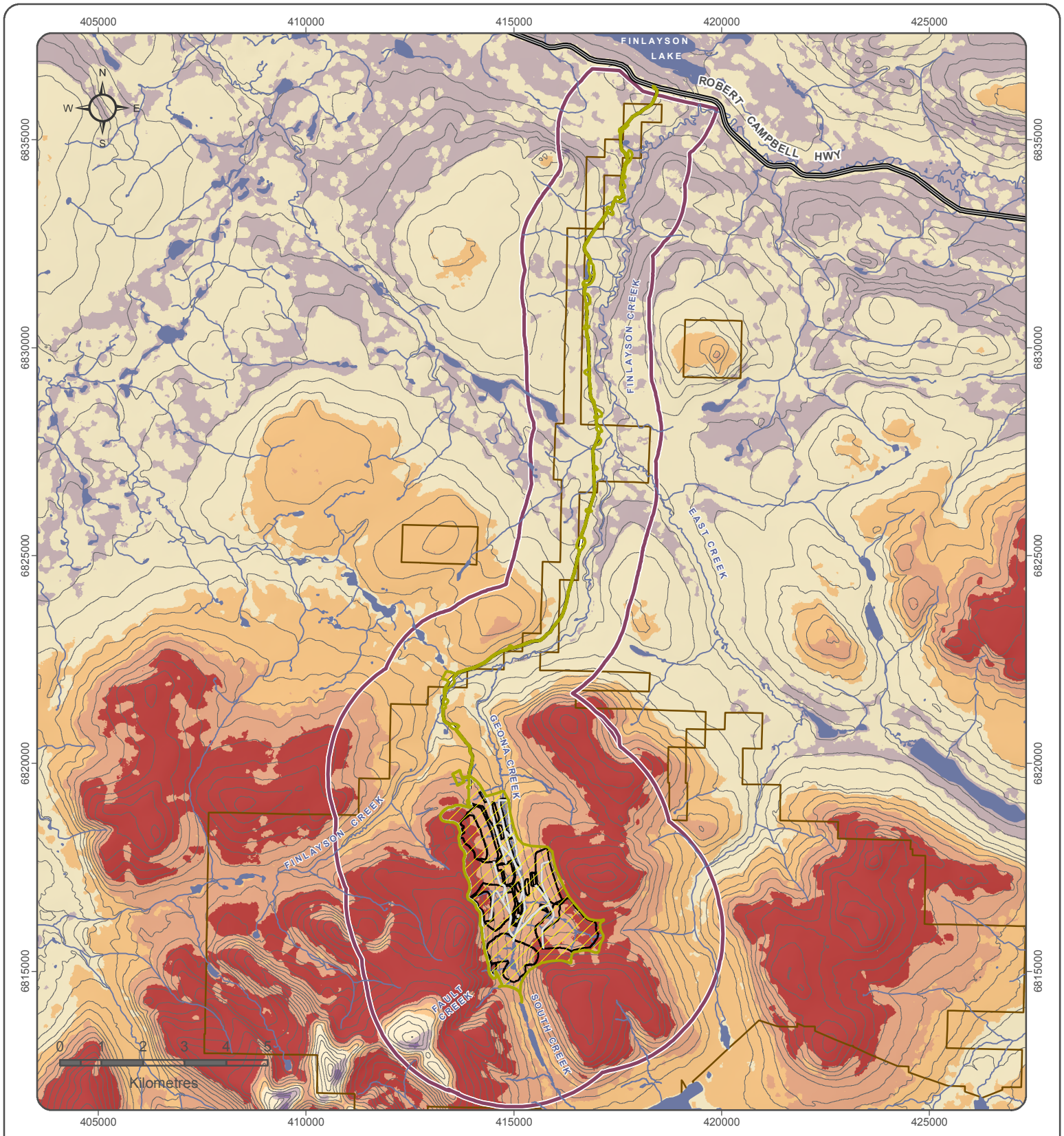

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Direct Disturbance Area
- Local Study Area (Indirect Zone of Influence)
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas

KUDZ ZE KAYAH PROJECT

FIGURE 13-9

FINLAYSON CARIBOU HERD RUT HABITAT SUITABILITY: LOCAL STUDY AREA AND PROJECT MINE FOOTPRINT

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AEG

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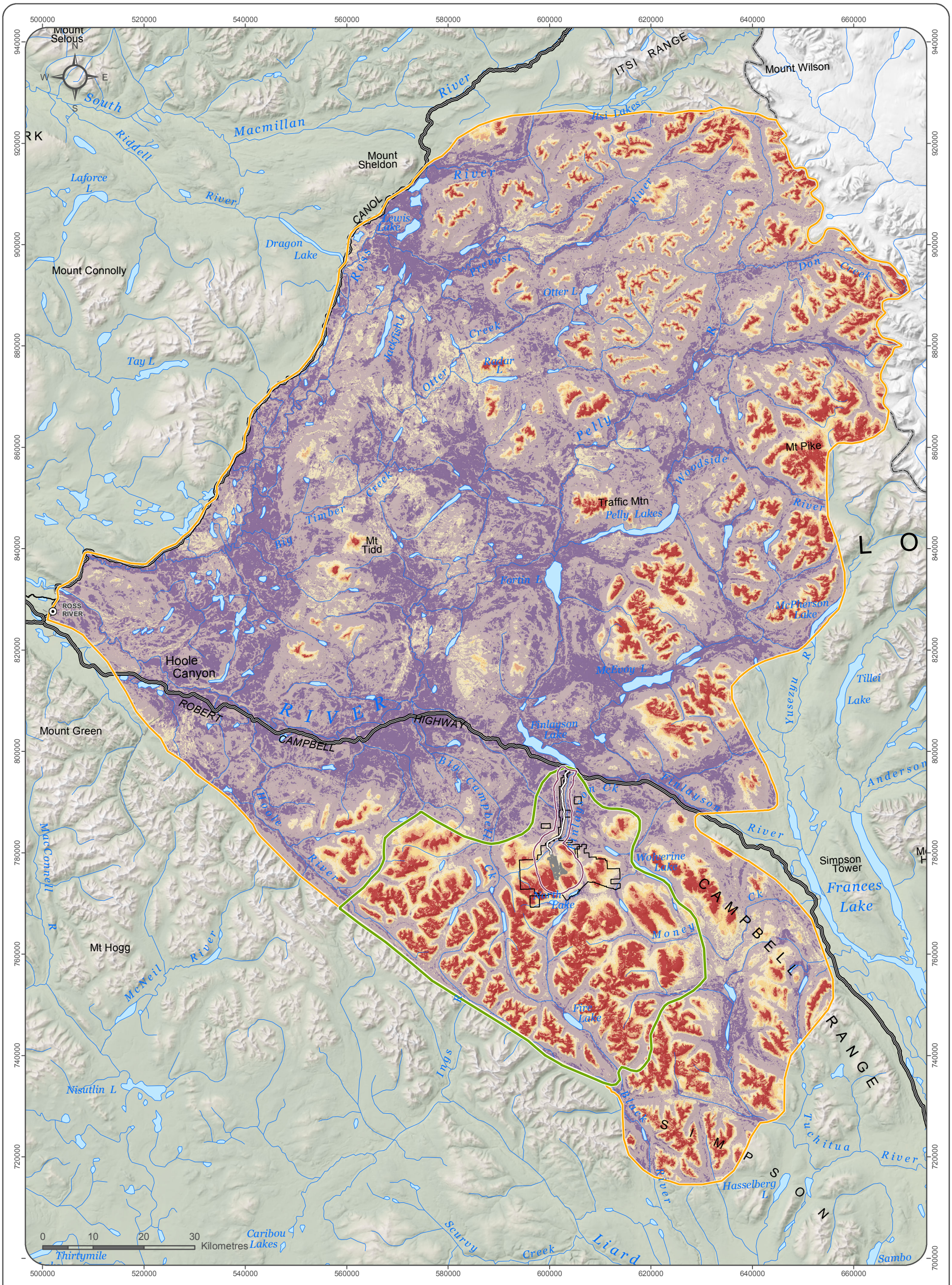

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area (Indirect Zone of Influence)
- Caribou Post Calving Study Area
- Finlayson Caribou Herd Home Range
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Mine Infrastructure

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FIGURE 13-10

FINLAYSON CARIBOU HERD POST CALVING HABITAT SUITABILITY HOME RANGE AND STUDY AREA

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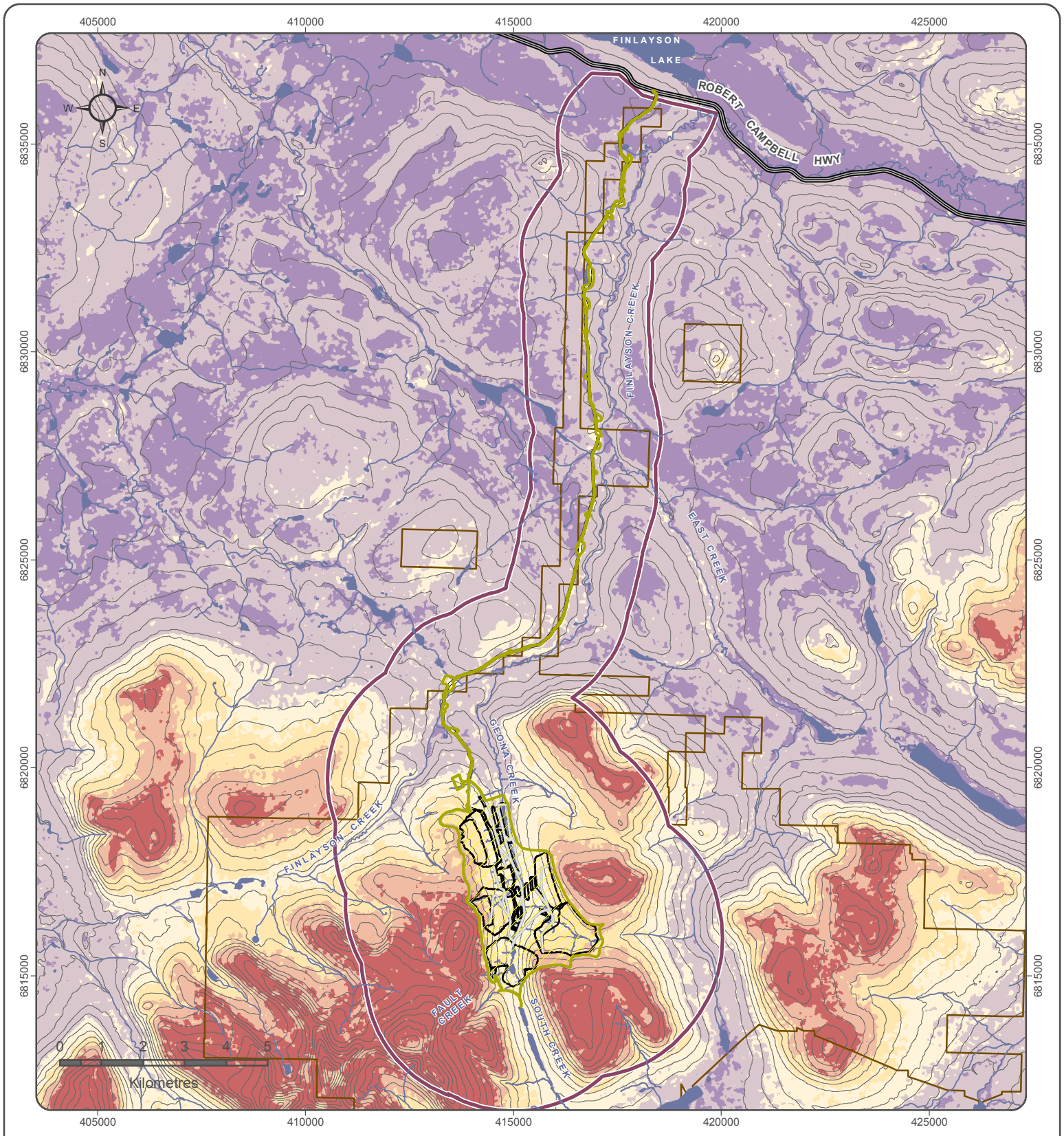

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Direct Disturbance Area
- Local Study Area (Indirect Zone of Influence)
- Location of Proposed Mine Infrastructure BMC
- Minerals (No.1) Ltd. Mineral Claim Areas

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FIGURE 13-11

FINLAYSON CARIBOU HERD POST CALVING HABITAT SUITABILITY LOCAL STUDY AREA AND PROPOSED MINE FOOTPRINT

JANUARY 2017

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Movement Patterns

The Project has the potential to affect caribou movement when caribou move between wintering grounds in the Pelly River lowlands and the subalpine and spring to fall alpine areas for calving, post calving, and rutting. Conserving and protecting key caribou habitat (i.e., rutting areas, migration corridors, and winter range) is crucial to herd health and abundance. Otherwise, disturbance from human activities can lead to range abandonment and fragmentation that can result in large scale loss of range (Nellemann et al., 2003). Movement across infrastructure may not be blocked by a physical barrier; however, it can be filtered by a physical structure or sensory disturbances (i.e., caribou are able to cross a road but do not because of stress associated with unknown stimuli). Management experience has shown that human infrastructure that greatly increases access by humans combined with herd fragmentation will lead to an eventual decline in caribou (Wittmer et al., 2005). The management implication is that access must be very carefully controlled, particularly where roads and other travel routes bisect caribou winter range or affect free movements between calving, post calving, and rutting areas. Higher densities of animals may occur in other foraging habitat when they are displaced from regular forage grounds (Vistnes and Nellemann, 2001).

Direct Mortality

Direct mortality risk on caribou resulting from the Project may occur due to increased traffic on the Access Road and Robert Campbell Highway. The period of highest risk from traffic is when caribou are moving from the rutting grounds at the south end of the Project to the wintering habitat near the Pelly River lowlands. Traffic-related mortality is described further in the sections on moose below.

Although hunting pressure can be a potential impact from access roads, an increase in mortality from hunting is not expected to occur in the Project area, since hunting is not permitted by mine staff, use of the Access Road is controlled at the gatehouse during construction and operations, and decommissioning of the Access Road will occur once reclamation is complete. Mortality can occur from incidents with Project infrastructure. There is potential for entrapment in facilities such as HDPE lined ponds, snowbanks, or the ABM lake at closure. In addition, direct mortality can be caused from drowning (if ice on ponds is too thin or suspended on managed ponds), blunders into trenches or holes, and entanglements with wire fences.

Mitigation measures for these effects include BMC's no hunting policy, traffic controls, access control, emergency egress, snow management, and barriers as presented in Section 13.4.2 mitigations and the Wildlife Protection Plan in Section 18.7.

Health Effects

Health of caribou has the potential to be affected from mine contaminants. Potential exposure pathways include ingesting water from the Operations Water Management Ponds, treatment ponds, or ABM lake at closure, or from ingesting plants that may have increased metal concentrations from accumulation or deposition. The likelihood for metals to transfer from vegetation to animals will be limited by dust control measures, wildlife access barriers, and water control and treatment programs.

Wildlife is unlikely to access the water collection ponds or water management ponds as they will be fenced. In addition, the water quality of the ponds is predicted to meet the livestock drinking water guidelines with the exception of the Class A and Class B Storage Facilities collection ponds, which may have some elevated metals. The ABM lake will be batch treated if necessary after closure to maintain water quality within acceptable guidelines for wildlife protection. Refer to Chapter 8 for more information regarding predicted water quality.

Aircraft Overflights

Use of the Finlayson Lake airstrip has the potential to cause ongoing disturbance to caribou and will require choosing appropriate takeoff and landing flight paths to minimize disturbance.

Exposure to chronic jet aircraft overflights has been correlated with shorter resting bouts in the post calving and insect seasons and increased daily movements of caribou in the post calving season (White et al., 1993; Maier, 1996; Maier et al., 1998). Harrington and Veitch (1992) and Harrington (2003) concluded that frequent overflights by low-level military jets can negatively affect calf survival. Most researchers studying the effects of aircraft overflights on caribou have suggested that female caribou with young calves are more reactive to aircraft overflights than caribou of other sex and age categories and that mitigation is particularly important in the calving and post calving seasons (Miller and Gunn, 1979; Harrington and Vietch, 1992; White et al., 1993; Maier et al., 1998). In contrast, Davis et al. (1985) concluded that caribou of the Delta Caribou Herd in Alaska were habituated to aircraft overflights, including military jets and civilian aircraft, and showed no evidence of long-term population effects from frequent aircraft activity. Further, acute responses of caribou in the Delta herd exposed to military jet overflights were mild in 49% of caribou showing no overt behavioral response and only 13% moving in response to an overflight (White et al., 1993).

Knowing there are statistically significant changes in behavior does necessarily imply that they are biologically significant. For population level effects to occur, natural adult mortality would have to increase and/or calf recruitment decrease. A possible scenario for this effect would be increased predation, particularly on newborn calves, due to displacement of animals from preferred habitats such as calving areas. Another possibility is energetic stress due to disturbance to suboptimal habitats or increased energy expenditure. Even though caribou are at low density they are likely to withdraw from industrial development activities. Whether they have to move and whether their fitness is compromised is speculative. If mortality factors such as wolf predation and hunting are managed, caribou may be able to co-exist with well-managed developments.

A landscape that is undergoing changes from both climatic and human-mediated factors requires an understanding of these dynamics that is essential to the conservation and management of these populations.

13.4.1.2 Moose

Project Interactions

Potential effects on moose include direct and indirect habitat loss, disruption of movement corridors, direct mortality, and health effects from stressors and environmental contaminants. These are discussed below and quantified where practicable.

The baseline surveys and historical information for moose populations in the Project area, indicate that moose utilize the LSA and surrounding region for all life stages. The most likely Project effect on moose in the LSA will be habitat loss. Other Project effects may be disruption of movement patterns through key late winter habitats; mainly around Finlayson Creek, Geona Creek, and the Access Road.

Winter habitat for moose has also been identified as important in the TK studies of the Kaska. Based on TK, snow depth is a limiting factor on the availability of winter habitat in that deeper snow reduces access to forage, limits movement, and makes them more susceptible to predation (Dena Kayeh Institute, 2010). Traditional knowledge also indicates the importance of winter habitat is determined where wildlife is loyal to a specific area (Dena Kayeh Institute, 2010). In this case moose are known to be loyal to the wintering area around the lowlands of Finlayson Lake as indicated by the WKA and distribution seen in the late winter surveys (Figure 13-4).

Habitat Suitability

As part of the baseline studies, post rut and late winter surveys were conducted to assess moose distribution patterns and abundance in the Project area. As additional support to the baseline studies, a habitat suitability model utilizing elevation, slope, aspect, and vegetation cover variables was prepared to predict the location of moose post rut and late winter habitat in the RSA and LSA (Appendix E-8). The classes in each variable were ranked based on their significance for moose during the specific season. Significance of each class was determined using existing site-specific observations of moose, expert opinion, and other moose habitat suitability models.

Approximately 47% (876 km^2) of the RSA is moderately high to high suitability post rut moose habitat (Figure 13-12). Approximately 69% (1,295 km^2) of the RSA is moderately high to high suitability late winter moose habitat (Figure 13-13). Of the moderately high to high suitability post rut moose habitat, approximately 1% (9.4 km^2) will be directly affected, and 15.58% (63 km^2) could be indirectly affected by the Project. Of the moderately high to high suitability late winter moose habitat, approximately 2.0% (8.4 km^2) will be directly affected, and 11.76% (83 km^2) could be indirectly affected by the Project.

Table 13-10 and Table 13-11 present habitat suitability for moose during the post rut and the late winter, respectively.

Table 13-12 presents a condensed summary of estimated moose habitat loss at maximum disturbance during operations. Project development is estimated to result in a direct and indirect loss of 4.7% of moderately high and high suitability moose post rut habitat in GMS 10-07. Similarly, Project development is estimated to result in a direct and indirect loss of 3.8% of moderately high

and high suitability late winter habitat in GMS 10-07. Reclamation at closure will replace moose habitat as presented in the mitigation summary in Section 13.4.2.

Table 13-10: Moose Post Rut Habitat Suitability Effects

Moose Habitat Suitability Index Regional Study Area (GMS 10-07)			
Habitat Suitability Index*	Number of Cells**	Area (ha)	Percent of RSA (%)
Nil	95,594	5,975	3%
Very Low	157,320	9,833	5%
Low	695,972	43,498	23%
Moderate	656,402	41,025	22%
Moderately High	830,800	51,925	28%
High	570,373	35,648	19%
Suitable Moose Habitat in LSA			
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of RSA (HSI)
Nil	1,680	105	2%
Very Low	3,822	239	2%
Low	43,437	2,715	6%
Moderate	30,952	1,935	5%
Moderately High	39,389	2,462	5%
High	61,846	3,865	11%
Directly Affected Suitable Moose Habitat from Project Feature Footprint			
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of RSA (HSI)
Very Low	174	11	0%
Low	586	37	0%
Moderate	206	13	0%
Moderately High	2,168	136	0%
High	12,799	800	2%

* Classifications of nil, very low and low are not located in the Project footprint

** Cell size 25 m x 25 m (625 m^2)

Table 13-11: Moose Late Winter Habitat Suitability Effects

Moose Habitat Suitability Index Regional Study Area (GMS 10-07)			
Habitat Suitability Index*	Number of Cells**	Area (ha)	Percent of RSA (%)
Nil	205,832	12,865	7%
Very Low	290,488	18,156	10%
Low	202,072	12,630	7%
Moderate	235,275	14,705	8%
Moderately High	592,723	37,045	20%
High	1,480,071	92,504	49%

Suitable Moose Habitat in LSA			
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of RSA (HSI)
Nil	1,176	74	1%
Very Low	15,124	945	5%
Low	14,958	935	7%
Moderate	17,042	1,065	7%
Moderately High	27,540	1,721	5%
High	105,286	6,580	7%
Directly Affected Suitable Moose Habitat from Project Feature Footprint			
Habitat Suitability Index	Number of Cells	Area (ha)	Percent of RSA (HSI)
Nil	4	0	
Very Low	76	5	0%
Low	335	21	0%
Moderate	2,133	133	0%
Moderately High	6,846	428	1%
High	6,539	409	1%

* Classifications of nil, very low and low are not located in the Project footprint

** Cell size 25 m x 25 m (625 m^2)

Table 13-12: Summary of Moose Habitat Loss

Suitability Ranking	Baseline Conditions for RSA[1] (km^2)	Direct Habitat Loss in Project Footprint[2] (km^2)	Indirect Habitat Loss in LSA[3] (km^2)	Total Habitat Change in RSA[4] (%)
Post rut Habitat of Moderately High and High Suitability	875	9.4	63.3	-4.7%
Late Winter Habitat of Moderately High and High Suitability	1,295	8.4	83.0	-3.8%

[1] Amount of habitat prior to any construction in the RSA

[2] Area of direct habitat lost to the Project Footprint, including Access Road

[3] Area of indirect habitat lost located in the LSA

[4] Percent change after direct and 50% of indirect habitat loss

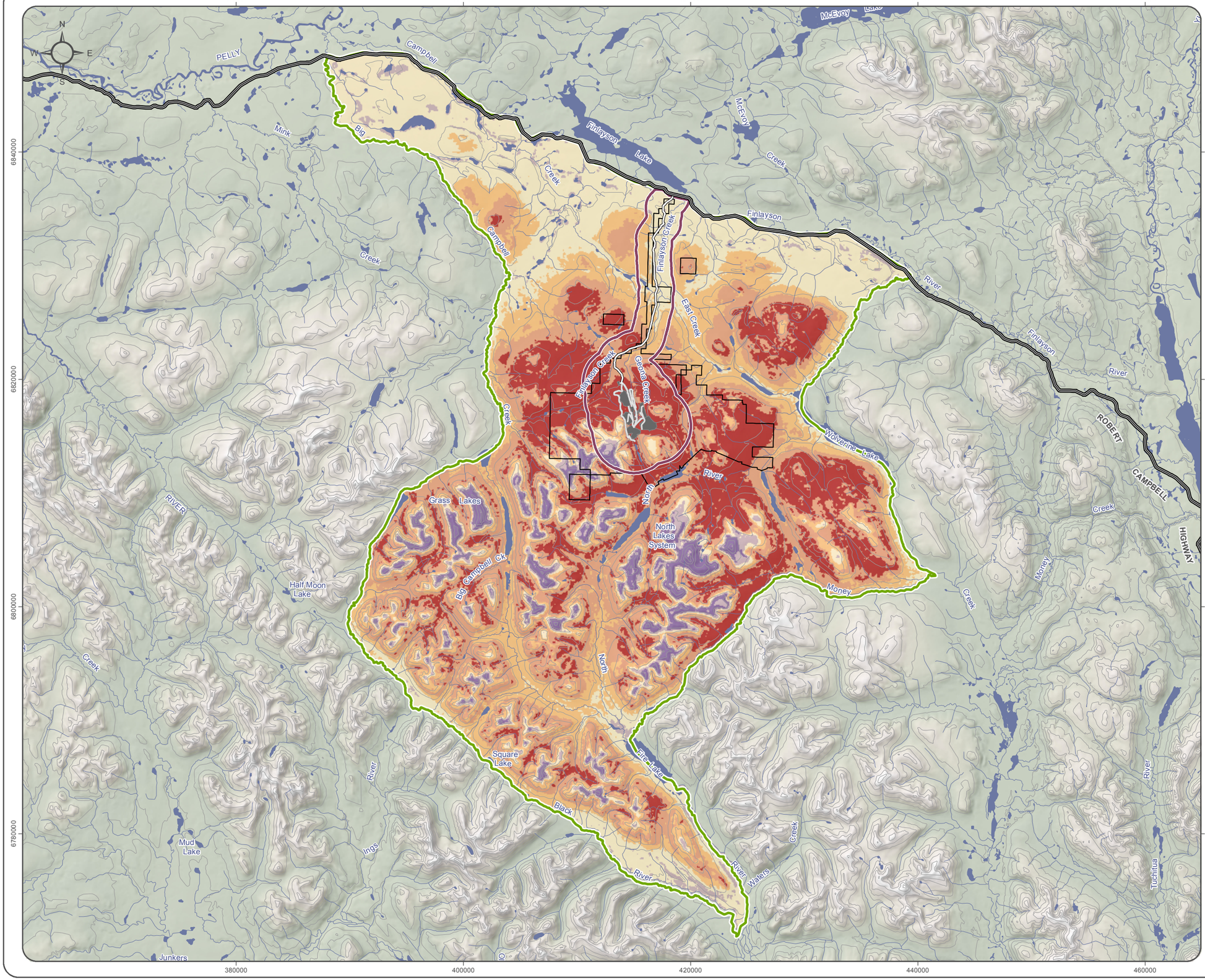

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FIGURE 13-12
MOOSE POST RUT HABITAT SUITABILITY

JANUARY 2017

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area
- Regional Study Area (Game Management Subzone 10-07)
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Robert Campbell Highway
- Watercourse
- Waterbody

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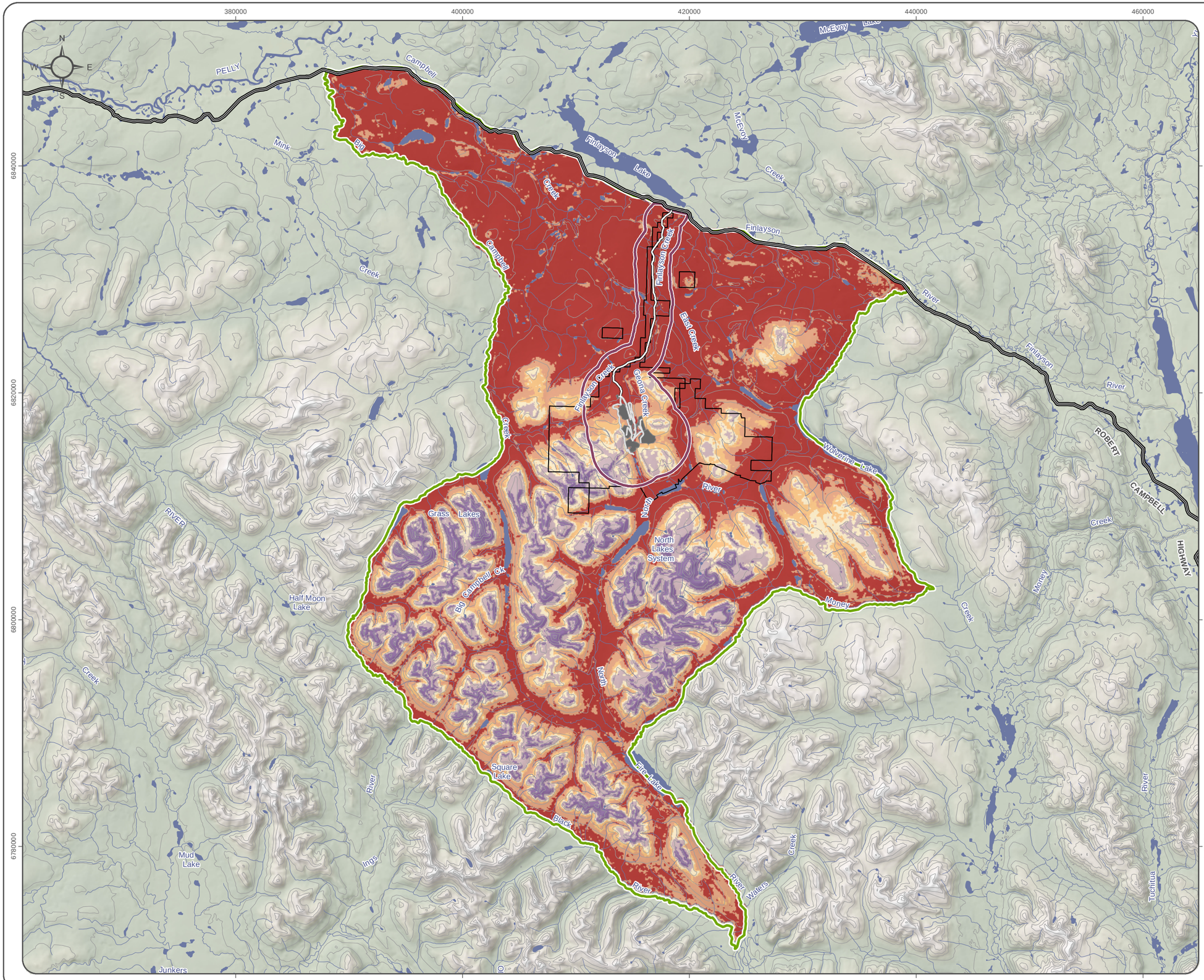

KUDZ ZE KAYAH PROJECT

FIGURE 13-13
MOOSE LATE WINTER HABITAT SUITABILITY

JANUARY 2017

HABITAT SUITABILITY INDEX

- Nil
- Very Low
- Low
- Moderate
- Moderately High
- High

- Local Study Area
- Regional Study Area (Game Management Subzone 10-07)
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Tote Road/Proposed Access Road
- Proposed Mine Road
- Robert Campbell Highway
- Watercourse
- Waterbody

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Movement Patterns

Moose wintering habitat in the region is located mainly north of the proposed mine from Geona Creek and throughout the boreal high zone around Finlayson Lake. Moose wintering is mapped as a WKA that overlaps the Access Road (Figure 13-4). As such, the increased road traffic associated with construction, operations, and closure is expected to create a partial movement barrier for ungulates ranging on winter grounds. Moose are known to avoid roads resulting in habitat loss and fragmentation (Neumann, 2009).

Direct Mortality

Increased road traffic associated with Project construction, operations, and closure has the potential to result in direct mortality. Moose are also prone to fall into deep man-made depressions, break through thin ice and drown, get trapped in debris, and die from other human caused mishaps. These potential direct mortality effects are described in more detail in the following sections.

An increase in mortality from hunting is not expected to occur since hunting is not permitted by mine staff, use of the Access Road is controlled at the gatehouse during construction and operations, and decommissioning of the Access Road will occur once reclamation is complete and no further water quality monitoring is required. These mitigations are presented further in Section 13.4.2 and in the Traffic and Access Management Plan in Section 18.12.

Collisions on Transportation Corridors

Construction and use of access roads are an essential infrastructure and activity component of the Project. Human transportation corridors alter habitat components and often bisect moose migration and daily travel routes. In winter and spring, roads may alter travel routes for moose and provide a mix of preferred forage species. Because roads provide edge habitat (new-growth browse) associated with other naturally disturbed habitat types sought out by moose (i.e., glaciated landforms, riparian habitats and burns) they form a 'trap' and induce a high collision risk with vehicles and have the potential to present a direct mortality risk as well as a human safety risk (Grenier, 1973; Child and Stuart, 1987; Child et al., 1991; Del Frate and Sparker, 1991; McDonald, 1991; Oosenbrug et al., 1991; Schwartz and Bartley, 1991).

Moose-vehicle collisions occur most frequently at dawn and dusk; under conditions of low visibility; on straight and relatively flat stretches of road; at vehicle speed in excess of 80 km/hr; and, because of driver inattention (Stuart, 1984; Del Frate and Sparker, 1991). The number of collisions increases during autumn and early winter and peaks in January and February. Roadway salting, high traffic volume and speed, and deep snow conditions exacerbate the problem (Child et al., 1991). Note that roadway salting will not be used at KZK. In particular, deep snowpack conditions and compacted roadway shoulders ploughed high form a barrier and can 'fence' moose onto roads and encourage them to travel the ploughed roadway as they seek a travel route of least resistance. Mitigations include constructing regular breaks in snowbanks to prevent fencing. When confronted with a threat, moose often flee by running along the roadway rather than escaping through deep snow. At night, some moose are "hypnotized" in the glare of vehicle headlights negating their normal flight response (Rausch, 1956).

Drowning

Drowning is a major cause of moose deaths during early spring and late winter as a result of falling through thin or 'rotting' ice on lakes, streams, ponds, reservoirs, and tailing ponds (Peterson, 1955). Moose may subsequently become weakened by fatigue in cold waters, succumb to hypothermia and drown. While drowning is a natural cause of incidental mortality to moose, the Project will prevent this by including design measures such as emergency egress routes and wildlife barriers where risks exist. Mitigations are presented in Section 13.4.2 and the Wildlife Protection Plan outlined in Section 18.7.

Blunders

Large depressions from open pit mining, exploration trenching, and borrow pits can claim the lives of moose that fall into these excavations. Fencing, wildlife barriers and progressive reclamation will be used at the Project to prevent these features from becoming a risk to moose survival. Mitigations are presented in Section 13.4.2 and the Wildlife Protection Plan outlined in Section 18.7.

Entanglements

Moose can become 'snared' in discarded cordage, cables, wires, and rope, and die because of exhaustion, strangulation, and/or injuries sustained in the struggle to free themselves. Wire fencing offers a particular hazard and will be avoided at the Project.

Health Effects

Health of moose has the potential to be affected from mine contaminants. Potential exposure pathways include ingesting water from the Operations Water Management Ponds, treatment ponds, or ABM lake at closure, or from ingesting plants that may have increased metal concentrations from accumulation or deposition. The likelihood for metals to transfer from vegetation to animals will be limited by dust control measures, wildlife access barriers, and water control and treatment programs.

The pathway for metals to increase in vegetation and then to animals will be limited by dust control measures and by water control and treatment programs. At closure, there is some risk of metal uptake from vegetation in the constructed wetlands. For the most part, the metals will adsorb to the wetland sediments, but moose may ingest some of the sediments when browsing on aquatic plants. However, the risk that moose would consume sufficient quantities of sediments to pose negative health effects is considered low.

Wildlife is unlikely to access the Water Collection Ponds or Water Management Ponds as they will be fenced, as well as a general deterrence from general human and equipment activity around the ponds. The risk from access to these ponds may increase in the closure phase when there is less activity in Project area. The water quality in the ponds is predicted to meet the livestock drinking water guidelines with the exception of the Class A and Class B Storage Facilities collection ponds, which may have some elevated metals. The ABM lake will be batch treated if necessary after closure to

maintain water quality within acceptable guidelines for wildlife protection. Refer to Chapter 8 for more information about predicted water quality.

Aircraft Overflights

Scheduled flights to the Finlayson Lake airstrip could have effects on moose in wintering grounds near Finlayson Lake. Potential population effects from continued disturbance from flights are similar to those described for caribou.

13.4.1.3 Grizzly Bear

Project Interactions

Grizzly bear are known to inhabit the Geona Creek and Finlayson Creek valleys for feeding. They are also known to den in the mountains that start at the southern portion of the LSA (Appendix E-8). Project interactions with grizzly bears are expected from loss of feeding habitat, potential disturbance to denning habitat, indirect disturbance of habitat from Project activities, risk of mortality from human-bear encounters and collisions with traffic, and potential effects on bear health from contaminants. These potential effects are described in the following sections.

Habitat Suitability

Key life phases for grizzly bear are the growing and feeding seasons from spring through fall, and denning for hibernation through the winter.

Denning habitat is considered primary habitat for grizzly bear (Nielsen et al., 2006). Therefore, the assessment focussed on denning habitat and was limited to the area of highly suitable habitat in the RSA. This habitat is described in more detail in Appendix E-8. The area of high, moderate, and low suitability denning habitat at baseline conditions, as well as the area of direct and indirect denning habitat loss were quantified to determine the percentage of total denning habitat loss for each suitability ranking in the GMA 10-07 (Table 13-13). Figure 13-14 shows the habitat suitability in relation to the Project Footprint used to quantify habitat changes.

Table 13-13: Change in Grizzly Bear Denning Habitat Due to Project Effects in the RSA

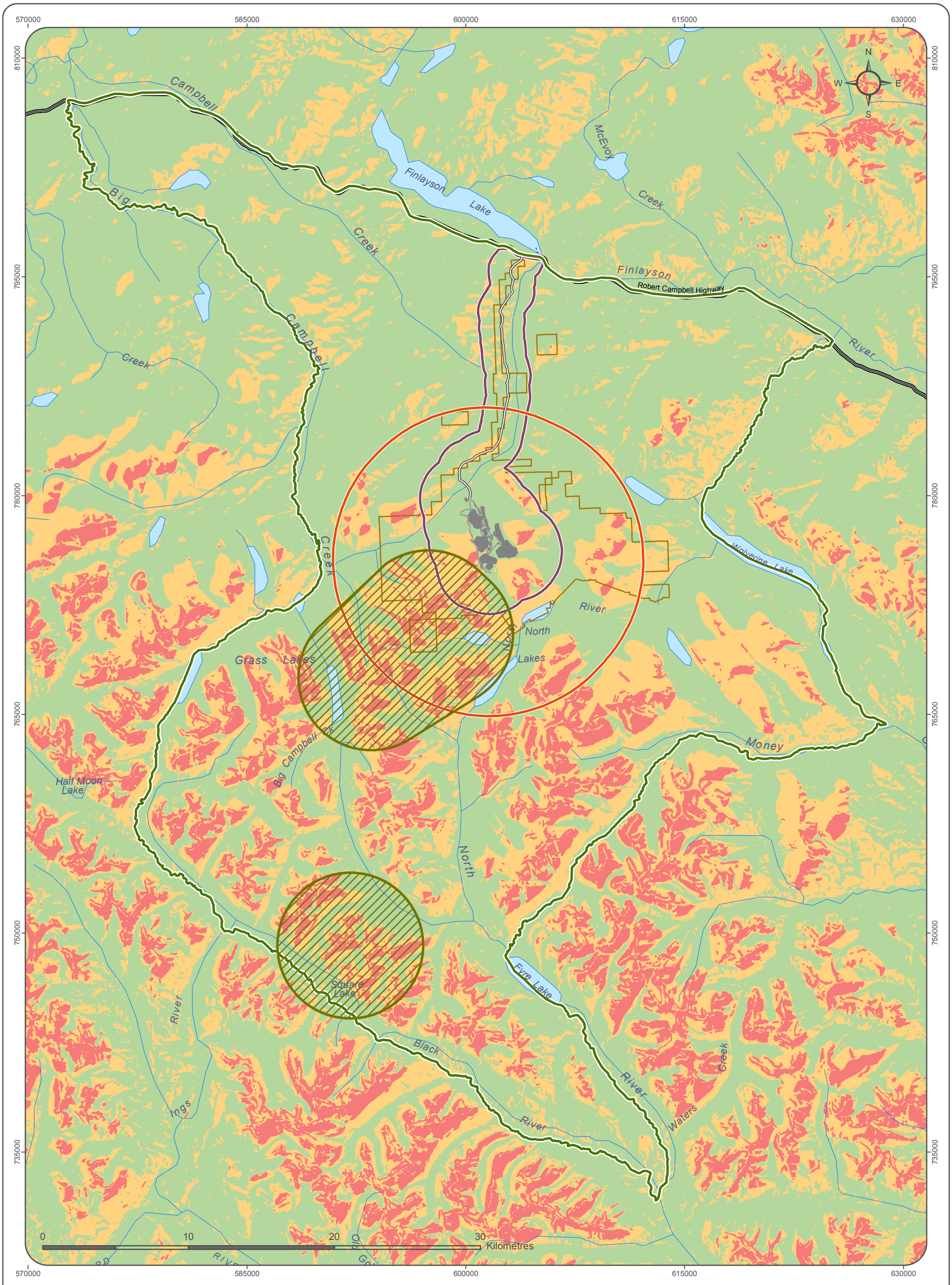
Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
High	191.61	0.04	4.90	-1
Moderate	586.88	1.89	40.18	-4
Low	1,114.06	8.02	69.46	-4

[1] Amount of habitat prior to any construction

[2] Area of habitat lost to the Project Footprint, including Access Road

[3] Area of habitat lost located with a 300 m buffer around the Project Footprint and Access Road

[4] Percent change after direct and 50% of indirect habitat loss



Grizzly Bear Denning Suitability

- Low
- Medium
- High

- Area in which 3 bear dens have been located
- Regional Study Area (Game Management Subzone 10-07)
- Local Study Area
- Bear Den Study Area

- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Mine Road

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FIGURE 13-4
GRIZZLY DENNING HABITAT SUITABILITY

JANUARY 2017

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Habitat suitability mapping was completed for denning habitat in the RSA; however, mapping was not completed for growing habitat for spring, summer, and fall since data for the required suitability criteria were not available from the regional Predictive Ecosystem Mapping, and there is insufficient information on grizzly bear distribution and habitat use in the RSA to validate the model. Grizzly bear are omnivores eating plants, berries, small mammals, and ungulates, feeding in valley bottoms and valley slopes ranging from the boreal forest to subalpine and alpine areas. To approximate the magnitude of feeding habitat effects, the Project Footprint was assumed to be all highly suitable feeding habitat for grizzly bear and the area of the Project Footprint was assumed to be lost and then taken as a proportion of the RSA to determine the percentage of habitat lost. Lost feeding habitat was assumed to total 67.1 km^2, including the Project Footprint as direct feeding habitat lost (9.8 km^2), plus an assumed indirect lost feeding habitat at 50% of the remaining area in the LSA (57.3 km^2). This total equates to 3% of the total area of the RSA, or 7% of the RSA when high suitability denning habitat is removed.

Direct Mortality

Grizzly bear mortality occurs from permitted hunting, controlled killings from threats to humans, self-defence, or poaching (McLellan et al., 1999). Hunting mortality is not expected to increase since access is controlled at the gatehouse and the Access Road will be decommissioned to prevent access once reclamation is complete. The risk of mortality to grizzly bears at the Project would most likely be from threats to staff and contractors caused by attractants such as garbage and chemicals.

Health Effects

Health of grizzly bear has the potential to be affected from mine contaminants. Potential exposure pathways include ingesting water from the Operations Water Management Ponds, treatment ponds, or ABM lake at closure, or from ingesting plants that may have increased metal concentrations from accumulation or deposition. The likelihood for metals to transfer from vegetation to animals will be limited by dust control measures, wildlife barriers, and water control and treatment programs.

Wildlife are unlikely to access the treatment ponds on a regular basis due to fencing around ponds with unsuitable water quality, as well as a general deterrence from general human and equipment activity around the ponds. The risk from access to these ponds may increase in the closure phase when there is less activity in Project area. The water quality of the ponds is predicted to meet the livestock drinking water guidelines with the exception of the Class A and Class B Storage Facilities collection ponds, which may have some elevated metals. The ABM lake will be batch treated if necessary after closure to maintain water quality within acceptable guidelines for wildlife protection. Refer to Chapter 8 for more information about predicted water quality.

13.4.1.4 Grey Wolf

Project Interactions

Wolves are expected to be affected by the Project as a result of loss of habitat for and displacement of ungulates (i.e., prey availability) in addition to direct mortality.

Prey Availability

Modelling of predation rates by wolves on moose in the Finlayson area by Hayes and Harestad (2000) indicate that moose densities are reduced from the potential habitat capacity by wolf prey rates. This link was corroborated by the increased moose and caribou populations following the wolf control program from 1983 to 1989 (Farnell et al., 2008). Therefore, caribou and moose habitat effects were used to determine the effects from the Project on the wolf populations.

It is projected that wolf packs will follow ungulate distributions, resulting in an equal amount of loss to wolves as there are to the combined effect on moose and caribou populations. The habitat loss estimates were ranged from 1.8% for caribou post calving habitat to 3% for caribou rut habitat, and from 3.8% for moose late winter habitat to 4.7% for moose post rut habitat.

It should be noted that Project effects will only influence local wolf packs as they are territorial with a range of 1,000 km^2 on average Yukon-wide. They do not migrate with prey populations.

Direct Mortality

Increased road traffic associated with Project construction, operations, and closure has the potential to result in direct mortality.

Health Effects

Health of wolves has the potential to be affected from mine contaminants; however, contaminant release will be avoided by implementing appropriate waste, water, and emission controls as presented in Section 13.4.2 and the conceptual management plans in Chapter 18.

13.4.1.5 Wolverine

Project Interactions

Although minimal observational data exists for wolverine in the LSA and RSA, incidental observations of wolverine have been recorded. Wolverine were observed in alpine areas, as well as subalpine habitat along the Access Road. Since wolverine are reclusive animals that require large, undisturbed tracts of wilderness (Rowland et al., 2003), habitat loss from site preparation and land clearing for Project infrastructure, and indirect loss of suitable habitat due to sensory disturbance (noise, visual, physical disturbance) will likely be the most substantial Project effect on this species. Additional Project effects on wolverine may occur due to direct mortality from vehicle collisions. Project activities that are likely to interact with wolverine and produce a Project effect are construction of the ABM open pit in the upper Geona Creek valley, construction of the Class A, B and C Storage Facilities, construction of the Overburden Stockpile, construction of new roads in the LSA, and an increase in traffic intensity on already existing roads.

Habitat Suitability

Habitat loss may act as a barrier to wolverine movement throughout the LSA due to this species reclusive behaviour and requirement for undisturbed tracts of wilderness. An increasing amount of

human activity and disturbance in their home range are likely to cause changes to their movement patterns to maintain their secretive behaviour. The creation of new roads in the LSA is going to occur and is likely to have Project effects on wolverine distribution and abundance. Road density and human population density have been identified as effective measurable parameters to predict Project effects on wolverine movement patterns and ultimately, abundance. To evaluate Project effects on wolverine, the maximum projected road density in the LSA was quantified and compared to a defined threshold.

The measurable parameter for the effect of direct disturbance on wolverine was road density (km/km^2). A road density of 0.6 km/km^2 has been identified as an apparent threshold value above which natural populations of certain large vertebrates decline (Beazley et al., 2004). A wolverine-specific threshold value of 0.63 km/km^2 was identified in Beazley et al. (2004) for reduced habitat security and increased mortality. Furthermore, a study by Rowland et al. (2003) reported three levels of road density for effectively predicting observations of wolverine. The three classes were reported at the following scale: low is less than or equal to 0.44 km/km^2; moderate is 0.44 to 1.06 km/km^2; high is greater than 1.06 km/km^2.

Direct Mortality

Direct mortalities of wolverine from vehicle collisions may occur but are likely to be rare due to this species reclusive behaviour and large home range. For example, only 12 known wolverine deaths in Ontario have resulted from vehicle collisions, from 1990 to 2013 (Ontario Wolverine Recovery Team, 2013). Furthermore, a synthesis of studies by Krebs et al. (2004) investigated wolverine survival rates and causes of mortality in North American wolverine. Data from 12 studies were synthesized and found among 239 wolverines that were radio-marked and monitored, only three were killed by vehicle collisions (i.e., road-rail).

Health Effects

Health of wolverine has the potential to be affected from mine contaminants; however, contaminant release will be avoided by implementing appropriate waste, water, and emission controls as presented in Section 13.4.2 and the management plans in Section 18.

13.4.1.6 Collared Pika

Project Interactions

Suitable habitat for collared pika consists of a naturally patchy landscape containing isolated talus deposits separated by expanses of alpine meadows (Franken and Hik, 2004). Pika are territorial animals that have small home ranges and do not venture far from talus patches; therefore, movements between talus patches are infrequent. Franken and Hik (2004) found that pika rarely move more than 6 m from the edge of the talus patch to forage due to the threat of predation. Therefore, effects to pika are only likely to occur for Project activities occurring in alpine habitat that contain talus deposits.

The most likely Project effect on collared pika is loss of habitat. Direct loss of habitat may occur from site preparation and land clearing during the construction phase, as well as road construction and

upgrades. In addition, the effectiveness of suitable habitat may be compromised due to sensory disturbances from increased noise, visuals, dust, and overall human presence and will be considered an indirect loss of habitat. Loss of habitat due to Project activities are expected to be minimal as most land clearing will occur in the subalpine, which is suboptimal pika habitat.

Project infrastructure that may interact with collared pika include construction of the ABM open pit in the upper Geona Creek valley, and construction of the Class A and B Storage Facilities. The Access Road north of camp will not interact with suitable pika habitat as it occurs in boreal forest.

Project infrastructure will not occur in suitable pika habitat, and as a result should not fragment pika habitat or create a barrier to pika movement. Likewise, road collisions with collared pika are unlikely due to the lack of overlap of Project infrastructure with suitable pika habitat. Even if roads were placed in suitable pika habitat, collisions would be unlikely because pika rarely expose themselves for fear of predation.

Multiple pika may inhabit an area of suitable habitat, given their small home range and limited habitat opportunities. Potential Project effects to pika colonies are expected to be similar to individuals. Given that Project infrastructure avoids suitable pika habitat, effects will be minimal to both individuals and colonies. If Project infrastructure does remove pika habitat, more than one pika will likely be affected.

Habitat Suitability

Assessment of Project effects on collared pika was based on quantifying potential loss of suitable habitat due to site preparation and land clearing. Suitable habitat was classified as high, moderate, and low. The measurable parameter for this effect was area (km^2) of highly suitable habitat. Highly suitable pika habitat was defined as alpine habitat (greater than 1,550 masl) that contained talus slopes adjacent to alpine meadow ecosystems dominated by Carex sp. Moderately suitable pika habitat was defined as alpine habitat that contained talus slopes but was not in association with alpine meadow ecosystems. Low suitable pika habitat was defined as all other habitat types. These suitability rankings for preferred collared pika habitat were based on the habitat description provided in the Assessment and Status Report on the Collared Pika (*Ochotona collaris*) in Canada (COSEWIC, 2011).

The evaluation of the assessment was limited to the area of highly suitable habitat in the LSA. The scope did not expand outside the LSA as Project effects are not expected to occur on pika outside the LSA. The area of high, moderate, and low suitability habitat at baseline conditions, as well as the area of direct and indirect habitat loss were quantified to determine the percentage of total habitat loss for each suitability ranking (Table 13-14). Figure 13-15 shows the habitat suitability in relation to the Project Footprint used to quantify habitat changes.

Table 13-14: Change in Collared Pika Habitat Quality Due to Project Effects in the LSA

Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
High	8.68	0.00	0.11	-0.6

Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
Moderate	0.98	0.00	0.00	0
Low	114.74	9.81	17.33	-16.1

[1] Amount of habitat prior to any construction

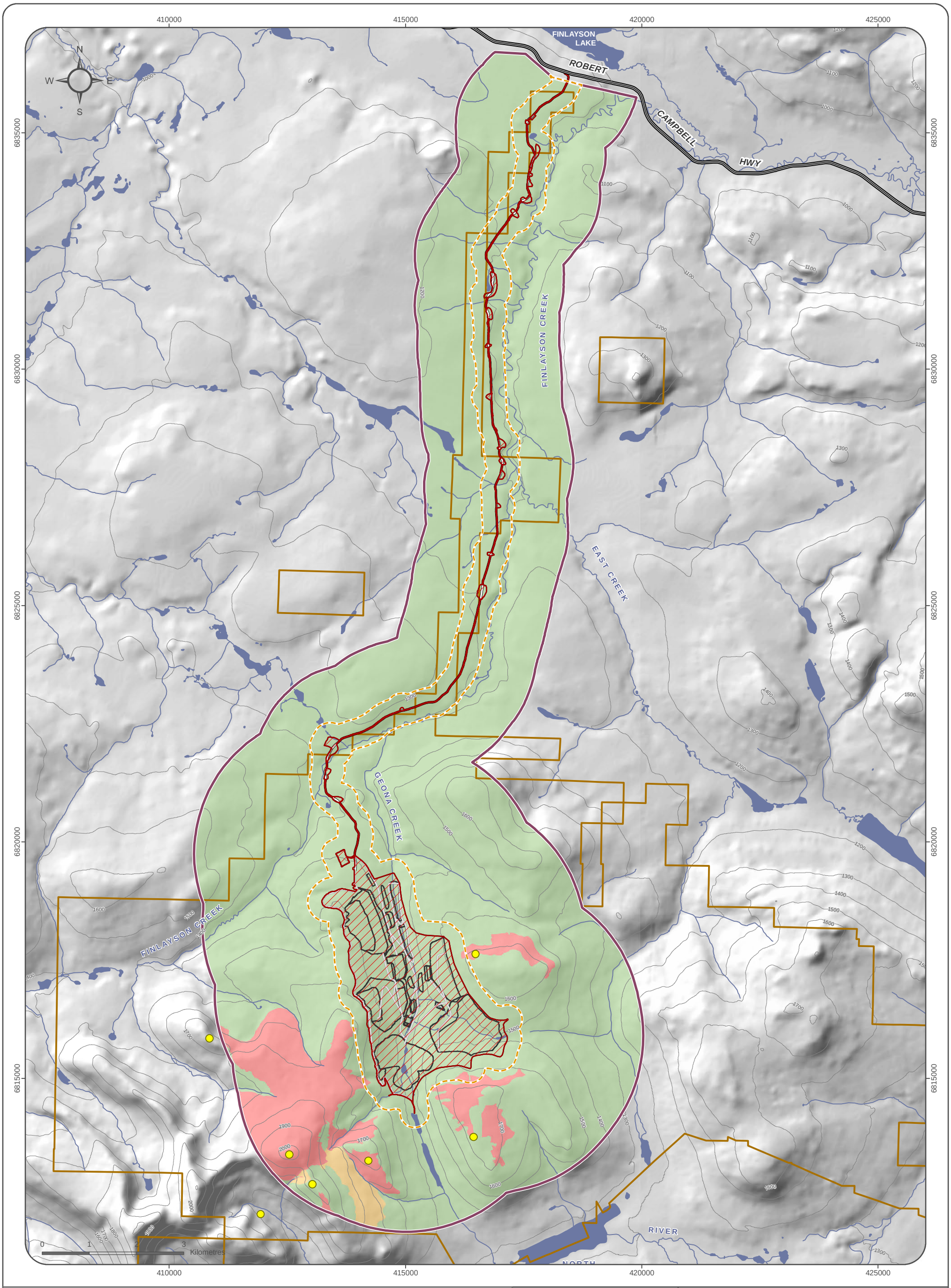
[2] Area of habitat lost to the Project Footprint, including Access Road

[3] Area of habitat lost located with a 300 m buffer around the Project Footprint and Access Road

[4] Percent change after direct and 50% of indirect habitat loss

Health Effects

Health of collared pika has the potential to be affected from mine contaminants; however, contaminant release will be avoided by implementing appropriate waste, water, and emission controls as presented in Section 13.4.2 and the conceptual management plans in Chapter 18.



Collared Pika Habitat Suitability

- High
- Moderate
- Low
- Collared Pika Observations

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (100 m interval)
- Watercourse
- Waterbody

- Local Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Indirect Disturbance Area
- Direct Disturbance Area

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FIGURE 13-15

COLLARED PIKA HABITAT SUITABILITY WITHIN LOCAL STUDY AREA

JANUARY 2017

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13.4.1.7 Bats

Project Interactions

Bat species were recorded at wetlands in mature spruce forests in the LSA, adjacent to the Tote Road. The species of bat detected in the LSA was presumed to be the little brown bat, based on their range of occurrence in Yukon (Environment Yukon, 2007). Bats were not recorded at wetlands in the subalpine habitat near the proposed Project Footprint in the upper Geona Creek valley, likely because of unsuitable habitat. The little brown bat prefers to roost and forage in mature/old growth boreal forest, adjacent to wetlands (Randall et al., 2014). Little brown bats are cavity roosters, known to roost in a wide variety of structures, including buildings, rock crevices, behind flaking bark, and in tree cavities (Slough and Jung, 2008; COSEWIC, 2013; Randall et al., 2014). Availability of suitable roost sites is a limiting factor for little brown bat abundance (COSEWIC, 2013). Project activities that cause direct and indirect habitat loss of potential roost sites will have the largest effect on the little brown bat population in the LSA; specifically, habitat loss along the Access Road corridor through mature boreal forest habitat.

The Access Road through mature boreal forest habitat already exists, but increased traffic may act as a barrier to bat movement by increasing habitat fragmentation. However, Abbott et al. (2012) investigated how road features facilitate or impede bat movements and found relatively new, four lane highways, with traffic volumes of approximately 20,000 vehicles per day, do not form absolute barriers to the movement of a range of bat species. Furthermore, Bennett et al. (2013) using simulation exercises parameterized by empirical data to document, noted as traffic volume and number of lanes increased, so did the incidence of bats exhibiting road-related avoidance behaviours. Roads with limited vehicle use and only two lanes had little or no effect on bat movement (Bennett et al., 2013). The Access Road will be a single lane road (upgraded from an existing tote road), with traffic volumes of 26 vehicles per day. Therefore, it is unlikely to form a barrier to the movement of the little brown bat.

Increased traffic along the Access Road will create additional sound that may disturb little brown bats. Bats use echolocation to navigate their environment and to search for prey. Echolocation for bats consists of emitting pulses of high frequency sound and listening for returning echoes. Differences in timing and frequency between pulses and their echoes inform bats about their surroundings (Wund, 2006; AMEC, 2014). Sound pulses used by little brown bats have a frequency of approximately 45 kHz (Fenton and Bell, 1979), which is well above the frequency of traffic or construction sound (AMEC, 2014). As a result, sound caused by Project activities is unlikely to cause adverse effects to bat navigation or hunting. Neonates (new born bats) produce calls to communicate with their mothers at the roost site (AMEC, 2014). It is unclear whether anthropogenic sound causes adverse effects on communication between mother and offspring.

Habitat Suitability

Summer habitat for bat species is characterized as foraging and roost locations, with the emphasis on roost locations. Therefore, the habitat suitability analysis for bats in the LSA was performed for potential roost site locations. Little brown bats generally roost in tall, large-diameter snags that are in the early to middle stages of decay and located in open areas in mature-old growth forest

(COSEWIC, 2013). The age of forest can be used as a coarse indicator of trends in the amount of roosting habitat and stand age appears to be more important than type of forest (COSEWIC, 2013). Although proximity to water is a known preference for bat foraging sites, it was not included as a parameter in the analysis for roost site habitat suitability. Randall et al. (2014) found female bats moved more than 5 km between their diurnal roost site and evening foraging area. This is consistent with other studies of Myotis that showed nightly foraging distances greater than 5 km by adult females (Zahn et al., 2005). Therefore, it was assumed all mature forest in the LSA could provide suitable roost sites.

Assessment of Project effects on bats was based on quantifying potential loss of suitable roosting habitat due to site preparation and land clearing. Suitable habitat was classified as high, moderate, and low (Appendix E-8). The measurable parameter for this effect was area (km^2) of highly suitable roosting habitat. Highly suitable bat roosting habitat was defined as any forested ecosystem unit in the boreal high bioclimatic zone (900 masl to 1,300 masl) that has greater than 70% mature-old growth forest. Moderately suitable bat roosting habitat was defined as any forest type in the boreal forest that has less than 70% mature-old growth forest. Low suitable bat roosting habitat was defined as all other habitat that does not meet the high or moderate ranking. These suitability rankings for preferred little brown bat roosting habitat were based on the habitat description provided in the Assessment and Status Report on the Little Brown (*Myotis Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*) and Tri-colored Bat (*Perimyotis subflavus*) in Canada (COSEWIC, 2013).

The evaluation of the assessment was limited to the area of highly suitable habitat in the LSA. The scope did not expand outside the LSA as Project effects are not expected to occur on bats outside the LSA. The area of high, moderate, and low suitable habitat at baseline conditions, as well as the area of direct and indirect habitat loss were quantified to determine the percentage of total habitat loss for each suitability ranking (Table 13-15). Figure 13-16 shows the habitat suitability in relation to the Project Footprint used to quantify habitat changes. Indirect habitat loss will be reclaimed as soon as operations are complete and sensory disturbances are diminished.

Table 13-15: Change in Little Brown Bat Habitat Quality Due to Project Effects in the LSA

Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
High	16.43	0.24	4.69	-15.7
Moderate	7.45	0.08	0.71	-5.8
Low	100.53	9.48	12.04	-15.4

[1] Amount of habitat prior to any construction

[2] Area of habitat lost to the Project Footprint, including Access Road

[3] Area of habitat lost located with a 300 m buffer around the Project Footprint and Access Road

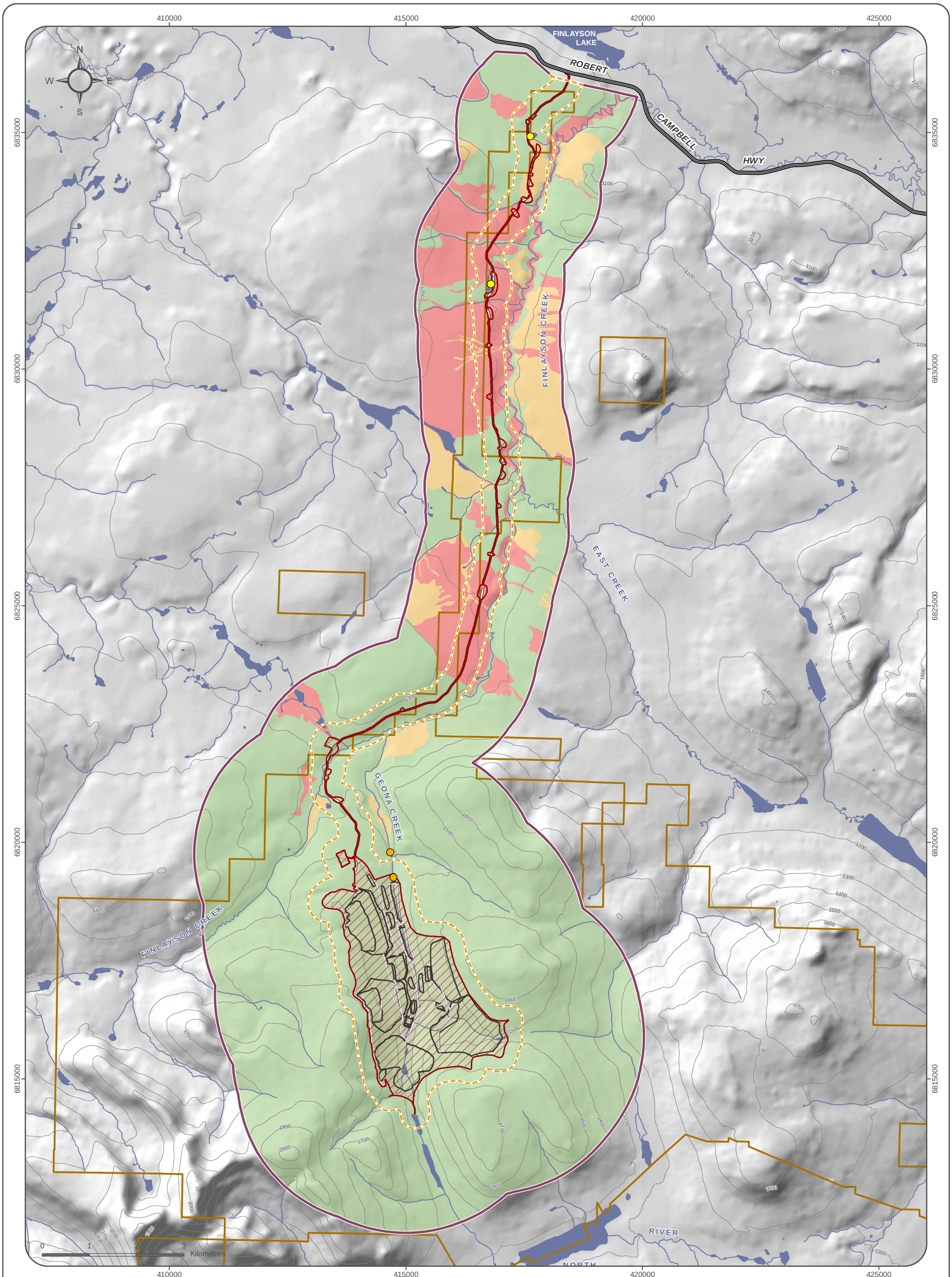
[4] Percent change after direct and 50% of indirect habitat loss

Direct Mortality

An increased risk of bat mortality from vehicle-bat collisions may occur due to increased vehicle traffic along the Access Road. However, bat casualties along the Access Road are expected to be low given that vehicle traffic will occur mostly during daytime hours when bats are roosting. Furthermore, studies have found that in general, bats are rarely found as road casualties (Lesiński et al., 2011).

Health Effects

Health of bats has the potential to be affected from mine contaminants; however, contaminant release will be avoided by implementing appropriate waste, water, and emission controls as presented in Section 13.4.2 and the conceptual management plans in Chapter 18.



Little Brown Bat Roosting Habitat

- High
- Moderate
- Low
- Bat Detector (Bats Detected) Bat
- Detector (No Bats Detected)

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Watercourse
- Waterbody

- Local Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Indirect Disturbance Area
- Direct Disturbance Area

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FIGURE 13-16

LITTLE BROWN BAT HABITAT SUITABILITY WITHIN LOCAL STUDY AREA

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13.4.1.8 Cliff-Nesting Raptors

Project Interactions

Baseline studies determined that minimal nesting habitat for cliff-nesting raptors exists with the LSA (Appendix E-8). The mountains in the LSA have gradually sloping peaks or loose talus rock with large and small boulders. There are few cliffs or rock outcrops that cliff-nesting raptors select for nesting (McIntyre and Schmidt, 2012). A well established, active golden eagle nest has been identified directly in the area that is proposed for mining activity. Based on the size of the nest, it is suspected the area has been used for many years as an active nesting territory by golden eagles.

The most likely Project effect on cliff-nesting raptors is loss of habitat. Direct habitat loss may include loss of current and potential future nesting sites, and loss of foraging sites associated with nesting sites. Foraging habitat is wide ranging and may even increase as a result of land clearing; therefore, the primary Project effect is expected to be on currently existing nest sites and potential loss of future nesting habitat. Indirect loss of nesting or foraging habitat may occur due to sensory disturbance from Project activities or reduction of habitat effectiveness for raptor prey (i.e., ptarmigan, snowshoe hare, marmot, and others). Sensory disturbance may result from increased aircraft travel, vehicle use, blasting and mining, and a general increase in human presence and disturbance on the landscape.

Project effects to cliff-nesting raptors are only applicable during the nesting season, unless the effect is removal of the nest site. Migratory golden eagles in Yukon return to their nesting grounds from late February to early April (McIntyre and Schmidt, 2012). This is the time that they are most susceptible to human disturbance and nest abandonment because they have not laid eggs and do not have a vested interest to remain in an area with human disturbance. April to early June is the time that eagles are most likely to abandon their nests due to human disturbance. However, an increasing amount of human disturbance over the course of the nesting season may prompt the eagles to abandon that nest site the following year and select a new nesting territory. McIntyre and Schmidt (2012) found the disturbance must be substantial and persistent, as individual eagles are not likely to abandon nesting territories even after they become unsuitable for raising young because of limited nesting opportunities elsewhere. This may be the case at KZK because baseline studies determined that minimal nesting habitat for cliff-nesting raptors exists with the LSA.

Long-term surveys in several parts of the western United States have shown declines in nesting golden eagle populations associated with human activity and habitat degradation (Steenhof et al., 2014). An increase in motorized activity could disturb eagles directly by flushing them and by preventing them from tending eggs or young. Findings from this study found that golden eagle responses to motorized vehicles on the ground differ from responses to aircraft. Helicopters flying near nests did not adversely affect golden eagle reproduction in Idaho and Utah. However, studies found golden eagles reacted to human disturbance (including vehicles) within 400 m of nesting sites to as far as 1,500 m (Steenhof et al., 2014).

It is possible that habituation by a pair of golden eagles is occurring in the LSA. This pair of golden eagles has nested in the LSA for the last two years, during which extensive exploration activities have occurred. The nest is located near the centre of the proposed Project Footprint and will increasingly

be encroached upon as mine development proceeds. Deterrence options for this nest may be necessary to remain in compliance with the *Migratory Bird Convention Act*.

Habitat Suitability

Assessment of Project effects on cliff-nesting raptors was based on quantifying potential loss of suitable nesting habitat. Suitable nesting habitat was classified as high, moderate, and low. The measurable parameter for this effect was area (km^2) of highly suitable habitat. Highly suitable cliff-nesting raptor habitat was defined as any habitat that displayed a slope greater than 30^o and was at an elevation greater than 1,300 masl. Moderately suitable cliff-nesting raptor habitat was defined as any habitat that displayed a slope between 15^o and 30^o and was at an elevation greater than 1,300 masl. Low suitable cliff-nesting raptor habitat was defined as any habitat that displayed a slope between 0^o and 15^o and covered all ranges of elevation. The parameters for suitability rankings for preferred cliff-nesting raptor habitat were based on a known preference for cliff-nesting raptors to select nest sites on steep rock faces or rocky outcrops, as well as reviewing actual nest site locations around the Project.

The evaluation of the assessment was limited to the area of highly suitable nesting habitat in the LSA. The scope did not expand outside the LSA as Project effects are not expected to occur on cliff-nesting raptors outside the LSA. The area of high, moderate, and low suitable habitat at baseline conditions, as well as the area of direct and indirect habitat loss were quantified to determine the percentage of total habitat loss for each suitability ranking (Table 13-16). Figure 13-17 shows the habitat suitability in relation to the Project Footprint used to quantify habitat changes. Indirect habitat loss will be reclaimed as soon as operations are complete and sensory disturbances are diminished.

Table 13-16: Change in Cliff-Nesting Raptor Habitat Quality Due to Project Effects in the LSA

Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
High	1.70	0.08	0.08	-7.2
Moderate	18.57	1.99	1.65	-15.2
Low	104.09	7.73	15.72	-15.0

[1] Amount of habitat prior to any construction

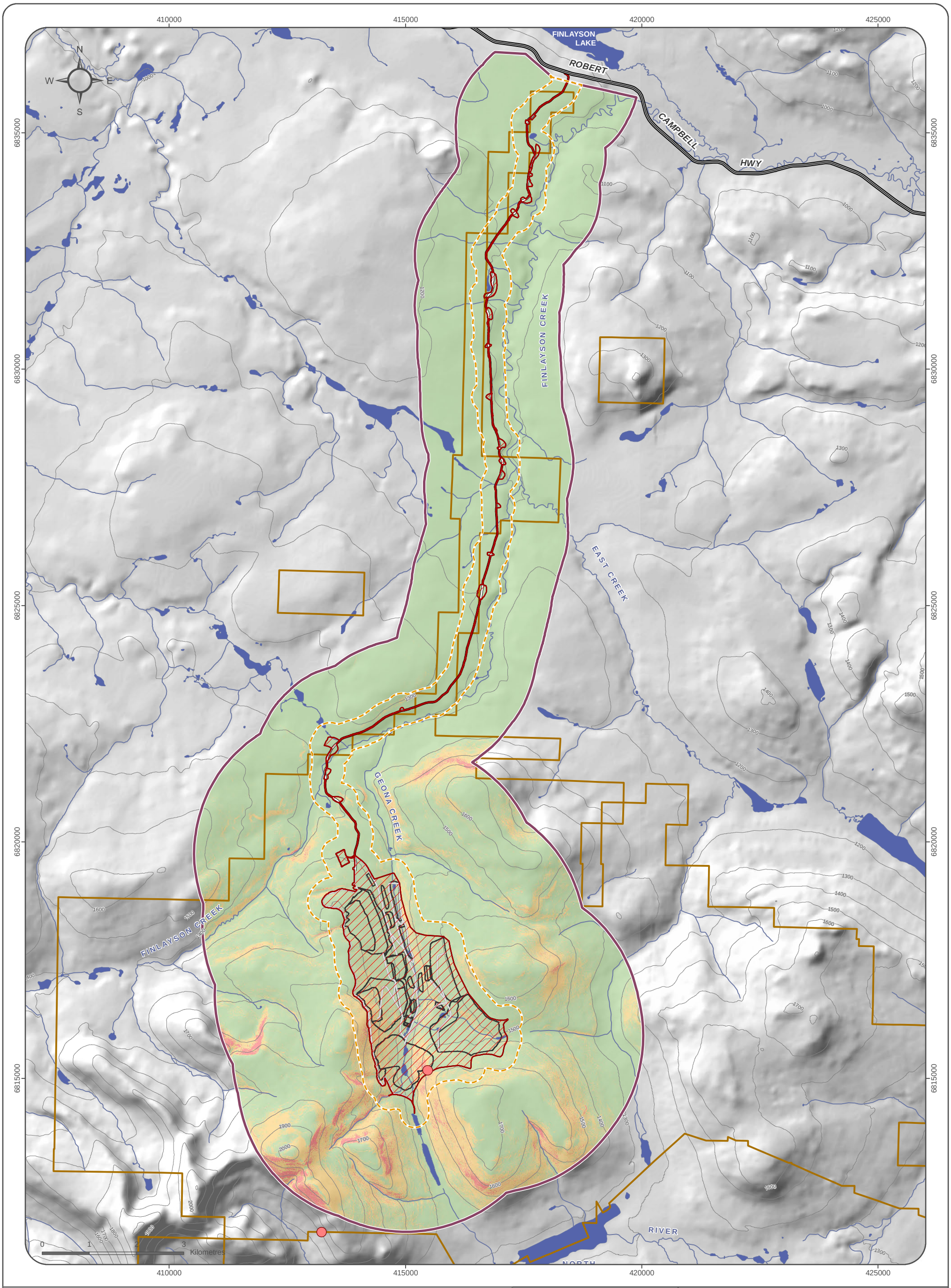
[2] Area of habitat lost to the Project Footprint, including Access Road

[3] Area of habitat lost located with a 300 m buffer around the Project Footprint and Access Road

[4] Percent change after direct and 50% of indirect habitat loss

Health Effects

Health of cliff-nesting raptors has the potential to be affected from mine contaminants; however, contaminant release will be avoided by implementing appropriate waste, water, and emission controls as presented in Section 13.4.2 and the management plans in Chapter 18.



Cliff-nesting Raptor Nesting Habitat

- Low
- Moderate
- High
- Raptor Nest Observation

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (100 m interval)
- Watercourse
- Local Study Area

- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Indirect Disturbance Area
- Direct Disturbance Area

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Datum: NAD 83; Projection: UTM Zone 9N

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FIGURE 13-17

CLIFF-NESTING RAPTOR NESTING HABITAT SUITABILITY WITHIN LOCAL STUDY AREA

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13.4.1.9 Passerines (Olive-sided Flycatcher)

Project Interactions

Olive-sided flycatcher was chosen as a representative species for all passerines for the EA, as it is a Species At Risk according to COSEWIC, and was found in multiple habitats in the Project area, including wetland, boreal forest, and subalpine. Suitable habitat for olive-sided flycatcher is most often associated with open areas containing tall, live trees or snags for perching (COSEWIC, 2007a). Open areas may be forest clearings, forest edges located near natural openings, burned forest or openings in old-growth forest stands. Tall, live trees or snags for perching are associated with mature trees and large dead trees (i.e., structural stage 6, 7). Generally, forest habitat is either coniferous or mixed wood. In the boreal forest, suitable habitat is more likely to be in or near wetland areas (COSEWIC, 2007a). Suitable habitat for olive-sided flycatcher may occur in subalpine and boreal forest.

Given the broadness of suitable habitat for this species, the most likely Project effect is loss of habitat. Direct loss of habitat may occur from site preparation and land clearing during the construction phase, as well as site construction and Tote Road upgrades. In addition, the effectiveness of suitable habitat may be compromised due to sensory disturbances from increased noise, visuals, dust, and overall human presence and will be considered an indirect loss of habitat. Specific Project components that may interact with olive-sided flycatcher include construction of the ABM open pit in the upper Geona Creek valley, construction of the Class A, B and C Storage Facilities, Overburden Stockpile, and the Access Road upgrades.

Direct mortality of olive-sided flycatchers due to vehicle collisions may occur, but numbers are expected to be too low to affect local populations, and were therefore not assessed. A comprehensive study quantifying estimates of avian mortality attributed to vehicle collisions in Canada found the lowest rates of bird collisions occurred in coniferous forest habitat (Bishop and Brogan, 2013). Furthermore, the study quantified a 2-lane road with low traffic volume, to have a collision mortality rate for all species combined of 0.093 birds/100 km/day. Considering the Access Road is approximately 25 km long, the total number of all bird strikes occurring during the 122-day breeding season is estimated to be 2.8.

Habitat Suitability

Assessment of Project effects on olive-sided flycatchers was based on quantifying potential loss of suitable nesting habitat due to site preparation and land clearing. Suitable nesting habitat was classified as high, moderate, and low. The measurable parameter for this effect was area (km^2) of highly suitable nesting habitat. Highly suitable olive-sided flycatcher nesting habitat was defined as any forest type in the boreal high ecotype (lower than 1,300 masl) or boreal subalpine ecotype (1,300 masl to 1,550 masl) that has greater than 50% mature-old growth, and was within 500 m of a water body (Appendix E-8). Moderately suitable olive-sided flycatcher nesting habitat was defined as any forest type in the boreal high ecotype or boreal subalpine ecotype that has greater than 50% mature-old growth, and was greater than 500 m from a water body. Low suitable olive-sided flycatcher nesting habitat was defined as all other habitat that does not meet the high or moderate ranking. These suitability rankings for preferred olive-sided flycatcher nesting habitat were based on

the habitat description provided in the Assessment and Status Report on the Olive-sided Flycatcher (*Contopus cooperi*) in Canada (COSEWIC, 2007a).

The evaluation of the assessment was limited to the area of highly suitable nesting habitat in the LSA. The scope did not expand outside the LSA as Project effects are not expected to occur on olive-sided flycatcher outside the LSA. The area of high, moderate, and low suitable habitat at baseline conditions, as well as the area of direct and indirect habitat loss were quantified to determine the percentage of total habitat loss for each suitability ranking (Table 13-17). Figure 13-18 shows the habitat suitability in relation to the Project Footprint used to quantify habitat changes. Habitat will be partially replaced during operations through progressive reclamation and fully at final reclamation.

Table 13-17: Change in Olive-sided Flycatcher Nesting Habitat Quality Due to Project Effects in the LSA

Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
High	10.92	0.60	3.12	-19.8
Moderate	6.73	0.13	0.50	-5.7
Low	106.74	9.08	13.83	-15.0

[1] Amount of habitat prior to any construction

[2] Area of habitat lost to the Project Footprint, including Access Road

[3] Area of habitat lost located with a 300 m buffer around the Project Footprint and Access Road

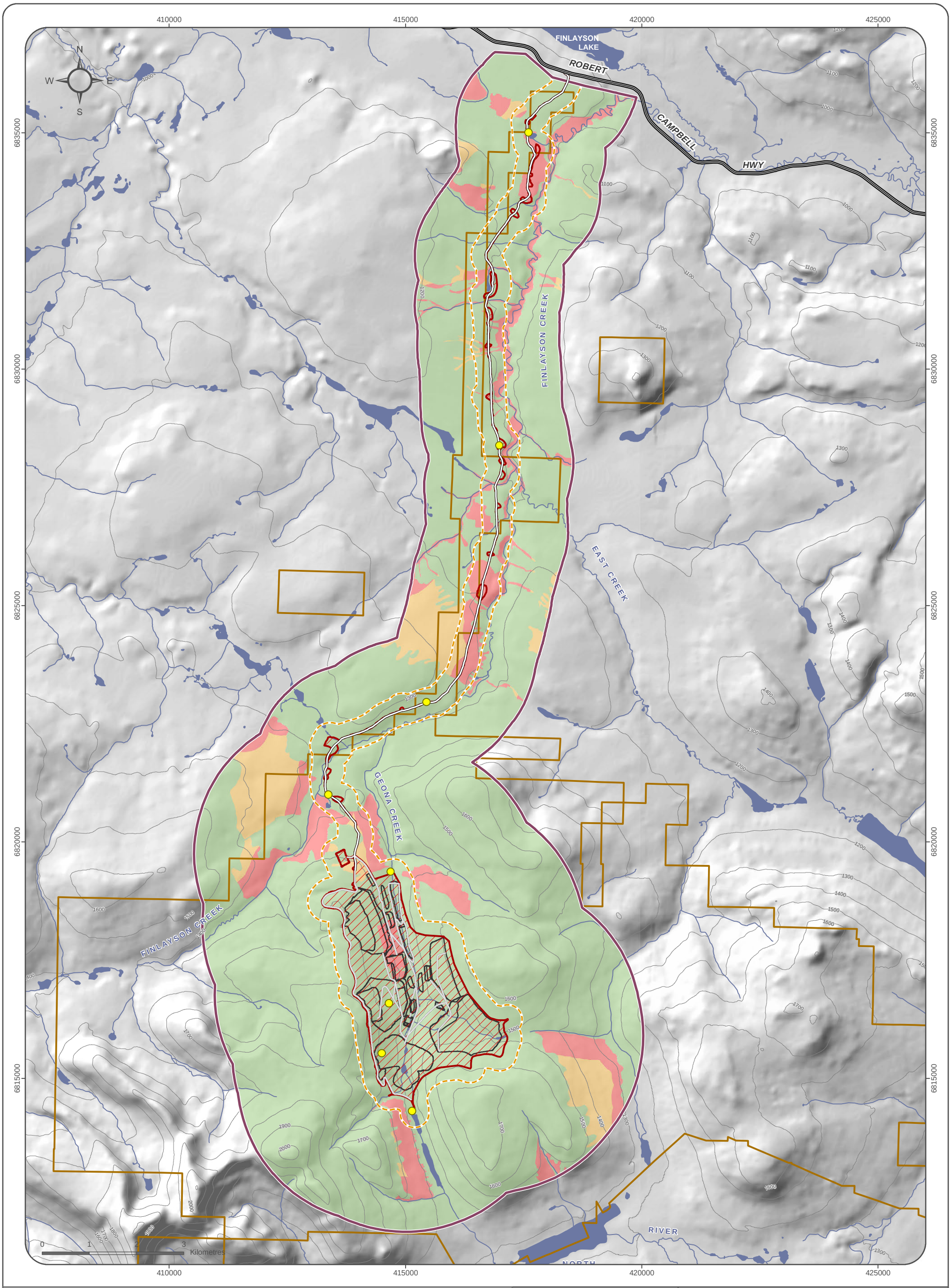
[4] Percent change after direct and 50% of indirect habitat loss

Direct Mortality

Increased road traffic associated with Project construction, operations, and closure has the potential to result in direct mortality.

Health Effects

Health of passerines has the potential to be affected from mine contaminants; however, contaminant release will be avoided by implementing appropriate waste, water, and emission controls as presented in Section 13.4.2 and the conceptual management plans in Chapter 18.



Olive-sided Flycatcher Suitable Nesting Habitat

- High
- Moderate
- low
- Olive-sided Flycatcher Observation
- Tote Road / Proposed Access Road
- Proposed Site Road
- Contour (100 m interval)
- Watercourse
- Waterbody
- Local Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Indirect Disturbance Area
- Direct Disturbance Area

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FIGURE 13-18

OLIVE-SIDED FLYCATCHER HABITAT SUITABILITY WITHIN LOCAL STUDY AREA

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13.4.1.10 Waterfowl

Project Interactions

Loss of wetland habitat is the main potential Project effect on waterfowl. Other potential effects such as direct mortality of waterfowl and barrier to waterfowl movement due to Project activities are expected to be minimal and are not considered in this assessment.

Wetland and riparian habitat along the Access Road will likely not be affected by Project activities due to the location of wetland and riparian habitat in relation to the expected road upgrades between the Robert Campbell Highway and the proposed mine site. The Access Road corridor will be widened but will have minimal effect on current wetland and riparian habitat. The greatest loss of habitat will be the wetlands associated with upper Geona Creek that will be removed during Project construction and activities. Project effects may be the direct loss of current or future nesting and foraging habitat, or indirect habitat loss due to sensory disturbance from human activity or noise. Sensory disturbance may result from increased vehicle use, blasting and mining, and a general increase in human presence and human disturbance near wetlands.

There is some potential interaction with impacted water as discussed below.

Habitat Suitability

The assessment of Project effects on waterfowl was based on quantifying potential loss of suitable habitat. Suitable habitat was classified as high, moderate, and low (Appendix E-8). The measurable parameter for this effect was area (km^2) of highly suitable habitat. Highly suitable waterfowl habitat was defined as any habitat type within 100 m of a water body (i.e., wetland and creek), including the water body itself. Moderately suitable waterfowl habitat was defined as any habitat type within 100 m to 200 m from a water body. Low suitable waterfowl habitat was defined as all other habitat that does not meet the high or moderate ranking. These suitability rankings for preferred waterfowl habitat were based on data from Hickie (1985), which states that most nests in or near wetlands occur within 100 m of water.

The evaluation of the assessment was limited to the area of highly suitable nesting habitat in the LSA. The scope did not expand outside the LSA as Project effects are not expected to occur on waterfowl outside the LSA. The area of high, moderate, and low suitable habitat at baseline conditions, as well as the area of direct and indirect habitat loss were quantified to determine the percentage of total habitat loss for each suitability ranking (Table 13-18). Figure 13-19 shows the habitat suitability in relation to the Project Footprint used to quantify habitat changes. Indirect habitat loss will be reclaimed as soon as operations are complete and sensory disturbances are diminished.

Table 13-18: Change in Waterfowl Habitat Quality Due to Project Effects in the LSA

Suitability Ranking	Baseline Conditions[1] (km^2)	Direct Habitat Loss[2] (km^2)	Indirect Habitat Loss[3] (km^2)	Total Habitat Change[4] (%)
High	18.23	1.92	3.37	-19.8
Moderate	16.16	1.51	3.03	-18.7
Low	90.02	6.36	11.05	-13.2

[1] Amount of habitat prior to any construction

[2] Area of habitat lost to the Project Footprint, including Access Road

[3] Area of habitat lost located with a 300 m buffer around the Project Footprint and Access Road

[4] Percent change after direct and 50% of indirect habitat loss

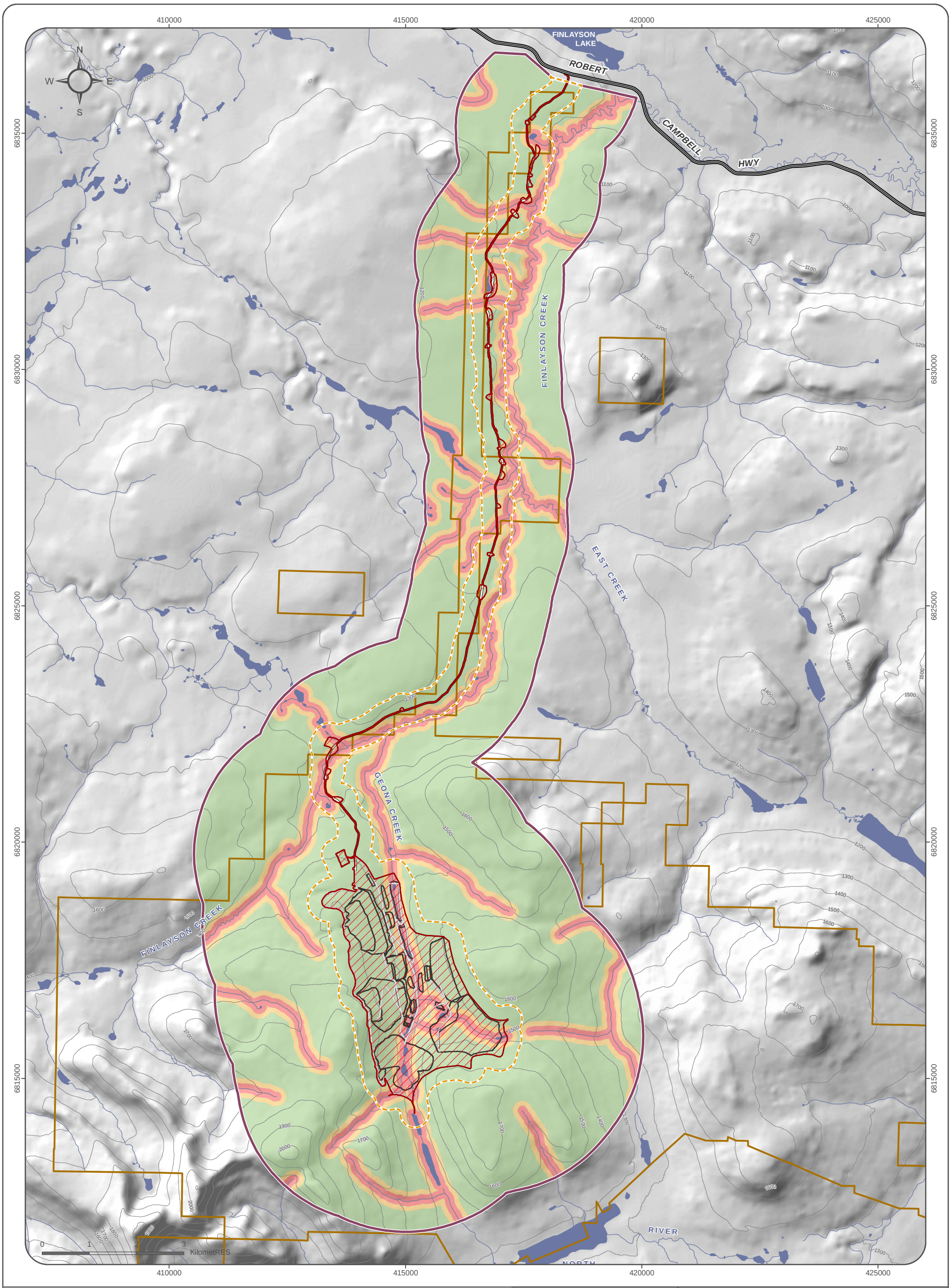
It is important to note that new wetlands, suitable for waterfowl use, will be created in the upper Geona Creek valley. These new wetlands will be created for the purposes of water management and water treatment. Furthermore, three fish habitat compensation wetlands will be constructed in the upper Geona Creek valley, totalling an area of approximately 2.0 ha. These wetlands will provide suitable nesting and foraging habitat for a variety of waterfowl.

Health Effects

Health of waterfowl has the potential to be affected from mine contaminants. Potential exposure pathways include ingesting water from the Operations Water Management Ponds, treatment ponds, or ABM lake at closure, or from ingesting plants that may have increased metal concentrations from accumulation or deposition. The likelihood for metals to transfer from vegetation to animals will be limited by dust control measures, and water control and treatment programs.

The pathway for metals to increase in vegetation and then to animals will be limited by dust control measures and by water control and treatment programs.

Wildlife is unlikely to access the water management ponds and water collection ponds due to fencing around ponds with unsuitable water quality, as well as a general deterrence from general human and equipment activity around the ponds. The risk from access to these ponds may increase in the closure phase when there is less activity in Project area. Water quality of the ponds is predicted to meet the livestock drinking water guidelines with the exception of the Class A and Class B Storage Facilities collection ponds, which may have some elevated metals. If monitoring of the metals in the Class A and B Storage Facilities are elevated above the livestock drinking water guidelines and water fowl are observed in the ponds, BMC will implement bird deterrent measures (which will be defined in the Adaptive Management Plan that is developed during permitting). The ABM lake will be batch treated if necessary after closure to maintain water quality within acceptable guidelines for wildlife protection. Refer to Chapter 8 for more information about predicted water quality.



Waterfowl Nesting / Feeding Habitat

- High
- Moderate
- Low

- Tote Road/Proposed Access Road
- Proposed Mine Road
- Contour (100 m interval)
- Watercourse
- Local Study Area
- Location of Proposed Mine Infrastructure
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Indirect Disturbance Area
- Direct Disturbance Area

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FIGURE 13-19

WATERFOWL HABITAT SUITABILITY WITHIN LOCAL STUDY AREA

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13.4.1.11 Bumble Bees

The greatest threat to the western bumble bee in the Project footprint is habitat loss. In Yukon, other threats include pathogens from exotic bees introduced into greenhouses, pesticides, and other chemicals (COSEWIC, 2014d). There are no pesticides or greenhouses managed with exotic species at the Project; therefore, the only potential effect is habitat loss for feeding and nests. The potential effects are the same as the gypsy cuckoo bumble bees, if they do occur in the LSA.

13.4.1.12 Summary

Table 13-19 provides a summary of the identified potential effects from the above sections that are carried forward for consideration of mitigation measures.

Table 13-19: Identified Potential Project Effects for the Wildlife and Wildlife Habitat

Subcomponent	Potential Effect	Project Phase
Finlayson Caribou Herd	Direct rut and post calving habitat loss	Construction, operations, active closure, post-closure
	Indirect rut, calving, and post calving habitat loss	Construction, operations, active closure
	Movement barrier between rut and wintering habitat from infrastructure and roads	Construction, operations, active closure
	Direct mortality from collisions with vehicles	Construction, operations, active closure
	Direct mortality from incidents with infrastructure	Construction, operations, active closure, post-closure
	Mortality from increased hunting pressure from available access	Construction, operations, active closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
	Disturbance of late winter range from aircraft	Construction, operations
Moose	Direct early winter and late winter habitat loss	Construction, operations, active closure, post-closure
	Indirect early winter and late winter habitat loss	Construction, operations, active closure
	Movement barrier in wintering habitat from infrastructure and road	Construction, operations, active closure
	Direct mortality from collisions with vehicles	Construction, operations, active closure
	Direct mortality from incidents with infrastructure	Construction, operations, active closure, post-closure
	Mortality from increased hunting pressure from available access	Construction, operation, active closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
	Disturbance of late winter range from aircraft	Construction, operations

Subcomponent	Potential Effect	Project Phase
Grizzly bear	Direct and indirect growing season habitat loss	Construction, operations, active closure
	Direct and indirect denning habitat loss	Construction, operations, active closure
	Mortality from human-bear conflict	Construction, operations, active closure
Grey wolf	Prey reduction due to ungulate loss of habitat	Construction, operations, active closure
	Direct mortality from collisions with vehicles	Construction, operations, active closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
Wolverine	Habitat avoidance from road density	Construction, operation, active closure
	Direct mortality from collisions with vehicles	Construction, operation, active closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
Collared pika	Loss of highly suitable habitat	Construction, operation, active closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
Little brown bat	Loss of highly suitable habitat	Construction, operation, active closure
	Direct mortality from collisions with vehicles	Construction, operation, active closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
Cliff-nesting raptors	Loss of highly suitable habitat or disturbance of nests	Construction, operation, active closure
	Health effects from ingestion of impacted water or plants	Construction, operations, active closure
Passerines (Olive-sided flycatcher)	Loss of highly suitable habitat	Construction, operations, active closure
	Direct mortality from collisions with vehicles	Construction, operations
	Health effects from ingestion of impacted water or plants	Operations, active closure
Waterfowl	Loss of highly suitable habitat	Construction, operation, closure
	Health effects from ingestion of impacted water or plants	Operations, active closure
Bumble bees	Direct habitat loss	Construction, operation

13.4.2 Mitigation Measures

This section discusses general and species-specific mitigation measures that BMC will implement to eliminate, minimize and/or reduce Project effects resulting from interactions between wildlife and Project activities. Some mitigation measures may be general in nature and applicable to all species, areas and phases of the Project. Other mitigations may be phase, species, area, or time-specific.

13.4.2.1 General Mitigation Measures

General Project mitigation measures relating to all wildlife species are described in the Wildlife Protection Plan (Section 18.7). Other management plans that include provisions to protect wildlife

and wildlife habitat include the Traffic and Access Management Plan (Section 18.12), Waste Management Plan (Section 18.2), Surface Water Management Plan (Section 18.4), Spill Contingency Plan (Section18.5), Noise Management Plan (Section 18.10), Air Quality Management Plan (Section 18.11), and Hazardous Materials Management (Section 18.3). The Wildlife Protection Plan (WPP) is the primary document that BMC will use to implement wildlife and wildlife habitat protection. The WPP is a "living document" that will undergo review on an annual basis and be adjusted to ensure an appropriate level of protection is maintained.

BMC's main policies related to wildlife protections include:

- Environment Policy (Appendix A-4);
- No Firearms Policy (Appendix A-8); and
- No Feeding of Animals Policy (Appendix A-9).

The following are general mitigation measures to reduce or eliminate Project effects on all wildlife species during construction, operation, closure, and post-closure:

- The Project Footprint was designed to cover as little area as practicable to minimize habitat loss and disturbance;
- Clearing will be kept to a minimum and only include areas needed to safely construct and operate the Project;
- Adhere to the policy of no feeding, harassment, or hunting of wildlife by employees and contractors;
- Avoid construction in and around sensitive areas, such as calving grounds, raptor nesting sites, den sites, or mineral licks during important seasonal periods (where practicable; the only known nearby mineral licks are south of the Project Footprint as noted in the ethnographic summary in Appendix F-3);
- Sensory disturbances will be minimized where practicable throughout the year; and
- Fugitive dust will be controlled using water sprays or approved dust suppressant (environmentally-benign that do not contain salts that would attract wildlife) to minimize the Project's zone of influence over the surrounding landscape (including passerine habitat).

The following are general mitigation measures to reduce or eliminate Project effects on all wildlife species resulting from use of the Access Road during construction, operation, closure, and post-closure (Chapter 18):

- Keep snowbanks less than one-metre high and provide wildlife passageways through banks along the Access Road and around site roads;
- Breaks in snow banks will be placed every 50 m to 100 m on both sides of the Access Road to enable passage of large mammals;
- Road embankments will be low profile to prevent the road acting as a barrier to, or channel for, wildlife movement;

- Enforce vehicle speed limits on employees and contractors and use radios to report wildlife on roads to reduce the incidence of collisions;
- Travel speeds along the road will be restricted to a maximum of 50 km/hr for daytime travel, and reduced during night-time or hazardous weather conditions (as appropriate);
- Minimum traffic levels will be maintained along the Access Road to the extent practical. Convoys of 2 or 3 vehicles will travel together along the Access Road to reduce periods of sensory disturbance, when practicable;
- Signage will be posted in high collision risk areas (e.g., blind or obstructed turns, water and wildlife crossings; Figure 18-5). Road travel speeds will be reduced to 30 km/hr in these areas. The signs will instruct drivers to reduce speed, remain alert, stop for wildlife, and wait for wildlife to move away (Figure-18-6). Wildlife will have the right-of-way along the road;
- Individual or groups of animals standing on the road will be allowed to move off the road unalarmed;
- Wildlife incidents (e.g., collisions) will be reported within 24 hours or as soon as practicable, and an investigation will try to identify the cause and remedial actions; and
- A guard at the gatehouse on the Access Road is in place to prevent public and hunter access. The gatehouse will continue to be guarded throughout the Project phases to restrict hunter access to the Project area.

Further details and a complete list of all of BMC's mitigation commitments are provided in the WPP (Chapter 18).

Additional specific mitigations for the valued wildlife subcomponents are presented in the sub-sections below. A table is also provided for each valued subcomponent that lists the potential Project effects on that species (or group) along with the Project phase when the effect will occur. For each potential effect, one or more mitigation measures are proposed that reduce or eliminate that effect. Depending on the predicted effectiveness of the mitigation measures (i.e., the degree to which the mitigation measure is expected to eliminate the effect), a determination is made as to whether there is a residual effect. If there is an expected residual effect, the significance of the effect is evaluated in Section 13.4.3.

13.4.2.2 Caribou

In addition to the general mitigation measures in Section 13.4.2.1, mitigation measures are specifically needed to minimize potential effects on caribou. The Wildlife Protection Plan, Section 18.7 provides additional detail. Mitigation measures start with the company policies of no unauthorized firearms, no hunting, no recreational ATVs or snowmobiles (Appendices A-8, A-9, and A-11).

In particular, seasonally sensitive times include: calving period in May in the alpine; post calving period in June and July in the alpine; and rut period in October in the alpine and subalpine, and November when caribou move from the alpine and subalpine areas with some crossing the Access

Road to the Pelly River lowlands. Activities in these areas during these times will be minimized as much as practicable. Detailed scheduling of activities will be developed as the Project carries forward into detailed design and construction scheduling. Minimizing disturbance during seasonally sensitive periods for wildlife is in keeping with Kaska land management practices (Dena Kayeh Institute, 2010).

Traffic and Access Management Plan details (Section 18.12) work to minimize effects on movement and prevent direct mortality from collisions with vehicles. The most important mitigation measure is continued operation of the manned gate to prevent hunter access to the Project. This is a proven mitigation measure required in the existing Tote Road permit and will continue for the life of the Project until the road is decommissioned. Table 13-20 summarizes the mitigation measures related to the identified potential effects along with the predicted effectiveness and a determination of whether there will be a residual effect after implementation of the mitigation measures.

Table 13-20: Proposed Mitigation Measures for Finlayson Caribou Herd

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Direct rut and post calving habitat loss	Construction, operations, active closure, post-closure	Reclamation (Appendix H-1); Minimize activities in alpine and subalpine during rut period (September 28 to October 31); Minimized Project Footprint	High	Yes
Indirect rut, calving, and post calving habitat loss	Construction, operations, active closure	Minimize activities in alpine during the calving period (May 1 to May 31); Minimize activities in alpine and subalpine during rut period (September 28 to October 31); No hunting policy (Appendix A-8); Regularly scheduled blasting	High	Yes
Movement barrier between rut and wintering habitat from infrastructure and road	Construction, operations, active closure	Speed limits (Section 18.12); Radio controlled Access Road (Section 18.12); Convoys of two or three vehicles to reduce sensory disturbance (Section 18.12)	Medium	Yes
Direct mortality from collisions with vehicles	Construction, operations, active closure	Speed limits (Section 18.12); Clearing vegetation from right-of-way; Radio controlled Access Road (Section 18.12); Implement protocol for vehicle-ungulate encounters (Section 18.12); Signage along road in areas with high frequency of ungulate crossings and reduced speed limits in these areas (Section 18.12) All other requirements currently included in the existing Tote Road Licence	Medium	Yes
Direct mortality from incidents with infrastructure	Construction, operations, active closure, post-closure	Fencing or provision of egress ramps from HDPE-lined facilities; Plough regular breaks in the snowbank along the road and around the Project Footprint; Leave haul road in pit to provide egress from ABM lake; Permanent wildlife barrier around ABM lake	High	No
Mortality from increased hunting pressure from available access	Construction, operation, active closure, post-closure	No hunting policy (Appendix A-8); Manned gate to prevent access to hunters; Decommission and reclaim road	High	No
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11) Pond access control	High	No
Disturbance of late winter range from aircraft	Construction, operations	Follow designated flight and landing route for flights to Finlayson Lake airstrip during winter that stay 1.5 km away from animals and maximize height above ground as long as practicable at landing and takeoff (Dena Kayeh Institute, 2010) that minimizes herd disturbance.	Medium	Yes

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.3 Moose

In addition to the general mitigation measures in Section 13.4.2.1, mitigation measures are specifically needed to minimize and or reduce effects on moose. In particular, the seasonally sensitive time is winter, from November through April, when moose use habitat from Geona Creek to Finlayson Lake (Figure 13-4).

Monitoring studies in 2015 and 2016 recorded and mapped wildlife observations and their associated movement corridors along the Access Road. This information will be used to prevent wildlife mortality from vehicle collisions. Road signage will be installed in these high use areas, as well as other mitigation measures such as seasonal speed limit reductions or fencing at high risk corners to reduce the risk of collisions and facilitate movement across the road.

Table 13-21 summarizes the mitigation measures related to the identified potential effects along with the predicted effectiveness and a determination of whether there will be a residual effect after implementation of the mitigation measures.

Table 13-21: Proposed Mitigation Measures for Moose

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Direct early winter and late winter habitat loss	Construction, operations, active closure, post-closure	Progressive reclamation (Appendix H-1); Minimized Project Footprint; Final reclamation at closure (Appendix H-1)	High	Yes
Indirect early winter and late winter habitat loss	Construction, operations, active closure	Progressive reclamation (Appendix H-1); Minimized Project Footprint; Final reclamation at closure (Appendix H-1)	High	Yes
Movement barrier in wintering habitat from infrastructure and road	Construction, operations, active closure	Speed limit (Section 18.12); Radio controlled Access Road (Section 18.12); Convoys of two or three vehicles to reduce sensory disturbance but maintaining 15 second distance between vehicles for human health and safety (Section 18.12)	Medium	Yes

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Direct mortality from collisions with vehicles	Construction, operations, active closure	Speed limit (Section 18.12); Clearing vegetation from right-of-way; Radio controlled Access Road (Section 18.12); Implement protocol for vehicle-ungulate encounters (Section 18.12); Signage along road in areas with high frequency of ungulate crossings (Section 18.12) All other requirements currently included in the existing Tote Road Licence	Medium	Yes
Direct mortality from incidents with infrastructure	Construction, operations, active closure, post-closure	Fencing or provision of egress ramps from HDPE-lined facilities; Plough regular breaks in the snowbank along the road and around the Project Footprint; Leave haul road in pit to provide egress from ABM lake Permanent wildlife barrier around ABM lake	High	No
Mortality from increased hunting pressure from available access	Construction, operation, active closure, post-closure	No hunting policy (Appendix A-8) Manned gate to prevent access to hunters (Section 18.12) Decommission and reclaim road (Appendix H-1)	High	No
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No
Disturbance of late winter range from aircraft	Construction, operations	Follow designated flight and landing route for flights to Finlayson Lake airstrip that minimizes herd disturbance	Medium	Yes

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.4 Grizzly Bear

In addition to the general mitigation measures in Section 13.4.2.1, mitigation measures are specifically needed to minimize effects on grizzly bear. In particular, the seasonally sensitive time is when activity at the open pit could disturb denning and winter hibernation. To prevent disturbance of denning bears, pre-denning monitoring will take place. If bear activity indicates they may be preparing to den in an area that could be disturbed by mining activity, the YG conservation officer and RRDC Land Stewards will be consulted to determine measures to prevent the bear from denning too close to the pit.

Mitigation measures to reduce attractants such as diligent garbage management are critical to preventing human-bear conflict that often results in destruction of the bear. The following are general mitigation measures for waste management for the Project to reduce human-bear conflicts (Waste Management Plan discussed further in Section 18.2):

- BMC will provide bear awareness training to all employees and contractors;
- BMC will be responsible for the regular collection and disposal of all waste material generated during the course of the Project;
- BMC will establish regular clean-up and disposal programs so as to prevent the unnecessary accumulation of wastes. Procedures will be adopted to promptly collect and remove any accumulated debris;
- BMC will ensure these wastes are stored in suitable containers until such time as they are removed from Project or incinerated;
- All waste removed from Project will be disposed of at an approved disposal facility, in compliance with applicable legislation and regulations;
- All food waste and domestic garbage from all Project areas will be collected and placed in an appropriate receptacle daily, and will be disposed of in an appropriate and safe manner; and
- All food wastes will be stored and disposed of in a manner that does not attract nuisance animals, and will be incinerated daily; and
- The waste management facility will be surrounded by a wildlife barrier.

Table 13-22 summarizes the mitigation measures related to the identified potential effects along with the predicted effectiveness and a determination of whether there will be a residual effect after implementation of the mitigation measures.

Table 13-22: Proposed Mitigation Measures for Grizzly Bear

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Direct and indirect growing season habitat loss	Construction, operations, active closure	Progressive reclamation and final reclamation at closure (Appendix H-1)	Medium	Yes
Direct and indirect denning habitat loss	Construction, operations, active closure	Pre-denning surveys and mitigations to prevent indirect effects (Section 18.7)	High	Yes
Mortality from human-bear conflict	Construction, operations, active closure	Implementation of wildlife protection plan with key procedures to manage garbage and bear awareness training for employees and contractors (Section 18.2)	High	No
Mortality from increased hunting pressure from available access	Construction, operation, active closure, post-closure	No hunting policy (Appendix A-8); Manned gate to prevent access to hunters until road is decommissioned (Section 18.12)	High	No
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.5 Grey Wolf

From the general mitigation measures in Section 13.4.2.1, the mitigation measures of particular relevance to reducing effects on wolf include:

- Minimum traffic levels will be maintained along the Access Road to the extent practical. Convoys of two or three vehicles to travel together to reduce periods of sensory disturbance when practicable.

Table 13-23 Table 13-23summarizes the mitigation measures related to the identified potential effects along with the predicted effectiveness and a determination of whether there will be a residual effect after implementation of the mitigation measures.

Table 13-23: Proposed Mitigation Measures for Grey Wolf

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Direct and indirect loss of habitat due to ungulate loss of habitat	Construction, operations, active closure	Reclamation (Appendix H-1)	Medium	Yes
Direct mortality from collisions with vehicles	Construction, operations, active closure	Speed limits (Section 18.12); Clearing vegetation from right-of-way; Radio controlled Access Road (Section 18.12); Ploughed breaks in snowbanks along road	Medium	Yes
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.6 Wolverine

General Project mitigation measures for wildlife are described above in Section 13.4.2, as well as in the WPP (Chapter 18). General mitigation measures that are particularly applicable to wolverine include those that aim to reduce the Project Footprint and unnecessary sensory disturbances.

Mitigation measures that are specific to reducing effects on wolverine include:

- Decommissioning of roads that are no longer required such that passage of vehicles is prevented; and
- Minimum traffic levels will be maintained along the Access Road to the extent practical. Convoys of two or three vehicles to travel together to reduce periods of sensory disturbance.

Table 13-24: Proposed Mitigation Measures for Wolverine

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Habitat avoidance from road density	Construction, operation, active closure	Decommission inactive roads (Appendix H-1); site clearing will be kept to a minimum	Medium	Yes
Direct mortality from collisions with vehicles	Construction, operation, active closure	Reduce travel speeds (Section 18.12); Clearing vegetation from right-of-way	High	No

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.7 Collared Pika

General Project mitigation measures for wildlife are described above in Section 13.4.2, as well as in the WPP (Chapter 18). General mitigation measures that are particularly applicable to collared pika include those that aim to reduce the Project Footprint and unnecessary sensory disturbances.

There are no species-specific mitigation measures suggested for collared pika.

Table 13-25: Proposed Mitigation Measures for Collared Pika

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Loss of highly suitable habitat	Construction, operation, active closure	Minimize site clearing; Reclamation (Appendix H-1); Noise minimization	Medium	Yes
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.8 Bats

General Project mitigation measures for wildlife are described above in Section 13.4.2, as well as in the WPP (Chapter 18). General mitigation measures that are particularly applicable to bats include those that aim to reduce the Project Footprint and unnecessary sensory disturbances. No other mitigations are proposed.

Table 13-26: Proposed Mitigation Measures for Bats

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Loss of highly suitable habitat	Construction, operation, active closure	Reclamation (Appendix H-1); site clearing of Access Road will be kept to a minimum	Medium	Yes
Direct mortality	Construction, operation, active closure	Reduce travel speeds (Section 18.12)	High	No
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.9 Cliff-Nesting Raptors

General Project mitigation measures for wildlife are described above in Section 13.4.2, as well as in the WPP (Chapter 18). General mitigation measures that are particularly applicable to cliff-nesting raptors include those that aim to reduce the Project Footprint and unnecessary sensory disturbances.

The following is a species-specific mitigation measure suggested for cliff-nesting raptors:

- Blasting to be restricted to the active mine and crushing Project area and if required outside that area;
- New nest site construction surveys will be conducted throughout the nesting season and mitigated as necessary. Potential sites, for example, include old nests, tall inactive equipment (e.g., crane booms), and building ledges under eaves.

Table 13-27: Proposed Mitigation Measures for Cliff-Nesting Raptors

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Loss of highly suitable habitat	Construction, operation, active closure	Reclamation (Appendix H-1); site clearing will be kept to a minimum	Medium	Yes
Disturbance to known nest sites	Construction, operation, active closure	Blasting to be restricted to the active mine and crushing Project area and if required outside that area. Prevent creation of new nest sites.	High	No

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.10 Passerines (Olive-sided Flycatcher)

General Project mitigation measures for wildlife are described above in Section 13.4.2, as well as in the WPP (Chapter 18). General mitigation measures that are particularly applicable to olive-sided flycatcher include those that aim to reduce the Project Footprint and unnecessary sensory disturbances.

The following are species-specific mitigation measures suggested for olive-sided flycatcher:

- Clearing will be planned to minimize disturbance to bird nesting; and
- Nest surveys will be conducted as described below for any clearing during the nesting season (with involvement from Kaska representatives identified by RRDC).

As much as possible, land clearing should occur outside the nesting season. If land clearing is to be conducted during the nesting season, breeding bird surveys will be conducted prior to clearing and active nests will be buffered. This is required to ensure compliance with the *Migratory Birds Convention Act 1994*, which prohibits the disturbance or destruction of migratory bird nests and eggs in Canada.

The following items will be applied while conducted breeding bird surveys:

- Surveys will be led by qualified and experienced individuals (including involvement from Kaska representatives identified by RRDC);
- Survey results will be communicated to the on site construction manager and clearing contractors, including any nests found and ensuing buffer zones;
- Any nest found should be protected with a buffer zone. Buffer zones vary depending on the species and the type of disturbance and will be determined by the expert contracted for clearing. As a starting guideline, species of Special Concern will have a 200 m buffer placed around their nest, while all other birds will have a 30 m buffer around their nest. The buffers can be removed after the young have permanently left the nest;
- If no nests are found, clearing activities will be completed within a 7-day window of survey conclusion; and
- A summary of results and proposed mitigation are to be provided to RRDC for their input and feedback.

Table 13-28: Proposed Mitigation Measures for Olive-sided Flycatcher

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Loss of highly suitable habitat	Construction, operations, active closure	Reclamation (Appendix H-1); Site clearing will be kept to a minimum	Medium	Yes
Direct mortality	Construction, operations	Perform nest surveys prior to clearing (Section 18.7)	High	No
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.11 Waterfowl

General Project mitigation measures for wildlife are described above in Section 13.4.2, as well as in the WPP (Chapter 18). General mitigation measures that are particularly applicable to waterfowl include those that aim to reduce the Project Footprint and unnecessary sensory disturbances.

The following are species-specific mitigation measures suggested for waterfowl:

- Clearing will be planned to minimize disturbance to waterfowl nesting; and
- Nest surveys will be conducted as described below for any clearing during the nesting season (with involvement from Kaska representatives identified by RRDC).

As much as possible, land clearing should occur outside the nesting season. If land clearing is to be conducted during the nesting season, breeding waterfowl surveys will be conducted prior to clearing and active nests will be buffered. This is required to ensure compliance with the *Migratory Birds Convention Act 1994*, which prohibits the disturbance or destruction of migratory bird nests and eggs in Canada. Protection of the diversity of birds is supported by Kaska management goals (RRDC Elders and Team, 2012).

The following items will be applied while conducted breeding waterfowl surveys:

- Surveys will be led by qualified and experienced individuals (including involvement from Kaska representatives identified by RRDC);
- Survey results will be communicated to the on site construction manager and clearing contractors, including any nests found and ensuing buffer zones;
- Any nest found should be protected with a buffer zone. Buffer zones vary depending on the species and the type of disturbance and will be determined by the expert contracted for clearing. As a starting guideline, species of Special Concern will have a 200 m buffer placed around their nest, while all other birds will have a 30 m buffer around their nest. The buffers can be removed after the young have permanently left the nest;

- If no nests are found, clearing activities will be completed within a 7-day window of survey conclusion; and
- A summary of results and proposed mitigation are to be provided to RRDC for their input and feedback.

Table 13-29: Proposed Mitigation Measures for Waterfowl

Potential Effect	Project Phase	Proposed Mitigation Measure*	Predicted Effectiveness of Mitigation (High, Medium, Low)	Residual Effect Identified (Yes/No)
Loss of highly suitable habitat	Construction, operation, active closure	Reclamation (Appendix H-1); Site clearing will be kept to a minimum; No-clearing buffer zones around wetlands; Creation of new wetlands for fish habitat compensation (Appendix E-4)	Medium	Yes
Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan (Section 18.11); Pond access controls	High	No

* Key mitigation measures are summarized in the table, with further mitigation measures discussed in text and in Chapter 18.

13.4.2.12 Bumble Bees

Progressive reclamation will mitigate any lost habitat for bumble bees. The magnitude of effect on bumble bee is rated as low.

13.4.3 Residual Effects, Consequence, and Significance Determination

In this section, the scale of the residual effects on each of the wildlife subcomponents are summarized. To determine whether the residual effects are significant, they are assessed according to the following criteria: direction, magnitude, geographic extent, duration, frequency, reversibility, environmental/socio-economic context, and probability. Refer to Section 13.1.3 for definitions of the assessment criteria.

A significant residual effect is considered to occur if it is adverse, of high magnitude, and extends across the regional study area. Alternatively, it is adverse, of high magnitude, in the local study area, and occurs over the long term.

13.4.3.1 Caribou

The residual effects on caribou include lost high suitability rutting and post calving habitat, disturbance of movement corridors between the Pelly River lowlands and the alpine areas around the Project, direct mortality from collisions with vehicles, and disturbance from flights using the Finlayson Lake airstrip.

Given the thresholds presented in Table 13-30 and the habitat loss estimates in Table 13-9, the projected habitat losses for caribou were determined to be low magnitude for the construction through closure phases of the Project. There is an estimated 3.0% (7.8 km^2 direct and 47.7 km^2 indirect) loss of highly suitable rut habitat; 1.8% (1.2 km^2 direct and 27.8 km^2 indirect) loss of highly suitable post calving habitat in the regional ZOI; and less than 1% of suitable rut and post calving habitat in the FCH range. This habitat will be reclaimed over the long-term except in the area of the ABM open pit.

Table 13-30: Thresholds for Project Effects to Caribou Abundance

Magnitude of Effect	Rut or Post Calving Habitat Loss Threshold (%)
Low	0 – 10
Moderate	10 – 15
High	> 15

Disturbance of movement corridors will be prevented by signage along road crossings. Signage, speed controls, and radio communications will also prevent direct mortality. Aircraft overflight effects will be minimized by route planning. The resulting magnitudes were assigned low ratings for these effects and are expected to only affect a small, local area. There is medium uncertainty in the likelihood of these effects.

The significance of residual effects of the Project on caribou is summarized in Table 13-31. Residual Project effects on caribou are considered not significant for all residual effects because they are low magnitude and local. The FCH has a high social context, but given the magnitude of potential effects and that effects are very likely with low uncertainty, the results were maintained as not significant.

Table 13-31: Significance of Residual Effects – Finlayson Caribou Herd

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Direct rut and post calving habitat loss	Adverse	Low	Local	Long term	Continuous	Reversible long term	High	Very likely Low uncertainty	Not significant
Indirect rut, calving, and post calving habitat loss	Adverse	Low	Local	Long term	Continuous	Reversible long term	High	Very likely Low uncertainty	Not significant
Movement barrier between rut and wintering habitat from infrastructure and road	Adverse	Low	Local	Long term	Continuous	Reversible short term	High	Very likely Medium uncertainty	Not significant
Direct mortality from collisions with vehicles	Adverse	Low	Local	Long term	Sporadic	Irreversible	High	Unlikely Medium uncertainty	Not significant
Disturbance of late winter range from aircraft	Adverse	Low	Local	Long term	Regular	Reversible short term	High	Very likely Medium uncertainty	Not significant

13.4.3.2 Moose

The residual effects on moose include lost high suitability post rut and late winter habitat, disturbance of movement corridors between the Finlayson Lake lowlands and the montane areas around the Project, direct mortality from collisions with vehicles, and disturbance from flights using the Finlayson Lake airstrip.

Project development is estimated to result in a direct and indirect loss of 4.7% (7.8 km^2 direct and 47.7 km^2 indirect) of moderately high and high suitability moose post rut habitat in GMS 10-07 (Table 13-12). Similarly, Project development is estimated to result in a direct and indirect loss of 3.8% (8.4 km^2 direct and 83.0 km^2 indirect) of moderately high and high suitability late winter habitat in GMS 10-07.

Given the thresholds presented in Table 13-32, the projected habitat losses for moose were determined to be low magnitude for the construction through closure phases of the Project.

Table 13-32: Thresholds for Project Effects to Moose Abundance

Magnitude of Effect	Post Rut or Late Winter Habitat Loss Threshold (%)
Low	0 – 10
Moderate	10 – 15
High	> 15

Disturbance of movement corridors will be prevented by signage along road crossings. Signage, speed controls, and radio communications will also prevent direct mortality. Aircraft overflight effects will be minimized by route planning. The resulting magnitudes were assigned low ratings for these effects and are expected to only affect a small, local area.

The significance of residual effects of the Project on moose is summarized in Table 13-33. Residual Project effects on moose are considered not significant for all residual effects because they are low magnitude and local.

Table 13-33: Significance of Residual Effects – Moose

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Direct early winter and late winter habitat loss	Adverse	Low	Local	Long term	Continuous	Reversible long term	High	Very likely Low uncertainty	Not significant
Indirect early winter and late winter habitat loss	Adverse	Low	Local	Long term	Continuous	Reversible long term	High	Very likely Low uncertainty	Not significant
Movement barrier in wintering habitat from infrastructure and road	Adverse	Low	Local	Long term	Continuous	Reversible short term	High	Very likely Medium uncertainty	Not significant
Direct mortality from collisions with vehicles	Adverse	Low	Local	Long term	Sporadic	Irreversible	High	Unlikely Medium uncertainty	Not significant
Disturbance of late winter range from aircraft	Adverse	Low	Local	Long term	Regular	Reversible short term	High	Very likely Medium uncertainty	Not significant

13.4.3.3 Grizzly Bear

The residual effects on grizzly bear include direct and indirect loss of high suitability growing and denning habitat.

The percentage of highly suitable habitat that will be lost, including both direct and indirect, was used to determine the magnitude of effect from Project activities on grizzly bear denning habitat (Table 13-13). Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 13-34.

Table 13-34: Thresholds for Project Effects to Suitable Grizzly Bear Denning Habitat

Magnitude of Effect	Habitat Loss Threshold (%)
Low	0 – 10
Moderate	10 – 15
High	> 15

The percentage of highly suitable grizzly bear denning habitat estimated to be lost due to Project activities is 1% (0.04 km^2 direct loss and 4.9 km^2 indirect loss) in the RSA equating to a low magnitude effect. This is a permanent loss since the habitat loss is from development of the open pit that cannot be reclaimed.

Lost suitable grizzly habitat for growing/feeding was assumed to total 67.1 km^2, including the Project Footprint as direct feeding habitat lost (9.8 km^2), plus an assumed indirect lost feeding habitat at 50% of the remaining area in the LSA (57.3 km^2). This total equates to 3% of the total area of the RSA, or 7% of the RSA when high suitability denning habitat is removed. In either case, this loss results in a low magnitude effect for the construction through closure phases of the Project.

The significance of residual effects of the Project on grizzly bear is summarized in Table 13-35. Residual Project effects on grizzly bear are considered not significant because they are low magnitude and local; however, effective implementation of mitigation measures is important due to their high social context.

Table 13-35: Significance of Residual Effects – Grizzly Bear

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Direct and indirect growing season habitat loss	Adverse	Low	Local	Long term	Continuous	Reversible long term	High	Very likely Low uncertainty	Not significant
Direct and indirect denning habitat loss	Adverse	Low	Local	Long term	Regular	Irreversible (for direct loss)	High	Very likely Low uncertainty	Not significant

13.4.3.4 Grey Wolf

The residual effects on grey wolf include reduced prey availability from ungulate habitat loss.

The habitat loss estimates ranged from 1.8% for caribou post calving habitat to 3% for caribou rut habitat, and from 3.8% for moose late winter habitat to 4.7% for moose post rut habitat. These were rated as low magnitude effects for both caribou and moose. Linking wolf to ungulate populations and the resulting thresholds in Table 13-3 and Table 13-36, this is estimated to result in a low magnitude effect on wolf populations for the construction through closure phases of the Project.

Table 13-36: Thresholds for Project Effects to Wolf Abundance

Magnitude of Effect	Threshold
Low	If moderate rating for either caribou or moose and low for the other, or low for both
Moderate	If high rating for either caribou or moose and low for the other, or moderate for both
High	If high rating for either caribou and moose and moderate for the other, or high for both

The significance of residual effects of the Project on wolf is summarized in Table 13-37. Residual Project effects on wolf are considered not significant because they are low magnitude and local.

Table 13-37: Significance of Residual Effects – Wolf

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Reduced prey availability due to ungulate loss of habitat	Adverse	Low	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant
Direct mortality from collisions with vehicles	Adverse	Low	Local	Long term	Sporadic	Irreversible	High	Unlikely Medium uncertainty	Not significant

13.4.3.5 Wolverine

The residual effect on wolverine is direct disturbance from roads and human activity.

Wolverine effects were assessed by road density. The evaluation of the assessment was limited to the LSA because Project roads are only going to be constructed in the LSA. For the purposes of this assessment, a road density greater than 0.6 km/km^2 has been selected to identify a high magnitude effect as supported by the discussion in Section 13.4.1.5. A moderate magnitude effect has been identified as a road density between 0.3 and 0.6 km/km^2. A low magnitude effect has been identified as a road density between 0 and 0.3 km/km^2 (Table 13-38).

The total road density in the LSA for all Project activities is 0.35 km/km^2, equating to a moderate magnitude effect during operations. Post-closure, once reclamation is complete, traffic will be limited to monitoring and therefore, the magnitude of effect is expected to return to low.

Table 13-38: Thresholds for Project Effects to Wolverine Abundance

Magnitude of Effect	Road Density Threshold (km/km^2)
Low	0 – 0.3
Moderate	> 0.3 – 0.6
High	> 0.6

The significance of residual effects of the Project on wolverine disturbance is summarized in Table 13-39. Residual Project effects on suitable wolverine habitat are considered not significant because they are of moderate magnitude, local, and reversible with reclamation.

Table 13-39: Significance of Residual Effects – Wolverine

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat avoidance from road density	Adverse	Moderate	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant

13.4.3.6 Collared Pika

The residual effects on collared pika include direct and indirect loss of high suitability habitat.

The percentage of highly suitable habitat estimated to be lost, including both direct and indirect, was used to determine the magnitude of effect from Project activities on collared pika. Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 13-40.

Table 13-40: Thresholds for Project Effects to Suitable Collared Pika Habitat

Magnitude of Effect	Habitat Loss Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

The area of direct loss of highly suitable habitat in the LSA is 0.0 km^2 and the area of indirect loss of highly suitable habitat in the LSA is 0.11 km^2. The percentage of highly suitable collared pika habitat estimated to be lost due to Project activities is 0.6% (Table 13-14), equating to a low magnitude effect. All highly suitable habitat loss will be a result of habitat indirectly affected due to sensory disturbances and not the removal of actual habitat. The habitat that will be indirectly affected by sensory disturbances will resume as viable suitable habitat once sensory disturbances are ceased.

The significance of residual effects of the Project on suitable collared pika habitat is summarized in Table 13-41. Residual Project effects on suitable pika habitat are considered not significant because they are of low magnitude and local.

Table 13-41: Significance of Residual Effects – Collared Pika

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat Loss	Adverse	Low	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant

13.4.3.7 Bats

The residual effects on bats include direct and indirect loss of high suitability habitat and direct mortality from vehicle collisions.

The percentage of highly suitable roosting habitat estimated to be lost, including both direct and indirect, was used to determine the magnitude of effect from Project activities on bats. Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 13-42.

Table 13-42: Thresholds for Project Effects to Suitable Bat Habitat

Magnitude of Effect	Habitat Loss Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

The percentage of highly suitable bat habitat that will be lost due to Project activities is 15.7%, equating to a moderate magnitude effect. It should be noted that only 1.5% (0.24 km^2) of highly suitable bat habitat will be directly lost to Project activities. The remaining 14.3% (4.69 km^2) of highly suitable habitat loss will be a result of habitat indirectly affected due to sensory disturbances and not the removal of actual habitat. The habitat that will be indirectly affected by sensory disturbances will resume as viable suitable habitat once sensory disturbances are ceased.

The significance of residual effects of the Project on suitable roosting habitat for little brown bat is summarized in Table 13-43. Residual Project effects on suitable little brown bat habitat is considered not significant because they are of moderate magnitude, local, and is reversible with restoration.

Some direct mortality from collisions with vehicles may occur that cannot be mitigated; however, the magnitude is deemed low because most traffic is during the day. The extent of effects is local resulting in a rating of not significant.

Table 13-43: Significance of Residual Effects – Bats

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat Loss	Adverse	Moderate	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant
Direct mortality	Adverse	Low	Local	Long term	Sporadic	Irreversible	Neutral	Very likely Moderate uncertainty	Not significant

13.4.3.8 Cliff-Nesting Raptors

The residual effects on cliff-nesting raptors include direct and indirect loss of high suitability nesting habitat.

The percentage of highly suitable nesting habitat estimated to be lost, including both direct and indirect, was used to determine the magnitude of effect from Project activities on cliff-nesting raptors. Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 13-44.

Table 13-44: Thresholds for Project Effects to Suitable Cliff-Nesting Raptor Habitat

Magnitude of Effect	Disturbance Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

The percentage of highly suitable cliff-nesting raptor habitat estimated to be lost due to Project activities is 7.2%, equating to a low magnitude effect. It should be noted that 3.6% (0.08 km^2) of highly suitable nesting habitat will be directly lost to Project activities. The remaining 3.6% (0.08 km^2) of highly suitable habitat loss will be a result of habitat indirectly affected due to sensory disturbances and not the removal of actual habitat.

The significance of residual effects of the Project on suitable cliff-nesting habitat is summarized in Table 13-45. Residual Project effects on suitable cliff-nesting raptor habitat are considered not significant because they are of low magnitude and local.

Table 13-45: Significance of Residual Effects – Cliff-Nesting Raptors

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat Loss	Adverse	Moderate	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant

13.4.3.9 Passerines (Olive-sided Flycatcher)

The residual effects on passerines include direct and indirect loss of high suitability habitat and direct mortality from vehicle collisions.

The percentage of highly suitable nesting habitat estimated to be lost, including both direct and indirect, was used to determine the magnitude of effect from Project activities on olive-sided flycatcher. Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 13-46.

Table 13-46: Thresholds for Project Effects to Suitable Olive-sided Flycatcher Nesting Habitat

Magnitude of Effect	Habitat Loss Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

The percentage of highly suitable olive-sided flycatcher nesting habitat estimated to be lost due to Project activities is 19.8% (Table 13-17), equating to a moderate magnitude effect. It should be noted that 5.5% (0.60 km^2) of highly suitable bat habitat will be directly lost to Project activities. The remaining 14.3% (3.12 km^2) of highly suitable habitat loss will be a result of habitat indirectly affected due to sensory disturbances and not the removal of actual habitat. The habitat that will be indirectly affected by sensory disturbances will resume as viable suitable habitat once sensory disturbances are ceased. Residual Project effects on suitable olive-sided flycatcher nesting habitat are considered not significant because they are of moderate magnitude and local.

The olive-sided flycatcher was assessed as a representative of passerines. Each passerine species inhabits a specific niche in the ecosystem; however, there are no ecosystems that will be removed to a significant degree (refer to the effects on vegetation and ecosystem units in Chapter 12). There is a diversity of habitat in the Geona Creek valley that is similar to the diversity in the neighbouring watersheds and it is expected that any displaced birds will use nearby, similar habitat. Therefore, the effects on passerines as a whole are assessed as not significant (low magnitude and local).

The significance of residual effects of the Project on suitable olive-sided flycatcher habitat is summarized in Table 13-47. Direct mortality from collisions with vehicles may occur but is difficult to mitigate. The magnitude is rated moderate because of the variety of species that could be affected. The extent of effects is local resulting in a rating of not significant with moderate uncertainty in the effect.

Table 13-47: Significance of Residual Effects – Passerines (Olive-sided Flycatcher)

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat Loss	Adverse	Moderate	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant
Direct mortality	Adverse	Low	Local	Long term	Sporadic	Irreversible	Neutral	Very likely Moderate uncertainty	Not significant

13.4.3.10 Waterfowl

The residual effect on waterfowl is direct and indirect loss of high suitability habitat.

The percentage of highly suitable habitat estimated to be lost, including both direct and indirect, was used to determine the magnitude of effect from Project activities on waterfowl. Thresholds used to quantify the magnitude of effect resulting from total habitat loss are presented in Table 13-48.

Table 13-48: Thresholds for Project Effects to Suitable Waterfowl Habitat

Magnitude of Effect	Disturbance Threshold (%)
Low	0 – 10
Moderate	10 – 25
High	> 25

The percentage of highly suitable waterfowl habitat estimated to be lost due to Project activities is 19.8% (Table 13-18), equating to a moderate magnitude effect. It should be noted that only 10.5% (1.92 km^2) of highly suitable bat habitat will be directly lost to Project activities. The remaining 9.3% (3.37 km^2) of highly suitable habitat loss will be a result of habitat indirectly affected due to sensory disturbances and not the removal of actual habitat.

The significance of residual effects of the Project on suitable waterfowl habitat is summarized in Table 13-49. Residual Project effects on suitable waterfowl habitat are considered not significant because they are of moderate magnitude, local.

Table 13-49: Significance of Residual Effects – Waterfowl

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat Loss	Adverse	Moderate	Local	Long term	Continuous	Reversible long term	Neutral	Very likely Low uncertainty	Not significant

13.4.3.11 Bumble Bees

The significance of residual effects of the Project on bumble bee habitat is summarized in Table 13-50. The area of direct loss is 651 ha (5% of the LSA) that will be progressively reclaimed with alternate habitat available throughout the LSA. Residual Project effects on bumble bee habitat are deemed not significant because they are low in magnitude, local, and reversible.

13.4.3.12 Summary

In summary, residual effects after mitigation were determined to be not significant for all subcomponents of wildlife and wildlife habitat. In most cases, effects were predicted to be local and occur for the duration of the mine after which most effects are reversed. Effective implementation of the mitigation measures, management plans, and adaptive management will be of utmost importance to ensure the effects remain not significant.

Table 13-50: Significance of Residual Effects – Bumble Bee

Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Significance
Habitat Loss	Adverse	Low	Local	Long term	Continuous	Reversible short term	Neutral	Very likely Low uncertainty	Not significant

13.5 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for wildlife and wildlife habitat follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. Cumulative effects are of particular importance and focus for the Kaska Nation; sustainability of resources in their traditional territory depends on effectively managing the pace and scale of resource development to reduce long-term adverse effects and enhance benefits (Dena Kayeh Institute, 2010). The following Project residual effects have been identified for wildlife and wildlife habitat and are considered through the CEA.

Table 13-51: Residual Effects on Wildlife and Wildlife Habitat

Subcomponent	Residual Effect
Caribou	Direct rut and post calving habitat loss
Caribou	Indirect rut and post calving habitat loss
Caribou	Disturbance of late winter range from aircraft
Caribou	Mortality from collisions with vehicles
Caribou	Increased predation due to increased wolf access on cleared roads
Moose	Direct early winter and late winter habitat loss
Moose	Indirect early winter and late winter habitat loss
Moose	Disturbance of late winter range from aircraft
Moose	Mortality from collisions with vehicles
Moose	Increased predation due to increased wolf access on cleared roads
Grizzly bear	Direct and indirect growing season habitat loss
Grizzly bear	Direct and indirect denning habitat loss
Grey wolf	Direct and indirect loss of habitat due to ungulate loss of habitat
Wolverine	Habitat avoidance from road density
Collared pika	Loss of highly suitable habitat
Bats	Loss of highly suitable habitat
Passerines (olive-sided flycatcher)	Loss of highly suitable habitat
Cliff-nesting raptors	Loss of highly suitable habitat
Waterfowl	Loss of highly suitable habitat
Bumble bee	Loss of habitat

13.5.1 Cumulative Effects Characterization

For past, present, and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the project or activity results in a demonstrable or measurable effect on the VC;
2. The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

The potential cumulative effects for wildlife and wildlife habitat are identified through the screening in Table 13-52. Further detail on the projects and activities considered below is provided in Section 5.7. Where the above conditions are met, the potential cumulative effects are described further below.

Table 13-52: Cumulative Effects Screening for Wildlife and Wildlife Habitat

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Wolverine Mine (*Yukon Zinc Corp.)*	Yes (project occurs in the FCH habitat range; project occurs in GMS 10-07)	Yes (loss of habitat; all species, with focus on ungulates)	Yes (mine was abandoned in 2015 – but habitat loss is still a residual effect)	Yes
Fyre Lake Property (*Pacific Ridge Exploration)*	Yes (project occurs in the FCH habitat range; project occurs in GMS 10-07)	Yes (loss of habitat; all species, with focus on ungulates)	Yes (project activities scheduled to occur annually beginning in 2015)	Yes
Selwyn Project *(Selwyn Chihong Mining Ltd)*	Yes (project occurs in the FCH habitat range)	Yes (loss of habitat; partial movement barrier; all species, with focus on ungulates)	Yes (current project activities assessed until 2021)	Yes
Ketza River Mine *(Ketza Group/ Veris Group*)	No (project occurs outside the FCH habitat range and outside GMS 10-07)	Yes (indirect effects on FCH)	No (mine abandoned)	No
Yukon Base Metal Project *(Overland Resources Ltd.)*	No (project occurs outside the FCH habitat range and outside GMS 10-07)	N/A	N/A	No
Grew Creek (*Golden Predator Corp*.)	No (project occurs outside the FCH habitat range and outside GMS 10-07)	N/A	N/A	No
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	Yes (project occurs in the FCH habitat range; project occurs in GMS 10-07)	Yes (loss of habitat; partial movement barrier; mortality from collisions; all species, with focus on ungulates)	Yes (current exploration activities assessed until 2021)	Yes
3 Aces Property (*Golden Predator Corp*.)	No (project occurs outside the FCH habitat range and outside GMS 10-07)	N/A	N/A	No

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Robert Campbell Highway	Yes (highway occurs in the FCH habitat range; highway occurs in GMS 10-07)	Yes (loss of habitat along alignment; partial movement barrier; mortality from collisions; all species, with focus on ungulates)	Yes (highway is active)	Yes
North Canol Road	No (highway is located outside the FCH habitat range and outside GMS 10-07)	N/A	N/A	No
Ross River	Yes (Ross River is in the FCH habitat range)	Yes (loss of habitat, including a 3 km perimeter of indirect loss around the townsites)	Yes (communities are active)	Yes
Guided Outfitting	Yes (outfitting occurs in the FCH habitat range; outfitting occurs in GMS 10-07)	Yes (direct risk of mortality – ungulates, grizzly bear)	Yes (guided outfitting is active)	Yes
Recreational Hunting	Yes (hunting occurs in the FCH habitat range; hunting occurs in GMS 10-07)	Yes (direct risk of mortality – ungulates, grizzly bear)	Yes (recreational hunting currently active)	Yes
First Nation Hunting	Yes (hunting occurs in the FCH habitat range; hunting occurs in GMS 10-07)	Yes (direct risk of mortality – ungulates, grizzly bear)	Yes (First Nations hunting currently active)	Yes
Traplines	Yes (traplines)	Yes (direct mortality risk of - furbearers)	Yes (traplines are current)	Yes

Note: If "No" is indicated for a condition the remaining conditions are indicated as N/A (not applicable) as all conditions must be met for potential cumulative effect to be identified.

As seen in the table above, there are potential cumulative effects for the Project in combination with the Wolverine Mine, Fyre Lake Property, Selwyn Project, Pelly Exploration, Robert Campbell Highway, guided outfitting, recreational hunting, First Nation hunting, and traplines. The significance of the cumulative effects of these projects/activities for caribou, moose, grizzly bear, and furbearers are discussed below. Cumulative effects were not assessed for all other species because their life-cycle range does not extend beyond the LSA and therefore will not be affected by other projects occurring concurrently. The following subsections discuss cumulative effects for caribou, moose, grizzly bear, and furbearers.

13.5.1.1 Caribou

Caribou are particularly sensitive to cumulative effects. Firstly, they are not well adapted to habitat degradation, fragmentation, and human disturbance (Vors and Boyce, 2009). Management experience has shown that human infrastructure that greatly increases access by humans combined with herd fragmentation will lead to an eventual decline in caribou (Johnson et al., 2005; Wittmer et al., 2005). Moreover, they are a wide-ranging species across the landscape that utilize

many different habitats throughout their life-cycle, and are therefore susceptible to human disturbance across a large spatial scale. Although companies monitor wildlife movements and behavior across their own development sites, there are few studies that quantify disturbance effects across the wider geographic range of caribou herds.

Zone of influence analyses can assist cumulative effects analyses. As described in Section 13.4.1, a study was conducted on northern mountain woodland caribou in over an area of 11,594 km^2 near Atlin, BC. The cumulative effect of roads, mines, and towns was quantified as an indirect high quality habitat loss of 8% in winter and 2% in summer due to avoidance in the zones of influence (Polfus et al, 2011). In a study of the Carcross herd winter range in the southern lakes district, Florkiewicz et al. (2007) found that caribou were spaced significantly further from an estimated zone of influence ranging from 250 m to 1,000 m based on identified land use activities and infrastructure. However, although some level of cumulative effect will occur, a clear separation of the cumulative effect from development and the effect from the natural variation in caribou range use and demography is challenging.

The continual development of land and increasing pressure from multiple land uses, especially on ranges and habitats for key life stages of caribou, are important factors that play a key role in the reduction of the overall abundance of herds. These key life stage habitats are finite, so maintaining their integrity is essential to maintaining the posterity of the species. An increase of human disturbance can lead to range abandonment and fragmentation, which can result in a large-scale loss of range or extirpation in a given area, such as what has happened in Europe (Nellemann et al., 2003).

For this study, cumulative effects on the FCH were assessed based on a quantification of the zones of influence from the various projects and activities in the herd's range (Figure 13-20). This figure illustrates how the FCH range is bounded on the west by the North Canol road and the Town of Ross River, and partitioned north and south by the Robert Campbell Highway. Mineral properties of Fyre Lake, Wolverine, Pelly Exploration, and KZK influence caribou rut habitat (Figure 13-8) in the FCH range south of the Robert Campbell Highway; the Selwyn mineral property influences rut habitat at the north end of the FCH range. Together, these activities influence approximately 12% (2,365 km^2) of the FCH range (20,369 km^2) after adding the direct footprints of the claims and roads and a 2 km avoidance zone supported by the study by Polfus et al. (2011). The Project and associated claims equates to 2% (375 km^2) of the 12% cumulative disturbance in the FCH range. It should be noted that disturbance is conservatively based on claim boundaries since information is limited for specific footprints of disturbance. Actual footprints will be less, but this provides a coarse estimate to gauge relative and worst case cumulative disturbance.

Other pressures on the herd include First Nation, guided, and recreational hunting, which cannot be easily mapped; however, hunting has been found to generally occur in 1 km of roads (Daust and Morgan, 2013). The resulting magnitude of cumulative effect from habitat loss and fragmentation is considered low, less than 10% (referring back to Table 13-30) when actual footprints are considered rather than overly conservative mineral claim blocks.

It should also be noted that the human development is just part of the complex set of factors affecting the FCH population. Other major influencing factors include predation, annual weather variability

(especially snow depth and distribution), and climate change. Predation is known to be one of the most significant factors affecting the herd population given the results from the wolf control program discussed earlier in Section 13.3.1. As discussed earlier in Section 13.4.1.1, the available habitat could support a larger herd; therefore, the incremental increase of development of the Project is not expected to be a large contributor to cumulative effects on the herd. Causes of population change appear to be less likely attributed to habitat losses than to predator and climate changes. A consistent monitoring program (lead by YG) over time would help track variations in the population and give clues to the causes of population changes.

13.5.1.2 Moose

Moose are more resilient to habitat changes than caribou, and in some instances, clearing of land can increase moose populations because the new growth is a desired food source. Nonetheless, moose are sensitive to human activity, especially hunting, and avoid roads except during migrations when they use trails and corridors; these disturbances affect ungulate energetics and populations (Neumann, 2009).

Figure 13-20 illustrates the areas of development in relation to the zones of influence for GMS 10-07. In GMS 10-07, moose are or will be affected by the mineral properties of Fyre Lake, Wolverine, Pelly Exploration, and KZK, the Robert Campbell Highway, and First Nation, guided, and recreational hunting. Exploration and mining claims and the highway plus a 2 km buffer around all boundaries covers 32% of the GMS 10-07 area. These activities fragment the habitat in GMS 10-07; however, the actual footprints of disturbance of projects are estimated at less than 10% resulting in a low magnitude rating for cumulative direct and indirect effects on the moose habitat and population. Large stretches of undisturbed tracts of land will still be available in GMS 10-07. It should be noted that following Kaska land management guidance, cumulative effects from habitat fragmentation can be minimized in the future by avoiding construction of roads that create circle routes that connect main roads (Dena Kayeh Institute, 2010). There are no circle routes created by any of the projects in the RSA which helps minimize fragmentation.

13.5.1.3 Grizzly Bear

Cumulative effects on grizzly bear in GMS 10-07 are expected from combined effects of the mineral properties of Fyre Lake, Wolverine, Pelly Exploration, and KZK, the Robert Campbell Highway, and First Nation, guided, and recreational hunting.

Grizzly bear densities in the Southern Lakes region of Yukon were estimated at 10 to 16 bears per 1,000 km^2 (Larsen et al., 1989). Densities are expected to be higher in the east-central Yukon compared to the Southern Lake region, as there is less human effect on wilderness, fewer roads, and lower hunting pressure (Desrochers et al., 2002; Environment Yukon, 2005); therefore, it is estimated there would be more than 30 grizzly bears in GMS 10-07. YG recorded harvest data averaged one grizzly bear per year from 1998 to 2014. No grizzly bear were harvested in GMS 10-07 in 2015 or 2016.

The thresholds chosen in Section 13.1.2 indicate that there should not be grizzly bear mortalities and road densities should be below 0.6 roads/ km^2. For GMS 10-07, there is the risk that grizzly bear

mortalities could have a higher occurrence from multiple projects and activities for this region due to the overall increase in frequency of human-bear encounters. However, no grizzly bear mortalities should cumulatively occur from vehicle collisions or project conflicts if all projects follow appropriate practices for working in bear country. If one or two mortalities occur in the region, this would represent a 4% to 7% loss in the population. This is above the conservation threshold for the Project presented in Table 13-3; however, a loss of one to two bears in the RSA would be similar to historic harvest numbers that have not reduced the regional grizzly bear population. Road densities are expected to remain below 0.6 roads/km^2 in GMS 10-07.

13.5.1.4 Furbearers (Grey Wolf and Wolverine)

Cumulative effects on furbearers are expected from combined effects of the mineral properties of Fyre Lake, Wolverine, Pelly Exploration, and KZK, the Robert Campbell Highway, and traplines. The two representative furbearers for this EA are grey wolf and wolverine.

Grey wolf populations follow caribou and moose populations; therefore, it is expected that cumulative effects to caribou and moose populations would also result in cumulative effects to wolf populations. The cumulative effects for both caribou and moose are considered low magnitude, therefore the cumulative effects on wolf populations are also considered low. This estimate is based on cumulative effects of the surrounding mineral properties, the highway, and trapline harvest. The level of cumulative effect is unknown because harvest is not reported; however, the regional wolf populations appear to be healthy and widespread based on the extent of wolf sightings and signs. These populations are already affected by the Robert Campbell Highway, the Wolverine mine, and surrounding exploration activities.

Effects on wolverine were considered moderate magnitude for the Project; however, road densities are low (less than 0.6 roads/km^2) and are expected to remain at less than 0.6 roads/km^2 in the RSA even if all proposed projects proceed. Therefore, no cumulative effect is expected.

Habitat fragmentation and movement barriers at the regional scale are less important for some of the smaller furbearers than larger mammals simply because of the size of the ranges. The trapline harvest in combination with accidental mortalities and habitat losses from activity on the mineral properties are also not expected to have residual cumulative effects. The mineral properties are widespread and would not create barriers for small mammals nor affect any significant areas of important habitat.

500000 600000 700000

1000000 900000 800000 700000

N W E S

MACTUNG MINE

THE YUKON BASE METAL PROJECT

SELWYN PROJECT

FARO MINE

FARO

Johnson Lake Campground

GREW CREEK PROPERTY

Lapie Canyon Campground

ROSS RIVER

CANTUNG MINE

3 ACES PROPERTY

PELLY EXPLORATION

KUDZ ZE KAYAH PROJECT

KETZA RIVER

Francis Lake Campground

WOLVERINE PROPERTY

FYRE LAKE PROPERTY

Kilometres 25 0 25 50

Kudz Ze Kayah Project

Exploration/Licencing

Temporary Closure/Reclamation/Closed/ Abandoned

Community

Campground

FCH Habitat Range

FCH Habitat Range 25 km Buffer

Potential Disturbance/Activity (5 km Buffer)

Potential Disturbance/Activity (10 km Buffer)

Quartz Mining Activity

Regional Study Area (Game Management Subzone 10-07)

Trapline Concession

Outfitting Concession

BMC MINERALS

ALEXCO ENVIRONMENTAL GROUP

KUDZ ZE KAYAH PROJECT

FIGURE 13-20

WILDLIFE CUMULATIVE EFFECTS ASSESSMENT AREAS AND PROJECT ACTIVITIES

JANUARY 2016

D:\Project\All\Projects\Kudz_Ze_Kayah\Maps\01_Overview\03-SpecificTopics\Cummulative_Effects_Land_Tenure\Caribou \Cumulative_FCH_Buffers_20161128.mxd (*Last edited by: amatlashevska;30/12/2016/09:47 AM*)

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In summary, the following potential cumulative effects have been identified for wildlife and wildlife habitat:

- FCH habitat loss and fragmentation;
- Moose habitat loss and fragmentation; and
- Grizzly bear habitat loss and fragmentation.

13.5.2 Cumulative Effects Mitigation Measures

Potential cumulative effects on wildlife and wildlife habitat and identified mitigation measures are summarized in and discussed further below.

It should be noted that cumulative effects need to be managed at the land use planning level with a variety of parties, including YG and RRDC Land Stewards. BMC is committed to working with YG, RRDC, other project proponents, and other stakeholders to address potential cumulative effects on FCH.

Table 13-53: Proposed Cumulative Effects Mitigation Measures for Wildlife and Wildlife Habitat

Potential Cumulative Effect	Mitigation Measures Identified for Project Effects	Additional Mitigation Measures (if possible)	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual cumulative effect identified? (Yes/No)
FCH habitat loss and fragmentation	Reclamation Speed limits Radio controlled Access Road Signage at road crossings on movement corridors	Collaboration with YG, RRDC Land Stewards, and other project owners	Medium	Yes
Moose habitat loss and fragmentation	Reclamation Speed limits Radio controlled Access Road Signage at road crossings on movement corridors	Collaboration with YG, RRDC Land Stewards, and other project owners	Medium	Yes
Grizzly bear habitat loss and fragmentation	Reclamation Speed limits Radio controlled Access Road	Collaboration with YG, RRDC Land Stewards, and other project owners	Medium	Yes

13.5.3 Cumulative Effects Significance Assessment

The significance of residual effects as a result of the Project on wildlife and wildlife habitat are summarized in Table 13-54.

Cumulative effects on caribou in the FCH range are assessed as low magnitude, regional, long-term, continuous, and reversible. The FCH has a high context, the effects are likely with a medium uncertainty. The result is a rating of not significant cumulative effects mainly because the magnitude of effects is low. Nonetheless, the FCH is considered the valued subcomponent with the highest social context for the Project, and BMC is committed to continue to work with government, RRDC and other stakeholders during the life of the mine to monitor the FCH population. Data from the monitoring program can be used by YG to help manage the herd.

Cumulative effects on moose were deemed low magnitude, regional, long-term, continuous, reversible, high context, and medium uncertainty. The resulting rating was not significant. Moose occurrences at the Project will be recorded over time to track use around the Project and follow up on predicted effects.

Cumulative effects on grizzly bear were deemed low magnitude, regional, long-term, continuous, reversible, high context, and medium uncertainty. The resulting rating was not significant. Similar to moose, grizzly bear occurrences will be tracked with the wildlife log.

Table 13-54: Cumulative Effects Significance Assessment for Wildlife and Wildlife Habitat

Residual Cumulative Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental and Socio-economic Context	Likelihood	Cumulative Effect Significance
FCH habitat loss and fragmentation	Adverse	Low	Regional	Long-term	Continuous	Reversible long term	High	Likely Medium uncertainty	Not significant
Moose habitat loss and fragmentation	Adverse	Low	Regional	Long-term	Continuous	Reversible long term	High	Likely Medium uncertainty	Not significant
Grizzly bear habitat loss and fragmentation	Adverse	Low	Regional	Long-term	Continuous	Reversible long term	High	Likely Medium uncertainty	Not significant

Note: Criteria definitions are provided in Table 13-3.

13.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the level of implementation and effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

In recognition of Kaska land stewardship role and due to the relevance of TK in the interpretation of wildlife monitoring data, Kaska members will be included in conducting the wildlife monitoring programs and interpreting the resulting data, wherever practicable.

BMC's wildlife monitoring program will focus on identifying changes to wildlife use and movement patterns resulting from Project development and operations. The monitoring program occur every three years (or more frequently if adaptive management plan deems required) during operations and closure, and will follow baseline study protocols with focus on key species and seasons. Traditional knowledge and scientific research will be integrated as it becomes available to help in the interpretation of ongoing monitoring data. In general, where possible and interest exists, one to two Kaska Land Stewards and/or TK Team with Kaska TK regarding wildlife will be contracted to participate in ongoing surveys of the wildlife monitoring programs. Kaska involvement will ensure their understanding of the effects of the mine on wildlife, especially culturally important species, and to ensure consideration and/or integration of Kaska TK into the monitoring program. Kaska Land Stewards and/or TK Team will review their contributions to the programs as part of the annual report before it goes to regulators.

Monitoring data will be reviewed and incorporated into annual reports, according to permit conditions, to identify whether the objectives and targets of the wildlife protection plan are being met and determine if any corrective actions or changes may be needed to mitigate wildlife impacts from the Project in comparison to the AMP thresholds (i.e. populations, diversity, locations, incidents).

A summary of BMC's wildlife survey frequency and schedule for the wildlife monitoring program is provided in Table 13-55.

Table 13-55: Wildlife Monitoring Programs

Program	Purpose and Methodology	Frequency and Timing
Wildlife Records Program	Observations and locations reported by employees and contractors on site and along access road.	Ongoing with results reviewed and reported annually.
Winter Wildlife Monitoring	Surveys will include snow track surveys to be completed at least every month shortly after fresh snow fall. Each month where there is snow cover. Gives information on small and medium furbearers as well as larger mammals. Helps determine winter travel routes. Surveys will also look for wolf dens to help interpret ungulate population trends.	Surveys will be carried out every three years depending on the results following the adaptive management plan. Survey to be conducted approximately between October to April each year (dependent on weather and snow conditions).
Finlayson Caribou Herd Fall Composition Counts	Aerial surveys to be carried out by helicopter during the fall rut period. Survey will be consistent with the methods and area surveyed in 2015 and 2016.	Surveys will be carried out every three years depending on the results following the adaptive management plan. Survey to be conducted from late- September to early October.
Moose Late Winter Survey	Aerial Surveys of moose in late winter in the study area to locate critical late winter habitat. Survey will be consistent with the methods and area surveyed in 2015 and 2016.	Surveys will be carried out every three years depending on the results following the adaptive management plan. Survey to be conducted from late winter (March - April).
Breeding Bird Counts	Determine trends in nesting bird populations in local study areas. Control sites established outside of Zone of Influence.	Surveys will be carried out every three years depending on the results following the adaptive management plan. Survey to be conducted from Spring May – June.
Facility Monitoring	Routine checking for wildlife issues on the site. Include checks to remove/prevent potential nesting locations during the pre-nesting period. Regular inspections of beaver dams to ensure culverts and creeks are flowing and not inhibiting correct operation of water management facilities.	Emphasis on migration periods spring (~April - June). Checks will be carried out regularly during the spring, summer and fall.

The proposed monitoring for wildlife and wildlife habitat is summarized as follows:

- Caribou - Regular surveys of the Finlayson caribou herd will continue to be conducted in concert with YG and RRDC. The purpose of the monitoring program will be to track habitat use and population trends to assess whether the predicted rut habitat avoidance occurs and whether the lost habitat or indirect effects on predation are affecting the overall population or recruitment. Caribou populations fluctuate naturally even in the absence of human intervention. The factors that influence population trends include predation, climatic effects, habitat availability, pathogens, and a host of other complex causes (Skoog, 1968). The presence of these natural events can obscure human caused effects on caribou populations. Conclusions about human impacts on caribou demography, movements, and behavior patterns can only be determined through direct correlation of cause and effect which requires ongoing monitoring. An emphasis on a population/demographic scale for caribou may be equally and perhaps more important than individual and group scale observations which cannot be extrapolated to the population level. Meaningful ecological data on limiting factors

(e.g., weather data, snow course surveys, wildfire mapping of the area) should continue over the duration of the Project.

- Moose - Actual effects from the Project on moose populations and distribution will be evaluated through periodic late winter ungulate surveys. Of particular interest will be the population numbers and distribution around late winter habitat east and west of the Access Road. It is predicted that the moose will continue to move east and west across the road through the winter with implementation of traffic controls and ploughing frequent breaks in the snow banks beside the road. Monitoring will help determine the effectiveness of these mitigation measures.
- Grizzly bear - The main purpose of the grizzly bear monitoring program is to prevent the disturbance of mining on hibernating bears. The area surrounding the open pit will be monitored during the pre-denning period to determine if there are any bears that may try to build a den near the open pit. This survey can be tied in with the annual caribou rut count survey when pre-denning bears are usually observed. If denning behaviour is observed, mitigation measures will then be developed with RRDC Land Stewards and YG conservation officers.
- Wolf, wolverine, and other furbearers – Furbearers such as wolf, wolverine, and small mammals will be monitored through a Winter Wildlife Monitoring Program to provide information on the presence of furbearers, as well as help determine winter travel routes and denning locations for a variety of species. Wolf den surveys were not specifically conducted for the Project but unpublished data indicates dens may be present near the Tote Road and north of the Robert Campbell Highway (Farnell, pers. comm). Due to the predator-prey relationship between wolf and ungulates, wolf dens will be added to the future wildlife monitoring program for the Project.
- Collared pika – Monitoring of collared pika will be through the Wildlife Records Program. The objective is to check if collared pika will be disturbed more than expected from Project activities.
- Raptors – The raptor nest located in the direct area of disturbance will be monitored annually to determine its status on a yearly basis. In addition to monitoring currently existing nest sites, BMC will conduct pre-nesting surveys to reduce the chance of disturbance from construction or operations.
- Passerines – The objective of bird monitoring is to track Project effects on bird use of the area and Project conformance with the purpose of the *Migratory Birds Convention Act*, to protect and conserve migratory birds. Point-count surveys will be conducted during the breeding bird season (June – July) to monitor long-term trends in nesting bird populations in the LSA. Surveys will be conducted after mine development and every three years through closure. Surveys will also occur outside the LSA to act as a control site to monitor natural fluctuations in breeding bird populations in the regional area. In addition to monitoring for the occurrence of nesting birds, routine monitoring to remove/prevent potential nesting locations will occur during the pre-nesting period.

- Waterfowl – The objective of bird monitoring is to track Project conformance with the purpose of the *Migratory Birds Convention Act*. Waterfowl use of the water management and water treatment ponds, as well as the fish habitat compensation ponds, will be monitored during operations as part of the regular Wildlife Records Program. Waterfowl deterrent actions will be implemented if water quality monitoring results of these ponds exceed acceptable standards. Monitoring of the reference wetlands outside the LSA will continue to maintain a record of waterfowl abundance and diversity at wetlands.

Additional mitigation measures may need to be implemented as the Project proceeds depending on the results of the follow-up monitoring through the adaptive management plan. Adaptive management is an important part of the Kaska land management framework that works to learn from collected information and improve on environmental management practices to reduce environmental effects as well as help prevent cumulative effects (Dena Kayeh Institute, 2010).

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

14 HERITAGE RESOURCES 14-1

14.1 ASSESSMENT APPROACH 14-1
14.1.1 Regional Setting 14-2
14.1.2 Selection of Subcomponents and Measurable Parameters 14-6
14.1.3 Criteria for Assessing Significance 14-7
14.2 ASSESSMENT BOUNDARIES 14-10
14.3 EXISTING CONDITIONS 14-13
14.4 PROJECT-SPECIFIC EFFECTS 14-15
14.4.1 Effects Characterization 14-15
14.4.2 Mitigation Measures 14-18
14.4.3 Residual Effects and Significance Determination 14-20
14.5 CUMULATIVE EFFECTS ASSESSMENT 14-20
14.6 EFFECTS MONITORING 14-20

LIST OF TABLES

Table 14-1: Heritage Resources Subcomponents and Measurable Parameters 14-7
Table 14-2: Heritage Resources Significance of Impacts Criteria Definition 14-8
Table 14-3: Study Areas for Heritage Resources 14-10
Table 14-4: Interaction Matrix for Heritage Resources 14-16
Table 14-5: Identified Potential Project Effects for Heritage Resources 14-17
Table 14-6: Proposed Mitigation Measures for Heritage Resources 14-19

LIST OF FIGURES

Figure 14-1: Heritage Resources Local Study Area 14-12

14 HERITAGE RESOURCES

This chapter provides an overview of the existing heritage resource conditions and assessment of the potential Project effects on heritage resources. Heritage resources were selected as a VC due to existing legislation and the high significance given them by the RRDC and LFN.

Heritage resources in Yukon are protected under the Yukon *Historic Resources Act* (Yukon Government, 2012), and protected and managed under provisions of the Yukon First Nations Umbrella Final Agreement (UFA) (Council of Yukon First Nations, 1993). Specifically, the provisions are included in Chapter 13 of the UFA. Besides the *Historic Resources Act*, the following additional legislation also serves to protect and manage heritage resources including chance finds:

- The Quartz Mining Regulation (YOIC, 2003/64) – under the *Quartz Mining Act* (Yukon Government, 2016) specifically Schedule 1 Operating Conditions, Section E regarding historic objects and burial grounds; and
- The Land Use Regulation under the *Territorial Lands (Yukon) Act* – specifically Section 9 (Prohibitions) (Yukon Government, 2014).

Other guidelines and polices that apply to the management of heritage resources include the Operational Policy for Heritage Resources Management on Yukon Lands, which communicates the Yukon Government's position on ownership and management of heritage resources (Yukon Government, 2010), and the guidelines for Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon (Yukon Government, 1999).

14.1 ASSESSMENT APPROACH

The Heritage Resources Impact Assessment (HRIA) generally follows the methods outlined in Chapter 5. The assessment approach also included those methods outlined in the Yukon Archaeological Sites Regulations (Yukon Government, 2003b) and corresponding Guidelines for Archaeological Permit Holders. The HRIA efforts were conducted under Class 2 permits following methods listed in each applicable permit application. The 2015 HRIA was conducted under permit #15-10ASR, and the 2016 HRIA efforts were conducted under permit #16-04ASR. These methods included a review of past heritage studies in the vicinity of the Project, in-field pedestrian assessment, subsurface shovel testing, site recording, impact assessments, reporting, and recommendations for resource management. The results and recommendations of the HRIA efforts were reported to BMC, the Yukon Government Heritage Resources Unit, RRDC, and LFN.

The assessment approach also includes integrating traditional knowledge (TK) with contemporary scientific knowledge as part of the provisions contained in the bilateral Socio-economic Participation Agreement between BMC and Kaska. Through this cooperative approach Kaska have committed to giving early and clear information to BMC on any environmental concerns they have, and BMC has committed to integrating TK into the gathering of information, the conduct of environmental baseline studies and the preparation of its reports related to the project. As such a Kaska Ethnographic Overview of the Kudze Ze Kayah Project has been prepared by Dialectic Research Ltd and is included as Appendix F-3, and corresponding overlaps of TK and heritage resources assessments are

discussed within this chapter. This ethnographic overview prepared by Dialetic Research Ltd was a desktop effort and did not include informant interviews and fieldwork. In addition, RRDC is also conducting Project-specific TK work and any new or additional pertinent information provided will be integrated into final project design and operations.

14.1.1 Regional Setting

The following is an overview of the culture history for the regional study area (RSA, see Section 14.2) consisting of the southern Yukon. Many researchers have reviewed the cultural history of this area and related it to a broader cultural history, and have presented the information using a variety of terms and temporal ranges (Workman, 1978; Clark, 1981; Wright, 1995, 1999; West, 1996). Temporal ranges listed here begin with years before present abbreviated BP.

14.1.1.1 Prehistoric Period (>11,000 BP to ca AD 1700s)

The earliest prehistoric occupation, which dates to early post-glacial times, is known as the Northern Cordilleran tradition (Clark, 1983; Hare, 1995). Only a few early Northern Cordilleran tradition occupations are known at present. One such site is located near Beaver Creek, dated to 10,670 radiocarbon years before present (BP) (Heffner, 2002). The majority of sites in this period appear to date older than 7,000 to 8,000 BP. The Northern Cordilleran tradition, with some overlap, predates the introduction of microlithic technology from Alaska into the interior of the central and southern Yukon (Clark, 1983; Hare, 1995).

The Little Arm phase dates from 7,000 to approximately 4,500 BP (Workman, 1978; Clark and Gotthardt, 1999) and can be defined by the use of microlithic technologies. After about 4,500 BP, there is less evidence of microblade use in Yukon, and an increase in the use of notched projectile points and a variety of scraping and carving tools. This is labeled the Taye Lake phase in southwest Yukon, or more broadly in Yukon and Alaska, the Northern Archaic tradition (Workman, 1978; Hare, 1995). The most recent archaeological culture of southern Yukon is that of the Aishihik phase (Workman, 1978). This phase is thought to be a cultural development from the earlier Taye Lake culture, although there are some significant differences in technology. The most notable is the introduction of the bow and arrow, replacing a type of throwing spear known as an atlatl (Hare et al., 2004). These Aishihik phase sites are found above the White River Volcanic ash layer (also known as Tephra) that is dated to about 1,250 BP (Clague et al., 1995).

14.1.1.2 Athabaskan Period (ca AD 500 to AD 1840s)

In the Athabaskan Period, the Project area is thought to have been populated by ancestors of the current RRDC and LFN which may have been comprised of the Shu-tah Dene, Northern Tuchone, and Kaska. A great deal of information concerning the Northern Tutchone people was recorded in oral traditions passed on through generations and recorded by various researchers (McClellan, 1981; Dobrowolsky, 1987; Gotthardt, 1987; McClellan et al., 1987; Legros, 1999).

From a tool kit perspective, the Athabaskan period has been identified as a shift to stemmed projectile points, the increased use of bone and antler projectile points, and the use of the bow and arrow.

This late prehistoric period is defined by those archaeological components dating after the fall of the White River Tephra. The Aishihik phase has been evaluated as ranging from approximately AD 750 to AD 1750 and also includes the use of native copper tools, stemmed projectile points, and gorges. Also indicative of the Aishihik phase are small stemmed Kavik points, end and side scrapers, and ground adzes (Hare, 1995). The poor preservation of organic materials makes the task of diet reconstruction more difficult than at coastal sites, but there is evidence of continued use of a variety of large and small mammals, fish, and birds. In the high elevations of the southern Yukon ice patches, examples of the transition from the older atlatl technology to the bow and arrow use has been clearly documented by recent finds (Hare et al., 2004). The shift to the new technology was a rather abrupt one at roughly AD 750 based on a good sample of dated atlatl dart shafts and bow and arrow remains.

14.1.1.3 Proto-historic Period (AD 1700s to ca AD 1840s)

The proto-historic period, as presented here, also overlaps with the late Athabaskan Period and can be defined by the appearance of non-native goods, other early trade items, and foreign (western or eastern) influences, but not the documented accounts of westerners themselves. Other indicators of the proto-historic period are the arrival of the first non-native diseases and oral traditions concerning non-natives. This period spans the time between the first introduction of non-native influences or artifacts, and the recording of first hand or primary written accounts. Unlike other cultural periods with more specific temporal ranges it is difficult and perhaps impossible to determine when the first 'outside' influences of Russian, Asian, European, or other cultures began to impact First Nations people in the Yukon interior.

Some of these far reaching effects may have been passed along from Russian exploration in the early and mid-1700s (Veniaminov, 1984) and other Asian and European (Andreev, 1944; Quimby, 1985) exploration and their contact with coastal communities. The Chilkat Tlingit from the Northwest Coast travelled and traded with many interior First Nation peoples throughout this proto-historic period, including the Kaska and the Northern Tutchone, and occasionally the Mountain Dene people from as far away as Fort Norman on the Mackenzie River. The Tlingit protected and controlled the trading routes into the interior and defended those routes when they were threatened. News of early non-native explorers and traders would have travelled inland along with foreign items such as metals, cloths, glass beads, and later tobacco and other goods.

In some of the earliest cases, the impacts of these foreign cultures could have had significant impacts even without the presence of the foreigners themselves. Such is the case for what is called 'drift-iron' whereby metals and other materials from Asian or European shipwreck wash ashore. Historical accounts of shipwrecks were reported in the mid-1700s, but much earlier wrecks were possible. Metals and other foreign trade items have been derived from ship wrecks off what is now British Columbia, southwest Alaska, and perhaps the northwest Alaska as well.

14.1.1.4 Historic Period (post AD 1840s)

During the early years of this period the Russians were expanding their exploration and trade network along the Pacific coast and up the major rivers of the Alaskan interior, while the British were exploring eastward into what would become Canada's Northwest and Yukon Territories, as well as Alaska. In the 1840s, representatives of the Hudson's Bay Company (HBC) established trading posts closer to the local study area. Frances Lake Post was established by the narrows of Frances Lake in 1840 while Fort Pelly Banks was constructed in the winter of 1842-43 on the Pelly River at the mouth of Campbell Creek. Fort Yukon was established by John Bell at the confluence of the Yukon and the Porcupine Rivers in 1847. The next year Robert Campbell established Fort Selkirk on the upper Yukon River and then relocated to an improved location in 1851. The Frances Lake post functioned primarily as a meat post and then as a staging post enroute to Fort Selkirk. These posts were plagued by starvation, poor supply and poor trade due to hostilities and feuding.

The location of Fort Selkirk was known to upset the Chilkat Tlingit who controlled the trade routes from the coast to the central Yukon. In 1852, a Chilkat Tlingit raiding party travelled inland and forced Robert Campbell and his crew to leave the trading post, which was consequently burned by the Northern Tutchone (Castillo, 2012). The posts at Frances Lake and the at Pelly Banks Fort were abandoned by the Hudson's Bay Company by 1851-1852, while Fort Halkett, on the Upper Liard River near what would become the BC-Yukon border, remained open until 1865.

In 1867, US Secretary of State William Seward was able to focus increasing American interests, and he convinced the United States Senate to purchase Alaska from Russia. Soon after the purchase, the US Army sent Captain Raymond up the Yukon River on the first stern-wheel steamer to reach Fort Yukon (Grauman, 1977). Raymond surveyed the location of Fort Yukon and proved that it was within US territory. The British sold the Fort to the US Government and relocated east across the 141st Meridian.

The inland fur industry continued to drive exploration and settlement into the late 1800s, but mining would shift the focus to the placer gold found in streams and alluvial deposits. Mining in the second half of the 19th century was a risky but often very lucrative enterprise. The impacts of mining would spread quickly and drastically change the larger regional area.

Mineral prospecting and mining efforts in the second half of the 19th century were in some ways very dependent on the existing infrastructure of the fur trading and missionary efforts. As the competition for the inland fur trade grew, so would the number of stern-wheelers on the Yukon River. These steamers could better supply the small number of trading posts along the Yukon and its tributaries and reduce the risk of prospectors running short of supplies. Therefore, more of the fur traders and other explorers turned their attention to search for gold and other minerals. Three key prospectors in the north were L.S. (Jack) McQueston, Al Mayo, and Arthur Harper. They wrote to miners in the United States to encourage them to come north. They also established outposts along the Yukon River, including Fort Reliance, established in 1874 near the confluence of the Klondike River (what would become Dawson City) (Wright, 1976).

Harper and another man may have been the first to travel up the Fortymile River in search of gold in 1881 (Buzzell, 2003). They collected a very rich sample, but were unable to relocate the exact location of their original find. In 1886, McQueston, Harper, and Mayo built a post on the confluence of the Stewart and Yukon Rivers which provided supplies for additional prospectors. Also in 1886, Howard Franklin made a richer find on the Fortymile River. Others rushed in and these claims along the Fortymile River attracted miners from across central and eastern Alaska, and even southeast Alaska. Forty Mile was the first town to grow to over a thousand people by the mid-1890s (Buzzell, 2003), and in 1887 the Stewart River post was deserted. Some prospectors that did not find easy success in Fortymile returned to the Stewart River and continued work in the area. In 1890, Harper re-established a trading post at the site of the old HBC post at Selkirk as interest in the area grew. This was followed by Jack Dalton who developed a series of existing First Nation trails beginning at tide water at Haines Alaska, into Fort Selkirk.

On August 16, 1896, George Carmack, Skookum Jim, and Tagish Charlie discovered a very rich claim on Bonanza Creek, a tributary to the Klondike River near Dawson. This discovery sparked one of the largest gold rushes in history. It would take almost a year for the news of the Klondike gold fields to spread south, even to places relatively close by in southeast Alaska. Most of the prospectors and traders in the Alaskan and Yukon interior had already converged on the Dawson area during the winter and spring, and supplies ran dangerously low. That would quickly change in the summer of 1897 and spring of 1898 as new towns and supply posts sprang up along the Gold Rush routes to cash in on the increased demand.

The population of Dawson City grew very fast and in 1898 reached a peak of over 30,000. However, the boom period did not last long and the vast majority of the population moved on very quickly with the news of other discoveries. The Gold Rush period saw greatly increased steamer traffic on the entire Yukon River drainage basin and across the interior. These shallow draft steamers were supported by a network of wood camps, shipyards, and a large workforce which kept the river traffic moving. This network provided the infrastructure backbone for trading posts, fish camps, missionaries, and mail routes, while meeting the needs of the growing number of prospectors and traders.

As the world's attention was drawn to growing concerns in Europe in 1939, the Canadian Government began building a chain of airfields across the northwest under the Northwest Staging Route Program. Following the bombing of Pearl Harbor there was no doubt that Alaska and the Yukon would play a key role in the war, and a road was required to link Alaska to the contiguous United States. It was quickly decided that the "Prairie Route" would be used, whereby key airfields would be linked from Great Falls, Montana to Fairbanks, Alaska. As part of the agreement, Canada agreed to build and improve airstrips along the way, including Watson Lake. In February 1942, the US War Department issued the directive to begin construction. These actions spurred on the building of approximately 2,446 km of new road through British Columbia and the Yukon Territory. Following the completion of the Alaska Highway the Canol Pipeline and Canol Road (North and South) were completed to allow the flow of oil from Norman Wells, Northwest Territories (NT) to Whitehorse in 1944. These two events increased access to the traditional territory of the RRDC and LFN and were largely responsible for commercial and mining/industrial activities in recent decades, including construction of the Robert Campbell Highway (Tungsten Road) in 1961.

14.1.1.5 The Kaska Nation

The Kaska Nation's traditional territory covers a large area of northwestern BC, southeastern Yukon, and southwestern NT. Within the Kaska traditional territory there are five First Nations: the Dease River First Nation, the Kwadacha Nation, the Ross River Dena Council, the Liard First Nation and the Daylu Dena Council. The Project falls within the traditional territories of the RRDC and LFN.

Prior to European contact, traditional subsistence activities of the Kaska typically featured a seasonal round of winter hunting and summer fishing covering vast areas. In summer, families congregated at lakes and rivers, where fish and plants were collected, dried and stored. In late summer, small groups dispersed throughout the uplands and higher valley systems to hunt in clan-owned territories. Temporary camp sites, situated within a variety of ecological zones, were often reoccupied year after year in order to exploit seasonally available resources (Honingmann, 1981).

Contact with neighbouring Nations was vital to First Nations' economies. Interior peoples traded hides, furs and obsidian to coastal groups for fish oil, dentalium, woodwork and blankets. Trails were an intrinsic part of this economy and traditional subsistence as a whole. The principal ethnographic descriptions of the Kaska Dena are available in Black (1955), Jenness (1937), and Morice (1893, 1903, 1905). Additional information on past lifeways can be found in Honigmann (1981).

Ross River, near the confluence of the Ross and Pelly Rivers, is the modern focal point of the RRDC. Originally, First Nations people used the area as a seasonal camp and gathering place. By 1903, a trading post was established nearby and later when the American army completed the Canol Pipeline and Canol Road in 1944, they connected Ross River by road to the rest of Yukon (Cohen, 1992). In 1962, Ross River was relocated to its current site close to the Robert Campbell Highway.

Watson Lake, Upper Liard and the adjoining settlements are the central communities of LFN. The amount of activity near Watson Lake was greatly increased when its airfield was established in 1939. This was part of the Canadian government's construction of a chain of airports across northeastern British Columbia and Yukon as part of the lend-lease program. The community was soon after used as a supply centre for the construction of the Alaska Highway in 1942.

14.1.2 Selection of Subcomponents and Measurable Parameters

The heritage resources subcomponents and measurable parameters are provided in Table 14-1. These subcomponents represent the different types of heritage resources that might be impacted by the Project. The UFA does not provide specific definitions of heritage resources but it does distinguish the types of resources. Part 6 of the *Historic Resources Act* does provide more detailed definitions. Presented below are general definitions used in the common practice of HRIAs.

Palaeonotological Resources include the fossilized, mummified, or skeletal remains of previous life forms. These resources may be found in sedimentary rock formations, or eroding streams and creeks and contain a great deal of information concerning past environments. The most common of these resources include the skeletal remains of ice age mammals which are often associated with dark humic deposits. These remains may date from approximately ten of thousands to many hundreds of thousands of years before present.

Archaeological or Prehistoric Sites generally represent use before European contact and are found on or under the ground surface, and may consist of the remains of ancient camps, including hearths, animal bone and stone tools and debris. In this usage, an Archaeological Site equates to a Prehistoric Site (a site that dates to the period before written history). Note, however, that in heritage resource management usage, archaeological resources are viewed as resources that are in subsurface context (buried) and may also include historic period objects and features.

Historic Sites contain heritage resources that are greater than 45 years in age and possess significant heritage value. By convention, historic sites date to the period for which written records are available; in this case, the historic period commenced with the arrival of the Hudson's Bay Company in the early-mid 19th century. Historic sites may include cabins, caches, camps, brush camps, and any other man-made structures, features or objects that date between about 1960 and 1830.

Human remains are non-fossilized remains of human bodies that are found outside a recognized cemetery or burial site.

Table 14-1: Heritage Resources Subcomponents and Measurable Parameters

Valued Component	Subcomponents	Measurable Parameters	Assessment Endpoint/Threshold Criteria
Heritage Resources	*Paleontological Resources*	Presence of resources in local study area (the Project)	Will any significant resources be subjected to significant adverse effects?
	Archaeological Resources	Presence of resources in local study area (the Project)	Will any significant resources be subjected to significant adverse effects?
	Historic & Built Structural Resources	Presence of resources in local study Area (the Project)	Will any significant resources be subjected to significant adverse effects?
	Human Remains	Presence of remains in local study area (the Project)	Will any remains be subjected to adverse effects?

Note: Further information on how significant resource and significant effect are defined is provided in Section 14.1.3.

Measurable parameters were selected based on existing legislation and guidelines noted above that serve to protect heritage resources and the Archaeological Sites Regulations that guide and track permitted heritage impact assessment efforts. For example, sub-surface testing of an archaeological site is in itself a type of adverse impact to the site, but recording, assessing, and managing the impacts to the site; including controlled data collection and reporting (where recommended), is a form of mitigation of planned impacts to a site.

14.1.3 Criteria for Assessing Significance

Significance is assigned to each identified residual effect. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;

- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and
- **Environmental and socio-economic context**: the ability of the VC to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, giving consideration to the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

The definition of criteria for determining significance of residual effects for heritage resources are presented in Table 14-2.

Table 14-2: Heritage Resources Significance of Impacts Criteria Definition

Criteria	Definition	
Direction	Beneficial	Changes to heritage resources would be an improvement (e.g., recording and sharing of information for future generations)
	Neutral	No changes to heritage resources
	Adverse	Heritage resources would change for the worse (e.g., sites impacted with little or no recording)
Magnitude	Low	No sites or resources impacted or changed
	Moderate	No significant sites or resources impacted or changed
	High	Significant sites or resources impacted or changed and not recorded or salvaged
Geographic Extent	Site	A single site or resource is impacted
	Local	Sites or resources are impacted
	Regional	A significant site(s) or resource(s) are impacted across a larger region
	Beyond Regional	A very rare or significant site or resource is impacted that is not likely to found elsewhere in the region
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent project phases or into post-closure phase (11 to 25 years)

Criteria	Definition	
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Environmental and Socio-economic Context	Low	The heritage resource is considered to have little to no unique economic or social attributes or significant data to add to the understanding of the past culture history
	Neutral	The heritage resource is considered to have some unique attributes or moderately significant data to add to the understanding of the past culture history
	High	The heritage resource is considered to be unique or has a high significance or can add significant data to the understanding of the past culture history

While discussing the significance of the possible impacts to heritage resources the significance of the heritage resources themselves also needs to be discussed. There is a wide range of heritage resource types and within these types there are a range of sites or resources each with their own level of relative significance. There are also many kinds of significance including public, ethnic, scientific, historic, and economic. These criteria are often used to assess the significance of heritage resources and the British Columbia Ministry of Forests, Lands and Natural Resource Operations has presented them as a guide for assessing significance in pre-contact sites and post-contact sites within their Archaeological Impact Assessment Guidelines (Province of British Columbia, 1998). These are described herein, as there are no commonly used equivalent guidelines in Yukon.

Public significance refers to the potential for the site or resource to be visited or used by the public such as in educational, interpretive, or recreational ways. Ethnic significance refers to the value placed on the site or resource by traditional, social or religious communities. Scientific significance refers to the value the site or resource has in adding understanding to the cultural history, cultural process, or prehistory. Historic significance refers to the site or resource's association with historically significant events, people, groups, organization, or institutions. Economic significance refers to the ability of the site or resource to be used to generate economic benefits for the local community or area through visitation or other means.

When assessing the overall significance of a heritage site or resource, the overall significance should also be considered in relation to the current context and integrity of the site or resource. For example, site integrity refers to the degree to which the site or resources has been impacted by past disturbances. If an archaeological site has been greatly disturbed it may lessen its scientific significance but not delete it altogether. In contrast, the disturbance may not reduce its ethnic

significance. Site context refers to the setting and sense of place which reflects, and are associated with, the value and importance of the resource. For example, if the resource is moved out of context or the context damaged or changed, the significance of the resource may be lessened.

Therefore, in terms of the significance or the degree of effect on heritage resources, sites or resources which have very little to no heritage significance may be viewed as having a higher threshold to possible effects. Conversely, very rare significant sites and resources may be viewed as having a much lower threshold to possible effects. Also, some types of sites or resources may have very low relative significance in most significance criteria but very high significance in only a few or one criteria. For example, an individual grave or spiritual place may have little to no scientific, economic, historic, or public significance but it may have very high ethnic significance to the deceased's family and descendant group. Thus far no site specific graves or sites with high ethnic significance, within the LSA, have been identified through heritage and TK efforts. However, if any such sites are identified thru future heritage and/or TK efforts they would be managed on a site by site basis through the HRMP.

As such, the evaluation of a significant effect on heritage resources depends on the significance of the site or resource, and the type of effect. During the HRIA process the sites and resources within the local study area are inventoried and evaluated for significance, then possible effects to them are evaluated. Under the relevant legislation and guidelines, effects to the heritage resources should be avoided, and if they can not be avoided, they should be minimized where possible, or mitigated thru systematic data recovery efforts. The type and amount of systematic data recovery mitigation is recommended and developed on a site by site basis. Effects to smaller less significant sites or resources may require relatively smaller mitigation efforts and effects to larger and or very significant sites may require a greater data recovery effort. Therefore, a significant effect is considered to occur if a site or resource is affected whereby the adverse effects can not be mitigated.

14.2 ASSESSMENT BOUNDARIES

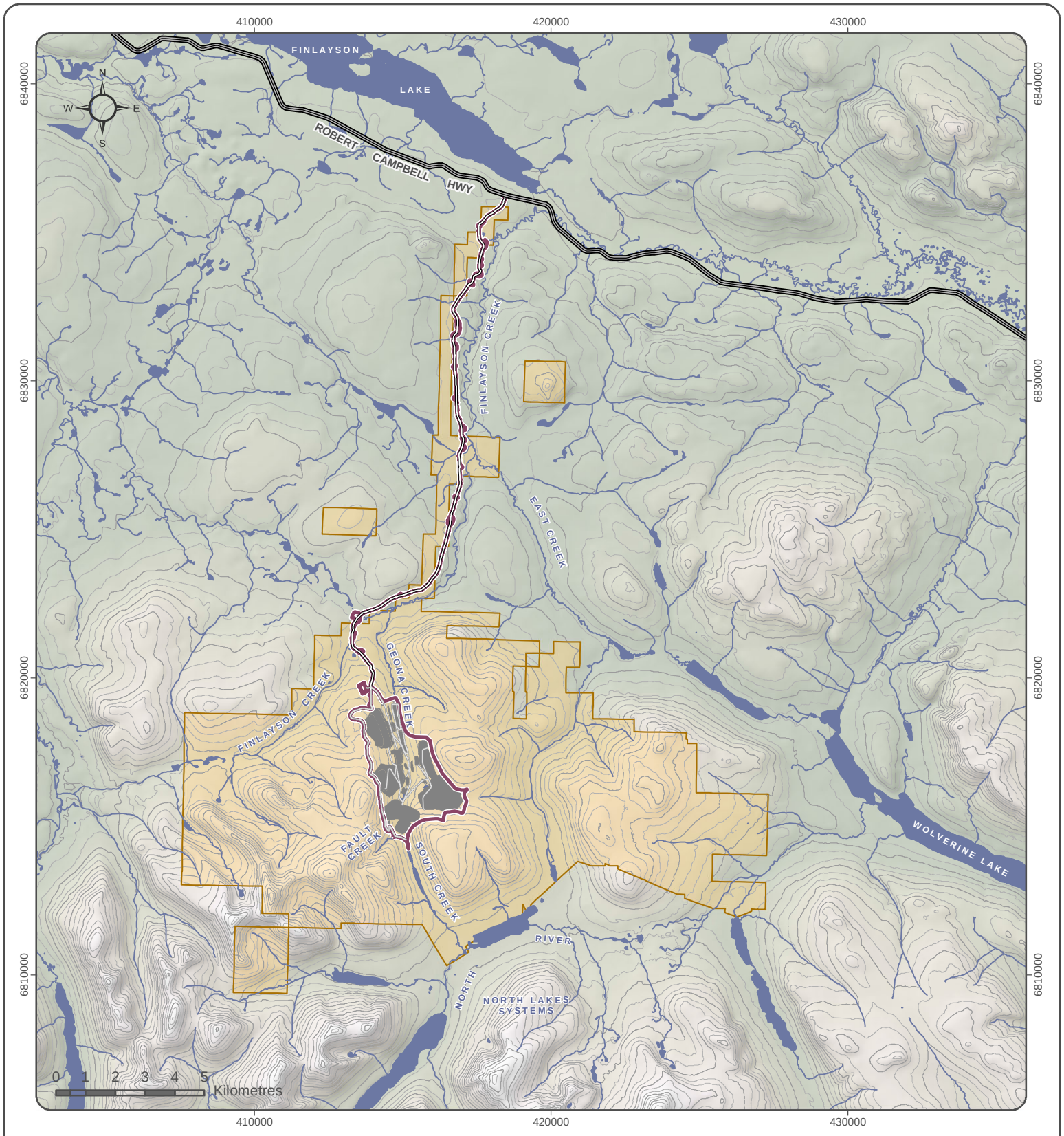
The local and regional study areas for heritage resources are described in the table below. The local study area was selected to include only the areas of planned ground disturbance (see Figure 14-1). As such those areas assessed include only those planned for ground disturbances, not the entire BMC claim block. The regional study area was selected to provide background context to allow comparisons of similar resources across the past use life of the local study area.

Table 14-3: Study Areas for Heritage Resources

Study Area	Heritage Resources Specific Study Area Description
Local Study Area	The local study area encompasses the development footprints of all Project infrastructure, including the access road.
Regional Study Area	The Project within the context of the archaeological and cultural history of the Southern Yukon.

Temporal boundaries apply to the time period of use history of the Project thru exploration, operations, reclamation, and closure of the Project. The Project phases considered in the EA include the following:

- **Construction Phase**: will last approximately two years and includes site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground development and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as closure phase): will last approximately three years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished onsite and will continue until active monitoring is no longer required; the phase is split into two periods: transitional 13-year period during which the ABM open pit continues to fill, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for pit to flood following the end of operations) and 10-year post-closure monitoring period.



Local Study Area

Location of Proposed Mine Infrastructure

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Tote Road/Proposed Access Road

Proposed Mine Road

KUDZ ZE KAYAH PROJECT

FIGURE 14-1

HERITAGE RESOURCES LOCAL STUDY AREA

JANUARY 2017

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.
Datum: NAD 83; Projection: UTM Zone 9N

AEG

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BMC MINERALS

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14.3 EXISTING CONDITIONS

This section presents a summary description of existing environmental conditions as they relate to the heritage resources. This characterization of the existing environment serves as the baseline against which the potential effects of the Project are assessed. The description of the existing environment has been focused on those components of the environment that may be affected by the Project.

The description of the existing environment for the heritage resources is based on the review of existing information and the results of the field programs conducted as part of the EA.

The Project, including the Tote Road, and associated ancillary developments have been the subject of heritage resources impact assessments in 1995 (Rutherford, 1995a, 1995b), 1996 (Rutherford, 1996), 2015 (Mooney and Bennett, 2016), and 2016 (Bennett, 2017). Bennett (2017) is included in Appendix F-1.

14.3.1.1 Previous Heritage Investigations

The Project, including the Tote Road, and associated ancillary developments have been the subject of heritage resources impact assessments in 1995 (Rutherford, 1995a, 1995b), 1996 (Rutherford, 1996), 2015 (Mooney and Bennett, 2016), and 2016 (Bennett, 2017).

In 1995, a heritage study was conducted in collaboration with the RRDC as part of the Initial Environmental Evaluation. The study identified no cultural materials or features (Rutherford, 1995a); however, a review of the oral history provided by Kaska members indicates that the Project area was used for subsistence hunting, trapping and fishing, and as an access route to the North Lakes (Rutherford, 1995b). The TK information collected by Rutherford from local Kaska elders also identified camps, cabins, and trails, but none of those resources or site specific resources overlapped with the proposed infrastructure.

In 1996, an additional study for cultural materials was undertaken at a proposed airstrip location near the Robert Campbell Highway (Rutherford, 1996). No cultural materials were identified in this follow-up study. Please note the proposed airstrip location in 1996 was not the same as the proposed Finlayson Lake airstrip extension as part of the current Project.

14.3.1.2 Recent Heritage Investigations

In 2015, Ecofor undertook a HRIA of the 2015 proposed Project area on behalf of BMC (Mooney and Bennett, 2016). Eight areas indicative of archaeological potential were identified and subject to subsurface testing, and were recorded as Shovel Test Locations (STLs). Out of the eight STLs, cultural materials were identified at two resulting in the identification of archaeological sites, JiTp-1 and JjTp-1, both of which are prehistoric, subsurface, lithic scatters. These were the first two archaeological sites recorded in the local study area.

Site JiTp-1 is a large, low density, subsurface lithic scatter, located within the planned footprint of the Class B Storage Facility. This site was recommended for avoidance, and if avoidance was not feasible, the effects to the site were recommended to be mitigated by systematic data recovery consisting of additional shovel testing and test unit excavation.

Site JjTp-1 is a small, low density, sub-surface lithic scatter near the Tote Road. This site was recommended for avoidance. However, since this site is not planned to be affected by upgrades to the Tote Road the site is recommended for continued avoidance.

As part of the 2015 HRIA efforts, Ecofor also inspected high elevation exploration targets for ice patch related heritage resources as required by BMCs exploration permit. This high elevation inspection of existing ice patch edges and remnant ice patch scars, revealed two wood fragments above the tree line that appear to have be modified and/or carried into the alpine by people. These two wood fragments were recorded as ice patch #1 and #2, and were submitted to the Yukon Heritage Resources Unit for care and curation. The age of these items is undetermined at this time, but they may represent known traditional uses such as seasonal caribou hunting and resource collection in the apline. A third ice patch related wood item #3 was found with an attached wire segment, similar to a snare pole, and was left in place as it was not threatened by any proposed impacts. This possible snare pole may represent known traditional seasonal trapping perhaps for ground squirrel or marmot. No further work was recommended for the ice patch edges and remnant scars associated with the high elevation exploration targets.

In 2016, Ecofor returned to conduct follow-up assessments at site JiTp-1 based on recommendations made during the previous phase of assessment conducted under permit 15-10ASR (Bennett, 2017), and to assess for the first time revised components of the current Project footprint. Follow-up work at JiTp-1 included additional shovel testing (n=41) and 6 m^2 of excavation divided between two blocks (4 m^2 and 2 m^2) centered on positive shovel tests. Three of the 41 shovel tests excavated in 2016 where positive for heritage resources (each containing a single lithic flake), and the excavation blocks yielded 88 lithic artifacts.

Assessments of revised component's footprints began with a pedestrian survey aimed at identifying areas of elevated potential for heritage resources, then moved on to shovel testing in identified areas of elevated potential. Areas surveyed included those associated with Access Road, ditching, revised Overburden Stockpile, Class A, B, and C Storage Facilities, ABM open pit, topsoil stockpiles, drill holes, process plant facility, potential construction laydown areas, Operations Water Management Ponds, and collection ponds. The pedestrian survey led to the identification of five additional areas of elevated heritage resource potential that were subsequently shovel tested. In total, 186 shovel tests were excavated at these new STLs, but all were negative for heritage resources.

In summary, five heritage resources have been identified and recorded across the Project. These consist of three high elevation wood fragments and two prehistoric archaeological sites. Two of the wood fragments appeared to have been modified and/or carried into areas planned for ground disturbance and were submitted to Yukon Heritage Resources Unit for care and curation. The third wood item with the wire attached, appears to be a modern snare pole in an area not planned for ground disturbance, and was left in place. The two prehistoric archaeological sites JiTp-1 and JjTp-1,

were both identified and recorded in 2015. As these two sites were found in the field they were assessed for their site significance and the potential impacts by proposed developments and management recommendations were presented on a site-by-site basis.

In 2016, additional HRIA efforts were conducted across the Project Footprints but no additional sites or resources were identified. Also in 2016, site JiTp-1 was the subject of systematic data recovery consisting of additional shovel tests and test unit excavations. The additional shovel testing failed to identify any new areas of artifact concentrations or cultural features at the site. The test unit excavations were located over the known areas of higher artifact densities, and collected a large representative sample of materials and information. No additional material types, features, or components were identified. Additional work at this site is not likely to add substantial data to the understanding of the past use history of the LSA or RSA. As such, no further work is recommended for this site as it is not considered significant. The results of these efforts have been submitted to BMC, the Heritage Resources Unit, RRDC, and LFN.

Archaeologists in the field flagged the locations of the two archaeological sites at time of discovery, however flagging tape is not permanent and as time passes it could be destroyed by weather, disturbed by wildlife or removed by humans.

No additional site specific heritage resources were identified in the Project footprint through the recently compiled TK overview for the Project (Appendix F-3). However, many traditional land uses are described which reflect past Kaska use which would leave physical remains of heritage resources within the LSA. For example, the known traditional travel corridors or trails reflect use along a main corridor which, was overlapped at least partially by segments of the Robert Campbell Highway. This roughly southeast to northwest travel corridor connected the west arm of Frances Lake to Finlayson Lake, and on to the Pelly River. In addition, the Finlayson Creek valley was known to be used as a roughly north to south connecting travel corridor, the use of which may be reflected by the prehistoric lithic site JjTp-1, identified near the existing Tote Road overlooking Finlayson Creek. The general location of these trails are presented in a 1896 map which highlighted the traditional route between Frances Lake and Pelly Banks (Pike, 1896). In this map the trail from the west side of Finlayson Lake continues west along a route that is somewhat similar to the current Robert Campbell Highway, including the location of the proposed Finlayson Lake airstrip extension.

14.4 PROJECT-SPECIFIC EFFECTS

This section assesses potential effects on heritage resources as a result of the Project by identifying potential interactions, characterizing potential effects, identifying applicable mitigation measures and determines significance of any identified residual effects.

14.4.1 Effects Characterization

In order to focus the effects assessment, the first step is to identify any potential interactions between Project activities and heritage resources. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1 or 2, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions;
1 – Lower risk interactions- *the interaction will not result in residual effect due to the application of the practices known to effectively mitigate predicted effects; and*
2 – Higher risk interactions- *it is reasonably foreseeable that residual adverse effects may result.*

The results of the interactions screening are presented in Table 14-4.

Table 14-4: Interaction Matrix for Heritage Resources

Project Activity	Paleontological Resources	Archaeological Resources	Historic & Built Resources	Human Remains
Construction				
Tote road upgrade to Access Road	1	1	1	1
Finlayson Lake airstrip upgrade	1	1	1	1
Site preparation and clearing	1	1	1	1
Site grading, including soil and overburden removal and stockpiling	1	1	1	1
Off site traffic (construction equipment and materials delivery)	0	0	0	0
On site traffic	0	0	0	0
ABM open pit development (including dewatering and Fault Creek diversion)	1	1	1	1
Infrastructure construction	0	0	0	0
Waste handling	0	0	0	0
Water use and management	0	0	0	0
Power generation	0	0	0	0
Worker transport	0	0	0	0
Construction camp operation	0	0	0	0
Workforce, procurement and hiring	0	0	0	0
Operations				
ABM open pit operations (including blasting and dewatering)	1	1	1	1
Underground operations	0	0	0	0
Ore processing	0	0	0	0
On site traffic	0	0	0	0
Off site traffic (highway)	0	0	0	0
Finlayson airstrip operations	0	0	0	0
Storage facilities management (Class A, B, and C)	1	1	1	1
Progressing reclamation of storage facilities	0	0	0	0
Water use (potable and non-potable)	0	0	0	0
Mine water management and treatment (including effluent discharge)	0	0	0	0

Project Activity	Paleontological Resources	Archaeological Resources	Historic & Built Resources	Human Remains
Waste management	0	0	0	0
Power generation	0	0	0	0
Worker transport	0	0	0	0
Camp operation	0	0	0	0
Workforce, procurement and hiring	0	0	0	0
Closure				
Processing plant decommissioning and site reclamation	0	0	0	0
ABM lake filling	0	0	0	0
Final storage facilities reclamation	0	0	0	0
Support infrastructure removal and site reclamation	0	0	0	0
Water management and treatment (including effluent discharge)	0	0	0	0
On site traffic	0	0	0	0
Off site traffic	0	0	0	0
Access road reclamation	1	1	1	1
Workforce, procurement and hiring	0	0	0	0

As discussed above, site JiTp-1 was identified within the footprint of the Class B Storage Facility and potential effect was identified for the site as a result of the Project. Following the recommendations of 2015 study, the subsequent data recovery has been completed in 2016 and the results have been shared with RRDC, LFN, and the Heritage Resources Unit of the Yukon Government. As such, the adverse effects to site JiTp-1 have been mitigated.

However complete and thorough, every heritage resource may not have been identified by impact assessment field efforts and remaining unrecorded heritage resources may be affected by the Project, or revisions to the Project. Potential effects as a result of chance find during Project construction, operations and closure are carried forward for consideration of mitigation measures.

14.4.1.1 Summary

Table 14-5 provides a summary of the identified potential effects from the above section that are carried forward for consideration of mitigation measures.

Table 14-5: Identified Potential Project Effects for Heritage Resources

Subcomponent	Potential Effect	Project Phase
Paleontological Resources	Impacts to unidentified sites or resources	Construction, Operation, and Closure
Archaeological Resources	Impacts to unidentified sites or resources	Construction, Operation, and Closure
Historic & Built Structural Resources	Impacts to unidentified sites or resources	Construction, Operation, and Closure
Human Remains	Impacts to unidentified human remains	Construction, Operation, and Closure

14.4.2 Mitigation Measures

Effects to heritage resources are most common during ground disturbances and construction and closure but can be avoided by identifying and avoiding effects prior to construction by avoidance or mitigation. As noted above the adverse effects to archaeological sites can be mitigated through systematic data recovery.

However complete and thorough, every heritage resource may not have been identified by impact assessment field efforts and remaining unrecorded heritage resources may be affected by the Project. As such, a Heritage Resource Management Plan (HRMP) was prepared for the Project and is intended to be used through the continued use-life of the Project from exploration, mining, reclamation and closure. This HRMP is included as Appendix F-2 and summarized in Section 18.13 of the Environmental Management Plan Chapter. This HRMP is based on four Action Items and four Communications Protocols which will be employed on an on-going basis. The four Action Items are:

- Heritage Resources Review of Any New Proposed Ground Disturbing Activities;
- Revisit and Reflag all Heritage Resource Sites Prior to Construction;
- Site by Site Management Efforts; and
- Identification of Any Newly Recorded Heritage Sites.

The four Communication Protocols are:

- Ground Disturbing Activities;
- Chance Finds Procedures;
- Planned Impacts of Known Sites; and
- Continued Communication with First Nations and the Heritage Resources Unit.

These Action Items and Communication Protocols will work in coordination to ensure any ground disturbing activities are reviewed for past heritage assessment work and if an assessment was not conducted then an HRIA for the area in question is required. An example of this is the proposed extension of the existing Finlayson Lake airstrip on the Robert Campbell Highway and any proposed borrow pits or improvements along the Tote Road. Since the proposed airstrip extension has not be the subject of HRIA efforts, and it is located along an area of increased archaeological potential near a small lake and a known trail, HRIA efforts are required prior to ground disturbance. Likewise, proposed improvements to the Tote Road, would be reviewed and assessed as needed prior to ground disturbance. These additional HRIA field efforts will incorporate TK to guide field efforts and include Kaska field participants in all fieldwork.

If any heritage resources are located they will be assessed and managed on a site by site basis. If sites are planned to be avoided then the area of the resource will be inspected on foot and reflagged prior to impacts. If any chance finds are discovered, work in the area will cease and the finds will be managed as per the HRMP, and all assessment results, recommendations, chance finds, and

management plans will be shared with the RRDC, LFN, and the Heritage Resources Unit of the Yukon Government.

The recommendations for the systematic data recovery of site JiTp-1 in 2015, and the subsequent completion of the data recovery in 2016 have been shared with RRDC, LFN, and the Heritage Resources Unit of the Yukon Government. As such the adverse effects to site JiTp-1 have been mitigated and are not carried forward in residual effects. Efforts to manage effects to any remaining, previously unrecorded heritage resources, thru the HRMP and chance finds management, are summarized in the following table format.

Potential effects on heritage resources and identified mitigation measures are summarized in Table 14-6 and discussed further below.

Table 14-6: Proposed Mitigation Measures for Heritage Resources

Potential Effect	Project Phase	Proposed Mitigation Measures	Predicted Effectiveness of Mitigation Measure (high, medium, low)	Residual effect identified? (Yes/No)
Potential effects to paleontological sites or resources	Construction, operations, and closure	HRMP including the Chance Finds Procedure, then site by site management plan	High	No
Potential effects to archaeological sites or resources	Construction, operations, and closure	HRMP including the Chance Finds Procedure, then site by site management plan	High	No
Potential effects to historic sites or resources	Construction, operations, and closure	HRMP including the Chance Finds Procedure, then site by site management plan	High	No
Potential effects to human remains	Construction, operations, and closure	HRMP including the Chance Finds Procedure, then site by site management plan	High	No

Although effects to heritage resources are more likely to occur in the construction phase, remaining previously un-recorded heritage resources may be affected during the operations and reclamation or closure phases and as such the HRMP applies through the entire Project life. In order to increase awareness of the possible types of heritage resources that may remain within the Project, on site staff will be given an overview of the HRMP and chance find procedures as part of their orientation. Copies of the *Handbook for the Identification of Heritage Sites and Features* (Gotthardt and Thomas, 2005) will be made available to the on site staff.

If additional heritage resources are identified through the HRMP, the first resource management option will be to avoid further impacts to the resource where possible. If avoiding impacts to the resource is not possible then a site or resource specific management plan will be prepared and reviewed by the Heritage Resources Unit, RRDC, and LFN prior to implementation. In the case of

paleontological site or resources, the resources may be able to be recorded, assessed in place, and removed. In the case of prehistoric or historic archaeological sites or resources the adverse impacts to the sites or resources may be mitigated thru systematic data recovery and archival research and informant/community interviews. In the case of historic built structures, the adverse impacts to these resources may be mitigated through detailed recording and research, informant/community interviews and systematic data recovery. In the case of possible impacts to human remains the adverse impacts to the remains may be mitigated thru detailed coordination with the coroner, the RCMP, RRDC, and LFN as well as detailed osteological analysis, and reburial, as determined thru the site by site management plan. Each site or resource specific mitigation effort will include detailed reporting and communication as per the HRMP, and may also include monitoring of ground disturbing activities.

14.4.3 Residual Effects and Significance Determination

No residual effects on heritage resources are predicted as a result of the proposed Project. The remains of one site, JiTp-1, will be destroyed through construction activities, and effects to the remaining site, JjTp-1, will be avoided. Adverse effects to any previously unrecorded heritage resources will be managed through the use of the HRMP and chance finds procedures. Consequently, heritage resources were not carried forward for determination of significance of Project effects.

14.5 CUMULATIVE EFFECTS ASSESSMENT

The Cumulative Effects Assessment (CEA) defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. As no residual effects have been identified for heritage resources, no cumulative effects are expected.

14.6 EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected environmental effects; and
- Implement additional mitigation measures as per adaptive management plans.

No specific monitoring has been recommended for the two known heritage resources within the Project. However, the HRMP and chance find procedures are required to be in-use for the entire life span of the Project, and if any previously unrecorded heritage resources are identified then a site or resource specific management plan will be prepared and implemented. If any additional areas are planned for ground disturbance, that have not been the subject of previous HRIA field efforts, then those areas should be assessed in the field for possible impacts to heritage resources. In some cases,

the site or resource specific management plan, for a newly identified site or resource, may include monitoring of ground disturbing activities.

The HRMP for the Project is described further in Section 18.13. of the Environmental Management Plan Chapter.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

15 SOCIO-ECONOMIC EFFECTS ASSESSMENT 15-1

15.1 ASSESSMENT APPROACH 15-1
15.1.1 Identified Interests and Selection of Valued Components 15-2
15.1.2 Criteria for Assessing Significance 15-5
15.2 ASSESSMENT BOUNDARIES 15-7
15.3 SOCIO-ECONOMIC SETTING 15-10
15.3.1 Project Area, Land and Resource Use 15-10
15.3.2 Yukon 15-11
15.3.3 Ross River 15-16
15.3.4 Watson Lake 15-19
15.3.5 Faro 15-21
15.3.6 Whitehorse 15-24
15.4 PROJECT EFFECTS: INTERACTION MATRIX 15-26
15.5 PROJECT EFFECTS: ECONOMY AND SUSTAINABLE LIVELIHOOD 15-29
15.5.1 Traditional Economic Activities — Hunting, Fishing, Trapping, Food Gathering 15-29
15.5.2 Economic Growth 15-31
15.5.3 Diverse and Stable Economy — Discouraging Boom and Bust 15-37
15.5.4 Employment 15-38
15.5.5 Employability — Education, Training and Experience 15-45
15.5.6 Broad Participation in Economic Development 15-47
15.5.7 Business Opportunities 15-47
15.5.8 Government Revenues 15-48
15.5.9 Summary of Residual Effects 15-50
15.6 PROJECT EFFECTS: HUMAN HEALTH AND WELL-BEING 15-53
15.6.1 Individual Health 15-54
15.6.2 Family Stress 15-55
15.6.3 Reducing Alcohol and Drug Abuse 15-56
15.6.4 Gathering Traditional Medicine 15-57
15.6.5 Public Health and Safety — Increased Traffic, Hazardous Material Transport, Waste Disposal 15-58
15.6.6 Workplace Health and Safety 15-59
15.6.7 Summary of Residual Effects 15-60
15.7 PROJECT EFFECTS: COMMUNITY VITALITY 15-64
15.7.1 Population — Number of Children 15-64
15.7.2 Healthy Local Business Sector — Reducing the Cost of Living 15-65
15.7.3 Reducing Crime 15-66
15.7.4 Reducing Discrimination and Racism 15-66
15.7.5 Political Structure 15-68
15.7.6 Community Events and Volunteerism 15-68
15.7.7 Recreational Facilities and Opportunities 15-69

15.7.8 Summary or Residual Effects 15-69
15.8 PROJECT EFFECTS: INFRASTRUCTURE AND SERVICES 15-71
15.8.1 Housing and Land Availability 15-72
15.8.2 Transportation Infrastructure — Roads and Airports 15-73
15.8.3 Power and Communication Infrastructure 15-73
15.8.4 Municipal Services — Water, Sewer, Solid Waste 15-74
15.8.5 Healthcare Services 15-74
15.8.6 Police Services 15-75
15.8.7 Child Care 15-75
15.8.8 Summary of Residual Effects 15-75
15.9 PROJECT EFFECTS: CULTURE, HISTORY AND HERITAGE 15-76
15.9.1 Language Preservation and Restoration 15-77
15.9.2 Traditional Knowledge and Practice: Preservation and Restoration 15-77
15.9.3 Heritage and Historic Sites 15-78
15.9.4 Summary of Residual Effects 15-78
15.10 RESIDUAL EFFECTS AND SIGNIFICANCE DETERMINATION 15-78
15.10.1 Economy and Sustainable Livelihood 15-79
15.10.2 Human Health and Well-being 15-84
15.10.3 Community Vitality 15-87
15.10.4 Infrastructure and Services 15-90
15.10.5 Culture, History and Heritage 15-90
15.10.6 Summary 15-90
15.11 CUMULATIVE EFFECTS 15-92
15.11.1 Cumulative Effects Characterization 15-93
15.11.2 Cumulative Effects Mitigation Measures 15-97
15.11.3 Cumulative Effects Significance Assessment 15-98
15.12 SOCIO-ECONOMIC EFFECTS MONITORING 15-98

LIST OF TABLES

Table 15-1: Valued Components, Identified Interests and Indicators 15-3
Table 15-2: Socio-economic Significance Criteria Definition 15-6
Table 15-3: Proposed Study Areas for Socio-economic VCs 15-8
Table 15-4: Yukon Industries as Percentage of GDP, 2014 15-14
Table 15-5: Interaction Matrix for the Socio-economic Valued Components 15-27
Table 15-6: Project Construction Impact on Yukon GDP 15-32
Table 15-7: Estimated Project Gross Revenue, CAN $ millions 15-33
Table 15-8: Economic Effect on Yukon GDP: Project Operations 15-33
Table 15-9: Community Employment Assumption Ranges: Operations Phase, Full-Time-Equivalents 15-34
Table 15-10: Per Cent Growth in Community Aggregate Personal Incomes: Operations Phase 15-35
Table 15-11: Project Closure Costs 15-36
Table 15-12: Project Closure Costs: Effect on GDP 15-36

Table 15-13: Summary of Employment: Number of Personnel in the Operations Phase 15-40
Table 15-14: Summary of Open Pit Labour Requirements, Number of Personnel by Year.....15-40
Table 15-15: Summary Underground Labour and Equipment Requirements by Year 15-42
Table 15-16: Processing Plant Labour Requirements 15-43
Table 15-17: Administration Labour Requirements 15-44
Table 15-18: Estimated Project Employee Income Taxes and Other Taxes.....15-50
Table 15-19: Residual Effects on Economy and Sustainable Livelihood 15-51
Table 15-20: Expected Truck Traffic: Operations Phase 15-58
Table 15-21: Residual Effects on Human Health and Well-Being 15-61
Table 15-22: Residual Effects on Community Vitality.....15-70
Table 15-23: Residual Effects on Infrastructure and Services 15-75
Table 15-24: Residual Effects on Culture, History and Heritage.....15-78
Table 15-25: Project Effects Significance Assessment for Economy and Sustainable Livelihood.....15-81
Table 15-26: Project Effects Significance Assessment for Human Health and Well-being.....15-85
Table 15-27: Project Effects Significance Assessment for Community Vitality 15-88
Table 15-28: Project Effects Significance Assessment for Infrastructure and Services 15-91
Table 15-29: Residual Effects Considered in the Cumulative Effects Assessment 15-92
Table 15-30: Screening Table for Socio-economic Cumulative Effects.....15-95
Table 15-31: Cumulative Effects Potential Interactions 15-96
Table 15-32: Socio-economic Cumulative Effects Mitigation Measures 15-97
Table 15-33: Cumulative Effects Significance Assessment 15-99

LIST OF FIGURES

Figure 15-1: Socio-economic Study Area and Local Communities 15-9
Figure 15-2: Project and Activities to be Considered in the Socio-economic Cumulative Effects Assessment 15-94

15 SOCIO-ECONOMIC EFFECTS ASSESSMENT

This chapter provides an overview of the existing socio-economic conditions and assessment of the potential Project effects on the socio-economic conditions.

The Project is in the Traditional Territory of both the Ross River Dena Council (RRDC) and the Liard First Nation (LFN). The two Kaska nations have 100% overlapping traditional territories. The socio-economic effects assessment focuses on the rural communities where the effects of the Project are expected to be largest. This includes: Ross River (home community of the RRDC); Watson Lake (home community of the LFN); and Faro. Some analysis has also been extended both to Whitehorse and to the entire Yukon, where appropriate.

15.1 ASSESSMENT APPROACH

Yukon Environmental and Socio-economic Assessment Board's (YESAB) *Guide to Socio-economic Effects Assessments* (YESAB, 2006) lays out seven principles to provide broad and general direction on how a proponent is to conduct a socio-economic effects assessment:

- Achieve a broad understanding of the local and regional settings potentially affected by the proposed action;
- Focus assessment on key aspects of the human environment;
- Provide valid and relevant information for use in decision-making;
- Identify methods and assumptions and define significance;
- Ensure that effect equity issues are described and analyzed;
- Consider and recommend suitable mitigation measures and include in the assessment mechanisms to improve the likelihood of mitigation success; and
- Determine the best development alternative(s) rather than merely serving as an arbiter between socio-economic benefit and social cost.

These principles have been followed throughout the effects assessment process for the Project.

YESAB suggests a six-step process for conducting socio-economic effects assessments (YESAB, 2006):

- Determine scope of project;
- Determine scope of assessment;
- Compile the socio-economic baseline;
- Characterize potential effects;
- Identify mitigation/enhancement measures; and
- Determine significance.

All the steps outlined are included in the socio-economic effects assessment for the Project:

- Project scope is laid out in Chapter 4 (Project Description);
- The scope of assessment is defined through identification of assessment boundaries in Section 15.2;
- The socio-economic baseline is provided as Appendix G-1 and summarized in Section 15.3;
- The characterization of potential effects along with their associated mitigation and enhancement measures are presented in Sections 15.4 through 15.9;
- Significance determination for identified residual effects is presented in Section 15.10; and
- An assessment of possible cumulative effects is presented in Section 15.11.

15.1.1 Identified Interests and Selection of Valued Components

Communities, governments, organizations, Kaska First Nation, and other groups and individuals have an interest in a proposed Project when the Project may have an effect, beneficial or adverse, on a part of the social and economic system that they, or those they represent, value. It is important to note that although the Project may affect an interest; it will not necessarily do so.

In the socio-economic context, Valued Components (VCs) are defined by YESAB (2006) as those parts of the socio-economic fabric that are valued because of their importance to the community, specifically because of their:

- Integral connection to, or reflection of, the socio-economic system;
- Commercial or economic value; and/or
- Their role in maintaining quality of life in a community.

Some VCs are specific to a particular community or interest, but many overlap among communities and interests.

The VCs for the Project have been identified through a variety of means including:

- Existing community plans and strategies;
- Meetings between BMC and Kaska First Nation and community representatives;
- Meetings between BMC and government representatives;
- Responses by stakeholders and interested parties (especially government agencies) to other similar projects submitted to the YESAB for Executive Committee level screening; and
- The professional judgement of the authors of the Project Proposal.

Through every aspect of the socio-economic effects assessment it is critical to make explicit the connections between identified interests, VCs (or their individual subcomponents), the indicators representing those VCs and subcomponents, the identification of mitigation or enhancement

measures, the determination of effects with mitigation and/or enhancement measures in place, and finally the determination of effect significance.

Table 15-1 shows the linkages between each VC identified for the Project, its subcomponents, the interests that are identified with each subcomponent, and the indicators chosen to measure effects on that subcomponent. The indicators are presented in detail in the socio-economic baseline report (Appendix G-1).

Table 15-1: Valued Components, Identified Interests and Indicators

Valued Component	Subcomponent	Identified Interest	Indicators
Economy and Sustainable Livelihood	Traditional economic activities — hunting, fishing, trapping, food gathering	Ross River Dena Council Liard First Nation Traditional land stewards Area trappers Environment Yukon	Harvest data (Source: Environment Yukon) Description
	Economic growth	Yukon Economic Development Ross River Dena Council Liard First Nation Town of Watson Lake Town of Faro	Yukon GDP (Source: Yukon Bureau of Statistics and Statistics Canada) Personal income by community (Source: Canada Revenue Agency)
	Diverse and stable economy — discouraging boom and bust	Ross River Dena Council Liard First Nation Town of Watson Lake Town of Faro Yukon Tourism Outfitter	Employment by industry (Source: 2006 Census and 2011 NHS) Population fluctuations over time (Source: Yukon Bureau of Statistics)
	Employment	Yukon Economic Development Ross River Dena Council Liard First Nation Town of Watson Lake Town of Faro	Employment, unemployment and participation rates (Source: 2006 Census and 2011 NHS)
	Employability — education, training and experience	Yukon Education Ross River Dena Council Liard First Nation Yukon College Yukon Mine Training Association	Highest level of education (Source: 2006 Census and 2011 NHS) Occupational breakdown (Source: 2006 Census and 2011 NHS)
	Broad participation in economic development	Ross River Dena Council Dena Nezziddi Corporation Liard First Nation LFN Development Corporation Yukon Economic Development Yukon Women's Directorate	First Nation's participation and employment rates Women's participation and employment rates (Source: 2006 Census and 2011 NHS)
	Business opportunities	Ross River businesses Watson Lake businesses Faro businesses	Description (see also Healthy business sector subcomponent below)

Valued Component	Subcomponent	Identified Interest	Indicators
	Government revenues	Town of Watson Lake Town of Faro Yukon government Federal government	Municipal taxes (Source: Town of Watson Lake and Town of Faro) Yukon and federal income taxes by community (Source: Canada Revenue Agency)
Human Health and Well-being	Individual health	Yukon Health and Social Services Ross River Dena Council Liard First Nation	Selected Health Survey statistics (Source: Statistics Canada)
	Family stress	Ross River Dena Council Liard First Nation Yukon Women's Directorate	Description, percentage of people divorced or separated (Source: 2006 Census and 2011 NHS)
	Reducing alcohol and drug abuse	Yukon Health and Social Services Ross River Dena Council Liard First Nation	Alcohol sales data (Source: Yukon Liquor Corporation) Number of heavy drinkers from Canadian Health Survey
	Gathering traditional medicine	Ross River Dena Council Liard First Nation	Description
	Public health and safety — increased traffic, hazardous material transport	Yukon Highways and Public Works Yukon Environmental Health Yukon Energy Mines and Resources	Traffic count data (Source: Yukon Highways and Public Works) Description
	Workplace health and safety	Yukon Workers Compensation Health and Safety Board (YWCHSB)	Mining accident rate and average days lost to injury (Source: WorkSafeBC)
Community Vitality	Population — number of children	Community of Ross River Town of Watson Lake Town of Faro City of Whitehorse	Community population, growth pattern and number of children (Source: Yukon Bureau of Statistics) School enrolment data (Source: Yukon Education)
	Healthy local business sector — reducing the cost of living	Community of Ross River Ross River Dena Council Town of Watson Lake Town of Faro	Number of businesses and employees (Source: Yukon Bureau of Statistics) Cost of living differential (Source: Yukon Bureau of Statistics)
	Reducing crime	Community of Ross River Town of Watson Lake Town of Faro	Community crime data (Source: Yukon Bureau of Statistics)
	Reducing discrimination and racism	Ross River Dena Council Liard First Nation	Income differentials between First Nations and others (Source: 2011 NHS)
	Political structure	Ross River Dena Council Liard First Nation Town of Watson Lake Town of Faro	Description
	Community events and volunteerism	Community of Ross River Town of Watson Lake Town of Faro	Description

Valued Component	Subcomponent	Identified Interest	Indicators
	Recreational facilities and opportunities	Community of Ross River Town of Watson Lake Town of Faro	Description
Infrastructure and Services	Housing and land availability	Community of Ross River Town of Watson Lake Town of Faro City of Whitehorse Yukon Energy Mines and Resources (YEMR)	Available lots (Source: Yukon Energy Mines and Resources) Residential rents and vacancy rates (Source: Yukon Bureau of Statistics)
	Transportation infrastructure — roads and airports	Yukon Highways and Public Works (YHPW)	Description Traffic count data (Source: Yukon Highways and Public Works)
	Municipal services — water, sewer, solid waste	Town of Watson Lake Town of Faro	Description
	Healthcare services	Yukon Health and Social Services (YHSS)	Description
	Police services	Yukon Justice	Description
	Child care	Community of Ross River Town of Watson Lake Town of Faro	Number of child care spaces available (Source: Yukon Health and Social Services)
Culture, History and Heritage	Language preservation and restoration	Ross River Dena Council Liard First Nation	Speakers of Aboriginal language (Source: Census 2006 and 2011 NHS) Description
	Traditional knowledge and practice preservation and restoration	Ross River Dena Council Liard First Nation	Description
	Heritage and historic sites	Ross River Dena Council Liard First Nation Yukon Heritage Branch	Description

15.1.2 Criteria for Assessing Significance

Significance is assigned to each identified VC or subcomponent. The definition of the term 'significance' is specific to each VC and describes the point beyond which a residual effect would be considered significant. The definition of significance considers the following criteria:

- **Direction**: long term trend of the residual effect;
- **Magnitude**: amount/intensity of change of the residual effect;
- **Geographic extent**: spatial extent over which the residual effect occurs;
- **Duration**: the period of time over which the residual effect is measurable;
- **Frequency**: the number of times the residual effect may occur;
- **Reversibility**: degree to which the residual effect is reversible or irreversible over time; and

- **Economic and social context**: the ability of the community to accommodate change.

As discussed in Chapter 5, separate from the above criteria is a likelihood determination. The likelihood determination provides context to the assessment and identified effects. The likelihood of the effect is discussed qualitatively, considering the following:

- **Probability**: The chance or possibility that an effect will occur (very likely, likely, unlikely, very unlikely). The probability determination may be influenced by probability of activity causing the effect occurring or the probability of mitigation being successful.
- **Uncertainty**: The possible error or range of error that may exist within assumptions used in the assessment (low, medium, high). The uncertainty addresses any assumptions made through the assessment.

Significance is described as a beneficial effect, not significant adverse effect, or significant adverse effect.

The definition of criteria for determining significance of residual effects for the socio-economic VCs are presented in Table 15-2.

Table 15-2: Socio-economic Significance Criteria Definition

Criteria	Definition	
Direction	Beneficial	Change in VC is an improvement to baseline
	Neutral	No change in VC
	Adverse	Change in VC is for the worse in relation to baseline
Magnitude	Low	Low to moderate effect to socio-economic fabric
	Moderate	Major effect to socio-economic fabric
	High	Catastrophic effect to socio-economic fabric
Geographic Extent	Site	Potential effect is limited to Project footprint
	Local	Potential effect is limited in the local communities (i.e., Ross River, Watson Lake and Faro)
	Regional	Potential effect extends beyond local communities to Whitehorse and other Yukon communities
	Beyond Regional	Potential effect extends beyond Yukon
Duration	Short term	Effect lasting through construction phase or decommissioning, reclamation and closure phase only (less than one to five years)
	Medium term	Effect lasting through operations phase only (approximately 10 years)
	Long term	Effect lasting through any two concurrent project phases or into post-closure phase (11 to 25 years)
	Far future	Effect lasting beyond 25 years
Frequency	Once	An effect that occurs once during any phase of the Project
	Sporadic	An effect that occurs at sporadic or intermittent intervals during any phase of the Project
	Regular	An effect that occurs regularly during any phase of the Project
	Continuous	An effect that occurs constantly during any phase of the Project

Criteria	Definition	
Reversibility	Reversible short term	An effect that can be reversed relatively quickly (i.e., in less than five years)
	Reversible long term	An effect can be reversed after many years (i.e., more than five years)
	Irreversible	An effect cannot be reversed (i.e., is permanent)
Economic and Social Context	Low	Very high to high degree of community resilience to type of change
	Neutral	Moderate degree of community resilience to type of change
	High	Low to very low degree of community resilience to type of change

Significance analysis is used to determine the anticipated level of success in mitigating adverse residual effects or enhancing beneficial residual effects following implementation of mitigation or enhancement measures.

In addition to the criteria in Table 15-2, the likelihood of an effect occurring and the level of uncertainty around that likelihood also play a role in significance analysis.

For socio-economic effects the assessment of significance relies on the professional judgement of the assessor. The magnitude of the anticipated effects and the resilience of the community to change (the economic and social context) are normally the key drivers in assessing significance. In assessing significance, it is important to recognize that the community of interest in the economic and social context criteria can vary between VCs and their subcomponents. Communities are not always defined by geography. For example, First Nation people, regardless of where they are living or which specific First Nation they are citizens of, often see themselves as part of a wider community bound together by a generally shared history and social position within the dominant culture. When assessing the magnitude criteria (the effect on the socio-economic fabric) the nature and extent of that effect can vary between VCs and their subcomponents in a very similar way.

The general requirements for an effect to meet the threshold of significance are:

- Direction must be adverse to be considered significant;
- If the effect cannot be reversed, then it is significant;
- If magnitude is high, then the effect is significant;
- If magnitude is moderate then economic and social context must be at least neutral, extent must be at least local, duration must be at least medium term, frequency at least regular and reversibility at least short term; and
- If magnitude is low then economic and social context must be high, the extent must be at least regional, duration must be at least long term, the frequency at least regular, and reversibility at least short term.

15.2 ASSESSMENT BOUNDARIES

The local and regional study areas for socio-economic Valued Components are described in the table below and are shown in Figure 15-1.

Table 15-3: Proposed Study Areas for Socio-economic VCs

Study Area	Socio-economic VCs Specific Study Area Description
Local Study Area	Communities of Ross River, Watson Lake, and Faro
Regional Study Area	Whitehorse and Yukon Territory

The Project will not produce socio-economic effects that are significant on a Canada-wide scale. With an estimated capital cost of less than $430 million (Canadian) and peak employment during operations of less than 500 total jobs, the Project will be statistically imperceptible in a $2.0 trillion economy with 18.2 million people employed. Therefore, the rest of Canada outside of Yukon is not included in the assessment of the Project.

The Project is expected to have Yukon-wide effects. Some of the territory-wide effects include, but are not limited to: economic growth; employment and territorial tax revenue. There may also be some territory-wide cumulative effects.

The social and economic effects of the Project will be more concentrated in the communities nearest to the mine, especially those relatively close by road. Ross River is the closest community to the Project and is the home community of the RRDC.

Similar to Ross River, Faro is relatively close to the Project by road. Faro has the housing and infrastructure to accommodate a large population increase and the Town continues in its efforts to attract new residents (especially families with children). Faro is therefore more likely than any other community to see a population increase because of the Project and, if that increase is significant, experience more socio-economic effects.

Watson Lake and its neighbouring LFN villages are somewhat more distant from the Project than Ross River and Faro; however, it is included in the scope of the assessment because it is within LFN Traditional Territory and much of the road transportation for the Project will go through the community.

Whitehorse is included separately as part of the RSA in the scope of assessment due to its central role in Yukon's economy and because it will be the point of hire for most of the Project's workers. Section 15.3 provides a summary description of the socio-economic setting of the Project that, for the purposes of the assessment, will consist of Whitehorse and the entire Yukon as the regional study area (RSA) and the communities of Ross River, Watson Lake and Faro as local study areas (LSAs). A short summary description of the land and resource use that occurs in the Project area is also included.

Local Study Area

Regional Study Area

Towns and Communities

Kudz Ze Kayah Project

Kaska Dena First Nation (Ross River Dena Council and Liard) Traditional Territory

KUDZ ZE KAYAH PROJECT

FIGURE 15-1

SOCIO-ECONOMIC STUDY AREA AND LOCAL COMMUNITIES

FEBRUARY 2017

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.
Datum: NAD 83; Projection: UTM Zone 9N

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BMC MINERALS

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Temporal boundaries are defined to include all Project phases within which effects are expected to occur. The Project phases considered in the EA include the following:

- **Construction Phase**: will last approximately 2 years and includes site preparation and clearing and establishment of Project infrastructure;
- **Operations Phase**: will last approximately 10 years and includes open pit and underground development and ore processing;
- **Decommissioning, Reclamation and Closure Phase** (referred to as closure phase): will last approximately 3 years; and
- **Post-closure Phase**: is assumed to begin once all physical activities have finished on site and will continue until active monitoring is no longer required; the phase is split into two periods: transitional 13-year period during which the ABM open pit continues to fill with water, ending when the ABM lake begins to spill to Geona Creek (assumed 16 years for the pit to flood following the end of operations) and a 10-year post-closure monitoring period.

15.3 SOCIO-ECONOMIC SETTING

YESAB (2006) requests that proponents demonstrate an awareness of the background social and economic conditions against which the Project will take place. Specifically, YESAB writes that a general understanding of the historical trends and present status of the following will be valuable in helping with identifying Valued Components and initial effects as completely as possible from the start:

- Societal relationships with the biophysical environment;
- Political and social resources;
- Culture, attitudes, and social/psychological conditions;
- Economic and financial background; and/or
- Relevant population (or demographic characteristics (e.g., age, gender, education and employment distributions).

The sections below provide a summary description of the socio-economic setting of the Project that consist of the entire Yukon and Whitehorse as the RSA and the communities of Ross River, Watson Lake and Faro as LSAs. A short summary description of the land and resource use that occurs in the Project area is also included.

Each community setting section below has a greater focus on history, social infrastructure and social issues than the Yukon section because the potential for social effects is relatively larger at the community level.

15.3.1 Project Area, Land and Resource Use

The Project is in the Kaska Traditional Territory approximately 115 km southeast of Ross River. It is approximately 24 km south of the Robert Campbell Highway and is accessed by a Tote Road that

leaves the highway at the south end of Finlayson Lake. The Tote Road is gated and licensed for use by BMC only and does not provide access for any other resource users.

The region has long been used by the Kaska to hunt, trap, fish, gather plants, and seek shelter. There are also traditional trails in the area used by Kaska citizens to travel between key traditional use locations. There are two main access routes to the proposed Project area, including from the west starting at Frances Lake along Money Creek as well as from the north at Pelly Banks through Finlayson Creek. The Project is in the far southeast corner of the Ross River group registered trapline (RTC) 405; however, the mineral claim blocks extend into RTC 250 which is held by two RRDC citizens. Based on desk-based research (Appendix F-3), the area in and around the proposed Project have been of particular importance for hunting for big game, such as caribou, moose, and sheep, especially in the North Lakes area (south of the Project). There is limited documentation about Kaska fishing and plant harvest in the area. There are several Kaska cabins in the region, including nearby locations along North Lakes, Money Peak, and Wolverine Lake with more distant locations along Frances Lake, Pelly Banks, and Money Creek.

The wider area surrounding the Project is used by non-First Nation hunters who typically gain access by flying to different lakes. The Project is within outfitting concession number 20, which is held by Yukon Big Game Outfitters.

The Project is in the Finlayson Lake Volcanic Massive Sulphide District that was largely discovered and defined in a rush of staking and exploration activity in the 1990s. The entire district is blanketed with quartz mining claims and there are at least 6 known significant volcanic massive sulphide deposits, including KZK. The now-closed Wolverine Mine (with its separate access road) is located approximately 25 km to the east of the Project.

The area has no known history of placer mining or forestry.

15.3.2 Yukon

Yukon is a large territory with a small population and the heavy reliance on government that is typical of relatively remote jurisdictions across the circumpolar north. Although Yukon has a variety of economic and industrial sectors, the government sector (largely financed through federal transfers) is the largest. It can be said that Canadian sovereignty is Yukon's largest export.

Yukon's strong public sector and its continued growth through increased federal government transfers has proved to be a double-edged sword; it has provided economic stability and a level of growth, but has done little to generate private sector economic diversification and exports (Taggart and Zanasi, pers. Comm.).

Mining has traditionally been the mainstay of Yukon's private sector industry. The dependence on mining gave rise to boom-and-bust cycles, typical of economies dependent on natural resources. Until this century, the size of the non-Aboriginal population fluctuated with the cycles of the mining industry. The opening of the Faro mine, one of the world's largest lead-zinc producers, in 1969 provided a significant boost and its series of closures and re-openings in the 1980s and 1990s resulted in substantial alternating declines and increases in economic activity and population.

Yukon's mining industry entered a prolonged slump following the closure of the Faro lead-zinc mine in January of 1998. By 2002 there were no operating hard-rock mines in Yukon, mineral exploration spending had declined steeply, and placer gold production had fallen to a 23-year low. The total value of mineral production in the territory fell from $225 million in 1997 to $82 million in 2003. However with increasing mineral prices through 2011, Yukon's mining industry rebounded with exploration expenditures reaching $332 million, by 2012 the value of mineral production was $486 million. This strong upward trend in prices reached its peak in 2011-2012. Falling prices since then have resulted in falling exploration expenditures and mineral production. By the end of 2015 Yukon mineral exploration expenditures had shrunk to approximately $73 million (less than one quarter of 2011 levels), and the value of mineral production had dropped by approximately half from its 2012 peak following the shutdown of the Bellekeno and Wolverine mines (NRC, n.d.).

Whitehorse, the territorial capital, has become increasingly important. Containing almost three-quarters of the territorial population, it dominates the territorial economy. Most services are only available in Whitehorse. Rural communities (where the First Nation population is concentrated) are generally not benefiting to the same degree from the high incomes and economic prosperity of the capital. Yukon's rural communities, like other rural and First Nation communities across Canada, suffer disproportionately from many social and economic problems, including generally high unemployment, low income, alcohol and drug abuse, and low educational levels.

In 1992, the Council for Yukon Indians (today the Council of Yukon First Nations) and the federal and territorial governments signed the Umbrella Final Agreement (UFA) to serve as the template for individual land claims agreements. Among the many provisions of that agreement was the creation of a new system of environmental and socio-economic assessment (*Yukon Environmental and Socio-economic Assessment Act* [*YESAA*]), as well as the development of a self-government regime giving signatory First Nations many additional government powers. Most Yukon First Nations have signed a land claims agreement. However, significantly for the Project, neither the Ross River Dena Council (RRDC) nor the Liard First Nation (LFN) have signed a final agreement and remain *Indian Act* bands.

15.3.2.1 Yukon: Demographics

In December 2015 the Yukon Bureau of Statistics estimated the population of Yukon at 37,566; up 1.1% from a year earlier. Yukon's population has been on an upward trend since December 2002 when 29,960 people lived in the territory, and passed its previous (1997) high point of 33,519 in 2008. More than 75% of Yukoners live in Whitehorse or its immediate vicinity, with most of the rest distributed in 16 small, widely scattered communities (YBS, n.d.).

The territory's population has a tilt toward men, with 105 males for every 100 females at the end of 2015. However, there is no longer a frontier-style skew toward men; in 1961, for example, there were 127 males for every 100 females. (YBS, n.d.; SCC, n.d.).

In the 2006 Census 25.1% of respondents identified themselves as Aboriginal, while in the less reliable (because of its voluntary nature) 2011 National Household Survey (NHS) 23.1% identified themselves as Aboriginal. In June of 2015 the Yukon Bureau of Statistics reported that 20.1% of

Yukon's population self-reported as First Nation. Note that the definition of Aboriginal is wider than First Nation as Aboriginal also includes Inuit, Inuvialuit, and Metis.

The median age of Yukon's population in 2006 was estimated by Statistics Canada to be 38.0; only slightly under the Canadian figure of 38.8 years, and up sharply from the 2001 figure of 35.8. The median age has continued to rise; in 2011 it had reached 39.1 years, and in June of 2015 the Yukon Bureau of Statistics reported a median age of 40 for non-First Nation Yukoners, but only 31 for Yukon First Nations' people (SCC, n.d.).

The overall population growth of Yukon was 18.9% between 2005 and 2015, with all age cohorts showing at least some growth over the decade. Reflecting the aging baby boom, the older age cohorts are growing much faster than the others. The number of 60-74 year olds increased by 2,637; a 90.5% rate of growth over the decade, while the numbers of those aged over 75 grew by nearly 60% over the same period. The lowest growth rates were for children aged 0-14 years (4.9%) and for those aged 40-59 years (6.0%) (YBS, n.d.).

15.3.2.2 Yukon: Labour Force and Employment

Over the past decade, Yukon's labour force increased by 15% from 18,000 in 2005 to 20,700 in 2014, with a peak labour force of 20,800 in 2012. Over the same period the unemployment rate has varied from 4.3% to 7.0% (YBS, n.d.).

Yukon has generally tended to have a very high labour force participation rate. The 2006 Census found 78.1% of Yukoners (aged 15+) in the labour force compared to only 66.8% for Canada. This is true for all age groups, reflecting that this high rate is not a result of people choosing work over schooling or because there are relatively fewer seniors in Yukon. The proportion of people attending school full-time in the territory is almost identical to the Canadian average. In 1996 the labour force participation rate was as high as 80.3% but has been drifting downward over the past decade with the increasing number of seniors, and as of 2014 had dropped to 74.7% (SCC, n.d.).

The number of Yukoners directly employed by all levels of government (federal, territorial, First Nation, municipal and government-funded agencies such as hospitals) in the territory was estimated at 7,800 in 2014; up 16.4% from 2005. The number of people employed in the private sector also increased by 24.3% over the same period. The result has been that public-sector employees have made up a very stable 39% of all those employed in the Yukon over the past decade (YBS, n.d.).

15.3.2.3 Yukon: Earnings and Income

Average weekly earnings from employment are generally higher in Yukon than across Canada. The difference between the territory's industrial aggregate weekly wage and the national average has tended to be in the 10% range. The figures for 2014 put average weekly earnings (including overtime) at $1,036 in Yukon compared to the Canadian figure of $935; a difference of 10.8% (YBS, n.d.).

The 2011 NHS found that Yukoner's median income was $40,391, or $10,513 (35%) higher than the Canadian median of $29,878. Yukon women appear to be doing particularly well compared to Canadian women overall, with a median income 54% higher than the Canadian median (SCC, n.d.).

Yukoners rely more heavily on market income (mostly from employment) and less on government transfers such as pensions, unemployment insurance and social assistance than other Canadians. Tax data shows that 90.8% of Yukon tax filers report market income versus the Canadian average of 87.6% (CRA, n.d.).

15.3.2.4 Yukon: Education Levels

Yukoners are, on average, better schooled than other Canadians. The 2011 NHS found that 67.1% of Yukoners aged 25 to 64 years had a post-secondary diploma, certificate or degree; the highest proportion in Canada. And a total of 12.3% of those aged 25 to 64 had less than a high school education (SCC, n.d.).

An interesting finding of the 2011 NHS data is that fewer younger adults entered the trades; only 15.8% of the young adult population (aged 25 to 34) had an apprenticeship or trades certificate compared with 35.5% of those aged 45 to 54 years (SCC, n.d.).

15.3.2.5 Yukon: GDP and Inflation

In 2014 the preliminary numbers for Yukon's Gross Domestic Product (GDP) totalled $2.183 billion (measured in 2007 dollars to take out the effects of inflation). This is down from the peak of $2.225 billion in 2012. Real (after inflation) GDP growth was very strong leading up to 2012 with year over year growth rates averaging 5.1% from 2005 through 2012. GDP shrank by 0.7% in 2013, and a further 1.2% in 2014 (YBS, n.d.).

The percentage distribution of the territory's 2014 GDP by industry is presented in Table 15-4.

Table 15-4: Yukon Industries as Percentage of GDP, 2014

Industry	Percentage of GDP
Public administration	23.3%
Real estate and leasing	14.0%
Mining and oil and gas extraction	13.2%
Construction	8.7%
Health care and social assistance	8.1%
Educational services	5.1%
Retail trade	5.0%
Professional, scientific and technical services	3.1%
Transportation and warehousing	3.0%

Industry	Percentage of GDP
Finance and insurance	3.0%
Accommodation and food services	2.9%
Information and cultural industries	2.8%
Utilities	1.9%
Other services	1.6%
Wholesale trade	1.4%
All others	2.9%

Over the past decade inflation in Whitehorse, as measured by the consumer price index, has typically followed overall Canadian trends but with sharper movements (note that inflation is measured for Whitehorse rather than Yukon). But the rate of inflation in Whitehorse has continued to fall in 2013 and 2014 while Canada's rate has been increasing again after falling from a peak in 2011 (YBS, n.d.).

15.3.2.6 Yukon: Industrial Structure

Yukon's industrial structure is heavily tilted to government and government-related industries; however, the resource sector, construction and tourism all play a role.

Federal government transfers to Yukon Government (YG) have been increasing; in part because of the devolution of some powers to the territorial government. Total transfers to YG were $473 million in 2003/04 but reached $1.03 billion in 2014/15; an increase of 118% over the 11 year period. Over 90% of the transfers are a result of territorial formula financing; a policy designed to fill the gap between the expenditure requirements and revenue-raising capacity of all of Canada's northern territories. Federal transfers accounted for approximately 83% of YG's revenues in 2014/15. The federal government also spends directly in Yukon and provides some funding to First Nation governments (YBS, n.d.).

Although Yukon has traditionally relied on mining as an economic mainstay, the industry entered a prolonged slump following the closure of the Faro lead-zinc mine in January of 1998. By 2002 there were no operating hard-rock mines in the Yukon, mineral exploration spending had declined steeply, and placer gold production had fallen to a 23-year low largely due to low gold prices. The total value of mineral production in the territory fell from $225 million in 1997 to $82 million in 2003.

In 2004 the value of total mineral production and mineral exploration expenditures began to rise. By 2012 Yukon had three mines operating at full commercial production: Minto (fall 2007), Bellekeno (fall 2010) and Wolverine (spring 2012). With the three mines coming on line and increasing production, the total value of Yukon's mineral production increased more than 10-fold between 2006 and 2012. However, the closure of Bellekeno in late 2013 and Wolverine in early 2015, combined with a fall in metal prices, has sent the value of the Yukon's mineral production plummeting from its 2012 peak of $486 million to a preliminary figure of $247 million in 2015.

Mineral exploration saw a short and sharp boom with expenditures rising from $91 million in 2009 to a peak of $332 million in 2011 before collapsing to $73 million in 2015 (preliminary data) (NRC, n.d.).

A strong construction sector helped drive Yukon's economy over the past decade. The total value of building permits issued rose to $130.5 million in 2014; up 73% from 2005. There have been significant annual swings in the overall rise in building permits; with a high of $176.8 million in 2011 and a low of $71.3 million in 2008 (YBS, n.d.).

Yukon's tourism industry appears to have largely been stable over the past decade. The YG Department of Tourism uses Yukon border crossings as a proxy for visitor counts. Between 2005 and 2015 these numbers have varied from a low of 286,853 in 2009 to a high of 350,095 in 2013. The 2015 number was 327,778 (YBS, n.d.).

Manufacturing does not play a large role in Yukon's economy, accounting for only 0.7% of GDP in 2014. Similarly, agriculture, forestry and fishing together account for an even smaller portion of GDP at 0.2%. Total value of agricultural production in Yukon has historically been less than $5 million annually, and forestry has largely been confined to local fuel wood and very small-scale valued added milling for local consumption (YBS, n.d.).

15.3.3 Ross River

15.3.3.1 Ross River: History

Ross River is located on the south bank of the Pelly River near the confluence of the Ross and Pelly Rivers. The South Canol Road runs through the community with a seasonal ferry providing access to the North Canol Road during the summer. The community is approximately 10 km from the Robert Campbell Highway.

The confluence of the Ross and Pelly Rivers has long been used as a gathering place for First Nation peoples, particularly in the late summer. The first permanent settlement was established in 1901 when Tom Smith started a small trading post on the north bank of the Pelly River and called the spot Smiths Landing. That winter approximately 15 First Nation families over-wintered near the post, creating the beginnings of the permanent community of Ross River. By 1903 a second, rival, trading post was set up on the south bank of the Pelly River opposite Smiths Landing. The settlement attracted an increasing number of people, mostly the Kaska, but including many First Nations people from the Mackenzie River region who would travel over the divide to meet others, trade, and sometimes stay. By 1914 over 1,000 people were gathering at Ross River in the summer. A severe influenza epidemic in 1916 hit the community's First Nation people hard, and increasing economic activity and new trading posts along the Mackenzie River reduced the numbers of people gathering and settling at Ross River.

World War II and the years immediately following brought substantial changes to Ross River. The building of the Canol Road and pipeline between 1942 and 1944 brought a large, but temporary, influx of outsiders to the area and the new road made the community much more accessible. The late

1940s and early 1950s also saw a collapse of fur prices and the permanent closure of most of the region's fur trading posts, including Pelly Banks, Sheldon Lake, Rose Point, Frances Lake and Macmillan River. By 1952 Ross River was designated as a band village and had the only remaining trading post in the region. The Canol Road shifted the commercial centre of the community to the south bank of the Pelly River at the new ferry crossing point, and the federal government began pressuring the Kaska citizens to move across the river from the Old Village. By the mid-1960s that pressure, and even the physical relocation of homes while their owners were away in the bush, resulted in the complete abandonment of the Old Village and the community of Ross River assumed the shape it has today.

Mining exploration increased in the region around Ross River through the 1950s, and an exploration and mining boom occurred in the 1960s and 1970s with the discovery and development of the Faro mine. Although Ross River Dena people did work in mining exploration, it was Ross River Dena citizens Arthur John, Jack Ladue, Robert Etzel and Joe Etzel who led Al Kulan to Vangorda Creek where he staked the first claims of what would become the Faro mine. The mining boom did little to benefit most of the Kaska citizens (RRDC, 2006).

The re-openings of the Faro mine and a smaller mining exploration boom in the 1990s brought more economic benefits to the RRDC and its people than in the 1960s and 1970s; however, those benefits remained relatively small and social problems remained large. The experience of being the indigenous population located in a region undergoing extended economic booms and gaining little economic benefit increased the determination of the RRDC to be at the centre of a long-term sustainable regional economy. More recently, the development of a mining strategy for the community, *The Snow that Eats the Snow,* and *Building on Strength: An Economic Development Strategy for Ross River,* reflect that determination (RRDC, 2006).

15.3.3.2 Ross River: Demographics and Community Economy

Over the past decade, Ross River's population has been slowly increasing from approximately 350 to approximately 400. In December 2015, the Yukon Bureau of Statistics put the population of Ross River at 411. Self-reported First Nation people make up nearly 80% of the population of the community (YBS, n.d.).

In general, the age distribution of Ross River's population is reasonably close to the Yukon overall, including the proportion of children and teens under the age of 19 (23.6% in Ross River versus 21.4% in Yukon) and people older than 65 years (8.0% in Ross River versus 11.1% in Yukon) (YBS, n.d.).

In the 2006 Census, Ross River had proportionally many more single parent families than Yukon, while matching the territorial pattern for couple families with and without children. Ross River had a very high proportion of residents who have not finished high school (50% of those aged 15 and over) and a very low proportion of university degree holders (4.3%) compared to Yukon (23% and 17.8%, respectively) (SCC, n.d.).

Statistics on the GDP of individual Yukon communities are not kept; however, a reasonably good indicator of the size of the local money economy is aggregate personal income. In the 2013 tax year (the latest for which data are available), residents of Ross River reported a total of $8.37 million in income from all sources. It is important to note that this represents only the formal, dollar economy; the value of subsistence activities and any other unpaid work are not captured by dollar measures of economy size (CRA, n.d.).

The latest available data (October 2015) from the Yukon Bureau of Statistics' spatial price index for Ross River indicates that a basket of regularly purchased items that would cost $100.00 in Whitehorse are priced at $117.60 in Ross River. Fruit and vegetables are the most expensive component (45.7% more expensive), while home heating fuel is the least expensive in relative terms (3.3% more expensive than Whitehorse) (YBS, n.d.).

Various levels of government provide Ross River's economic base. The 2006 Census found that the most common jobs were in the trades and in the transportation occupational cluster, which includes most construction workers, equipment operators and truck drivers (many of whom are employed by governments). Sales and service occupations matched the trades in numbers and includes those working in the retail sector, daycare workers, restaurant and hotel workers and others. The next largest occupational group was in the social science, education and government service cluster (SCC, n.d.).

Incomes in Ross River are far below the territorial average. The 2006 Census found the average individual income in Ross River was $26,000 compared to the Yukon average of $38,700. Average family income in Ross River was $50,900; only 40% of the Yukon figure of $86,000. From Canada Revenue Agency data for 2013 (the latest available), the average income of tax filers in Ross River was $30,985; the lowest community average in Yukon. The average Yukon tax filer reported income of $52,288 in 2013 (SCC, n.d.; CRA, n.d.).

For 2015 the Yukon Bureau of Statistics reports that Ross River had 14 local businesses employing a total of 16 people in the community. This compares unfavourably with 2010 when 14 local business employed 31 people in the community (YBS, n.d.).

15.3.3.3 Ross River: Social Infrastructure and Social Issues

Ross River is the home community of the Ross River Dena Council, a mainly Kaska First Nation, and it is a predominantly Aboriginal community. The RRDC is not recognized as a self-governing First Nation by the federal government under the UFA, but does see itself as exercising inherent self-government rights over its Traditional Territory. The RRDC delivers a variety of services to its citizens in the community. Ross River has no form of local or municipal government.

Policing in Ross River is the responsibility of the Royal Canadian Mounted Police (RCMP) who maintain a detachment in the community. Fire and ambulance services are provided by volunteer organizations. YG maintains a health centre staffed with community nurse practitioners in the community. The Ross River School offers Kindergarten through Grade 12. A total of 56 students were enrolled in all grades in June 2016; up from 49 in June 2015. Yukon College operates a satellite

community campus in Ross River. The community campus provides academic upgrading courses, General Educational Development (GED) tests, computer training and various occupation-related courses (YG Education, 2016).

The community lost its major recreational facility, the indoor unheated hockey rink, to a fire in 2011. The facility was rebuilt in 2013 and hockey started up again in early 2014.

In developing an integrated community sustainability plan in 2006, people in Ross River identified substance abuse as a serious health and social problem in the community and made the elimination of such abuse as a long-term community goal. Another community health issue identified in the plan was the need for clean, high quality water in the community and better means of sewage disposal (RRDC, 2006).

Statistics Canada's means of collecting crime data has changed with the result is that crime data from 2012, 2013 and 2014 (the latest available) cannot be directly compared to previous years. The total number of criminal code violations (excluding traffic) reported by police in Ross River dropped from 142 in 2012 to 134 in 2013 and then rose to 161 in 2014. For 2014 this indicates a crime rate of approximately 40 violations per 100 inhabitants (note that this is not an official number but is calculated from the 2014 population as estimated by Yukon Bureau of Statistics) (YBS, n.d.).

15.3.4 Watson Lake

15.3.4.1 Watson Lake: History

Watson Lake is situated in the south-eastern corner of the Yukon at the junction of the Alaska Highway and the Robert Campbell Highway. Watson Lake, along with neighbouring Upper Liard, Two Mile and Two and One-Half Mile Villages, is the home community of the Liard First Nation.

Watson Lake had its beginnings as a permanent community in 1941 when the Canadian government began to build a chain of airfields across the north to ferry planes to the Soviet Union, followed quickly by the construction of the Alaska Highway in 1942. Watson Lake and its airfield became a transportation hub and service centre for the region; a role reinforced with the construction of the Robert Campbell Highway north to Ross River in the late 1960s, and the completion of the Stewart Cassiar Highway south in the early 1970's.

The community has served as the service centre for mines in the region, including the Cassiar asbestos mine in BC, that operated from 1952 to 1992, and the Cantung mine located over the border in the Northwest Territories (NWT) which operated from 1962 to 1986, and then intermittently from 2002 to 2015. Over the decades Watson Lake has also served as the centre of the Yukon's small forest industry, with the most recent effort of running a local sawmilling operation resulting in bankruptcy in 2000. Although the southeast Yukon is considered to have significant potential oil and gas reserves, only the Kotaneelee field has been developed but ceased production in 2012.

15.3.4.2 Watson Lake: Demographics and Community Economy

Over the past decade the population of Watson Lake has remained relatively stable at around 1,500 citizens. In December of 2015 the Yukon Bureau of Statistics reported the community's population as having slipped to 1,455. Self-reported First Nation people made up 41% of the community's population in 2015 (YBS, n.d.).

In the younger age cohorts, the age distribution of Watson Lake's population does not differ significantly from that of Yukon, but the community does have significantly more people aged 65 years and older (15.5% of the population compared to 11.1% for Yukon). The 2011 NHS found that approximately 19% of all families in Watson Lake were lone-parent families, almost identical to the Yukon proportion of 20% of all families (YBS, n.d.; SCC, n.d.).

Statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local money economy is aggregate personal income. In the 2013 tax year (the latest for which data are available), residents of Watson Lake reported a total of $39.65 million in income from all sources. It is important to note that this represents only the formal, dollar economy; the value of subsistence activities and any other unpaid work are not captured by dollar measures of economy size (CRA, n.d.).

The 2006 Census found a stark difference in employment between the Town of Watson Lake and the three neighbouring Kaska villages. The labour force participation rate in the town was 81.3%; higher than for Yukon and much higher than the LFN rate of 63.8%. The unemployment rate in the Upper Liard, Two Mile and Two and One-Half Mile Villages, at 45.9%, was almost four times higher than the 11.9% rate in the Town of Watson Lake. Among residents of the three Kaska villages, the most common occupations are in sales and service, and trades, transport, equipment operators, utilities and manufacturing per the 2006 Census. Comparable numbers are not available from the 2011 NHS (SCC, n.d.).

In 2006 the overall levels of education in Upper Liard, Two Mile and Two and One-Half Mile Villages were much lower than Yukon, with 56.6% of the population aged 15 to 64 not yet having a high school diploma or its equivalent (the Yukon number is 21%). However, nearly 21% of 15 to 64 year olds in the three villages have an apprenticeship or trades certificate; nearly double the Yukon figure of 11.8%. Comparable numbers are not available from the 2011 NHS (SCC, n.d.).

The latest available data (October 2015) from the Yukon Bureau of Statistics' spatial price index for Watson Lake indicates that a basket of regularly purchased items that would cost $100.00 in Whitehorse are priced at $110.20 in Watson Lake. Household operations are the most expensive component (44.5% higher) while gasoline is less expensive in Watson Lake than it is in Whitehorse (YBS, n.d.).

From Canada Revenue Agency data for 2013 (the latest available), the average income of tax filers in Watson Lake was $38,572, significantly lower than the average Yukon tax filer reported $52,288 in income (CRA, n.d.).

In its 2015 business survey the Yukon Bureau of Statistics reported that Watson Lake has 100 locally-based businesses employing a total of 350 people. This is largely unchanged from 2010 when there were 105 local businesses employing a total of 320 people in the community (YBS, n.d.).

15.3.4.3 Watson Lake: Social Infrastructure and Social Issues

Watson Lake itself has been an incorporated municipality since 1984 and the Town collects property taxes, delivers a variety of municipal services, and has the authority to pass bylaws in the municipality. The Liard First Nation acts as the only form of local government in Upper Liard, Two Mile and Two and One-Half Mile Villages.

Policing in Watson Lake is the responsibility of the RCMP who maintain a detachment in the community. The fire department is largely staffed by volunteers. YG has built and maintains a regional hospital staffed with doctors, nurses and support staff. YG also provides the ambulance services in Watson Lake with assistance from volunteers after hours.

The Johnson Elementary School offers Kindergarten through Grade 7 with a total of 122 students enrolled in all grades in June 2016; up from 113 in June 2015. The Watson Lake Secondary School offers Grades 8 through 12 and had 93 students enrolled in June 2016; essentially unchanged from June of 2015. Yukon College operates a satellite community campus in Watson Lake. As in other rural communities, the campus provides academic upgrading courses, GED, computer training and various occupation-related courses (YG Education, 2016).

In 2000 Watson Lake opened its new recreation centre that features a community hall, meeting rooms, squash courts, fitness room, a youth centre, bowling alley, hockey arena, and curling club. The community also boasts a downhill ski facility and a seasonal swimming pool.

Statistics Canada's means of collecting crime data has changed with the result that crime data from 2012, 2013 and 2014 (the latest available) cannot be directly compared to previous years. The total number of criminal code violations (excluding traffic) reported by police in Watson Lake rose from 683 in 2012 to 740 in 2013 and then dropped sharply to 546 in 2014. For 2014 this indicates a crime rate of approximately 36 violations per 100 inhabitants (note that this is not an official number but is calculated from the 2014 population as estimated by Yukon Bureau of Statistics; SCC and YBS).

15.3.5 Faro

15.3.5.1 Faro: History

The mineral claims that would become the Faro lead-zinc mine were first staked by Al Kulan in 1953 (the Vangorda deposit) and 1956 (Faro No. 1). Lack of funds, low metal prices, and the area's remoteness stopped further work and the claims lapsed. However, rising metal prices renewed interest in the area in the early 1960s and by 1965 extensive exploration showed clearly that the makings of a mine were present. Cyprus Anvil made the decision to go into production in 1967 and construction of the town began in the fall of 1968. In June of 1969, the first 50 houses were near completion when, area fire destroyed 48 of them. It was an inauspicious start, but the decision to

rebuild on the same site was made immediately. Three months later, the first families moved into the new town of Faro.

Although the company owned nearly all the housing in the community and had built the recreation centre, Faro did not remain a company town for long. The town incorporated in December of 1970. The 1970s were boom times for Faro. The mine was profitable, wages were high, there were the benefits of heavily subsidized housing, and the town grew. Although there were strikes, social problems (alcohol and drug abuse were not uncommon) and a seemingly constant shortage of housing, most residents recall the early years fondly.

In 1981 Cyprus Anvil became a subsidiary of Dome Petroleum. Dome Petroleum had neither the expertise nor the interest to run the mine, metal prices dropped, and Cyprus Anvil began losing money and building up debt. A temporary shutdown was announced in June of 1982, and Dome Petroleum put the operation up for sale. The shutdown continued as metal prices remained very low and the mine remained unsold. By May 1985, the company announced it was permanently closing the mine and by July1985 Faro was a virtual ghost town with a population of less than 100. However, in late 1985 Curragh Resources Inc. (Curragh) purchased the Project with significant government assistance and mined the Faro ore body until 1990 before moving on to the Vangorda deposit. By 1992 however, the company was mired in difficulties and these drove the company to bankruptcy. In April of 1993 the Faro mine was shut down for the second time. This time there was no major stripping program to allow some people to continue working, and again the town's population dropped precipitously (though it never fell below approximately 400).

In 1994 Anvil Range Mining Corporation (Anvil Range), bought the property with no direct government assistance. and after a $75 million stripping program and work at the mill, production began again in August of 1995. Work resumed at the Vangorda deposit and the company began to mine the Grum deposit. Full commercial production was achieved by November 1995.

In November of 1996, however, Anvil Range announced that there would be a temporary closure of the mine by the end of the year. Anvil Range declared bankruptcy in April 1998, leaving the property in the hands of a receiver.

15.3.5.2 Faro: Demographics

Since 2005, the town's population has remained stable at just under 400 residents. According to Yukon Bureau of Statistics data, in December of 2015 Faro's population was 388. Faro's population is reasonably closely balanced between men and women (55% men and 45% women) but is much older than the Yukon figure (42% of Faro residents are over the age of 55 years compared to 27% of Yukoners; YBS, n.d.).

In 2015 18.6% of the population were under 19 years of age compared with the Yukon average of 21.4%. Faro has a marked skew towards older, but still working age, adults. In 2015, 34.3% of the population was aged 50 to 64 years compared to 23.4% for Yukon. This disproportionately older population includes those aged 65 years and older, with 17.0% of the population in that age group compared to 11.1% for Yukon (YBS, n.d.).

Faro has relatively few Aboriginal residents, with 9.6% of the population self-identifying as Aboriginal in 2015 compared with a Yukon-wide average of nearly 21%. The 2011 NHS found that Faro had proportionately fewer single parent families than Yukon (10% of families versus 20%) (SCC, n.d.).

15.3.5.3 Faro: Community Economy

Statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local money economy is aggregate personal income. In the 2013 tax year (the latest for which data are available), residents of Faro reported a total of $12.52 million in income from all sources. It is important to note that this represents only the formal, dollar economy; the value of subsistence activities and any other unpaid work are not captured by dollar measures of economy size (CRA, n.d.).

The latest available data (October 2015) from the Yukon Bureau of Statistics' spatial price index for Faro indicates that a basket of regularly purchased items that would cost $100.00 in Whitehorse are priced at $110.50 in Faro.

The 2006 Census found that Faro had an experienced labour force of 180 people. The most common industry employing Faro workers was public administration (25% of the labour force) but the community had 14% of the workforce working in mining and oil and gas extraction, higher than the Yukon figure. The Census shows the most common occupations in Faro to be in the trades, transport and equipment operator's category, in sales and service occupations, and in business, finance and administration occupations. Comparable numbers are not available from the 2011 NHS (SCC, n.d.).

Average incomes in Faro are lower than those in Yukon but higher than most of Yukon's other rural communities. From Canada Revenue Agency data for 2013 (the latest available) the average income of tax filers in Faro was $44,707, lower than the average Yukon tax filer reported $52,288 in income (CRA, n.d.).

In its 2015 business survey the Yukon Bureau of Statistics reported that Faro has 30 locally-based businesses employing a total of 47 people (YBS, n.d.).

15.3.5.4 Faro: Social Infrastructure and Issues

Faro has been an incorporated municipality since 1970 and the Town collects property taxes, delivers a variety of municipal services, and has the authority to pass bylaws in the municipality. YG provides other community infrastructure and services including the school and the health centre.

Policing in Faro is the responsibility of the RCMP who maintain a local detachment. Fire protection, ambulance and search and rescue services are provided by volunteer organizations.

Statistics Canada's means of collecting crime data has changed with the result that crime data from 2012, 2013 and 2014 (the latest available) cannot be directly compared to previous years. The total number of criminal code violations (excluding traffic) reported by police in Faro rose from 39 in 2012

to 47 in 2013 and then dropped to 38 in 2014. For 2014 this indicates a crime rate of approximately 10 violations per 100 inhabitants (note that this is not an official number but is calculated from the 2014 population as estimated by the Yukon Bureau of Statistics). Faro appears to have the lowest crime rate in Yukon (SCC, n.d.; YBS, n.d.).

YG maintains the Faro Community Health Centre staffed by nurse practitioners. The territorial government also provides schooling in Faro through the Del van Gorder School which offers classes from Kindergarten through to Grade 12. In June 2016 total enrolment was 49 for all grade levels, down from 53 in June 2015. Yukon College operates a satellite community campus in Faro. The community campus provides academic upgrading courses, GED, computer training and various occupation-related courses in Faro (YG Education, 2016).

Faro has a municipal recreation centre that offers a variety of programs and recreation opportunities and it has a golf course that winds its way through the center of the community.

15.3.6 Whitehorse

15.3.6.1 Whitehorse: History

Whitehorse, Yukon's capital city, is located at the head of navigation of the Yukon River and is by far the largest community in the territory.

Whitehorse became a permanent community following the completion of the White Pass and Yukon Route railway in 1900. The railway was built in response to the gold rush, although the height of the frenzy was already over by 1900. As the Yukon's transportation hub Whitehorse has achieved a level of stability although a significant portion of the population, most of those working in the shipyards for example, remained highly transient and largely seasonal.

Copper was discovered with the first claims staked on the Whitehorse Copper Belt in 1898 and the first shipment of high-grade ore from the area was in 1900. The completion of the railway made mining economic and underground copper mines nearby aided in the development of Whitehorse. However high transportation costs meant that mining continued to be a marginal and discontinuous part of the Whitehorse economy. Nine different mines produced high-grade ore between 1909 and 1920 but then stopped entirely before resuming in the 1960s.

The inter-war period from 1918 through 1939 brought a prolonged economic slump to Yukon and to Whitehorse. The 1921 census found there were only 4,157 people in the Yukon Territory; less than half the population of ten years earlier and even Whitehorse, whose population usually grew in the summer months, with the increase in transportation activity, held only 331 people in 1921, down from 727 in the last census.

The construction of the Alaska Highway remains the single largest project undertaken in the Yukon; a true megaproject. It was completed very quickly and with almost no planning and Whitehorse found itself at the center of a maelstrom. Prior to the building of the highway Whitehorse had remained a very small and largely seasonal community of a few hundred people with no expectations

of growth. In June of 1942 more than 3,000 soldiers from the United States Army Corps of engineers arrived and a year later Whitehorse had a population of more than 10,000 military people along with civilian administrators, maintenance and construction workers. At the end of the war the Americans left much as they arrived; quickly and with little planning. In the process tons of useable materials of all kinds, from heavy equipment to office paper; were not sold off but dumped and burned to avoid destroying the local retail market.

In the late 1970s planning was underway for another Yukon megaproject,– the Alaska Highway natural gas pipeline. Yukon braced for another construction boom with government developing entire new neighbourhoods of empty residential lots and business expanding in anticipation. However, this project was never built.

In 1985 the federal government altered the way in which transfer payments were made from the federal to the territorial government. This resulted in significantly more federal money flowing to Yukon, and Whitehorse has benefited greatly over the past three decades. One effect of the flow of federal money has been the overall growth of the public sector that has attracted a highly educated and relatively well paid workforce in the community.

15.3.6.2 Whitehorse: Demographics

Between 2005 and 2015 the population of Whitehorse and surrounding area has grown significantly from 23,608 to 28,872; an increase of 22.3%, per Yukon Bureau of Statistics data. Whitehorse's population is reasonably closely balanced between men and women. Whitehorse, due to its having a large majority of Yukon's population, is leading the overall aging of the territory's population with large relative increases in the population of those 60 years of age and older (YBS, n.d.).

In 2015, 14.5% of the city's population self-identified as Aboriginal compared with a Yukon-wide average of nearly 21%. The 2011 NHS found that lone-parent families made up 20% of all census families in Whitehorse (SCC, n.d.).

15.3.6.3 Whitehorse: Community Economy

Statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local money economy is aggregate personal income. In the 2013 tax year (the latest for which data are available), residents of Whitehorse reported a total of $1.17 billion in income from all sources. It is important to note that this represents only the formal, dollar economy; the value of subsistence activities and any other unpaid work are not captured by dollar measures of economy size (CRA, n.d.).

Over the past decade inflation has remained low in Whitehorse, averaging just under 2% annually from 2005 through 2014. The highest inflation in the period was 3.6% in 2008 and the lowest was 0.4% in 2009 (YBS, n.d.).

Average incomes in Whitehorse are higher than those in the rest of Yukon, reflecting the city's economic dominance in the territory. From Canada Revenue Agency data for 2013 (the latest

available) the average income of tax filers in Whitehorse was $55,221, higher than the average Yukon tax filer reported $52,288 in income (CRA, n.d.).

In its 2015 business survey the Yukon Bureau of Statistics reported that Whitehorse has 2,265 locally-based businesses employing a total of 10,114 people (YBS, n.d.).

15.3.6.4 Whitehorse: Social Infrastructure and Issues

Whitehorse has been an incorporated municipality since 1950 and the City collects property taxes, delivers an extensive variety of municipal services, and has the authority to pass bylaws in the municipality.

Whitehorse has nearly all, or more than, the government services and recreational infrastructure available in much larger centers in other parts of Canada. It has an extensive retail sector to go with its relatively affluent workforce and a large and vibrant cultural sector.

Statistics Canada's means of collecting crime data has changed and one result is that crime data from 2012, 2013 and 2014 (the latest available) cannot be directly compared to previous years. The total number of criminal code violations (excluding traffic) reported by police in Whitehorse rose from 5,259 in 2012 to 6,220 in 2013 and then rose again to 6,380 in 2014. For 2014 this indicates a crime rate of approximately 22 violations per 100 inhabitants (note that this is not an official number but is calculated from the 2014 population as estimated by Yukon Bureau of Statistics; YBS, n.d.).

15.4 PROJECT EFFECTS: INTERACTION MATRIX

The socio-economic effects assessment includes assessment of the following VCs:

- Economy and Sustainable Livelihood;
- Human Health and Well-being;
- Community Vitality;
- Infrastructure and Services; and
- Culture, History and Heritage.

To focus the effects assessment, the first step is to identify any potential interactions between Project activities and the socio-economic VCs. Note that these are overall interactions with the VCs. This first screening step identifies interactions and ranks them according to reasonably foreseeable effects. Ranking, 0, 1, 2 or 3, is made in consideration of the Project activities and consultation efforts to indicate:

0 – Nominal risk interactions- the interaction will result in no effect
1 – Lower risk interactions- the interaction will not result in an adverse residual effect due to the application of the practices known to effectively mitigate predicted effects;

2 – Higher risk interactions- it is reasonably foreseeable that adverse residual effects may result despite mitigation practises; and
3 – Interactions that are expected to result in beneficial residual effects.

The results of the interactions screening are presented in Table 15-5.

Table 15-5: Interaction Matrix for the Socio-economic Valued Components

Project Activity	Economy and Sustainable Livelihood	Human Health and Well-being	Community Vitality	Infrastructure and Services	Cultural History and Heritage
Construction					
Tote Road upgrade to Access Road	0	1	0	0	1
Finlayson Lake airstrip upgrade	0	1	0	3	1
Site preparation and clearing	0	1	0	0	1
Site grading, including soil and overburden removal and stockpiling	0	1	0	0	1
Off site traffic (construction equipment and materials delivery)	0	2	0	1	0
On site traffic	0	1	0	0	0
ABM open pit development (including dewatering and Fault Creek diversion)	0	1	0	0	1
Infrastructure construction	0	1	0	0	1
Waste handling	0	1	0	0	0
Water use and management	0	1	0	0	0
Power generation	0	1	0	0	0
Worker transport	0	1	0	0	0
Construction camp operation	0	1	0	0	0
Workforce, procurement and hiring	3	1	3	0	0
Operations					
ABM open pit operations (including blasting and dewatering)	0	1	0	0	1
Underground operations	0	1	0	0	1
Ore processing	0	1	0	0	0
On site traffic	0	1	0	0	0
Off site traffic (highway)	0	2	0	1	0
Finlayson Lake airstrip operations	0	1	0	1	0
Storage facilities management (Class A, B, and C)	0	1	0	0	0
Progressing reclamation of storage facilities	0	1	0	0	1
Water use (potable and non-potable)	0	1	0	0	0

Project Activity	Economy and Sustainable Livelihood	Human Health and Well-being	Community Vitality	Infrastructure and Services	Cultural History and Heritage
Mine water management and treatment (including effluent discharge)	0	1	0	0	0
Waste management	0	1	0	0	0
Power generation	0	1	0	0	0
Worker transport	0	1	0	0	0
Camp operation	0	1	0	0	0
Workforce, procurement and hiring	3	1	3	0	0
Closure					
Processing plant decommissioning and site reclamation	0	1	0	0	1
ABM lake filling	0	1	0	0	0
Final storage facilities reclamation	0	1	0	0	1
Support infrastructure removal and site reclamation	0	1	0	0	0
Water management, treatment and discharge	0	1	0	0	0
On site traffic	0	1	0	0	0
Off site traffic	0	2	0	1	0
Access road reclamation	0	1	0	0	0
Workforce, procurement and hiring	3	1	3	0	0

Most of the activities listed have no direct interaction with the economy and sustainable livelihood VC or the community vitality VC, effects and interaction are almost all related to employment and purchasing of goods and services (workforce, procurement and hiring), which are expected to have beneficial residual effects.

For the human health and well-being VC almost all of the project activities carry a degree of risk to those working. The workforce, procurement and hiring ctivity is included as a potential adverse interaction with human health and well-being due to the risk of increased alcohol and drug abuse accompanying a rise in income. Off site traffic is the only activity that may result in residual adverse effects due to an increase in accidents. The risk is higher off site as the actions of other drivers are not subject to mitigation measures.

Most of the Project activities will have no direct interaction with the infrastructure and services VC, with the exception of the Finlayson Lake airstrip.

All Project activities that involve earth moving have the potential to interact with the culture, history and heritage VC by disturbing sites or artefacts.

15.5 PROJECT EFFECTS: ECONOMY AND SUSTAINABLE LIVELIHOOD

Yukon communities and Kaska First Nation place a high value on a sustainable, diverse, and stable community economy that provides local employment and business opportunities, and helps to support local government. Promoting the self-sufficiency of community members and avoiding the excesses of a boom and bust economy are also valued. The assessment of potential effects on economy and sustainable livelihood VC includes assessment of the following subcomponents:

- Traditional economic activities — hunting, fishing, trapping, food gathering;
- Economic growth;
- Diverse and stable economy — discouraging boom and bust;
- Employment;
- Employability — education, training and experience;
- Broad participation in economic development;
- Business opportunities; and
- Government revenues.

To focus the effects assessment, the first step was to identify any potential interactions between Project activities and the economy and sustainable livelihood VC. The results of the interactions screening were presented in Table 15-5.

The effects assessment of the Project on the subcomponents of the economy and sustainable livelihood VC are described in Sections 15.5.1 through 15.5.8.

The expected residual effects on each of the subcomponents of the economy and sustainable livelihood VC are summarized in Table 15-19.

15.5.1 Traditional Economic Activities — Hunting, Fishing, Trapping, Food Gathering

15.5.1.1 Effects Characterization

Traditional economic activities, hunting, fishing, gathering, and trapping, form an important part of life for both Kaska citizens and non-First Nation Yukoners. They are particularly important to the RRDC, the LFN, the traditional land stewards of the area, and the Ross River group trappers. Environment Yukon also has an interest through its responsibilities and activities connected to hunting, fishing, and trapping throughout Yukon.

The construction and operations of the Project is likely to have a number of effects on traditional economic activities, particularly hunting and trapping. Potential effects include:

- Improved access to an area through improved maintenance of existing roads can make pursuing traditional economic activities, such as hunting, easier for local people, both Kaska citizens and non-First Nation;
- Increased ease of access, however, can also lead to increased hunting pressures from people outside the region and thereby limit the ability of local residents to continue these activities;
- Increased traffic and industrial activity in the region may act to drive wildlife away from the immediate site and along the road corridors to the Project. The Finlayson Caribou Heard is of special concern in this context (potential effects to wildlife from increased traffic both on and off site are assessed in Chapter 13);
- If Project employees hunt in the region, they play a role in increasing hunting pressures and possibly reducing traditional economic activities; and
- Opportunities to pursue traditional economic activities are reduced in proportion the amount of time spent in the paid labour force.

For Kaska citizens, trapping is not just an effort to earn part of an individual's income. It also plays an important role in continuing the individual and collective connection to, and stewardship of, the land. Therefore, the value of trapping is not just the dollar value of the fur harvested. Although there is no access to the harvest data for the region around the Project or for the Ross River group trapline (RTC 405), trapping harvest data collected for other projects shows a pattern of wide annual variations in harvest levels (for example, data from the Ketza River Project). The variation in harvest is likely the result of a combination of factors: variation in animal populations (especially lynx, as they go through their population cycle), variation in fur prices, and varying levels of trapping effort for other reasons including the traditional management practice of ceasing trapping in an area for several years to allow populations to recover.

For the Kaska there is an ongoing tension around access to the land, especially for hunting in Kaska Traditional Territory. A recent example is the lawsuit by the RRDC for YG to consult with the RRDC before issuing hunting licences that allow non-Kaska people to hunt in its Traditional Territory. Partially underlying that tension is the traditional approach to shifting the focus of activities and land use in response to environmental changes within an overall structure of traditional land stewardship practiced by different extended families over different areas. The development and operation of the Faro mine from the 1960s through to the late 1990s caused a general shift in land use and traditional activities away from Faro and to the east and south, including the area around the Project (Appendix F-3).

15.5.1.2 Mitigation Measures

BMC will be implementing several mitigation measures to reduce any adverse effects of the Project on traditional economic activities, including:

- All firearms are prohibited unless otherwise authorized by BMC management (Appendix A-8);

- All hunting of wildlife or recreational shooting by employees, contractors and visitors is strictly prohibited, as outlined in the No Firearms Policy (Appendix A-8); this policy will be communicated to all employees and contractors during the site orientation;
- Recreational use of all-terrain vehicles (ATVs) and snowmobiles are prohibited (Appendix A-11);
- Access and use of the Tote Road has been strictly controlled since the 1990s and there will be ongoing access control to the mine site, as per the requirements of the Tote Road Licence. Use of the Access Road during Project operations to access recreational areas for ATV and snowmobile use will be strictly prohibited;
- Implementation of the Traffic and Access Management Plan (see Section 18.12) will mitigate the adverse effect of increased traffic on area wildlife; and
- As part of the Socio-economic Participation Agreement (SEPA) BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights under the registered group trapline, and operated trap lines within the Project area.

The application of mitigation measures is expected to result in no residual effects to increased access and employee hunting, as a component of traditional economic activities.

Increased traffic and activity along the Robert Campbell Highway, even with mitigation in place, is predicted to have an adverse residual effect.

With the mitigation measures in place, there remains the adverse residual effect on traditional economic activities created by shift work. For some employees, planning annual vacation time (up to two one-month periods of time off per annum for those on the 2-week-in, 1-week-out shift) to allow for extended hunts may mitigate the effects.

Although BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights under the registered group trapline, and operated trap lines within the Project area, a residual adverse effect is predicted.

15.5.2 Economic Growth

15.5.2.1 Effects Characterization

Economic growth is usually measured by changes in Gross Domestic Product (GDP). The effect on GDP will be the value-added portion of the gross output (i.e, total sales and expenditures) that remains in Yukon. The effects, termed economic impacts, will be different for the three phases of the Project.

The calculation of economic impacts requires the use of a model that accurately captures, at least in broad terms, how the Yukon economy's various industries interact with one another and with the economies of other jurisdictions. The private sector Canadian Regional Input Output Model (CRIOM)

is used as it allows calculating community level economic impacts while being based on Statistics Canada's Interprovincial Input-Output Model (IIOM). For some Yukon-wide calculations, both models are used and the results compared.

Economic impacts are usually classified as direct, indirect or induced:

- Direct impacts are the value-added increase in employment, local incomes, and local GDP retained in the area, and tax receipts to all governments created directly by the spending of the Project;
- Indirect impacts are the value-added increase in employment, local incomes and local GDP retained in the area, and tax receipts to all governments from local suppliers of goods and services to the Project; and
- Induced impacts are the value-added increase in employment, local incomes, local GDP retained in the area and tax receipts to all governments from the spending of additional labour income generated by the Project.

Yukon Economic Growth: Construction Phase

Total capital costs are estimated at CAN$426 million. Using the two models yields substantially different values for the direct effects on GDP. The following presents the impact of the mine construction expenditures on Yukon's GDP. The percentage of GDP is based on the 2014 total Yukon GDP in current dollars of $2.603 billion and the multipliers used are for spending on "Other Engineering Construction", which includes mine construction.

The impact of mine construction is substantial, amounting to between 7.7% and 11.7% of the Yukon's annual GDP. Because mine construction will extend over two years the annual effect is halved, but even an increase of 3.8% to 5.8% in GDP is considerable (Table 15-6). Note that Statistics Canada's model does not provide explicit estimates of induced impacts, but these are implicit in the total impacts produced by the model.

Table 15-6: Project Construction Impact on Yukon GDP

Effect	Statistics Canada IIOM		CRIOM	
	Value added	% of GDP	Value added	% of GDP
Direct effect	$114,438,011	4.4%	$191,635,760	7.4%
Indirect effect	$60,326,296	2.3%	$62,898,343	2.4%
Total effect	$200,761,932	7.7%	$303,490,213	11.7%

Community Economic Growth: Construction Phase

The effect of construction on community economic growth is more difficult to estimate as it is not known how much of the construction workforce will be drawn from the affected communities. Statistics Canada's IIOM model estimates that the $426 million of construction expenditure will result in 1,035 person-years of direct employment and a total of 1,764 person-years once the indirect and induced effects are considered. The model is predicting about 500 direct jobs over two years.

Yukon Economic Growth: Operations Phase

The effect of Project operations on economic growth depends on the total revenue from mining operations. Anticipated gross revenue over the 10-year life of the Project is shown in Table 15-7.

Table 15-7: Estimated Project Gross Revenue, CAN $ millions

Year	Copper	Zinc	Lead	Gold	Silver	Total
Year 1	$31.8	$153.2	$30.0	$46.2	$72.4	**$333.6**
Year 2	$86.1	$239.1	$38.9	$87.6	$145.6	**$597.3**
Year 3	$103.4	$239.1	$39.2	$65.0	$113.8	**$560.4**
Year 4	$103.4	$203.2	$35.4	$66.5	$118.4	**$526.8**
Year 5	$112.0	$203.2	$42.4	$68.9	$128.7	**$555.2**
Year 6	$94.7	$215.2	$41.3	$62.6	$115.0	**$528.9**
Year 7	$103.4	$203.2	$47.0	$81.6	$136.7	**$571.8**
Year 8	$129.2	$239.1	$20.1	$75.0	$133.6	**$597.0**
Year 9	$103.4	$227.1	$70.6	$83.9	$176.3	**$661.2**
Year 10	$10.6	$19.6	$41.3	$28.2	$59.1	**$158.8**
Total	**$877.8**	**$1,941.8**	**$406.4**	**$665.4**	**$1,199.4**	**$5,090.8**

The gross revenue constitutes an injection into the economy and needs to be translated into increases in GDP or value added. Two different models for the direct effects on GDP were used, the results of which are presented in Table 15-8. In the Statistics Canada model, the multiplier for *Copper, nickel, lead and zinc ore mining* is not available for the Yukon for confidentiality reasons so the *Gold and silver ore mining* multipliers, which are fairly similar to the other metal mining multipliers in other jurisdictions were used.

The effect of Project operations on GDP will be substantial. Estimates range from 3.9% during the final year of production to 18% at the height of production (depending on which model is used).) The effect on GDP will decline considerably after year nine which will result in a decline in the Yukon's GDP of about 12-13%. Note that Yukon's total GDP is assumed to increase at a rate of 2% per year in these calculations (Table 15-8).

Table 15-8: Economic Effect on Yukon GDP: Project Operations

Year	Statistics Canada IIOM			CRIOM		
	Direct Effect	Total Effect	% of GDP	Direct Effect	Total Effect	% of GDP
Year 1	$217,338,843	$273,405,027	10.5%	$198,067,344	$258,768,111	9.9%
Year 2	$389,170,011	$489,562,913	18.4%	$351,472,448	$459,186,539	17.3%
Year 3	$365,145,772	$459,341,221	17.0%	$329,759,168	$430,818,924	15.9%
Year 4	$343,242,515	$431,787,652	15.6%	$309,987,744	$404,988,230	14.7%

Year	Statistics Canada IIOM			CRIOM		
	Direct Effect	Total Effect	% of GDP	Direct Effect	Total Effect	% of GDP
Year 5	$361,738,716	$455,055,257	16.2%	$326,699,328	$426,821,301	15.1%
Year 6	$344,603,172	$433,499,313	15.1%	$311,223,456	$406,602,653	14.1%
Year 7	$372,582,700	$468,696,628	16.0%	$336,467,360	$439,582,909	15.0%
Year 8	$388,985,766	$489,331,139	16.4%	$351,295,904	$458,955,907	15.3%
Year 9	$430,862,423	$542,010,578	17.8%	$389,073,472	$508,310,976	16.7%
Year 10	$103,476,573	$130,170,083	4.2%	$93,443,536	$122,080,732	3.9%

Community Economic Growth: Operations Phase

Community GDP can be estimated by aggregate personal income. Increases in aggregate community personal incomes depends on how many people the Project will employ in each community and what the increase in their incomes will be.

Table 15-9 shows the Project operations phase employment estimates as full-time-equivalents. Given BMC's Yukon point-of hire policy, the rest of the workforce is assumed to come from Whitehorse, although some may come from other communities or from outside Yukon. It is noted that the values presented in Table 15-9 are highly uncertain and will depend on other employment opportunities in the region, which include local employment in the Faro clean-up, other mines and mining exploration projects, government jobs and other services related to tourism. There is further uncertainty given that the point of hire for contractors may be different. It is noted that during the 2016 exploration field program over 30 people from Ross River were employed at the site. BMC also understands that over 80 contract truck drivers were employed from Watson Lake to support the transport of Yukon Zinc concentrate. However, local employment for trucking BMC's concentrate is not included in the estimate provided in Table 15-9.

Table 15-9: Community Employment Assumption Ranges: Operations Phase, Full-Time-Equivalents

Year	Ross River	Faro	Watson Lake	Whitehorse
Year 1	10-30	10-30	35-55	200-250
Year 2	10-30	10-30	35-55	200-250
Year 3	10-30	10-30	35-55	200-250
Year 4	10-30	10-30	35-55	200-250
Year 5	10-30	10-30	35-55	200-250
Year 6	10-30	10-30	35-55	200-250
Year 7	10-30	10-30	35-55	200-250
Year 8	10-30	10-30	35-55	200-250
Year 9	10-30	10-30	35-55	200-250
Year 10	10-30	10-30	35-55	50-100

An average income of $80,000 per year is assumed for each worker, based on rounding the $82,730 average salary of BMC employees. The estimated average income will increase by approximately $40,000 (this is based on rounding the 2010 average declared income in the three communities to $40,000).

Total annual increase in aggregate personal incomes will therefore be $400,000 each for Ross River and Faro and $1.4 million for Watson Lake. Depending on the year, increased aggregate personal incomes in Whitehorse and the rest of the Yukon will range from $4.0 million in the last year of operations to $11.1 million at the peak in years four and five.

Table 15-10 shows that the increase in incomes (and therefore community GDP) will be important for the three rural communities, representing an increase of about 4.5% for Ross River, 3% for Faro and 3.5% for Watson Lake.

Table 15-10: Per Cent Growth in Community Aggregate Personal Incomes: Operations Phase

Year	Ross River	Faro	Watson Lake	Whitehorse
Year 1	4.7%	3.2%	3.5%	0.7%
Year 2	4.7%	3.1%	3.5%	0.8%
Year 3	4.6%	3.1%	3.4%	0.8%
Year 4	4.6%	3.1%	3.4%	0.9%
Year 5	4.5%	3.0%	3.4%	0.9%
Year 6	4.5%	3.0%	3.3%	0.9%
Year 7	4.5%	3.0%	3.3%	0.8%
Year 8	4.4%	3.0%	3.3%	0.7%
Year 9	4.4%	2.9%	3.2%	0.6%
Year 10	4.3%	2.9%	3.2%	0.3%

The additional income will also have an induced effect on community income as the mine employees spend their income. The CRIOM model estimates that this spending will result in an increase of $51,328 in total community income for Ross River, $52,276 in Faro and $274,360 in Watson Lake.

Economic Growth: Closure Phase

Table 15-11 presents estimated Project closure costs, which total $40.0 million at closure and $22 million post-closure, totalling $62 million. Note that there are closure-related expenditures that occur during operations and the effect of these on economic growth are captured above.

Table 15-11: Project Closure Costs

Closure Implementation	During Operations (CAD$M)	Closure (CAD$M)	Post Closure (CAD$M)	Total Cost (CAD$M)
General & Administration	$0.000	$0.300	$3.200	$3.500
Closure Planning	$0.300	$0.000	$0.000	$0.300
Open Pits	$0.450	$1.050	$0.000	$1.500
Waste Rock and Tailings	$19.000	$21.000	$0.000	$40.000
Surface Facilities	$0.000	$1.300	$0.200	$1.500
Water Storage Ponds	$0.000	$0.650	$0.100	$0.750
Infrastructure	$0.000	$0.350	$0.150	$0.500
Waste Disposal / Remediation	$0.000	$0.090	$0.010	$0.100
Roads and Trails	$0.000	$0.100	$0.150	$0.250
Water and Solutions Management	$0.000	$3.650	$7.000	$10.650
Quarries and Borrow Pits	$0.000	$0.025	$0.025	$0.050
Sediment and Erosion Control	$0.000	$0.030	$0.070	$0.100
Post Closure Care, Maintenance, and Monitoring Costs	$0.000	$0.480	$5.120	$5.600
Sub-total	***$19.750***	***$29.025***	***$16.025***	***$64.800***
Indirect Costs (%)	15%	15%	15%	15%
Indirect Costs	$2.963	$4.354	$2.404	$9.720
Total Closure Implementation Costs	***$22.713***	***$33.379***	***$18.429***	***$74.520***
Contingency Allowance	20%	20%	20%	20%
Contingency Amount	$4.543	$6.676	$3.686	$14.904
Total Closure Cost (including Contingency)	***$27.255***	***$40.055***	***$22.115***	***$89.424***

Project closure will result in a decline in Yukon GDP. The two models again give different results; however, the total impact of the closure expenditures is between 0.9% and 1.4% of Yukon's GDP. This compares to the 17-18% at the height of operations and the 3.9% of GDP for Year 10 of operations (Table 15-12).

Table 15-12: Project Closure Costs: Effect on GDP

Effect	IIOM		CRIOM	
	Impact on GDP	% of GDP	Impact on GDP	% of GDP
Direct effect	$16,678,246	0.5%	$27,929,080	0.9%
Indirect effect	$8,791,981	0.3%	$9,166,832	0.3%
Total effect	$29,259,132	0.9%	$44,230,797	1.4%

15.5.2.2 Enhancement Measure

The point of hire for the Project will be Yukon (i.e., Whitehorse, Ross River, Faro and Watson Lake). This will help ensure that the Project's residual effects on economic growth are beneficial. In order to achieve the requirements of the Community Relations Policy (Appendix A-2) and further support local participation, BMC will:

- Encourage the participation of local communities, local Indigenous Peoples and associated businesses in its projects wherever practicable; and
- Develop and implement community relations management procedures and strategies that includes business alliances, employment and training initiatives on safety in the workplace and practical operating skills.

15.5.3 Diverse and Stable Economy — Discouraging Boom and Bust

15.5.3.1 Effects Characterization

Yukon has a history of significant swings in GDP growth, mainly related to the opening and closing of different mines. By its very nature mining has a tendency toward creating a boom and bust cycle, particularly in a small local economy. Any mine is fundamentally limited by its ore reserves and cannot continue production when the ore is gone. The construction and operations of a mine can be designed to extend its life and therefore extending the period over which economic benefits flow to local communities.

The construction of the Project is scheduled to be complete in two years. It is not financially or logistically feasible to extend the construction phase to provide longer-term economic benefits.

The currently delineated ore reserves allow for the planned ten years of operations at a nominal two million tonnes per annum through the Process Plant. Significantly reducing the through-put to extend the mine life and provide longer-term economic benefits will mean significantly reducing the rate of return on investment, as many of the fixed costs needed to get the mine operational cannot be reduced in proportion to the through-put reduction. The overall net present value of the Project decreases as the mine life increases and this lowers its attractiveness to investors and operators. Therefore, it is not feasible to extend the mine life by reducing the through-put.

15.5.3.2 Mitigation Measures

Mines frequently add to their reserves through new discoveries as they mine and so extend the mine life even as they deplete the resource. The main mitigation measure is BMC's plans for continued exploration on the KZK property and nearby properties to delineate further ore reserves and extend the mine life.

Although new discoveries may extend the mine life, it is uncertain if an additional project will be in construction at the time of the closure of KZK; therefore, for the purposes of this assessment the

residual effects are assessed to be adverse. However, if another project were to be constructed as KZK closed there would be no residual adverse effect.

15.5.4 Employment

15.5.4.1 Effects Characterization

Employment is often seen as the single most important potential benefit of mining development, especially at the community level. There is now no need for people to live relatively near their place of work in the mining industry. With fly-in camps and long rotations now being standard in the industry, mine employees can and do live almost anywhere and commute almost entirely by air. This has advantages for mining companies; they can recruit their workforce from all of Canada and are not constrained by small local labour pools or the need to build towns, such as Faro, in the mine's vicinity.

The biggest disadvantage of relying on a workforce that has no ties to the mine's region is higher turnover. A local workforce tends to have lower employee turnover. If a millwright lives in Vancouver, it makes little difference to the worker which northern mine he/she works for. A worker living in a nearby community (or at least in the territory) appears less likely to switch to a job in another territory because of the substantial increase in travel time if nothing else. Employee turnover rates in mines can be high and these high rates come with very high costs in recruiting, training, and a loss of efficiency.

The planned shift rotations are 2 weeks on and 1 week off with certain staff on a 9 days on and 5 days off rotation. Contractors will work a similar schedule to the 2 weeks on and 1 week-off roster.

There will be different ways of transporting workers depending on where their point of hire is located. Local employees from Ross River, Faro and Watson Lake will likely be driven in by a contracted or BMC shuttle to and from their respective communities. There is also the potential of flying these employees to site; however, that will depend on the number of employees on a shift, weather, time of year and other factors. The percentage of local employees will not be known until operations are commenced; however, using a figure of 25% (80 personnel) of the total workforce would mean that there would be 3 shuttle trips per week to transport them between site and the local communities.

All other direct employees will have a point of hire of Whitehorse and will be flown from Whitehorse to Finlayson Lake airstrip and then transported by shuttle to the site. Using the above estimate, 75% (250 personnel) would travel from Whitehorse. Each week would require 5 flights (18 passengers per flight) between the two airports and 3 bus trips between Finlayson Lake airstrip and site, if some of the flights were on the same day.

Accommodation on site during operations will be at a 250-person camp that will be run hotel style. The camp will be typical of an accommodation complex of this size in northern BC or Yukon and will provide all necessary facilities for the workforce. Catering will be provided by a contractor and camp management will be by BMC.

Employment: Construction Phase

Estimated construction labour requirements are approximate at present and will not be fully defined until the final engineering stage. There will be different sub-phases and numbers within the construction phase, and requirements for specialized labour, will fluctuate with each sub-phase.

There will be two main areas of focus during construction: Process Plant construction and earthworks. Estimated total number of people employed at the height of Process Plant construction will be 300 with an additional 75 involved in earthworks. Process Plant construction trades required will be welders, electricians, carpenters, surveyors, crane operators and riggers and other trades associated with a large industrial construction project. The earthworks component will require operators of all open pit mining machinery.

Ross River, Faro and Watson Lake all have relatively high proportions of their populations working in trades, transport, equipment operators and related occupations (35%, 25% and 22%, respectively) who are most likely to find employment on the Project during the construction phase.

Employment: Operations Phase

A summary of employment numbers for the operations phase is shown in Table 15-13. Table 15-14 shows the labour requirements for the open pit portion of the Project by year. The open pit will largely be staffed by a contract miner.

Table 15-15 shows the labour and equipment requirements for the underground portion of the Project by year. The underground will largely be staffed by a contract miner.

Table 15-16 shows the labour requirements for the Process Plant. The Process Plant will be staffed by BMC employees.

Table 15-17 shows the labour requirements for overall administration of the Project. These positions will be filled by BMC employees.

In addition, the ore haul contract is expected to employ approximately 120 people.

Table 15-13: Summary of Employment: Number of Personnel in the Operations Phase

Department	Roster	Preproduction Year		Production Year									
		-2	-1	1	2	3	4	5	6	7	8	9	10
Open Pit	9/5	8	8	8	8	8	8	8	8	8	8	8	0
	2/1	92	95	150	142	142	133	131	122	122	122	119	0
Underground	9/5	0	0	0	0	0	0	0	0	0	0	0	0
	2/1	0	0	0	41	77	83	83	83	61	41	41	0
Processing	9/5	0	0	12	12	12	12	12	12	12	12	12	12
	2/1	0	0	62	62	62	62	62	62	62	62	62	62
Administration	9/5	0	0	18	18	18	18	18	18	18	18	18	18
(Including Camp, Road Maintenance Contractors)	2/1	0	17	26	26	26	26	26	26	26	26	26	26
Total by Roster	9/5	8	8	38	38	38	38	38	38	38	38	38	30
	2/1	92	112	238	271	307	304	302	293	271	251	248	88
Total Personnel		***100***	***120***	***276***	***309***	***345***	***342***	***340***	***331***	***309***	***289***	***286***	***118***
Total On site at One Time		***66***	***80***	***183***	***205***	***229***	***227***	***226***	***220***	***205***	***192***	***190***	***78***

Table 15-14: Summary of Open Pit Labour Requirements, Number of Personnel by Year

Personnel	Preproduction Year		Production Year									
	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Excavator Operator	6	6	9	9	9	6	6	6	6	6	6	0
Truck Driver	11	14	52	44	44	38	36	30	30	30	27	0
Dozer Operator	9	9	9	9	9	9	9	9	9	9	9	0
Grader / Water Truck Op	6	6	6	6	6	6	6	6	6	6	6	0
Driller	3	3	6	6	6	6	6	3	3	3	3	0
Front End Loader	3	3	3	3	3	3	3	3	3	3	3	0
Blast Crew	6	6	6	6	6	6	6	6	6	6	6	0
Subtotal Operators	***44***	***47***	***91***	***83***	***83***	***74***	***72***	***63***	***63***	***63***	***60***	***0***

Personnel	Preproduction Year		Production Year									
	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Tradesmen - Electrical	3	3	3	3	3	3	3	3	3	3	3	0
Tradesmen - Boilermaker	6	6	6	6	6	6	6	6	6	6	6	0
Tradesmen - Mechanical	15	15	15	15	15	15	15	15	15	15	15	0
Fuel and Lube	3	3	3	3	3	3	3	3	3	3	3	0
Subtotal Maintenance	***27***	***27***	***27***	***27***	***27***	***27***	***27***	***27***	***27***	***27***	***27***	***0***
Contractor Manager	1	1	1	1	1	1	1	1	1	1	1	0
Mining Foreman	1	1	1	1	1	1	1	1	1	1	1	0
Shift Supervisor	6	6	6	6	6	6	6	6	6	6	6	0
Safety and Training	3	3	3	3	3	3	3	3	3	3	3	0
Dispatch	3	3	3	3	3	3	3	3	3	3	3	0
Maintenance Foreman	1	1	1	1	1	1	1	1	1	1	1	0
Maintenance Supervisor	3	3	3	3	3	3	3	3	3	3	3	0
Clerk	2	2	2	2	2	2	2	2	2	2	2	0
Subtotal Contractor Staff	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***0***
Mining Manager	1	1	1	1	1	1	1	1	1	1	1	0
Open Pit Foreman	1	1	1	1	1	1	1	1	1	1	1	0
Chief Geologist	1	1	1	1	1	1	1	1	1	1	1	0
Geologist	2	2	2	2	2	2	2	2	2	2	2	0
Grade Control Technician	3	3	3	3	3	3	3	3	3	3	3	0
Chief Mining Engineer	1	1	1	1	1	1	1	1	1	1	1	0
Mining Engineer	3	3	3	3	3	3	3	3	3	3	3	0
Mine Technician	3	3	3	3	3	3	3	3	3	3	3	0
Senior Surveyor	1	1	1	1	1	1	1	1	1	1	1	0
Surveyor	2	2	2	2	2	2	2	2	2	2	2	0
Clerk	2	2	2	2	2	2	2	2	2	2	2	0
Subtotal BMC Staff	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***20***	***0***
Total	**111**	**114**	**158**	**150**	**150**	**141**	**139**	**130**	**130**	**130**	**127**	**0**

Table 15-15: Summary Underground Labour and Equipment Requirements by Year

Personnel	Preproduction Year		Production Year									
	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Truck Driver	0	0	0	3	3	3	3	3	3	3	3	0
Scoop Operator	0	0	0	3	9	9	9	9	6	3	3	0
2 Boom Jumbo Operator	0	0	0	3	9	9	9	9	6	3	3	0
Longhole Driller	0	0	0	0	0	3	3	3	0	0	0	0
Bolter Operator	0	0	0	3	9	9	9	9	6	3	3	0
Getman Blastcrew	0	0	0	3	3	6	6	6	3	3	3	0
Labourers	0	0	0	6	12	12	12	12	6	6	6	0
Subtotal Operators	***0***	***0***	***0***	***21***	***45***	***51***	***51***	***51***	***30***	***21***	***21***	***0***
Tradesmen - Electrical	0	0	0	2	3	3	3	3	2	2	2	0
Tradesmen - Boilermaker	0	0	0	1	1	1	1	1	1	1	1	0
Tradesmen - Mechanical	0	0	0	3	9	9	9	9	9	3	3	0
Subtotal Maintenance	***0***	***0***	***0***	***6***	***13***	***13***	***13***	***13***	***12***	***6***	***6***	***0***
Contractor Manager	0	0	0	1	1	1	1	1	1	1	1	0
Mining Foreman	0	0	0	1	1	1	1	1	1	1	1	0
Shift Supervisor	0	0	0	3	3	3	3	3	3	3	3	0
Safety and Training	0	0	0	1	1	1	1	1	1	1	1	0
Maintenance Supervisor	0	0	0	1	1	1	1	1	1	1	1	0
Clerk	0	0	0	1	1	1	1	1	1	1	1	0
Subtotal Contractor Staff	***0***	***0***	***0***	***8***	***8***	***8***	***8***	***8***	***8***	***8***	***8***	***0***
Underground Superintendent	0	0	0	1	1	1	1	1	1	1	1	0
Underground Foreman	0	0	0	1	1	1	1	1	1	1	1	0
Geologist/Sampler	0	0	0	3	6	6	6	6	3	3	3	0
Mining Engineer	0	0	0	1	2	2	2	2	1	1	1	0
Surveyor	0	0	0	1	2	2	2	2	1	1	1	0
Subtotal BMC Staff	***0***	***0***	***0***	***7***	***12***	***12***	***12***	***12***	***7***	***7***	***7***	***0***
Total	**0**	**0**	**0**	**42**	**78**	**84**	**84**	**84**	**57**	**42**	**42**	**0**

Table 15-16: Processing Plant Labour Requirements

Position	Shift Rotation	Number of Personnel
Processing		
Treatment Plant Manager	9/5`	1
Plant Superintendent	2/1	2
Processing Trainer	9/5	1
Shift Supervisor	2/1	3
Control Room Operator	2/1	3
Operator: Crushing and Loading	2/1	3
Operator: Stockpile and Milling	2/1	3
Operator: Concentrator	2/1	3
Operator: Dewatering	2/1	3
Operator: Tails Filters	2/1	3
Operator: Tailings FEL	2/1	3
Operator: Dry Stack Dozer Operator	2/1	3
Operator: Dry Stack Truck Driver	2/1	6
Operator: Gold Room	9/5	0
Operator: Sampling and Reagents	2/1	3
Operator: Paste Plant	2/1	3
Processing Administrator	9/5	1
Subtotal - Processing		***44***
Metallurgy		
Senior Metallurgist	2/1	1
Metallurgist	2/1	2
Subtotal - Metallurgy		**3**
Laboratory		
Senior Chemist	9/5	1
Chemist	2/1	2
Sample Preparation	2/1	3
Subtotal - Laboratory		**6**
Maintenance		
Maintenance Manager	9/5	1
Maintenance Planner	9/5	2
Maintenance Supervisor (Mechanical)	9/5	1
Maintenance Supervisor (Electrical)	9/5	1
Millwright	2/1	6
Boilermaker	2/1	2
Electrician	2/1	3
Trades Assistant	2/1	1

Position	Shift Rotation	Number of Personnel
Instrument Technician	2/1	1
Refrigeration / HVAC Technician	2/1	2
Automotive Technician	2/1	1
Subtotal - Maintenance		**21**
GRAND TOTAL		**74**

Table 15-17: Administration Labour Requirements

Position	Shift Rotation	Number of Personnel
General Administration		
General Manager	9/5	1
OHS and Training Manager	9/5	1
Commercial Manager	9/5	1
Environment and Community Manager	9/5	1
IT Officer	9/5	1
Subtotal -General Administration		**5**
Accounting and Administration		
Site Accountant	9/5	1
Accounts Payable Clerk	9/5	1
Payroll Clerk	9/5	1
Administration Clerk	9/5	2
Subtotal - Accounting and Administration		**5**
Supply and Security		
Store Supervisor	2/1	1
Stores Personnel	2/1	3
Gatehouse Security	2/1	3
Subtotal -Supply and Security		**7**
Environment and Community		
Environmental Officer	9/5	1
Environmental Technician	2/1	2
Community Mentor	9/5	1
Subtotal – Environment and Community		**4**
OHS and Training		
Site Nurse	9/5	2
Emergency Services Officer	9/5	2
Training Officer	9/5	2
Subtotal – OHS and Training		**6**
Camp and Site Services		
Camp Manager	9/5	1

Position	Shift Rotation	Number of Personnel
Subtotal – Camp and Site Services		**1**
GRAND TOTAL		**28**

Employment: Closure and Reclamation

Firm employment numbers and labour costs during the closure and reclamation phase will not be known until detailed engineering is complete.

However, Statistics Canada's IIOM provides a multiplier of 4.52 Yukon person-years of employment (direct, indirect and induced) per $1.0 million in expenditures in "Other engineering construction." This implies that the Project's estimated closure and post-closure expenditures of approximately $62 million will result in a total of 281 person-years of employment spread over the estimated 30-year closure and post-closure period with most of the effect occurring in the 3-year active closure phase.

15.5.4.2 Enhancement Measures

The point of hire for the Project will be Yukon.

BMC will continue to honour the terms of the Socio-economic Participation Agreement (SEPA) by working with the Kaska to fill openings at the Project (for both BMC and its contractors) for qualified persons, and to the extent permitted by law, give preference to qualified job applicants in the following priority:

- Ross River Dena Council citizens;
- Other Kaska citizens;
- Other Yukon First Nation citizens;
- Other Yukon residents; and
- Others.

With the application of the employment enhancement measures residual effects will be beneficial.

15.5.5 Employability — Education, Training and Experience

15.5.5.1 Effects Characterization

Employability can be measured by the level of training and education, as well as the work experience of the population.

The Project is expected to have a beneficial effect on the employability VC through increased demand for a labour force with specific qualifications and certifications.

BMC views the long-term development of education levels and transferable skills as one of the long-term benefits the Project will offer to employees and their communities.

15.5.5.2 Enhancement Measures

The Project's employability enhancement measures include:

- BMC's Kaska Education Scholarship Program;
- BMC's Mentor Program;
- General workplace training for employees;
- Trades apprenticeships; and
- Summer employment for Kaska students.

In 2016 BMC initiated the Kaska Education Scholarship Program with RRDC. It is a 3-year interim program with a total value of $75,000. It includes up to two university scholarships of $5,000 per year for three years for the study of mining related fields, one general university study scholarship for $4,000 for one year, a total of five scholarships of $1,000 per year for study at Yukon College, and a total of ten $500 study assistance packages of one year duration are available to secondary school students in their final year of high school. There is also a Scholarship Program outlined in the SEPA which will be implemented upon construction as per the requirements of the SEPA. The main goal of implementing a Kaska Education Scholarship Program early and separate from the SEPA is to facilitate Kaska citizens in becoming job ready/qualified for technical and supervisory roles prior to construction (as degree programs are typically 4 years).

BMC has implemented a Mentor Program intended to facilitate employment for Kaska, to enhance the job retention outcomes for locals, and to encourage managerial skill development among Kaska employees. The aim is to have Kaska citizens in positions of management at the operation as soon as competence and qualifications are demonstrated to the level required by BMC in their management positions. This program was implemented in 2015 as part of the KZK Exploration and Environmental Programs and will continue as the Project proceeds.

BMC and its contractors are committed to providing the workplace training required by employees to do their jobs in a safe and effective manner.

BMC and its contractors will provide training through trades apprenticeships based on specific trade interests from the local community members and Kaska citizens.

To the extent that the Project requires summer employees, BMC will cooperate with Kaska to provide opportunities for Kaska students, particularly those who are studying in the areas of mining, geology, process and other engineering, and business administration.

The application of the employability enhancement measures will help ensure residual effects will be beneficial.

15.5.6 Broad Participation in Economic Development

15.5.6.1 Effects Characterization

BMC has demonstrated its commitment to providing employment and contracting opportunities to a wide cross-section of Yukon society over the past two years of exploration activities in the Project area. First Nation people and Kaska particularly, have been a significant part of the exploration workforce. BMC has regularly employed First Nation contractors for work such as road maintenance and pad building and has used the Dena General Store and Tu-Lidlini Petroleum as suppliers (see Section 15.5.7).

15.5.6.2 Enhancement Measures

BMC will continue to apply its Kaska hiring preference and will continue to honour its SEPA commitments to Kaska business.

BMC will rigorously apply its Employment and Anti-Discrimination Policy (Appendix A-3).

The application of the broad participation in economic development enhancement measures will help ensure residual effects will be beneficial.

15.5.7 Business Opportunities

15.5.7.1 Effects Characterization

The Project is expected to provide a beneficial effect through an increase in the number of contracts available for Kaska, local and Yukon firms.

15.5.7.2 Enhancement Measures

As part of the SEPA, Kaska companies will be offered the right to submit a first proposal on the following contracts for goods and services:

- Winter road construction;
- Site clearing for the permanent access road;
- Access road security;
- Miscellaneous “civil” work (e.g., back hoe, cat hauling);
- Camp catering;
- Reclamation work such as re-seeding;
- Janitorial services;
- Laundry and linen services;

- Line-cutting;
- Concentrate haulage;
- Expediting; and
- Mine site fuel supply.

The list is not to be considered exhaustive. In addition, the SEPA statement includes the provision that BMC shall ensure that all its sub-contract tender documents contain a "local benefits" component and that BMC shall give the local benefits component meaningful consideration when evaluating tender bids. This will benefit both Kaska and non-Kaska businesses.

BMC has already demonstrated that its commitment to providing business opportunities to the Kaska and other Yukon companies is real and significant. In 2015 BMC expended $1.53 million with Kaska businesses and as of September 2016, over 70% of major contracts on the Project were with businesses associated with the Kaska and other First Nations. A partial list of Kaska and other Yukon firms contracted by BMC in 2016 includes:

- Tu Lidlini Petroleum;
- Ross River General Store;
- New Age Drilling Solutions;
- T. Moon Construction;
- C. McCloud Construction; and
- Equity Exploration (a BC based firm with significant numbers of Yukon staff).

BMC will continue to honour both the letter and the spirit of its SEPA with the Kaska.

All of BMC's contractors will also be required to honour the letter and the spirit of the SEPA.

The application of the business opportunities enhancement measures will help ensure that residual effects will be beneficial.

15.5.8 Government Revenues

15.5.8.1 Effects Characterization

The Project will directly increase government revenues through various taxes, fees, royalties, and other payments. There will also be indirect effects through the income taxes, GST, excise taxes and property taxes paid by employees.

Royalties

YG collects mining royalties under the *Quartz Mining Act*. The royalty is a tax payable annually, on an escalating rate basis, for any profits from mining that exceed $10,000. The profit subject to the royalty

is the amount by which the value of annual output from mining (revenues) exceeds eligible deductions (costs) for the year. The royalty rate begins at 3% for profits between $10,000 and $1 million, increases to 5% for profits of $1 million to $5 million, increases to 6% for $5 million to $10 million and continues to step up by 1% for each $5 million thereafter.

Calculating the profit for the purposes of collecting the royalty is a very complex undertaking on both the revenue and cost side. This can and does lead to very large annual swings in royalty payments even when production remains relatively constant. For example, the Minto mine's annual royalty payments varied from $200,000 to $9.3 million from 2007 through 2014 (Capstone, 2016)

BMC expects to pay up to $229 million in royalties over the Project's operating life.

Corporate Income Taxes

Corporations in the Yukon pay income taxes on their profits to both the federal and the territorial governments. As with royalty calculations, estimating the amount of corporate income taxes likely to be paid by the Project is a very uncertain business.

BMC expects to pay up to $270 million in Yukon corporate tax and up to $270 million in federal corporate tax over the Project.

Underlining the uncertainty of tax calculations, the CRIOM generates an estimate of $23.2 million in Yukon corporate taxes and $54.2 million in Federal corporate taxes over the life of the Project from construction to closure. If indirect and induced effects are considered, these amounts increase to $27.6 million for YG and $64.4 million for Canada.

First Nation Revenues

The RRDC and the LFN may gain additional revenue, but this is entirely dependent on their SEPA with BMC. Terms of the SEPA are confidential. As neither the RRDC nor the LFN are self-governing First Nations under the UFA, they will not collect the First Nation share of income taxes paid by residents on settlement land.

Other Government Revenues

The major other government revenue generated by the Project will be the income taxes paid by Project employees, both those working for BMC and those working for BMC's contractors. Making firm estimates of the overall income tax take by governments is not possible without making a series of assumptions. Unknowns at the present include the labour component (including the likely salary ranges) of construction, the labour component of mining contracts for the open pit and for underground, and the labour component of other contracts including the ore haul. Another unknown is what proportion of all workers will be resident in the Yukon.

Other government revenues include GST paid by both the Project and by employees, excise taxes and property taxes.

CRIOM does estimate income and other taxes based on spending and revenues. Table 15-18 shows the model's estimate of total personal income taxes and other taxes paid within the Yukon over the life of the Project. Note that "Other Taxes" excludes corporate income taxes, but does include royalties although not as a separate category. Note that the model results are based on average payments by the Canadian mining industry.

Table 15-18: Estimated Project Employee Income Taxes and Other Taxes

Year	Territorial Income Tax	Federal Income Tax	Other Taxes
Construction	$5,980,519	$13,635,584	$9,517,439
Year 1	$6,062,565	$13,822,647	$8,532,856
Year 2	$3,416,473	$7,789,558	$4,808,569
Year 3	$5,688,031	$12,968,711	$8,005,714
Year 4	$5,346,993	$12,191,144	$7,525,713
Year 5	$5,635,252	$12,848,373	$7,931,430
Year 6	$5,368,308	$12,239,742	$7,555,715
Year 7	$5,803,741	$13,232,529	$8,168,571
Year 8	$6,059,520	$13,815,704	$8,528,573
Year 9	$6,711,146	$15,301,413	$9,445,716
Year 10	$1,611,812	$3,674,931	$2,268,571
Closure	$871,603	$1,987,256	$1,387,076
Total	$58,555,961	$133,507,592	$83,675,943

Table 15-18 shows the model's estimate direct effect on taxes resulting from the construction and closure spending as well as that generated by gross mining revenue during operations. The tax revenues will be greater than shown because of indirect and induced effects. With indirect and induced effects included, total territorial income taxes paid will increase to $86.5 million, federal income taxes to $197.3 million, and other taxes to $271.5 million.

15.5.8.2 Mitigation and Enhancement Measures

There are no mitigation or enhancement measures for government revenues. All residual effects are expected to be beneficial.

15.5.9 Summary of Residual Effects

Table 15-19 presents the summary of the residual effects for the economy and sustainable livelihood VC and associated subcomponents.

Table 15-19: Residual Effects on Economy and Sustainable Livelihood

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial /Yes Adverse /No)
Traditional economic activities — hunting, fishing, trapping, food gathering	Potentially reduced opportunity to pursue traditional economic activities.	Construction, operations, active closure	Two x four-week periods of annual vacation/time off plus regular time off on rotation.	Medium	Yes, adverse
	Easier access to area for hunting and fishing: reduced wildlife stocks.	Construction, operations, closure	BMC policies include no firearms, no hunting, and no fishing by employees while on rotation. No hunting by anyone allowed on site and no public use of Access Road.	High	No
	Increased traffic and industrial activity in the region may act to drive wildlife away.	Construction, operations, closure	Recreational use of all-terrain vehicles (ATVs) and snowmobiles is prohibited. No public use of Access Road. Implement traffic and access management plan.	Medium	Yes, adverse
	Disruption and loss of access.	Construction, operations, closure	BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights.	Medium	Yes, adverse
Economic growth	The Project will provide economic growth to Yukon.	Construction, operations, closure	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honor the SEPA provisions for providing business opportunities to local and Yukon companies.	High	Yes, beneficial

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial /Yes Adverse /No)
	The Project will provide economic growth to the communities.	Construction, operations, closure	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honor the SEPA provisions for providing business opportunities to local and Yukon companies.	High	Yes, beneficial
Diverse and stable economy — discouraging boom and bust	Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	Construction, operations, closure	BMC will continue to explore its property for further reserves and attempt to extend the operating life of the mine.	Medium	Yes, adverse
Employment	The Project will provide Kaska citizens and other Yukon residents employment during the construction phase.	Construction	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	High	Yes, beneficial
	The Project will provide Kaska citizens and other Yukon residents employment during the operations phase.	Operations	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	High	Yes, beneficial
	The Project will provide Kaska citizens and other Yukon residents employment during the decommissioning and reclamation phase.	Closure	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	High	Yes, beneficial
Employability — education, training and experience	The Project has the potential to improve education levels.	Construction, operations, closure	BMC will continue to offer its Kaska Education Scholarship Program.	Medium	Yes, beneficial
	The Project has the potential to offer training to Kaska and Yukon employees.	Construction, operations, closure	BMC will continue its Mentor Program BMC and its contractors will offer general workplace training for employees. Trades apprenticeships will be part of the Project.	Medium	Yes, beneficial

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial /Yes Adverse /No)
	The Project has the potential to offer work experience to Kaska and Yukon residents.	Construction, operations, closure	BMC will offer summer employment for Kaska students when the Project requires summer help.	Medium	Yes, beneficial
Broad participation in economic development	Potential to continue the direct beneficial effect through the Project providing jobs and business opportunities to the entire cross-section of Yukon society.	Construction, operations, closure	BMC will continue to apply its Kaska hiring preference and will continue to honour its SEPA commitments to Kaska business. Rigorous application of BMC's Employment and Anti-Discrimination Policy.	Medium	Yes, beneficial
Business opportunities	Potential to continue the direct beneficial effect through the Project providing business opportunities to Kaska and Yukon businesses.	Construction, operations, closure	BMC and its contractors will continue to honor both the letter and the spirit of its SEPA with the RRDC.	High	Yes, beneficial
Government revenues	Potential beneficial effect of increased government revenues at the municipal, territorial and federal level through various taxes, fees, royalties, and other payments.	Construction, operations, closure	None.	N/A	Yes, beneficial

15.6 PROJECT EFFECTS: HUMAN HEALTH AND WELL-BEING

Human health and well-being are universally valued. The assessment of potential effects on human health and well-being VC includes assessment of the following subcomponents:

- Individual health;
- Family stress;
- Reducing alcohol and drug abuse;
- Gathering traditional medicine;
- Public health and safety — increased traffic, hazardous material transport, waste disposal; and
- Workplace health and safety.

In order to focus the effects assessment, the first step was to identify any potential interactions between Project activities and the human health and well-being VC. The results of the interactions screening were presented in Table 15-5. The effects assessment of the Project on the subcomponents of the human health and well-being VC are described in Sections 15.6.1 through 15.6.6. A summary of expected residual effects on the VC subcomponents is in Table 15-21.

15.6.1 Individual Health

15.6.1.1 Effects Characterization

Better individual health is clearly associated with higher incomes and higher education levels. Statistics Canada (2003) notes:

> *Health can be influenced by income and education. People with higher incomes can generally expect to live longer and healthier lives than those earning less. In 1996–97, only 47% of Canadians at the lowest income level rated their health as very good or excellent, compared with 73% in the highest income group. … Only 19% of people who had not graduated from high school said their health was excellent, whereas more than 30% of university graduates claimed they enjoyed excellent health.*

In general, steady employment and increased incomes are strongly correlated with a greater sense of self-worth, better individual health, and better family stability and health. By offering relatively long-term, steady, and relatively well-paid employment, along with the possible increases in education and skill levels through apprenticeships and training, the Project will likely have an overall beneficial effect on individual health in all employee's communities.

15.6.1.2 Mitigation and Enhancement Measures

To help employees and their families maintain good health, BMC will negotiate on behalf of all employees for favourable arrangements with suppliers of life and property insurance to significantly reduce the costs of these products and offer a dental and health plan for employees.

BMC will also support the provision of information regarding health and wellness education programmes and will initiate an Employee Assistance Program (EAP) to ensure that access to counselling services will be made available to all employees and employee families as required.

With the application of the individual health mitigation and enhancement measures, residual effects are expected to be beneficial.

15.6.2 Family Stress

15.6.2.1 Effects Characterization

The Project will not have any direct effect on family stress and related domestic abuse and violence. However, by providing relatively long-term and generally well-paid work the Project will likely have indirect effects, both beneficial and adverse.

Steady employment and increased incomes lead to a greater sense of self-worth and allow people to provide more for their family's material well-being. This should lead toward reducing the amount of family stress.

The combination of a sudden increase in income and the need for individuals employed at the mine to be away from their families for their work rotation can have adverse effects on family health and well-being. Studies conducted in the NWT show that the development of a resource-based industry near a small community caused disruptions to family life. Increased income in families and communities that are already experiencing stress, in conjunction with rotational employment, commuting, the stress of single parenting or integrating an absent parent back into the family can lead to increased substance abuse, behaviour problems for children, and sometimes, family violence. (NWT Status of Women Council, 1995 and 1999).

Another potential source of stress for employee families is the nature of camp-based work with a 2-week in, 1-week out rotation (or 9-days in and 5-days out for some positions) that is planned for the Project. There is evidence that longer rotations with equal time on and off is more sustainable for families in the long term. Very long rotations (e.g., three weeks in, three weeks out) may be even better for employee family life but would be worse for the workers since working a full three weeks of 12 hour shifts has been implicated in higher workplace accident rates (Storey, K., M. Shrimpton, et al., 1989)

BMC is aware that these rotations can be onerous for employees, and especially those with families. However, there are substantial operational and financial advantages to the rotations planned for the Project. These advantages largely accrue to BMC but some are also linked to other wider social benefits that the Project is expected to bring. The largest of these is making it easier for BMC to meet its commitment to the Yukon as the point of hire for the project as a 2-week in and 1-week out rotation will require fewer employees overall. In addition, a 2-week in and 1-week out rotation allows for better site control during operations (fewer changeovers) and therefore improves safety, especially underground.

15.6.2.2 Mitigation Measures

BMC intends to mitigate possible family stress of its employees through:

- Extensive screening of employees before hire to gauge their suitability for shift work and to help educate them on its potential effects;

- Point of hire being Yukon in reduces travel time of employees to get back to their families;
- Provide assistance and education through its EAP to all employees and their families as required including:
  - Financial management training;
  - Drug and alcohol counselling (including time off for employees who need treatment);
  - Marriage counselling; and
  - Healthy living education (i.e., benefits of diet and exercise);
- BMC will host annual family days at the mine site to show spouses and children of the employees the mine and associated facilities (BMC's experience is that families are more comfortable with their spouses being away if they have seen the site and facilities first hand);
- Communications at the site will be via microwave (to maximize bandwidth) and individual connections in each room to ensure that employees can easily communicate via Skype/Facetime etc. with their spouses and children in the privacy of their room rather than in a communal area;
- BMC will provide recreational facilities at the site and all meal times will have healthy food options, to promote health and well-being of employees while on-shift (with the intent that this would also extend to off-shift healthy living);
- Training of employees (e.g., trades, apprenticeships, management) to promote progression in their careers (which may enhance job satisfaction);
- Bereavement leave will be available to all employees; and
- The 2 week in and 1 week out shift rotations, when combined with the four weeks of annual holiday available after the first year of employment, will allow employees to take one month off twice per year.

Even with all the mitigation in place, the nature of camp-based work, necessary for the Project, will result in a adverse residual effect.

15.6.3 Reducing Alcohol and Drug Abuse

15.6.3.1 Effects Characterization

Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable. Although BMC cannot be responsible for any employee's actions while on their own time, the company will promote a reduction of drug and alcohol abuse among its employees and the employees of any Project contractors to help ensure a safe worksite, reduce employee turnover, and to help protect the general health and well-being of its employees and their communities.

15.6.3.2 Mitigation Measures

The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted.

BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter (see BMC's Fitness for Work Policy in Appendix A-5);

BMC will also support the provision of information regarding health and wellness education programmes and access to counselling services will be made available to all employees and employee families through its EAP, as required.

Even with the application of the reducing alcohol and drug abuse mitigation measures, residual effects are expected to be adverse.

15.6.4 Gathering Traditional Medicine

15.6.4.1 Effects Characterization

Concern over the possible effects of mining projects on the gathering of traditional medicine has been raised by RRDC citizens in the past both in the context of specific sites and in the more general context of reduced time to pursue traditional activities.

On site cultural awareness training was provided to BMC management in the summer of 2016. During the field component, the RRDC elders that were providing the training identified large areas of berry patches. The areas also contained several different types of medicinal plants. Prior to this, no site-specific concerns over traditional medicines were raised during the community engagement for the Project and the ethnographic overview did not reveal any site-specific or area-specific gathering of traditional medicine (Appendix F-3).

The percent loss of vegetation resources due to the Project footprint is assessed in Section 12.4.1.

15.6.4.2 Mitigation Measures

Due to the Tote Road licence requirements and BMC's commitment to public health and safety the operating area of the Project will continue to not be available for collection of traditional medicines however the Company will work with local elders to find a way to allow collection in other areas where safety will not be compromised. As part of the progressive reclamation and final reclamation planning, BMC has committed to working with RRDC in identifying the species that will be used for the reclamation purposes and developing a seed collection program and seed bank in Ross River. Therefore, the potential effects on traditional medicines will be in part mitigated through this program. However, not all traditional medicines will be amendable for use in reclamation, therefore, the Project is likely to have a small adverse residual effect on the gathering of traditional medicine.

15.6.5 Public Health and Safety — Increased Traffic, Hazardous Material Transport, Waste Disposal

15.6.5.1 Effects Characterization

The expected increase in traffic and hazardous material transport during operations is shown in Table 15-20. Most of this traffic, including the concentrate haul, is expected to be over the southern portion of the Robert Campbell Highway between the Project and Watson Lake. The truck traffic during the operations phase is more regular and predictable than the construction phase. The construction phase will likely have truck traffic of around seven trucks per day but will vary significantly depending on where certain materials are sourced from. For example, if gravel for concrete was sourced on site then there would not be any need to truck it in from other sources.

Table 15-20: Expected Truck Traffic: Operations Phase

Year 2 to Year 9 average	Annual Requirement	Load/ Truck (average)	Trucks/ year	Trucks/ Month	Trucks/ day
Reagents	15,400 tonnes	20	770	64	2.1
Operations Fuel	10,201,000 litres	43,900	232	19	0.6
Generator LNG	991,200 GJ	1,500	661	55	1.8
Explosives	6,400 tonnes	20	320	27	0.9
Underground Paste Cement	13,300 tonnes	40	333	28	0.9
Miscellaneous	5,000 tonnes	20	250	21	0.7
Subtotal:			***2,566***	***214***	***7.1***
Concentrates					
Cu/Zn -Tridem Trucking	250,000 tonnes	44	5,682	473.5	15.8
Pb-Containerized Trucking	36,500 tonnes	33	1,106	92.2	3.1
TOTAL			**9,354**	**780**	**26**

Although relatively large (the Project will roughly double the average daily traffic on the southern portion of the Robert Campbell Highway [see Section 15.8.2]); the absolute traffic numbers on this highway will remain small.

As with any similar project there is the risk of an accidental spill or release of hazardous materials. This potential effect has been assessed in Section 17.3.2 of the accidents and malfunctions chapter and is therefore not carried forward in the socio-economic assessment.

15.6.5.2 Mitigation Measures

The impacts of the increased truck transportation due to concentrate haulage will be mitigated in part through the Traffic and Access Management Plan (Section 18.12). This plan includes BMC's commitment to contracting a qualified trucking firm that will:

- Use only experienced, professional drivers;
- Equip all trucks with two-way radio communications; and
- Implement design, safety and operating procedures proven by similar trucking systems utilized in Yukon and Canada.

Risks from hazardous materials and from spills will be mitigated through the application of the Hazardous Materials Management Plan (Section 18.3) and Spill Contingency Plan (Section 18.5).

To ensure public health is protected, BMC will follow all relevant regulations concerning potable water, food safety, and the disposal of sewage and garbage under the oversight of the Environmental Health Services Branch of YG. These are further described in the various sections of Chapter 18.

With the mitigation measures in place, no residual effects to public health and safety are predicted.

15.6.6 Workplace Health and Safety

15.6.6.1 Effects Characterization

All workplaces have inherent hazards. The Project has a potential to result in adverse effects as a result of workplace accidents.

15.6.6.2 Mitigation Measures

The health and safety of those working on the Project is a top priority for BMC. The company will rigorously follow all applicable safety laws and regulations in all aspects of its operations.

All employees will receive the safety training they require to do their jobs properly and safely. A rigorously enforced dry camp will also improve workplace safety.

There will be a fully trained nurse/Emergency Medical Technician on site at all times along with all required medical supplies and equipment. Included in that equipment will be a properly equipped vehicle dedicated for medical evacuations, if necessary. In addition, helicopter medevacs will be available when needed.

Underground mining can pose its own unique workplace safety risks. The planned approach to the underground portions of the Project is to have a specialized underground mining contractor do the work. BMC will ensure that the contractor rigorously follows all applicable safety laws and regulations for the underground operations.

Implementation of BMC's Occupational Health and Safety Policy (Appendix A-6) and Safety, Health, and Emergency Response Plan (conceptual level detail of the plan provided in Section 18.15).

With the workplace health and safety measures in place, no residual effects are expected.

15.6.7 Summary of Residual Effects

Table 15-21 presents the summary of the residual effects for the human health and well-being VC and associated subcomponents.

Table 15-21: Residual Effects on Human Health and Well-Being

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial /Yes Adverse /No)
Individual Health	The Project has the potential to provide a small beneficial effect by offering steady and well-paid employment, and education and skills development.	Construction, operations, closure	BMC will be offering a dental and extended health plan to all BMC employees at the Project. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Medium	Yes, beneficial
Family Stress	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.	Construction, operations, closure	Steady employment and increased incomes are strongly correlated with a greater sense of self-worth and better family stability and health. Extensive screening of employees before hire to gauge their suitability for shift work and to help educate them on its potential effects. Point of hire being Yukon in reduces travel time of employees to get back to their families. Provide assistance and education to all employees and their families as required including: • Financial management training; • Drug and alcohol counselling (including time off for employees who need treatment); • Marriage counselling; and • Healthy living education (i.e., benefits of diet and exercise). BMC will host annual family days at the mine site to show spouses and children of the employees the mine and associated facilities (BMC's experience is that families are more comfortable with their spouses being away if they have seen the site and facilities first hand). Communications at the site will be via microwave (to maximize bandwidth) and individual connections in each room to ensure that employees can easily communicate via Skype/Facetime etc. with	Medium	Yes, adverse

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial /Yes Adverse /No)
			their spouses and children in the privacy of their room rather than in a communal area. BMC will provide recreational facilities at the site and all meal times will have healthy food options, to promote health and well-being of employees while on-shift (with the intent that this would also extend to off-shift healthy living). Training of employees (e.g., trades, apprenticeships, management) to promote progression in their careers (which may enhance job satisfaction). Bereavement leave will be available to all employees. The 2 week in and 1 week out shift rotations, when combined with the four weeks of annual holiday available after the first year of employment, will allow employees to take one month off twice per year.		
Reducing Alcohol and Drug Abuse	Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	Construction, operations, closure	The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Medium	Yes, adverse
Gathering traditional medicine	Possible reduction in traditional medicine gathering and use due to rotation shift work and loss of gathering areas.	Construction, operations, closure	As part of the progressive reclamation and final reclamation planning, BMC has committed to working with RRDC in identifying the species that will be used for the reclamation purposes and developing a seed collection program and seed bank in Ross River.	Medium	Yes, adverse
Public Health and Safety	Significant increases in highway traffic and therefore accidents.	Construction, operations, closure	Traffic and Access Management Plan, including: Use only experienced, professional drivers; Equip all trucks with two-way radio communications; and Implement design, safety and operating procedures proven by similar trucking systems utilized in Yukon.	High	No

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial /Yes Adverse /No)
	The possibility of a spill or accident that will have a potential public health or safety effect along with an adverse environmental effect.	Construction, operations, closure	BMC will implement its:Traffic and Access Management Plan; Hazardous Materials; Management Plan and Spill Contingency plan.	High	No
	Possible improper disposal of sewage and garbage.	Construction, operations, closure	BMC will follow all relevant regulations concerning potable water, food safety, and the disposal of sewage and garbage under the oversight of the Environmental Health Services Branch of YG.	High	No
Workplace health and safety	Potential adverse effects of workplace accidents.	Construction, operations, closure	BMC and its contractors will follow all applicable safety laws and regulations in every aspect of operations. BMC and its contractors will provide every employee with the training required to safely do their work. Implementation of BMC's Occupational Health and Safety Policy and Safety, Health, And Environmental Management Plan.	High	No

15.7 PROJECT EFFECTS: COMMUNITY VITALITY

The assessment of potential effects on community vitality VC includes assessment of the following subcomponents:

- Population — number of children;
- Healthy local business sector — reducing the cost of living;
- Reducing crime;
- Reducing discrimination and racism;
- Political structure;
- Community events and volunteerism; and
- Recreational facilities and opportunities.

In order to focus the effects assessment, the first step was to identify any potential interactions between Project activities and the community vitality VC. The results of the interactions screening were presented in Table 15-5. The effects assessment of the Project on the subcomponents of the community vitality VC are described in Sections 15.6.1 through 15.6.6. A summary of the expected residual effects on this VC's subcomponents is presented in Table 15-22.

15.7.1 Population — Number of Children

15.7.1.1 Effects Characterization

Population and population growth can have both beneficial and adverse effects for small communities. Residents often appreciate the small population while also wishing for the increased amenities and activities that come with more people. There is often a complex web of reasons and motivations behind any decision by employees to relocate. A 2014 study of workers in the NWT diamond mines (GNWT 2014) found that reasons for employees to relocate to the NWT included: work availability and pay (the primary reason) through desire to experience northern life; through a spouse finding employment; company policies joining family; and changes in shift rotations. Reasons for considering moving out of the NWT included: the high cost of living; desire to be closer to family; other job opportunities; general desire for change; and educational opportunities.

Faro has long attempted to increase its population to make the community more vibrant, achieve and maintain a population large enough to support more business services, make more efficient use of its existing infrastructure, and increase the tax base sufficiently to allow the municipality to maintain and upgrade its infrastructure. An influx of newcomers to Faro is desired by the community.

Faro especially attempts to attract families with children as new community residents. The Del Van Gorder School is operating far below its capacity and as the overall number of children shrinks, the incentive grows for parents of school age children to move to where there are more school age children, and more extracurricular activities with a broader social environment for their children.

Families with children are also seen as more likely to be more active participants in the community and more likely to volunteer to create more community activities and events.

Faro has the available housing and related infrastructure available for people to relocate to the community (see Section 15.8.1). BMC's decision to make the Yukon the point of hire for the Project creates an incentive for employees from elsewhere to relocate to the Yukon and perhaps to Faro. The Project is likely to have only a slight beneficial effect in increasing Faro's population.

In the past, residents of Ross River and RRDC leadership expressed strong reservations about an influx of newcomers, wanting the community to remain stable or grow slowly. This outlook may have shifted somewhat as there appears to be more community support for population growth. And there is anecdotal evidence that RRDC citizens relocating back to the community are generally very welcome. However, as Ross River currently does not have any available housing or building land for newcomers, the Project will likely have no effect on the population of the community.

Watson Lake has the housing and related infrastructure available for people to relocate to the community (see Section 15.8.1). The community has also had a declining population per Yukon Bureau of Statistics data; the population has dropped by about 150 people over the past seven years. Like Faro, the general sense is that some community population growth would be a beneficial outcome. BMC's decision to make the Yukon the point of hire for the Project creates an incentive for employees from elsewhere to relocate to the Yukon and perhaps to Watson Lake. The community is also the logical logistical centre for the concentrate haul contract that will employ approximately 120 people. The concentrate haul employees will have an incentive to relocate to Watson Lake. The Project is therefore likely to have a small beneficial effect and help increase the community's population.

Whitehorse has the capacity to readily absorb any increase in population caused by Project employees relocating from outside of Yukon. Whitehorse, with its greater amenities and options for individuals and families is also the likely preference for relocating employees, especially those with children.

15.7.1.2 Enhancement Measures

BMC's decision to make Yukon the point of hire for employees creates an incentive for employees from elsewhere to move to the territory.

Residual effects are expected to be beneficial.

15.7.2 Healthy Local Business Sector — Reducing the Cost of Living

15.7.2.1 Effects Characterization

A healthy business sector not only provides economic benefits, it strengthens the community by providing more services, potentially reducing the cost of living in the community and reducing the need for community members to work elsewhere.

The value expressed in this subcomponent is broader than simply having local community businesses capture additional contracts from the Project (see Section 15.5.7 for business opportunities). It is the desire for a broader and deeper local business sector that serves the whole community, increases the circulation of money within the community, and helps reduce the cost of living.

The Project is expected to have an indirect beneficial effect on this subcomponent through providing well paid employment and business opportunities to local firms. Higher incomes locally will lead to greater demand for goods and services, encouraging the diversification and growth of existing businesses and the establishment of new ones.

15.7.2.2 Enhancement Measures

BMC will continue to provide local communities (Ross River, Watson Lake and Faro) with employment and business opportunities, especially through its SEPA with the Kaska. Therefore, residual effects are expected to be beneficial.

15.7.3 Reducing Crime

15.7.3.1 Effects Characterization

People feeling safe and secure in a community, and especially safe from excessive or pervasive crime, plays a large role in community vitality. The Project will have only indirect effects, if any, on reducing crime levels. Increased employment opportunities can usually be expected to reduce crime. However, if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise rather than fall.

15.7.3.2 Mitigation Measures

The mitigation measures for this subcomponent are BMC's policies on alcohol and drug abuse and provision of counselling as required (see Section 15.6.3).

Any residual effects will likely be adverse.

15.7.4 Reducing Discrimination and Racism

15.7.4.1 Effects Characterization

Potential increased work place discrimination, racism, hostility, and prejudice toward groups with different ethnicities, races, gender, or religions. In particular, Kaska mine employees will make up a fraction of the total work force at the mine site. The remainder of the operation's work force will originate from a mixture of different localities. Employees will coexist in the small, remote premises at the mine site. Mine employees will work, eat, and live together in rotations of two weeks. Close quarters, combined with work-related pressures and demands create an environment for potential

conflict among employees from different backgrounds. The range of expression of this conflict may be as subtle as separate social group formation to as severe as use of violence and racial hate speech.

15.7.4.2 Mitigation Measures

BMC will attempt to have a beneficial effect of reducing discrimination and racism by doing all it can to eliminate all forms of discrimination and racism in the workplace. The company's Employment and Anti-Discrimination Policy (Appendix A-3) reads, in part:

> *All employment processes and ongoing employee performance evaluation shall be merit based, without regard to other factors such as sex, marital status, pregnancy, parental status, age, race, impairment, religion, political belief, social origin, lawful sexual activity, social preference and family responsibilities.*

Managers and staff at every level of the organisation shall ensure they and the people around them do not engage in discriminatory behaviour. All employees will be held responsible for the implementation of this policy and relevant programmes within their area of responsibility.

BMC will strictly enforce its Employment and Anti-Discrimination Policy prohibiting any form of discrimination or racism in the workplace. Complaints will be treated seriously and dealt with immediately. In addition to the community mentors providing a conduit to the Kaska, every department manager will have a specific requirement to maintain direct contact with the local communities.

All BMC directors, supervisors and managers will have mandatory, ongoing (annual) cultural awareness training. The higher the level of employee within the company, the greater the degree of training required.

In its Community Relations Policy (Appendix A-2) BMC states: "*We will strive for the improvement of cross-cultural awareness through the induction, training and education of our personnel in local Indigenous Peoples culture and workplace relationships*."

To the extent permitted by law, BMC's policy will give preference to qualified job applicants in the following priority (see Section 15.5.4):

- RRDC citizens;
- Other Kaska citizens;
- Other Yukon First Nation citizens;
- Other Yukon residents; and
- All others.

BMC's SEPA with the RRDC that ensures Kaska business may submit first proposals across a wide array of possible contract opportunities (see Section 15.5.7). In addition, the SEPA commits BMC to hiring two Kaska citizens (one from LFN and one from RRDC) as community mentors. The mentors

will be responsible, in part, for building and maintaining Kaska employee's workplace relationships and assisting with Kaska employee retention

With the reducing discrimination and racism mitigations and measures to enhance respectful workplace culture that celebrates diversity in place, any residual effects are expected to be small but beneficial overall.

15.7.5 Political Structure

15.7.5.1 Effects Characterization

The construction, operations and closure of the Project will likely have no effect on local, First Nation, or territorial governance, political structures or decision making capacity. BMC has been working closely with the RRDC (in fact the company began building a relationship with the RRDC before it purchased the Project in 2015) and with YG to date and will continue to do so as the Project moves forward. Therefore, no potential effects are expected.

However, it should be noted that in the past the RRDC has taken the position that, although it may choose to participate in the *YESAA* process, it is not bound by *YESAA* or by decisions made by YESAB that affect its Traditional Territory. This position is based in part on the definition of Yukon Indian Person in *YESAA*. RRDC citizens are not enrolled under a final land claims agreement and so do not fall under the definition. BMC has no means of addressing this issue or in mitigating its effects.

15.7.6 Community Events and Volunteerism

15.7.6.1 Effects Characterization

Community events are particularly important in small communities and those communities depend heavily on volunteers and volunteer organizations to make things happen. One effect of increased rotational shift employment in a community may be a reduction in volunteer availability. However, there is also anecdotal evidence that employees, while off shift, have more time to assist with community events.

The Project will likely have little effect on volunteerism in the communities. However, BMC has been involved in supporting several community events and projects since acquiring the Project including:

- First Aid training;
- GPS, Environmental Monitoring and Laboratory skills training;
- Housing Maintenance Program in conjunction with Yukon College;
- School lunch program;
- Tu Lidlini Youth Group to Kamloops;
- Community BBQs;

- New Years' fireworks show;
- Hand game tournament donation; and
- Ross River Christmas party donation.

Total support for these events and projects has been over $28,500 to date.

15.7.6.2 Enhancement Measures

BMC will continue to support community events and projects as the Project proceeds. Residual effects are expected to be beneficial.

15.7.7 Recreational Facilities and Opportunities

15.7.7.1 Effects Characterization

Recreation opportunities and facilities will not be directly affected by the Project as employees on shift will use camp facilities and large population increases in any of the communities are not expected (see Section 15.7.1).

15.7.7.2 Enhancement Measures

As the Project proceeds, BMC will consider making donations to community recreation projects on a case-by-case basis. Any residual effects are expected to be beneficial.

15.7.8 Summary or Residual Effects

Table 15-22 presents the summary of the residual effects for the community vitality VC and associated subcomponents.

Table 15-22: Residual Effects on Community Vitality

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial/ Yes Adverse/ No)
Population: number of children	The Project may attract new residents and their families to the Yukon. Increased population, and especially families with children is desired in Faro and Watson Lake.	Construction, operations, closure	BMC's decision to make the Yukon the point of hire for employees creates an incentive for employees from elsewhere to move to the territory.	Medium	Yes, beneficial
Healthy local business sector: reducing the cost of living	The Project has the potential to improve the health of the local business sector.	Construction, operations, closure	Higher incomes locally may lead to greater demand for goods and services, encouraging the diversification and growth of existing businesses and the establishment of new ones.	Low	Yes, beneficial
Reducing crime	The Project can potentially reduce crime through employment opportunities. But if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.	Construction, operations, closure	The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Low	Yes, adverse
Reducing discrimination and racism	The Project has the potential to reduce discrimination and racism.	Construction, operations, closure	BMC will strictly enforce its Employment and Anti-Discrimination Policy prohibiting any form of discrimination or racism in the workplace. Complaints will be treated seriously and dealt with immediately. BMC and its contractors will continue to honour the SEPA provisions of preferential Kaska and other First Nation hire. BMC will hire two Kaska community mentors.	Medium	Yes, beneficial

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial/ Yes Adverse/ No)
Political structure, leadership and capacity	No potential effects identified	N/A	None. No effect expected.	N/A	No
Community events and volunteerism	The Project has the potential to beneficially affect community events through sponsorship.	Construction, operations, closure	BMC will continue to support community events and projects as the Project proceeds.	Medium	Yes, beneficial
Recreational facilities and opportunities	The Project has the potential to beneficially affect recreation facilities and opportunities through donations and sponsorship. .	Construction, operations, closure	BMC will consider supporting recreation projects as the Project proceeds.	Low	No

15.8 PROJECT EFFECTS: INFRASTRUCTURE AND SERVICES

Infrastructure and related services make up the physical core of any community. The assessment of potential effects on infrastructure and services VC includes assessment of the following subcomponents:

- Housing and land availability;
- Transportation infrastructure — roads and airports;
- Power and communication infrastructure;
- Municipal services — water, sewer, solid waste;
- Healthcare services;
- Police services; and
- Child care.

In order to focus the effects assessment, the first step was to identify any potential interactions between Project activities and the infrastructure and services VC. The results of the interactions screening were presented in Table 15-5. The effects assessment of the Project on the subcomponents of the infrastructure and services VC are described in Sections 15.8.1 through 15.8.7 A summary of the expected residual effects on this VC's subcomponents is presented in Table 15-23.

15.8.1 Housing and Land Availability

15.8.1.1 Effects Characterization

BMC recognizes the value to the company of drawing as much of its workforce from local communities as practicable to minimize its employee transportation costs and decrease turnover. However, the existing labour pool in the local rural communities is small.

Population growth that generates housing demand is a beneficial effect when that demand can be readily met by the local housing market but an adverse effect if it strains the supply.

From Section 15.7.1, the Project is expected to have no effect on the population of Ross River, lead to a small population increase in Watson Lake, a very small increase in Faro and a small increase in Whitehorse. All these communities are expected to be able to meet a low-level population influx from existing housing or existing land for housing construction.

Ross River does not have capacity to house new residents. In September 2016, there were no houses listed for sale or rent in Ross River, either through a real estate agent or through private sale. Further, YG listed no residential lots for sale in the community. The community cannot have a significant influx of new residents in the short to medium term, as there is no available housing or land to construct new houses on. The Project will therefore have no effect on housing and land availability in the community.

Faro has an abundance of housing available for new residents. In September of 2016, there were seven houses listed for sale and YG had five country residential lots for sale. However, there are also a total of 37 buildings with 170 housing units that have been abandoned and the Town of Faro is currently in the process of taking ownership of them because of unpaid property taxes. Once the transfer of title is complete, the Town will be looking to sell any that it can. All the units will require renovations and upgrades. The effect of a slight population increase (see Section 15.7.1) will be minimal. Any new residents moving to Faro because of the Project proceeding will have a beneficial effect on housing and land availability by helping to absorb some of the over-supply.

Watson Lake has the immediate capacity to house at least some new residents. In September of 2016, there were three houses listed for sale and YG was offering 14 lots for immediate sale. In addition, Yukon Bureau of Statistics data indicates a residential rental vacancy rate of 14% to 20% over the past several years. Any new residents moving to Watson Lake because of the Project proceeding will have a neutral to beneficial effect on housing and land availability. Existing housing capacity is expected to be able to meet the small increase in population expected.

Whitehorse too has the immediate capacity to house new residents. In September of 2016, there were approximately 200 listings advertising houses for sale. Yukon Land Services Branch currently has a low number of residential lots for sale (six total in September 2016); however, the next phases of the Whistle Bend subdivision are expected to be for sale in the near future. Whitehorse has had a very low residential rental vacancy rate for many years, often hovering near zero. However, there are currently several rental unit projects under development in the community that will likely lead to a

higher vacancy rate. Whitehorse, and its housing market, is large enough that the Project is unlikely to have a significant effect on housing and land availability.

15.8.1.2 Enhancement Measures

No additional enhancement measures are identified beyond the point of hire policy.

Overall, any residual effects are expected to be beneficial, especially in the communities of Faro and Watson Lake.

15.8.2 Transportation Infrastructure — Roads and Airports

15.8.2.1 Effects Characterization

The construction and operations of the Project will affect the Robert Campbell Highway. The expected daily average truck traffic during the operations phase will be 26 trucks making round-trips to the site per day (see Section 15.6.5). These trucks are expected to travel on the southern Robert Campbell Highway between the Project and Watson Lake. The Project truck traffic will therefore mean approximately doubling the daily traffic at the traffic counter at KM 110 Tutchitua where the daily year-round vehicle count varied from 17 to 44 over the 1997 through 2011 period. Although doubling the traffic count appears significant, the still-low absolute numbers means the Project will likely not have a large effect on the highway itself as the use is well within design parameters.

YG Highways has been upgrading portions of the Robert Campbell Highway and the Project proceeding will create an incentive to continue the upgrades and perhaps re-allocated other funding to where use is increasing.

BMC plans to extend the length of the Finlayson Lake airstrip to accommodate the two-engine commuter aircraft that will shuttle the crews into and out of the site resulting in a permanent improvement to the airstrip as infrastructure. As the Finlayson Lake airstrip is owned and operated by the Yukon Transportation Department they will be responsible for its continued maintenance. However, during the winter months and during high snow fall periods, BMC may need to clear the runway (if Yukon Transportation is unable to clear it in a timely fashion).

15.8.2.2 Enhancement Measures

None beyond existing Project plans.

15.8.3 Power and Communication Infrastructure

15.8.3.1 Effects Characterization

The Project will have no effect on Yukon's power infrastructure. The site power supply will be a site-based bi-fuel (natural gas and diesel) power plant, located adjacent to the processing plant

facilities. The power plant will consist of six 4.2 MW continuous rated generators in an N+2 configuration. The engines will run a variable ratio of natural gas to diesel (from 100% diesel to 99% natural gas) giving flexibility in fuel usage depending on fuel prices or for times of road closure or supply difficulties.

15.8.3.2 Mitigation Measures

The Project will have no effect on Yukon's power or communication infrastructure. All on site communications and power generation infrastructure will be provided by BMC. Therefore, no further mitigation measures are required.

15.8.4 Municipal Services — Water, Sewer, Solid Waste

15.8.4.1 Effects Characterization

The Project will have no effect on municipal infrastructure such as water or sewer systems, unless the Project results in a substantial increase in the population of Watson Lake, Ross River or Faro. Such large increases are highly unlikely, see Section 15.7.1. The population of Whitehorse is already sufficiently large that any increase in population from the Project can be readily absorbed without affecting municipal services.

15.8.4.2 Mitigation Measures

Past mining projects have raised concerns in rural communities, and especially incorporated communities, that their solid waste disposal facilities could be overwhelmed by waste being trucked in for disposal. The Project will not use the solid waste disposal facilities at Watson Lake, Ross River or Faro at any stage of construction, operations or closure. Waste disposal for the Project will be as outlined in Section 18.2, the conceptual Waste Management Plan:

- All combustible waste will be incinerated on site;
- Incinerator ash will be landfilled on site;
- Hazardous and special wastes will be shipped to licensed recycle or disposal facility on regular basis;
- Waste oil will be burned to provide heat for buildings on site; and
- Treated grey water will be diverted to an on site septic field while bio-solids will be dried and deposited in the on site landfill.

Therefore, the Project will not have any residual effects on municipal services.

15.8.5 Healthcare Services

The Project is not expected to have any effect on the provision of healthcare services in the communities unless an unexpectedly large number of employees decide to relocate to Watson Lake,

Faro or Ross River over the course of the construction or operations of the Project. This is unlikely to occur (see Section 15.7.1). Therefore, the Project will not have any residual effects on healthcare services.

15.8.6 Police Services

The Project is not expected to have any effect on the provision of police services in the communities unless an unexpectedly large number of employees decide to relocate to Watson Lake, Faro or Ross River over the course of the construction or operations of the Project. This is unlikely to occur (see Section 15.7.1). The police detachments staffing levels are set by the police services agreement between YG Justice and the RCMP. These are based on population with a minimum which applies to Ross River and Faro. Therefore, the Project will not have any residual effects on police services.

15.8.7 Child Care

Child care, or the lack of it, might present a significant hurdle for parents who wish to take advantage of employment that requires them to be away from home for two weeks at a time. Obviously, this hurdle is especially high for single parents. There is no organized childcare available on a round-the-clock basis for two weeks at a time. The only viable option for most parents in this situation is to rely on spouses or extended family for child care. These caregivers in turn may rely on local childcare services for daycare.

While BMC is aware of this issue, the company has neither the responsibility nor any practical means of addressing it or in mitigating its effects. No residual effects are anticipated on child care as a result of the Project.

15.8.8 Summary of Residual Effects

Table 15-23 presents the summary of the residual effects for the infrastructure and services VC and associated subcomponents.

Table 15-23: Residual Effects on Infrastructure and Services

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial/ Yes Adverse/ No)
Housing and land availability	The Project has the potential to have a beneficial effect on the oversupply of housing in Faro and, to a lesser extent, Watson Lake through the relocation of employees to these communities.	Construction, operations, closure	No additional enhancement measures, beyond the point of hire policy, have been identified.	Low	Yes, beneficial

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial/ Yes Adverse/ No)
Transportation infrastructure	Potential beneficial effect on the Robert Campbell Highway through highway improvements making it easier for people to travel between the communities of Ross River and Watson Lake.	Closure	Project provides continued incentive for YG Highways to continue highway improvements.	Medium	Yes, beneficial
Transportation infrastructure	Potential beneficial effect on Finlayson airstrip through improved infrastructure.	Construction, operations, closure	BMC will improve the airstrip making it more accessible for long term use.	Medium	Yes, beneficial
Municipal services: water, sewer, solid waste	If significant numbers of employees relocate, small communities' services may be stressed. Potential adverse effect if the Project uses municipal solid waste facilities.	Construction, operations, closure	BMC will not use municipal solid waste facilities.	High	No
Healthcare services	No potential effects on healthcare services identified.	N/A	None. No effect expected.	N/A	No
Police services	No potential effects on police services identified.	N/A	None. No effect expected.	N/A	No
Child care	No potential effects on child care identified.	N/A	None. No effect expected.	N/A	No

15.9 PROJECT EFFECTS: CULTURE, HISTORY AND HERITAGE

Culture, history and heritage form a critical part of community identity. For the Kaska, much of this identity centers on the Kaska language, the practice, preservation and restoration of traditional knowledge and the heritage sites in Kaska Traditional Territory.

The assessment of potential effects on culture, history and heritage VC includes assessment of the following subcomponents:

- Language preservation and restoration;
- Traditional knowledge and practice; and
- Heritage and historic sites.

In order to focus the effects assessment, the first step was to identify any potential interactions between Project activities and the culture, history and heritage VC. The results of the interactions screening were presented in Table 15-5. The effects assessment of the Project on the subcomponents

of the culture, history and heritage VC are described in Sections 15.6.1 through Section 15.9.4. A summary of the expected residual effects on this VC's subcomponents is in Table 15-24.

15.9.1 Language Preservation and Restoration

15.9.1.1 Effects Characterization

Kaska, like most other First Nation languages, has been in decline for decades due to several factors including residential schools and the spread of popular media into every community. Efforts at language restoration tend to be focussed on school-aged youth in the schools.

The Project will not have any direct effect on the preservation and restoration of the Kaska language. Indirectly, First Nation people who choose to work at the mine could, if they have not been working full time prior, have less time and opportunity to use their language. However, most working age Kaska citizens will face this challenge no matter where they are employed.

15.9.1.2 Mitigation Measures

BMC will strictly enforce its Employment and Anti-Discrimination Policy (Appendix A-3) and its Community Relations Policy (Appendix A-2) BMC states: *We will strive for the improvement of cross-cultural awareness through the induction, training and education of our personnel in local Indigenous Peoples culture and workplace relationships*.

BMC is committed to hiring Kaska citizens through the SEPA. BMC will also be hiring two community mentors to assist Kaska employees while on-shift and off-shift. Through these measures, BMC intends that Kaska employees will be comfortable and supported to speak Kaska while at work. Subsequently, no residual effects are predicted.

15.9.2 Traditional Knowledge and Practice: Preservation and Restoration

15.9.2.1 Effects Characterization

Traditional knowledge and practice, like First Nation languages, has suffered declines over a period of decades due to a variety of factors. One of these factors may be that as more people enter the formal labour market, there are fewer out harvesting from the land and therefore there is less country food available for sharing in the community.

The Project will not have any direct effect on the preservation and restoration of traditional knowledge and practice. Indirectly, First Nation people who choose to work at the mine will, if they have not been working full-time prior, have less time to pursue these activities. However, most working age Kaska citizens will face this challenge to a greater or lesser degree.

15.9.2.2 Mitigation Measures

The work rotations will be such that at least some traditional knowledge practises can still be undertaken. The opportunity for most shift workers at the Project to two four-week periods off each year will also help mitigate the effect. Overall, no residual effects are predicted.

15.9.3 Heritage and Historic Sites

Heritage and historic sites are assessed in detail in Chapter 14 (no significant effects have been identified through the assessment). The proposed mitigation measures for heritage and historic sites is provided in Section 18.13 and Appendix F-2.

15.9.4 Summary of Residual Effects

Table 15-24 presents the summary of the residual effects for the culture, history and heritage VC and associated subcomponents.

Table 15-24: Residual Effects on Culture, History and Heritage

Subcomponent	Potential Effect	Project Phase	Proposed Mitigation or Enhancement Measures	Predicted Effectiveness of Mitigation or Enhancement (High, Medium, Low)	Residual Effect Identified (Yes Beneficial/ Yes Adverse/ No)
Language preservation and restoration	First Nation employees have less time to use and help restore their languages.	N/A	Employment and Anti-Discrimination Policy (Appendix A-3; Community Relations Policy (Appendix A-2); BMC will hire two Kaska mentors.	High	No
Traditional knowledge and practice preservation and restoration	First Nation employees have less time to practice and restore traditional knowledge.	N/A	Shift rotations will allow for some time to still practice and restore traditional knowledge. Ability to take two four-week periods off work each year will assist in providing time.	Medium	Yes, adverse
Heritage and historic sites	See Chapter 14				

15.10 RESIDUAL EFFECTS AND SIGNIFICANCE DETERMINATION

As noted in Section 15.1.2, significance analysis is used to determine the anticipated level of success in mitigating adverse residual effects or enhancing beneficial residual effects following implementation of mitigation or enhancement measures. For socioeconomic effects the assessment of significance relies on the professional judgement of the assessor. The magnitude of the anticipated effects and the resilience of the community to change (the economic and social context) are normally the key drivers in assessing significance.

As noted in Section 15.1.2, the general requirements for an effect to meet the threshold of significance are:

- Direction must be adverse to be considered significant;
- If the effect cannot be reversed, then it is significant;
- If magnitude is high, then the effect is significant;
- If magnitude is moderate, then economic and social context must be at least neutral, extent must be at least local, duration must be at least medium term, frequency at least regular and reversibility at least short term; and
- If magnitude is low then economic and social context must be high, the extent must be at least regional, duration must be at least long term, the frequency at least regular, and reversibility at least short term.

The sections below provide a brief discussion on how the significance determination for each VC subcomponent was determined. Where appropriate, subcomponents are discussed as a group rather than individually. Table 15-25 to Table 15-28 provide a summary of significance determination for each of the VCs. Significance is described as a beneficial effect, no significant effect, or significant effect. As per the methods presented in Chapter 5 only those effects that are residual after the application of mitigation measures, are carried forward to the significance determination.

15.10.1 Economy and Sustainable Livelihood

15.10.1.1 Traditional Economic Activities

The Project may potentially reduce opportunity to pursue traditional economic activities for those employed. The effect is of moderate magnitude but the economic and social context is low (high resilience) particularly after the application of the annual two four-week periods of vacations time off mitigating factor. It is therefore judged to be not significant. This assessment has a highly likely probability of occurrence with a moderate degree of uncertainty given the planned shift rotations and the wide-spread pursuit of traditional economic activities in the Yukon.

The increased traffic and industrial activity caused by the Project in the region may act to drive wildlife away. This adverse effect has a likely probability of occurrence but is reversible in the short term and the magnitude is low. It is judged to be not significant.

The Project is likely to cause some disruption and loss of access in relation to traditional economic activities; however, magnitude is low, community resilience is high to this form of change and it is reversible in the short term. The effect is therefore judged to be not significant.

15.10.1.2 Economic Growth

The Project will provide economic growth to Yukon and to the communities. This beneficial effect has a very high probability of occurring.

15.10.1.3 Diverse and Stable Economy

There is the possibility of creating a boom and bust cycle through a relatively short Project life, particularly in small communities. The Project has 10-year operations period and BMC plans continued exploration on the KZK property and nearby properties to delineate further ore reserves and extend the mine life or create another project. However, the experience of other Yukon mines indicates that creating a local boom and bust cycle has a likely probability of occurrence with high degree of uncertainty. However, the magnitude is low and community resilience being high in dealing with this effect. Further, exploration might extend mine life, potentially delaying the bust. It is therefore judged to be not significant.

15.10.1.4 Employment

The Project will provide Kaska citizens and other Yukon residents employment during the construction, operations and decommissioning phases. This beneficial effect has a very high probability of occurring.

15.10.1.5 Employability

The Project has the potential to improve education levels, to offer training to Kaska and Yukon employees, and to offer work experience to Kaska and Yukon people. This beneficial effect has a very high probability of occurring.

15.10.1.6 Broad Participation in Economic Development

Potential to continue the direct beneficial effect through the Project providing jobs and business opportunities to the entire cross-section of Yukon society. This beneficial effect has a high probability of occurring.

15.10.1.7 Business Opportunities

Potential to continue the direct beneficial effect through the Project providing business opportunities to Kaska and other Yukon businesses. This beneficial effect has a very high probability of occurring.

15.10.1.8 Government Revenues

The Project has the potential beneficial residual effect of increased government revenues at the municipal, territorial and federal level through various taxes, fees, royalties, and other payments. This beneficial effect has a very high likelihood of occurrence.

Table 15-25: Project Effects Significance Assessment for Economy and Sustainable Livelihood

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Traditional economic activities — hunting, fishing, trapping, food gathering	Potentially reduced opportunity to pursue traditional economic activities.	Adverse	Moderate	Local	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with moderate degree of uncertainty due to planned shift rotations	Not significant
	Increased traffic and industrial activity in the region may act to drive wildlife away.	Adverse	Low	Local	Long term	Regular	Reversible short term	Low	Likely probability of occurrence with moderate degree of uncertainty	Not significant
	Disruption and loss of access.	Adverse	Low	Local	Long term	Regular	Reversible short term	Low	Likely probability of occurrence with moderate degree of uncertainty	Not significant
Economic growth	The Project will provide economic growth to Yukon.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
	The Project will provide economic growth to the communities.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Diverse and stable economy — discouraging boom and bust	Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	Adverse	Low	Local	Long term	Once or sporadic	Reversible short term	Low	Likely probability of occurrence with high degree of uncertainty	Not significant
Employment	The Project will provide Kaska citizens and other Yukon residents employment during the construction phase.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
	The Project will provide Kaska citizens and other Yukon residents employment during the operations phase.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
	The Project will provide Kaska citizens and other Yukon residents employment during the decommissioning and reclamation phase.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
Employability — education, training and experience	The Project has the potential to improve education levels.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Likely probability of occurrence with low degree of uncertainty	Beneficial

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
	The Project has the potential to offer training to Kaska and Yukon employees.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
	The Project has the potential to offer work experience to Kaska and Yukon residents.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
Broad participation in economic development	Potential to continue the direct beneficial effect through the Project providing jobs and business opportunities to the entire cross-section of Yukon society.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Likely probability of occurrence with low degree of uncertainty	Beneficial
Business opportunities	Potential to continue the direct beneficial effect through the Project providing business opportunities to Kaska and Yukon businesses.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial
Government revenues	Potential beneficial effect of increased government revenues at the municipal, territorial and federal level through various taxes, fees, royalties, and other payments.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Highly likely probability of occurrence with low degree of uncertainty	Beneficial

15.10.2 Human Health and Well-being

15.10.2.1 Individual Health

The Project has the potential to provide a small beneficial effect by offering steady and well-paid employment, and education and skills development. This beneficial residual effect is likely to occur with a medium degree of uncertainty.

15.10.2.2 Family Stress

The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being. This adverse effect has likely probability of occurrence with low degree of uncertainty due to the shift rotations that have more days on shift than off shift. The literature shows that families generally have a low level of resilience in dealing with this effect. However, the extensive mitigation measures planned to reduce stress for employees and their families are judged to increase that resilience sufficiently to make the effect not significant.

15.10.2.3 Reducing Alcohol and Drug Abuse

Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable. This adverse residual effect has a likely probability of occurring from the experience of other projects but is of low magnitude and communities have a high degree of resilience in dealing with it. The effect is therefore judged to be not significant.

15.10.2.4 Gathering Traditional Medicine

Possible reduction in traditional medicine use due to rotation shift work and loss of gathering sources may be an adverse effect of the Project. This effect has a low level of magnitude, is local in geographic extent and is of sporadic frequency. Overall it has an unlikely probability with medium level of uncertainty depending on whether First Nation employees currently gather traditional medicine. It is not a significant effect.

Table 15-26: Project Effects Significance Assessment for Human Health and Well-being

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Individual Health	The Project has the potential to provide a small beneficial effect by offering steady and well-paid employment, and education and skills development.	Beneficial	Low	Regional	Long term	Regular	Reversible short term	Low	Likely probability of occurrence with medium degree of uncertainty.	Beneficial
Family Stress	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.	Adverse	Low	Regional	Long term	Regular	Reversible short term	Neutral	Likely probability of occurrence with low degree of uncertainty due to the shift rotations that have substantially more days on shift than off shift.	Not significant
Reducing Alcohol and Drug Abuse	Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	Adverse	Low	Regional	Long term	Regular	Reversible short term	Low	Likely probability with medium level of uncertainty based on the experience of other projects.	Not significant

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Gathering traditional medicine	Possible reduction in traditional medicine use due to rotation shift work.	Adverse	Low	Local	Long term	Sporadic	Reversible short term	Low	Unlikely probability with medium level of uncertainty depending on whether First Nation employees currently gather traditional medicine.	Not significant

15.10.3 Community Vitality

15.10.3.1 Population

The Project may attract new residents and their families to Yukon. Increased population, and especially families with children is desired in Faro and Watson Lake. The effect is beneficial in direction, and could be of moderate magnitude. It is likely with a low degree of uncertainty given BMC's point of hire policy.

15.10.3.2 Healthy Local Business Sector

The Project has the potential to improve the health of the local business sector both through providing business opportunities and through the increased spending of its employees. This is a beneficial effect and BMC's policies and track record make it likely with a low degree of uncertainty.

15.10.3.3 Reducing Crime

The Project can potentially reduce crime through employment opportunities. However, if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise. Given the experience in other communities with similar projects, it is likely with a low degree of uncertainty that the overall effect will be adverse rather than beneficial; however, the effect will not be significant.

15.10.3.4 Reducing Discrimination and Racism

The Project has the potential to reduce discrimination and racism. BMC will enforce its policies and continue its current efforts, subsequently it is considered likely with a medium degree of uncertainty that the effect will be beneficial.

15.10.3.5 Community Events and Volunteerism

The Project has the potential to beneficially affect community events through sponsorship.

This is very likely to create a beneficial effect with low degree of uncertainty given BMC's track record in local community event sponsorship.

15.10.3.6 Recreational Facilities and Opportunities

The Project has the potential to beneficially affect recreation facilities and opportunities through donations and sponsorship.

This is very likely to create a beneficial effect with low degree of uncertainty given BMC's track record in local community event sponsorship.

Table 15-27: Project Effects Significance Assessment for Community Vitality

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Population: number of children	The Project may attract new residents and their families to the Yukon. Increased population, and especially families with children is desired in Faro and Watson Lake.	Beneficial	Moderate	Local	Medium term	Sporadic	Reversible short term	Low	BMC's point of hire policy make this effect likely with a medium degree of uncertainty.	Beneficial
Healthy local business sector: reducing the cost of living	The Project has the potential to improve the health of the local business sector.	Beneficial	Low	Local	Medium term	Regular	Reversible short term	Low	BMC's policies and track record make this effect likely with a low degree of uncertainty.	Beneficial
Reducing crime	The Project can potentially reduce crime through employment opportunities. But if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.	Beneficial or adverse	Moderate	Local	Medium term	Sporadic	Reversible short term	Low	Given the experience in other communities with similar projects, it is likely with a low degree of uncertainty that the overall effect will be adverse rather than beneficial.	Not significant

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Reducing discrimination and racism	The Project has the potential to reduce discrimination and racism.	Beneficial	Moderate	Local	Medium term	Regular	Reversible short term	Neutral	If BMC rigorously enforces its policies and continues its current efforts, it is likely with a medium degree of uncertainty that the effect will be beneficial.	Beneficial
Community events and volunteerism	The Project has the potential to beneficially affect community events through sponsorship.	Beneficial	Low	Local	Medium term	Sporadic	Reversible short term	Low	Very likely with low degree of uncertainty given BMC's track record in local community event sponsorship.	Beneficial
Recreational facilities and opportunities	The Project has the potential to beneficially affect recreation facilities and opportunities through donations and sponsorship.	Beneficial	Low	Local	Medium term	Sporadic	Reversible short term	Low	Very likely with low degree of uncertainty given BMC's track record in local community event sponsorship.	Beneficial

15.10.4 Infrastructure and Services

15.10.4.1 Housing and Land Availability

The Project has the potential to have a beneficial effect on the oversupply of housing in Faro and, to a lesser extent, Watson Lake through the relocation of employees to these communities. This effect is local in geographic extent, of medium term duration, sporadic in frequency and reversible in the short term. BMC's point of hire policy make it likely to occur and it will be beneficial.

15.10.4.2 Transportation Infrastructure

The residual effect on highway infrastructure is in a beneficial direction through the Project providing incentive for YG Highways to continue to make improvements to the Robert Campbell Highway and therefore make traveling between Ross River and Watson Lake easier.

BMC will improve the Finlayson Lake airstrip and the Project is therefore predicted to have a beneficial long term effect.

15.10.5 Culture, History and Heritage

There are no residual effects predicted for culture, history, and heritage.

15.10.6 Summary

In summary, residual effects after mitigation/enhancement were determined to be either beneficial or not significant for all VCs assessed.

Table 15-28: Project Effects Significance Assessment for Infrastructure and Services

Subcomponent	Residual Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not Significant/ Beneficial)
Housing and land availability	The Project has the potential to have a beneficial effect on the oversupply of housing in Faro and, to a lesser extent, Watson Lake through the relocation of employees to these communities.	Beneficial	Low	Local	Medium term	Sporadic	Reversible short term	Low	BMC's point of hire policy makes probability likely with low degree of uncertainty.	Beneficial
Transportation infrastructure	Potential beneficial effect on the Robert Campbell Highway through highway improvements making it easier for people to travel between the communities of Ross River and Watson Lake.	Beneficial	Low	Regional	Long term	Continuous	Reversible short term	Low	Project providing incentive to YG Highways to continue road upgrades makes probability likely with low degree of uncertainty.	Beneficial
Transportation infrastructure	Potential beneficial effect on Finlayson airstrip through improved infrastructure.	Beneficial	Low	Local	Long term	Continuous	Reversible short term	Low	BMC improving the airstrip ensures a beneficial effect.	Beneficial

15.11 CUMULATIVE EFFECTS

The cumulative effects assessment (CEA) for socio-economic VCs follows the methods described in Chapter 5. The CEA defines the potential interaction of the Project residual effects and the potential residual effects resulting from other past or present projects (where their effects may not be captured under the current conditions), as well as reasonably foreseeable/known future projects. Reasonably foreseeable/known future projects are those projects or land use activities for which proposals have been submitted to YESAB. CEA for socio-economic VCs focuses on adverse residual effects. YESAB's *Guide to Socio-economic Effects Assessments* states that an examination of cumulative socio-economic effects should:

- Estimate potential cumulative effects on culture –values, tradition, language, spirituality;
- Estimate potential cumulative effects on social cohesion, quality of life and ability to adapt beneficially to pace of economic change; and
- Estimate potential cumulative effects on land usability for traditional economy and/or other alternative economic activities.

Table 15-29 summarizes the Project's adverse residual effects have been identified for the socio-economic VCs.

Table 15-29: Residual Effects Considered in the Cumulative Effects Assessment

Valued Component	Subcomponent	Residual Adverse Effect
Economy and Sustainable Livelihood	Traditional economic activities — hunting, fishing, trapping, food gathering	Potentially reduced opportunity to pursue traditional economic activities.
	Traditional economic activities — hunting, fishing, trapping, food gathering	Increased traffic and industrial activity in the region may act to drive wildlife away.
	Traditional economic activities — hunting, fishing, trapping, food gathering	Disruption and loss of access.
	Diverse and stable economy — discouraging boom and bust	Creation of boom and bust cycle through relatively short Project life, particularly in small communities.
Human Health and Well-being	Family Stress	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.
	Reducing Alcohol and Drug Abuse	Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.
	Gathering traditional medicine	Possible reduction in traditional medicine use due to rotation shift work.
Community Vitality	Reducing Crime	The Project can potentially reduce crime through employment opportunities. But if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.

15.11.1 Cumulative Effects Characterization

For past, present and future projects/activities to be considered the following conditions must be met:

1. There is information available to identify if the project or activity results in a demonstrable or measurable effect on the VC;
2. The Project-specific residual effect on the VC overlaps in time with the effects from other project or activity (i.e., effects happen at the same time); and
3. The Project-specific residual effect on the VC overlaps spatially with the effects from other project or activity (i.e., effects occur in the same area).

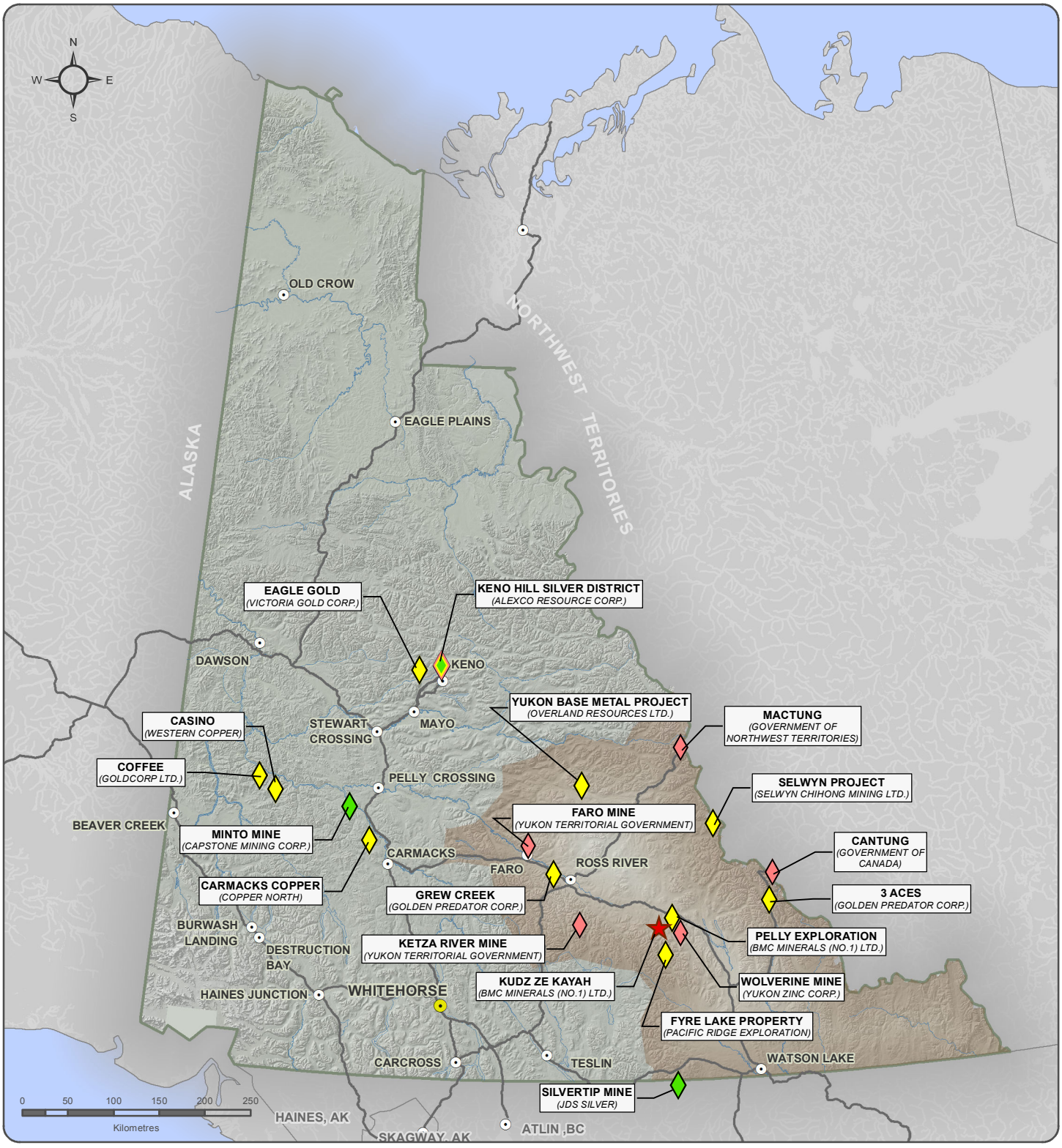
The cumulative socio-economic effects will consequently depend on the status of other projects in the region and in Yukon.

Table 15-30 screens known projects and activities that may overlap sufficiently with the Project to interact with one of the eight residual adverse Project effects listed in Table 15-29 and produce cumulative socio-economic effects. The projects and activities considered in the socio-economic cumulative effects assessment are shown in Figure 15-2.

Overlap in space is defined for this assessment as whether the project may occur in Kaska Traditional Territory or in Yukon. All of the projects and activities listed in Table 15-30 are considered to overlap in space with Project's residual effects.

Whether there is a likely overlap in time with the Project is difficult to predict as it is unknown which (if any) projects will proceed within the next decade.

All of the projects listed in Table 15-30 that have an overlap in type of effect, whether in Kaska Traditional Territory or in other parts of the Yukon, have the potential to interact with one of the residual adverse effects of the Project.



PROJECT STATUS

- Construction/Active
- Exploration/Licencing
- Temporary Closure/Reclamation/Closed/Abandoned
- Exploration/Licencing/Temporary Closure/Reclamation/Closed/Abandoned
- Kaska Dena First Nation (Ross River Dena Council and Liard) Traditional Territory

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Datum: NAD 83; Projection: UTM Zone 9N

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AEG

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 15-2

PROJECTS AND ACTIVITIES TO BE CONSIDERED IN THE SOCIO-ECONOMIC CUMULATIVE EFFECTS ASSESSMENT

MARCH 2017

D:\Project\AllProjects\Kudz_Ze_Kayah\Maps\01_Overview\03-SpecificTopics\Cumulative_Effects_Land_Tenure\Cumulative_Assessment_20170227.mxd

Table 15-30: Screening Table for Socio-economic Cumulative Effects

Project/Activity	Overlap in Space (Yes/No)	Overlap in Type of Effect (Yes/No)	Overlap in Time (Yes/No)	Considered Further for Potential Cumulative Effect? (Yes/No)
Kaska Traditional Territory				
3 Aces (*Golden Predator Corp.*)	Yes	Yes	Yes	Yes
Cantung Mine (*Abandoned*)	Yes	Yes	No	No
Faro Mine (*Abandoned*)	Yes	Yes	Yes	Yes
Fyre Lake Property (*Pacific Ridge Exploration Ltd.)*	Yes	Yes	No	No
Grew Creek (*Golden Predator Corp*.)	Yes	Yes	No	No
Ketza River Mine (*Abandoned*)	Yes	Yes	Yes	Yes
Mactung (*Government of Northwest Territories*)	Yes	Yes	No	No
Pelly Exploration (*BMC Minerals (No.1) Ltd.)*	Yes	Yes	Yes	Yes
Selwyn Project (*Selwyn Chihong Mining Ltd.)*	Yes	Yes	Yes	Yes
Silvertip Mine (*JDS Silver*)	Yes	Yes	Yes	Yes
Wolverine Mine (*Yukon Zinc Corp.*)	Yes	Yes	Yes	Yes
Yukon Base Metal Project (*Overland Resources Ltd.*)	Yes	Yes	No	No
Yukon				
Carmacks Copper (*Copper North*)	Yes	Yes	No	No
Casino (*Western Copper*)	Yes	Yes	No	No
Coffee (*Goldcorp Ltd*.)	Yes	Yes	Yes	Yes
Eagle Gold (*Victoria Gold Corp*.)	Yes	Yes	Yes	Yes
Keno Hill Silver District (*Alexco Resource Corp*.)	Yes	Yes	Yes	Yes
Minto Mine (*Capstone Mining Corp*.)	Yes	Yes	No	No
Other activities				
Single/Group Trapline Concessions Outfitting Concessions	Yes	No	Yes	No

Based on the screening against the projects in Table 15-30, the summary of potential cumulative effects interactions is presented in Table 15-31. Each of the identified interactions is carried forward for consideration of mitigation measures.

Table 15-31: Cumulative Effects Potential Interactions

Project Residual Adverse Effect	Potential Interactions
Potentially reduced opportunity to pursue traditional economic activities.	All projects that require employees to work in camp on shift rotations potentially reduce the opportunity of employees to pursue traditional economic activities. For the individual, this effect is non-cumulative as one can only work one job at a time. A cumulative effect is possible at the extended family or community level if sufficient numbers go to work on different projects and different rotations.
Increased traffic and industrial activity in the region may act to drive wildlife away.	The Wolverine mine and the Pelly Exploration project are the two projects in closest spatial proximity to the Project and so most likely to create a demonstrable cumulative effect with this subcomponent of the economy and sustainable livelihood VC. However, Wolverine is now closed, reducing traffic and activity and Pelly Exploration is an exploration project that adds little to the level of industrial activity.
Disruption and loss of access.	All of the Kaska Traditional Territory projects considered for cumulative effects: 3 Aces, Faro, Ketza, Pelly Exploration, Selwyn, Silvertip and Wolverine will result in a certain amount of disruption and loss of access for traditional economic activities. BMC has agreed to pay a land use interruption supplement. The Kaska adapt by shifting their traditional activities temporarily to other areas.
Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	The potential for interactions that lead to cumulative effects for this Project effect is determined by the business decisions made by the owners and managers of all of the projects listed to be considered for potential cumulative effects in Table 15-30. If several projects proceed near-simultaneously they will quickly exceed the labour force and business capacity to supply them creating a boom. And several near-simultaneous shut-downs will create a bust. On the other hand, sequential openings, with one mine starting up as another enter closure could mitigate the boom and bust cycle.
The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.	All projects that require employees to work in camp on shift rotations potentially create adverse effects on family health and well-being. For the individual, this effect is non-cumulative as one can only work one job at a time. A cumulative effect is possible at the extended family or community level if sufficient numbers go to work on different projects and different rotations.
Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	All projects that provide relatively well paying work, especially for individuals who have not been accustomed to the level of income, risk being the cause of increased alcohol and drug abuse. For the individual, this effect is non-cumulative as one can only work one job at a time. A cumulative effect is possible at the extended family or community level if sufficient numbers go to work on different projects and different rotations.
Possible reduction in traditional medicine use due to rotation shift work.	All projects that require employees to work in camp on shift rotations potentially reduce the opportunity of employees to gather and use traditional medicines. For the individual, this effect is non-cumulative as one can only work one job at a time. A cumulative effect is possible at the extended family or community level if sufficient numbers go to work on different projects and different rotations. However, this cumulative effect tends to be self-limiting as only individuals willing to work on extended rotations will do so.
The Project can potentially reduce crime through employment opportunities. But if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.	All projects that provide relatively well paying work, especially for individuals who have not been accustomed to the level of income, risk being the cause of increased alcohol and drug abuse. For the individual, this effect is non-cumulative as one can only work one job at a time. A cumulative effect is possible at the extended family or community level if sufficient numbers go to work on different projects and different rotations.

15.11.2 Cumulative Effects Mitigation Measures

Proposed cumulative effects mitigation measures are presented in Table 15-32. Where residual cumulative effects are identified, they are carried forward in the assessment for consideration of significance.

Table 15-32: Socio-economic Cumulative Effects Mitigation Measures

Project Residual Adverse Effect	Cumulative Effects Mitigation Measures	Residual Cumulative Effect Identified (Yes/No)
Potentially reduced opportunity to pursue traditional economic activities.	Projects implementing the common shift rotation of two weeks in and two weeks out will mitigate this effect.	No
Increased traffic and industrial activity in the region may act to drive wildlife away.	BMC will implement its Traffic and Access Management Plan to minimize Project effects on regional wildlife. All future projects will likely be required to implement equivalent plans.	No
Disruption and loss of access.	As part of the Socio-economic Participation Agreement (SEPA) BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights under the registered group trapline, and operated trap lines within the Project area. Other projects will be expected to do the equivalent.	No
Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	There are no mitigation measures that BMC and the owners and managers of all of the projects listed to be considered for potential cumulative effects in Table 15-30 can take to avoid creating a boom and bust cycle beyond exploring for further deposits in an attempt to extend mine life and making rational business decisions.	Yes
The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.	Projects implementing the common shift rotation of two weeks in and two weeks out will mitigate this effect according to the literature on the effects of rotation shift work in Canada.	No
Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	BMC will have a dry camp, will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter and BMC will also support the provision of information regarding health and wellness education programmes and access to counselling services will be made available to all employees, as required. It is expected that all other projects will implement the equivalent mitigation measures.	No
Possible reduction in traditional medicine use due to rotation shift work.	Projects implementing the common shift rotation of two weeks in and two weeks out will mitigate this effect.	No
The Project can potentially reduce crime through employment opportunities. But if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.	BMC will have a dry camp, will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter and BMC will also support the provision of information regarding health and wellness education programmes and access to counselling services will be made available to all employees, as required. It is expected that all other projects will implement the equivalent mitigation measures.	No

15.11.3 Cumulative Effects Significance Assessment

With the mitigation measures discussed in Table 15-32, one residual cumulative effect was identified for potential creation of boom and bust cycle in the local economy. Cumulative effect may occur if several projects proceed near-simultaneously they will quickly exceed the labour force and business capacity to supply them creating a boom or several near-simultaneous shut-downs will create a bust. The magnitude of this potential cumulative effect is considered to moderate with regional extent. The experience of other Yukon mines indicates that creating a local boom and bust cycle has a likely probability of occurrence with high degree of uncertainty; however, regional extent effect is considered to be unlikely with high degree of uncertainty. The community resilience is high in dealing with this effect. It is therefore judged to be not significant.

15.12 SOCIO-ECONOMIC EFFECTS MONITORING

Monitoring programs are designed and intended to:

- Test the accuracy of predicted effects and the value of recommended mitigation and enhancement measures;
- Determine the effectiveness of mitigation or enhancement measures and the need for modification to those measures to ensure effect predictions remain valid;
- Identify unexpected effects; and
- Implement additional mitigation or enhancement measures as per adaptive management plans.

The conceptual socio-economic management plan is provided in Section 18.14.

Table 15-33: Cumulative Effects Significance Assessment

Subcomponent	Residual Cumulative Effect	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Economic and Social Context	Probability	Significance (Significant/ Not significant/ Beneficial)
Diverse and stable economy — discouraging boom and bust.	Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	Adverse	Moderate	Regional	Long term	Once or sporadic	Reversible short term	Low	Unlikely probability of occurrence with high degree of uncertainty.	Not significant

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

16 EFFECTS OF THE ENVIRONMENT ON THE PROJECT 16-1

16.1 ASSESSMENT APPROACH 16-1

16.2 TERRAIN HAZARDS 16-3

16.2.1 Assessment Context and Effects Characterization 16-3
16.2.2 Mitigation Measures 16-5
16.2.3 Effects Assessment 16-6

16.3 SEISMIC ACTIVITY 16-6

16.3.1 Assessment Context and Effects Characterization 16-6
16.3.2 Mitigations Measures 16-9
16.3.3 Effects Assessment 16-9

16.4 EXTREME WEATHER EVENTS 16-9

16.4.1 Assessment Context and Effects Characterization 16-9
16.4.2 Mitigation Measures 16-12
16.4.3 Effects Assessment 16-13

16.5 FOREST FIRE 16-14

16.5.1 Assessment Context and Effects Characterization 16-14
16.5.2 Mitigation Measures 16-16
16.5.3 Effects Assessment 16-16

16.6 CLIMATE CHANGE 16-16

16.6.1 Assessment Context and Effects Characterization 16-16
16.6.2 Mitigation Measures 16-23
16.6.3 Assessment Summary 16-24

16.7 SUMMARY OF POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT 16-24

LIST OF TABLES

Table 16-1: Categories of Likelihood for Environmental Events 16-2
Table 16-2: Categories of Severity of Potential Effects of the Environment on the Project 16-2
Table 16-3: Seismic Annual Exceedance Probability, Return Period, and Peak Ground Acceleration 16-7
Table 16-4: Maximum 24-hour precipitation events at seven regional stations (period of record) 16-10
Table 16-5: Design 24-hour Precipitation Events 16-10
Table 16-6: Likelihood of Flooding from Infrastructure 16-13
Table 16-7: Global-scale assessment of recent observed changes, human contribution to the changes, and projected further changes for the early (2016–2035) and late (2081–2100) 21st century 16-17
Table 16-8: Projected Change in Global Mean Surface Air Temperature for 2046-2065 Relative to the Reference Period of 1986-2005 (°C) 16-18
Table 16-9: Examples of Key Findings of Yukon Climate Change 16-23

LIST OF FIGURES

Figure 16-1: Terrain Hazards 16-4
Figure 16-2: Regional Tectonic and Historic Seismicity 16-8
Figure 16-3: Fire History in Proximity of Kudz Ze Kayah Project Area 16-15
Figure 16-4: Observed Historical and Model Projected Mean Annual Temperature, RCP4.5 Scenario 16-19
Figure 16-5: Observed Historical and Model Projected Mean Annual Temperature, RCP8.5 Scenario 16-20
Figure 16-6: Observed Historical and Model Projected Mean Annual Precipitation, RCP4.5 Scenario 16-21
Figure 16-7: Observed Historical and Model Projected Mean Annual Precipitation, RCP8.5 Scenario 16-22

16 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) requires that potential effects of the environment on the Project (e.g., landslides, floods, extreme weather, earthquakes, predicted effects of climate change on Project components and activities) be considered in the Project Proposal. In addition, *YESAA* requires that critical site conditions (e.g., ground stability) that could affect the timing of operations for the Project, as well as the manner in which they could affect it, be described.

This chapter characterizes potential environmental conditions and climate change scenarios that may affect the Project.

16.1 ASSESSMENT APPROACH

The consideration of potential effects of the environment on the Project includes identification of environmental factors deemed to have reasonably possible consequences for the Project, and the mitigation measures currently implemented or planned to reduce or eliminate potential effects. Consideration is also given as to whether they could affect one or more components of the Project.

To characterize the potential environmental effects on the Project, the likelihood of the event (ranging from 'very unlikely' to 'very likely') and the consequence/severity of the effect (ranging from 'negligible' to 'extreme') are considered. Likelihood and severity of effects are expanded upon below. Measures to mitigate these potential effects, contingency plans and response options, are identified. The majority of mitigation measures were identified early in the Project planning process and are integrated into the design of the Project. The design-based mitigation measures are described in Chapter 4. Conceptual management plans are described in Chapter 18.

The environmental events which were considered to have a potential to affect the Project components and activities during all Project phases include:

- Site-specific terrain hazards (i.e., permafrost degradation, landslides, slope stability);
- Seismic activity;
- Extreme weather events (i.e., severe rainstorms and flooding, extreme snow and ice accumulation, high winds, extreme temperature);
- Forest fire; and
- Climate change.

Table 16-1 presents the categories of likelihood for a potential extreme environmental event to occur over the life of the Project. For the purposes of the likelihood assessment, the Project life is considered to be construction, operations, and closure phases, as well as the transition period of post-closure phase that includes pit filling and active water treatment (as required), with combined duration of 28 years (i.e., 2 years construction period, 10 years operations period, 3 years active closure period, and 13 years of transition to post-closure period).

Table 16-1: Categories of Likelihood for Environmental Events

Rating	Description	Quantitative Threshold
Very unlikely	The event is not expected to occur during the life of the Project	< 0.1% chance of occurrence during Project life (construction, operations, and closure phases)
Unlikely	The event is not likely to occur during the life of the Project	0.1%-10% chance of occurrence during Project life (construction, operations, and closure phases)
Likely	The event is probable during the life of the Project	10%-50% chance of occurrence during Project life (construction, operations, and closure phases)
Very likely	The event is expected to occur during the life of the Project	> 50% chance of occurrence during Project life (construction, operations, and closure phases)

Existing information is used to determine a probability of occurrence for an environmental event and establish quantitative threshold for likelihood of an event, if available. Conversely, where existing information is not available, professional judgement is used to characterize the likelihood of occurrence using general description of each of the ratings.

The potential severity of the effects is rated by selecting the category (or level of severity) which most accurately describes the effect. The assessment of severity is informed by design-based mitigation measures, proposed management plans, proposed monitoring plans and response measures, as well as professional judgement. Table 16-2 presents the five categories of severity which are used to rank the potential effects of the environment on the Project.

Table 16-2: Categories of Severity of Potential Effects of the Environment on the Project

Severity of Potential Effect	Description of the Potential Effect on the Project
Negligible	No measurable effect, no stoppage in Project activity, negligible damage to minor structures.
Low	Minor effect on Project component or activity, no stoppage in Project activity, damage is minor and repairable.
Moderate	Moderate effect on Project component or activity, minor stoppage in Project activity (i.e., less than a month), substantial damage to infrastructure.
High	High effect on Project component or activity, less than 6 months' delay in Project for repairs, major damage to infrastructure.
Extreme	Catastrophic effect on Project component or activity, early closure, major damage to infrastructure.

If the severity of potential effect is considered to be high or above, additional mitigation measures are discussed to lower the severity of the potential effects of the environment on the Project.

16.2 TERRAIN HAZARDS

16.2.1 Assessment Context and Effects Characterization

Terrain analysis conducted by Knight Piesold in 2016 was supported by test pit findings from 1995/1996 (Appendix E-5; Norecol, Dames & Moore Ltd., 1996). The findings of the analysis are presented in Chapter 11 and Appendix E-5, and summarized herein where they related to hazards. Figure 16-1 shows the finding of the terrain hazards analysis.

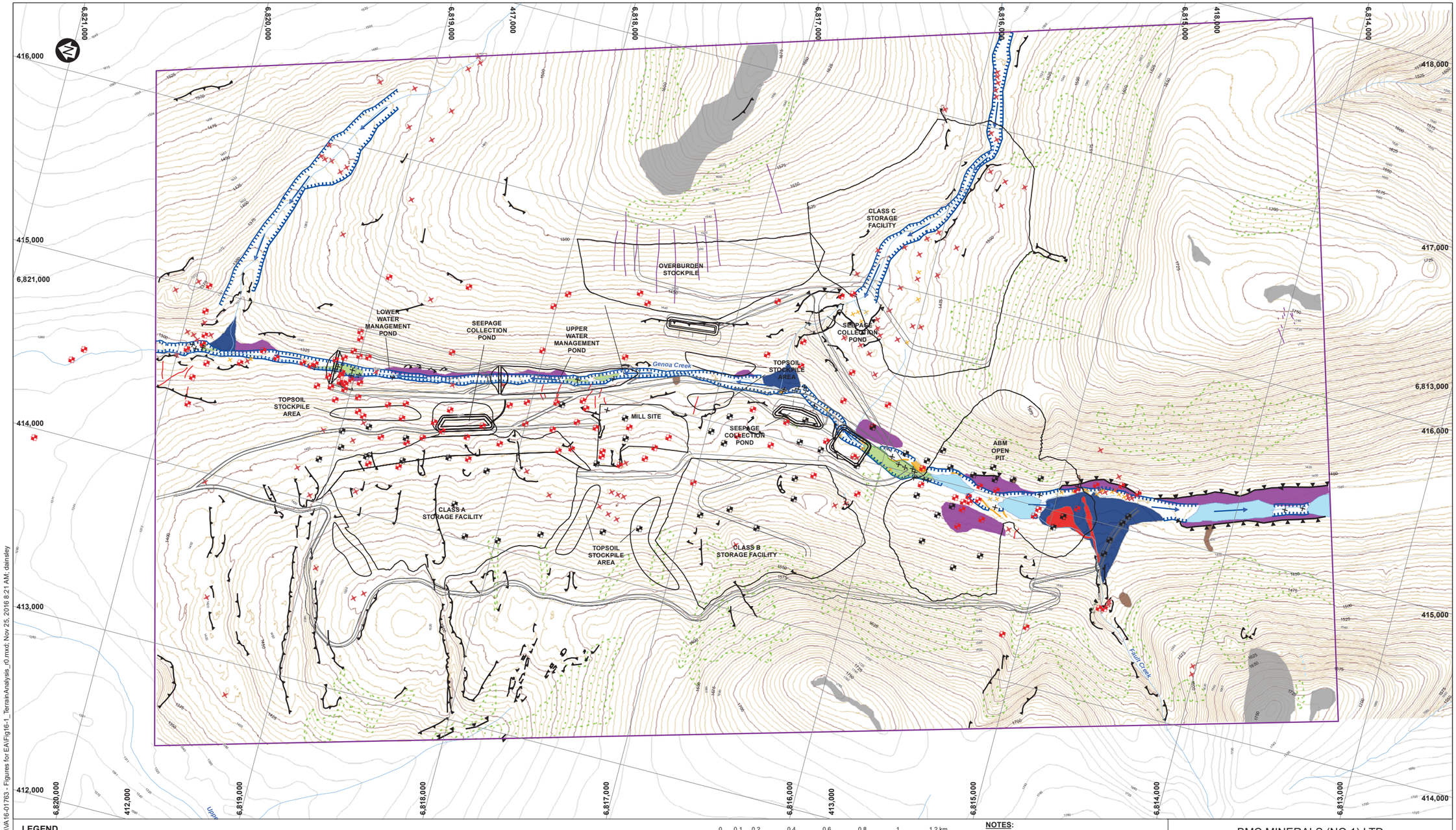
The steepest terrain is in the southwest part of the Project footprint where the slopes are moderately inclined and locally moderately steep. Moderately steep to steep slopes occur along two gullies upslope from the site of the proposed ABM open pit, and a band of moderate slopes occurs at the toe of the east side of the Geona Creek Valley.

Although the terrain is predominantly gently inclined, debris slides have occurred, locally, on moderate natural slopes either side of Geona Creek. There is an active fan at the confluence of Fault Creek and Geona Creek in the south part of the footprint area of the proposed ABM open pit, on which a recent (1995) debris flood occurred on the fan. One landform, located at the top of Fault Creek, may be the remnant of a landslide.

The terrain analysis confirmed discontinuous permafrost and periglacial processes across the Project Footprint with permafrost distribution partly controlled by slope aspect with the sheltered north-facing slopes being the most prone to having permafrost. Permafrost is present on north and west facing slopes, especially above 1,400 masl, although permafrost has been observed as low as 1,250 masl. Permafrost related ground movement or solifluction is present on slopes greater than approximately 4H:1V. No permafrost was identified within the Class A and Class B Storage Facilities footprints, with the exception of the Ablation Till found to be locally frozen in test pits undertaken in the toe area of the north part of the footprint of the proposed Class A Storage Facility. Available data indicates permafrost occurring within the Overburden Stockpile and northern Class C Storage Facility areas (Appendix E-5). Shallow flow slope failure and slope creep caused by permafrost at the Class C Storage Facility and Overburden Stockpile are not anticipated for the following reasons (Knight Piésold Ltd., 2016):

- The Class C Storage Facility is placed in a confined valley with a shallow basin grade, thus limiting the potential for movement, and
- The Class C Storage facility and Overburden Stockpile foundations typically consist of sand and gravel soils with some silt. These soils are expected to consolidate at the same rate as thawing occurs, therefore exhibiting an effective shear strength similar to unfrozen soils during any thawing.

Construction of the Class A and B Storage facilities will include removing the overburden down to bedrock, thus removing any potentially unidentified permafrost in these areas. Therefore, no potential effects on the Project as a result of permafrost are expected and are not considered further.



LEGEND

GENERAL
- TESTPIT 2016
- TESTPIT PRIOR TO 2016
- CONTOUR (5 M)
- CONTOUR (20 M)
- RIVER/CREEK
- STUDY AREA
- PROPOSED MINE FACILITIES

TERRAIN FEATURES
- CONVEX SLOPE BREAK
- CONCAVE SLOPE BREAK
- STRIPES
- MELTWATER CORRIDOR
- ORGANIC SWAMP
- ALLUVIAL FAN
- LAKE DEPOSIT
- COLLUVIAL APRON
- GLACIOFLUVIAL TERRACE
- BEDROCK KNOLL OR RIDGE

TERRAIN HAZARDS
- GULLY EROSION
- RECENT DEBRIS FLOOD DEPOSIT
- RECENT DEBRIS SLIDE
- DEBRIS SLIDE
- THERMAL EROSION
- THAW LAKE
- SOLIFLUCTED SLOPE

LANDFORMS
- ESKER
- KAME
- KETTLE

0 0.1 0.2 0.4 0.6 0.8 1 1.2 km

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED
0	24NOV'16	ISSUED FOR INFORMATION	JEH	KK	LJG

ISSUED FOR INFORMATION

NOTES:

1. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 9N.

2. THE CONTOUR DATA IS 5 METRES LIDAR CONTOURS INSIDE THE STUDY AREA AND 20 METRES GEOYUKON CONTOURS OUTSIDE THE STUDY AREA. (HTTP://MAPSERVICES.GOV.YK.CA/GEOYUKON).

3. THIS MAP IS PRODUCED AT A NOMINAL SCALE OF 1:10,000 FOR 24X36 ("D" SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

4. FACILITIES TAKEN FROM A PROJECT GENERATED ARRANGEMENT PLAN DATED NOVEMBER 16, 2016.

BMC MINERALS (NO.1) LTD

KUDZ ZE KAYEH PROJECT

TERRAIN ANALYSIS MAP

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-640/2	VA16-01763

FIGURE 16-1 REV 0

0 0.1 0.2 0.4 0.6 0.8 1 1.2 km

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Extensive areas of solifluction were mapped on the upper slopes. The footprints of the proposed ABM open pit, and the three proposed Storage Facilities extend into areas of solifluction, with only small area of Class A Storage Facility identified to have an area of solifluction in the southwest corner of the facility. Areas of solifluction were identified in the upper slopes of both Class B and Class C Storage Facilities. Area of solifluction was identified only in one Topsoil Stockpile Area adjacent to the Class B Storage Facility. Stripes extend down from the toe are of the soliflucted slopes and extend across much of the footprint area of the Overburden Stockpile. These features are likely to be preferential flowpaths for near-surface water. Thaw lakes on the Geona Creek Valley floor and thermal erosion on the lower slopes on the west side of the valley provide local evidence of permafrost degradation. The 1995/1996 site investigations found permafrost to be more extensive along the portion of the drainage line in the north part of the Project area where the valley floor has a northerly aspect (Appendix E-5). The terrain slope angles presented in Chapter 11, Figure 11-4, show areas of high slope angle where landslides are more likely to occur.

As discussed in Appendix E-5, the terrain analysis highlighted local geohazards at the site despite the terrain being predominantly gently inclined. Debris slides have occurred, locally, on moderate natural slopes either side of Genoa Creek. It is possible that these landslides were caused, at least in part, by permafrost degradation. There is an active fan at the confluence of Fault Creek and Genoa Creek in the south part of the footprint area of the ABM open pit (Figure 16-1). The 1995 ortho-imagery shows evidence of a recent debris flood on the fan. Recent debris slides have been identified on the incised gully side slopes adjacent to Fault Creek and are a possible source of enhanced sediment load that could initiate debris floods.

Based on the above discussion, the following terrain hazards may have potential effects on the Project:

- The possibility of terrain instability occurring, in particular in the areas of solifluction; and
- The debris flood hazard in the south part of the footprint of the ABM open pit.

16.2.2 Mitigation Measures

Geotechnical investigations and stability analysis were completed to inform the Project design to minimize risk of terrain hazards. The design of Fault Creek diversion will further consider the potential risk associated with the debris flood hazard identified in order to protect the ABM open pit and proposed road in the area.

As identified above, effects on the Project as a result of the permafrost in the area are not expected considering the limited areas of permafrost identified within the infrastructure footprint and design consideration outlined above. Additional mitigation measures relating to terrain stability have also been identified in Section 11.4.2.1.

Geotechnical inspections will be undertaken by an engineer licensed to practice in the Yukon on an annual basis during operations for all storage facilities and water management infrastructure. Physical inspections of all Storage Facilities and water management infrastructure will be conducted on a monthly basis during operations by site personnel.

16.2.3 Effects Assessment

The potential effect on the Project as a result of terrain instability may affect Storage Facilities, roads and the ABM open pit (Figure 16-1). As discussed above, the terrain analysis highlighted local geohazards at the site and signs of previous landslides in the area. Debris slides have occurred, locally, on moderate natural slopes either side of Genoa Creek. Therefore, the likelihood of terrain instability occurring within the Project Footprint is considered to be likely. However, these events are likely to be small in scale and localized, as design of Project components takes into account local geotechnical conditions. Stability assessment and geotechnical characterization were undertaken for Storage Facilities and Process Plant, and included consideration of potential effects on these for slope stability and permafrost degradation (Appendices C-2, C-4, and C-6). The severity of any such event is considered to be low, as no stoppage in Project activities is expected, and any damage is expected to be minor and repairable.

The potential effects on the Project as a result of debris flood hazard in the south part of the footprint of the ABM open pit may affect ABM open pit operations. Recent debris slides have been identified in this area. Therefore, the likelihood of debris slides in this area is considered to be likely. The Project design will take into account this hazard and will provide deflection on the south part of the alluvial fan in order to protect the ABM open pit and the road in the area. With the design mitigation in place, the severity of the potential effects is considered to be negligible as no Project infrastructure will be affected.

Therefore, no significant effects to the Project or Project timing are anticipated as a result of terrain hazards.

16.3 SEISMIC ACTIVITY

16.3.1 Assessment Context and Effects Characterization

The Project is located in the Yukon-Tanana Terrane approximately 30 km east of the Tintina Fault (Figure 16-2), which trends to the northwest and extends from BC to Alaska. The Tintina Fault is one of the most prominent physiographic and geologic features in Yukon (Yukon Government, 2015). The Project is located in an area of low seismic activity (Hyndman et al., 2005). Seismicity can trigger a variety of natural hazards: ground vibrations, large landslides, avalanches, liquefaction of saturated sediments, and surface rupture.

Figure 16-2 (data from Yukon Geological Survey, 2016) shows the regional tectonics and historical seismicity of the Yukon Territory, surrounding regions, and the Project location. A preliminary seismic hazard assessment was completed using the 2015 National Building Code Seismic Hazard Calculation (NRCC, 2015) for the Project location. The results of the assessment are in Table 16-3.

Table 16-3: Seismic Annual Exceedance Probability, Return Period, and Peak Ground Acceleration

Return Period (Years)	Peak Ground Acceleration PGA (g)	Probability of Exceedance in 28 Years
100	0.013	25%
475	0.044	6%
1,000	0.073	3%
2,475	0.131	1%

The Peak Ground Acceleration (PGA) is a measure of how hard the earth shakes, and is measured in units of acceleration due to gravity (g). The United States Geological Survey (USGS) has developed a table of intensity descriptions for PGA (USGS, 2013). The 100 year return period quake has a PGA of 0.013 g and would be perceived as weak and would not cause any potential damage. The 475 and 1,000 year return periods quakes have a PGA of 0.044 g and 0.073 g, respectively, and would be perceived as "moderate", and could cause very light potential damage. The 2,475 year return period has a PGA of 0.131 and would be perceived as a "strong" quake, with light potential structural damage.

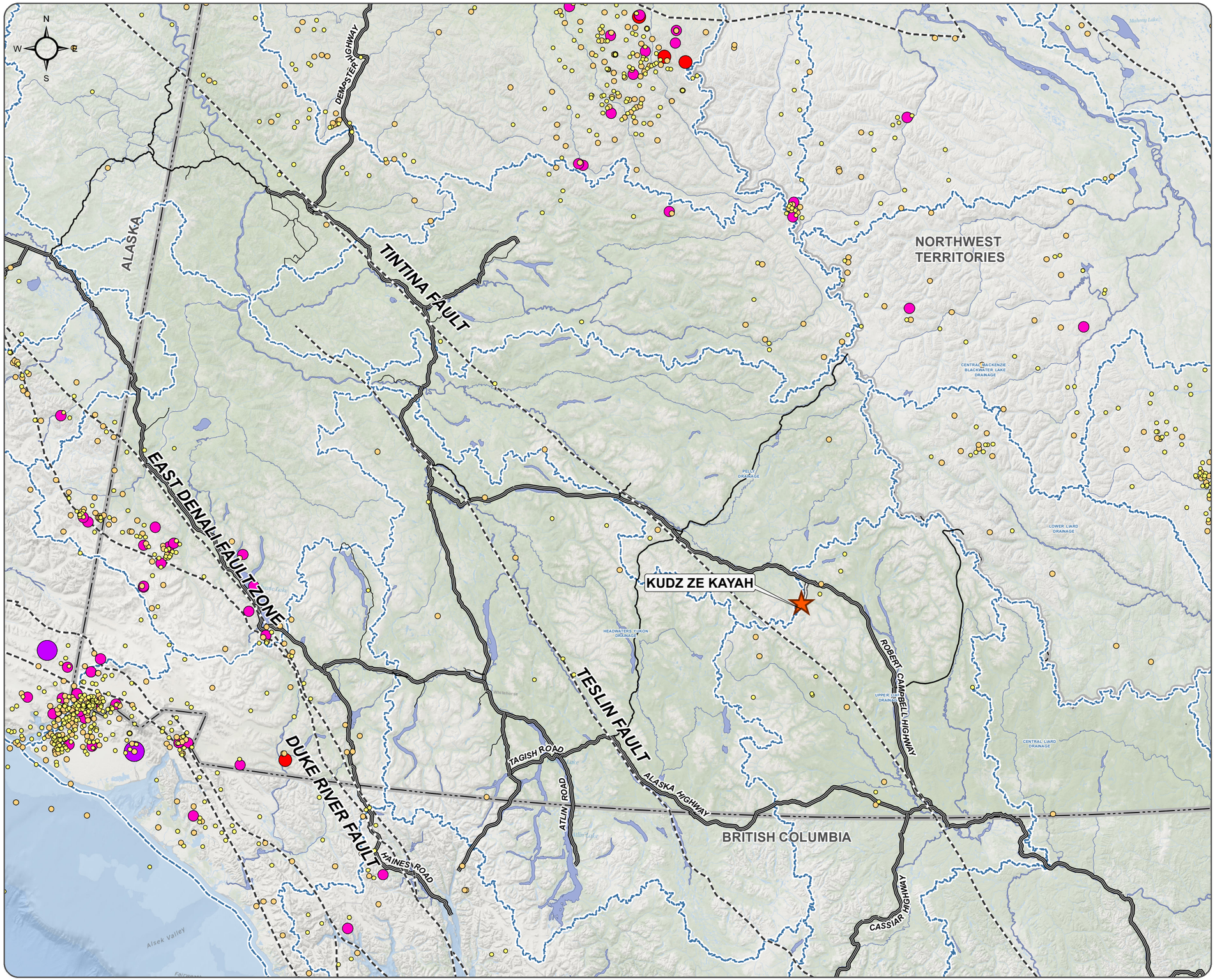
As the 2,475 year return period quake is the only one with potential to affect the Project, it is the only event that is considered in this assessment.

BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 16-2
REGIONAL TECTONIC AND AND HISTORIC SEISMICITY

NOVEMBER 2016



Kudz Ze Kayah Project

Major Faults

EARTHQUAKE OCCURENCES

SYMBOL SIZE PROPORTIONAL TO MAGNITUDE

- < 4.00
- < 5.00
- < 6.00
- < 7.00
- < 8.00

ALEXCO ENVIRONMENTAL GROUP

Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.
Drainage areas obtained from National Hydrology Network 2011

Historical Seismic Activity and Major Faults data provided by Yukon Geological Survey, June 2016

Datum: NAD 83; Projection UTM Zone 9N

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1:3,000,000 when printed on 11 x 17 inch paper

0 50 100 150 200

Kilometres

D:\Project\All Projects\Kudz_Ze_Kayah\Maps\01_Overview\03-Specific Topics\Surficial_Geology\Regional_Seismic_Activity.mxd
(*Last edited by: amatlashevska; 11/15/2016/1:6:00 PM*)

16.3.2 Mitigations Measures

Seismic activity for the Project area is incorporated into the design of major infrastructure components such as the Storage Facilities, Operations Water Management Ponds, water treatment plant, power facilities, and Process Plant Facility. The Project has been designed to ensure that components and activities will perform at earthquake exposure up to the expectations and in compliance with current standards in Canada. Procedures and protocols to be followed in the unlikely event of an earthquake will be in accordance with general emergency response procedures, which will be developed as part of the Health, Safety and Emergency Response Plan (conceptual plan details provided in Section 18.15).

All buildings on site will be designed according to the National Building Code of Canada (NRCC, 2015). The National Building Code of Canada incorporates technical requirements to ensure that buildings are protected against earthquakes based on local seismic conditions. The code generally applies to buildings and not geotechnical structures (e.g., dams). The two dams associated with the Operations Water Management Ponds will be constructed in accordance with the Canadian Dam Association's Dam Safety Guidelines. The Storage Facilities are designed using the 1 in 2,475 year earthquake event and have a factor of safety above 1 for seismic conditions.

16.3.3 Effects Assessment

As the 2,475 year return period quake is the only one with potential to affect the Project, it is the only event that is considered in this assessment. Using the binomial distribution, the probability of a 1 in 2,475 year seismic event being exceeded once in the 28 year Project life is 1%. Therefore, the likelihood of a 1 in 2,475 year seismic event is rated as unlikely.

Should an event exceeding design specifications occur, damage to Project infrastructure may occur. The severity of such an event is expected to be moderate as minor stoppage in Project activities may be expected and substantial damage to infrastructure may occur.

The severity of seismic events with return period of less than 1 in 2,475 years is rated as negligible as no adverse effects to the Project or Project timing are anticipated due to these earthquakes.

The Project design specifications have considered the potential for seismicity to affect the Project and given that the likelihood of an event larger than design specifications is rated as unlikely the potential effects of the seismic activity on the Project is considered to be not significant.

16.4 EXTREME WEATHER EVENTS

16.4.1 Assessment Context and Effects Characterization

Globally and locally, there has been an increase in the incidence of extreme weather conditions, a trend that most climate models predict will continue in association with ongoing climate change (this is expanded upon below in Section 16.6). Extreme weather conditions and weather events which could potentially affect the Project include severe rain and flooding, extreme snow and ice

accumulations, wind, and extreme temperatures. Meteorology data in the Project area is described further in Section 6.3.2 and Appendix D-2.

16.4.1.1 Severe Rainstorms and Flooding

Table 16-4 presents the maximum 24-hour precipitation events recorded at all regional meteorological stations (the two Ross River stations were combined) during their respective period of record. The overall maximum of 47 mm of rain was recorded in Watson Lake on June 22, 1987. The maximum 24-hour rain precipitation event recorded in the Project area from August 2015 to August 2016 was 43 mm, on August 26, 2015.

Table 16-4: Maximum 24-hour precipitation events at seven regional stations (period of record)

Location	Period of Record	Rain		Snow		Precipitation	
		Amount (mm)	Date	Amount (cm)	Date	Amount (mm)	Date
Hour Lake	1982-2014	33.2	28 Jul 2000	24.8	25 Mar 2004	33.2	28 Jul 2000
Tuchitua	1967-2014	36.0	02 Jun 2001	29.8	28 Dec 1980	36.0	02 Jun 2001
Ketza River Mine	1985-1995	32.0	08 Aug 1991	33.0	24 Jan 1986	33.0	24 Jan 1986
Swift River	1966-2008	45.0	12 Jul 1988	37.0	24 Dec 1992	45.0	12 Jul 1988
Ross River	1964-1994; 1993-2008	38.9	13 Jul 1975	15.2	12 Jan 1973	38.9	13 Jul 1975
Watson Lake A	1953-2014; 2014-2016	47.0	22 Jun 1987	26.7	05 Dec 1959	47.0	22 Jun 1987
Faro A	1978-2016	29.4	28 May 1993	12.8	30 Nov 1993	29.4	28 May 1993

The 24-hour precipitation events and the probable maximum precipitation for the Project area and infrastructure for which these design return periods are shown in Table 16-5. The exceedance of the design return period would result in flooding from the identified water management infrastructure and have potential to affect the Project.

Table 16-5: Design 24-hour Precipitation Events

Design Return Period	Rainfall amount (mm)	Infrastructure
1 in 2 year	23	N/A
1 in 10 year	38	Class C Storage Facility and Overburden Stockpile Collection Ponds
1 in 50 year	51	N/A
1 in 100 year	56	Open Pit Dewatering Surface Water Inflow
1 in 200 year	62	Class A, and B Storage Facility Collection Ponds, Upper and Lower Management Ponds, diversion ditches
1 in 1,000 year	74	N/A
Probable Maximum Precipitation (PMP)	205	N/A

Source: Knight Piésold Ltd., 2016

16.4.1.2 Extreme Snow and Ice Accumulations

Table 16-4 presents the maximum 24-hour snow events recorded at all regional meteorological stations (the two Ross River stations were combined) during their respective period of record. The overall maximum of 37 cm was recorded in Swift River on December 24, 1992. Snow depth data is limited on site and snow survey's conducted in 2016 and 1995 measured an average snow depth of up to 56 cm and approximately 90 cm, respectively, in the Project area.

Avalanches generally occur on slopes between 25 and 45 degrees. Slope angles in majority of the Project area are below 25 degrees, with some steeper areas occur in the southern part of the site (see Figure 11-4). The avalanche hazard is very small in the Project area due to the limited snow accumulations (approximately 1 m) and the relatively flat slopes (Appendix E-5).

Large snowfall events could impede the movement of equipment and activities on the mine site. Access to the mine site could become limited as well due to snowfall amounts and/or poor visibility due to blizzard conditions. Infrastructure may experience increased loads from snow accumulation which could cause structural damage. Snowpack depths may increase rapidly during a snowstorm and increase the risk of avalanches on steep valley walls.

16.4.1.3 Wind

During historic data collection in 1995, the monthly average wind speed ranged from 5.6 m/s in July to 6.8 m/s in May at the low elevation station and between 9.6 m/s (June) and 12.7 m/s (May) at the high elevation station (Norecol, Dames & Moore Ltd., 1996). Meteorology data collected on site during baseline studies between September 2015 and August 2016 at the high elevation station (1,542 masl) measured the average wind speed to be 5 m/s (18 km/hr), with monthly averages ranging from 3.8 m/s (December) and 6.4 m/s (November). The maximum wind speed recorded during 1995 was 80 km/hr (22.3 m/s) for the low elevation station and 107 km/hr (29.7 m/s) for the high elevation station (Norecol, Dames & Moore Ltd., 1996). The maximum wind gust speed recorded on site between September 2015 to August 2016 was 100 km/hr (28.5 m/s). A wind speed of 100 km/hr is described on the Beaufort Wind Scale as a storm with trees uprooted and considerable structural damage occurring (although the measured winds did not affect the tent structures at the exploration camp and no trees were observed to be uprooted following the winds).

High winds during periods of below-freezing air temperatures would contribute to increased wind chill and blowing snow, which would reduce visibility, limiting access to and from the Project. Effects of high winds would be particularly severe during snowfall and may cause thick snow drifts. High winds could cause downed trees, which could block the access road and site roads. Power lines, antennas, and buildings could be susceptible to damage by winds if improperly designed or installed. High winds during a forest fire would accelerate the spread of the fire.

16.4.1.4 Extreme Temperature

The extreme maximum temperature recorded in Project area from September 2015 to August 2016 was 19.9°C in July 2016. During historic data collection in 1995, maximum temperature recorded was 25.1°C in June 1995 (Norecol, Dames & Moore Ltd., 1996). Extreme heat is not considered to be a risk in the Project area. However, higher seasonal temperatures could cause increased snow melt and increased precipitation of rain instead of snow which would cause more surface water runoff. In addition, higher temperatures during dry periods could increase the likelihood of forest fires occurring (see Section 16.5).

The extreme minimum temperature recorded in the Project area from September 2015 to August 2016 was -26.28°C in November 2016. During 1995 data collection, data was only collected from April to September (Norecol, Dames & Moore Ltd., 1996), therefore no extreme minimum temperature is used from that data set. Extreme cold temperatures can affect machinery and infrastructure. During extreme low temperatures, power demand for heating increases. If cold temperatures prolong winter conditions, there could be an increased snow accumulation which would increase maintenance demands on the Project. In addition, the spring runoff could be delayed due to later melting of the snow pack. Low temperatures also increase the risk of pipeline freezing and frost heaving on pit walls and road cuts.

16.4.2 Mitigation Measures

Design of water management features allows for rainfall events of 1 in 10 year to 1 in 200 year depending on the infrastructure function and location (Table 16-5). In addition, the Overburden Stockpile Collection Pond and Class A, B, and C Storage Facility Collection Ponds are sized to manage freshet inflow volumes. Diversions around the Project will help manage surface water runoff by diverting it to streams.

Stream channels at road crossings will be through culverts. Road closures would be minimal for extreme events only and would be temporary with traffic resuming when the water level lowers and structural checks of the road and crossings have been made. Further to the above mitigation measures, weather forecasts will be monitored to anticipate large rainfall events and make necessary preparations and changes to operations to minimize effects of extreme weather events on the Project, as necessary (e.g., reduce activities, minimize traffic).

Infrastructure on site will be constructed to withstand periods of heavy snowfall and snow can be shovelled off roofs after heavy snowfalls if needed to prevent roof damage from excessive loads. To maintain safe working conditions excessive snow will be removed where needed (blast areas, active areas of storage facilities, stockpiles).

Mitigation and response to extreme weather events will follow the Sediment and Erosion Plan, Surface Water Management Plan, and Health, Safety and Emergency Response Plan (conceptual management plans are provided in Chapter 18).

16.4.3 Effects Assessment

16.4.3.1 Severe Rainstorms and Flooding

The design return period for the Project's water management infrastructure is show in Table 16-6. The probability of the exceedance of the design return period event and correlating likelihood is also shown in Table 16-6.

Table 16-6: Likelihood of Flooding from Infrastructure

Design Return Period	Infrastructure	Probability of Exceedance in 28 Years	Likelihood
1 in 10 year	Class C Storage Facility and Overburden Stockpile Collection Ponds	95%	Very Likely
1 in 100 year	Open Pit Dewatering Surface Water Inflow	25%	Likely
1 in 200 year	Class A, and B Storage Facility Collection Ponds, Upper and Lower Management Ponds	13%	Likely

Although the likelihood of the 1 in 10 year event is very likely the only infrastructure such event is likely to affect is Class C Storage Facility and Overburden Stockpile Collection Ponds. As the water quality in these ponds is not expected to be of concern therefore consequence of these ponds releasing excess water after shorter settling time is not likely to affect other Project activities and their timing. No Project activity stoppage is expected, therefore the severity of this event is considered to be negligible.

The likelihood of 1 in 100 year event is assessed as likely as probability over Project life is 25%. The 1 in 100 year event may cause minor stoppage in Project activity if the pit dewatering system is affected. Therefore, the severity of this event is considered to be moderate.

The likelihood of 1 in 200 year event is assessed as likely as probability over Project life is 13%. The 1 in 200 year event is likely to affect Project's water management infrastructure and cause localized flooding. Minor stoppage in Project activities is expected as a result of this event (i.e., less than a month) and some damage to infrastructure may occur as a result of the flooding. Therefore, the severity of this event is considered to be moderate.

Given that the severity of the potential effects is not expected to exceed moderate as a result of severe rainstorm and flooding events, these are not considered to have significant effects on the Project.

16.4.3.2 Extreme Snow and Ice Accumulations

Given the local climate, it is considered likely that extreme snowfall events that could impede the movement of equipment and activities on the mine site occur during the life of the Project. Access to the mine site could become limited as well due to snowfall amounts and/or poor visibility due to blizzard conditions. The severity of such events is considered to be low as only minor effect on Project timing are expected, with Project activities returning to normal shortly following the event. These

events are not expected to be severe enough to cause substantial damage to Project infrastructure, as Project design accounts for local climate. Therefore, the extreme snow events are not considered to have a significant effect on the Project.

16.4.3.3 Wind

As noted above, high winds have been recorded on site during baseline data collection and therefore, it is considered likely that high wind events may occur during the life of the Project. However, it is not expected that major infrastructure damage occurs during these events. The severity of these events is considered to be negligible as only negligible damage to minor structures would occur. Therefore, the extreme wind events are not considered to have a significant effect on the Project.

16.4.3.4 Extreme Temperatures

As noted above extreme high temperatures are not expected on site. Extreme low temperatures may occur and considered to be likely during the life of the Project. These events could affect Project activities and their timing, with minor Project activity stoppage expected. The Project design specifications and scheduling have considered potential extreme temperature events. Therefore, no significant effects to the Project or Project timing are anticipated as a result of extreme weather events that are likely to occur during the life of the Project.

16.5 FOREST FIRE

16.5.1 Assessment Context and Effects Characterization

Forest fire risk in the Project area is greatest in the summer, especially from late June to early August, during prolonged periods of higher temperatures. Between 1950 and 2006, 6,294 wildfires were recorded in Yukon. Of these, 49% were lightning induced and 51% were human caused. Over this period, an estimated 8.15 million hectares burned (Yukon Government, 2011).

Information supplied by Yukon Government Wildland Fire Management department shows that large fires have not occurred in the Project area since the 1940s, which is the earliest date that records are available. The closest notable fire occurred in the 1990s and was located approximately 25 km to the southeast, just south of Wolverine Lake (Figure 16-3).

Evidence of fire disturbance was observed in some of the forested ecosystem plots surveyed. Signs of earlier fires (greater than 100 years old) included charcoal in soil pits, distinctive age classes between subalpine fir (90 years old) and surviving veteran white spruce (greater than 150 years old), burn scars on snags, and coarse woody debris in isolated sites (likely caused by spot fires).

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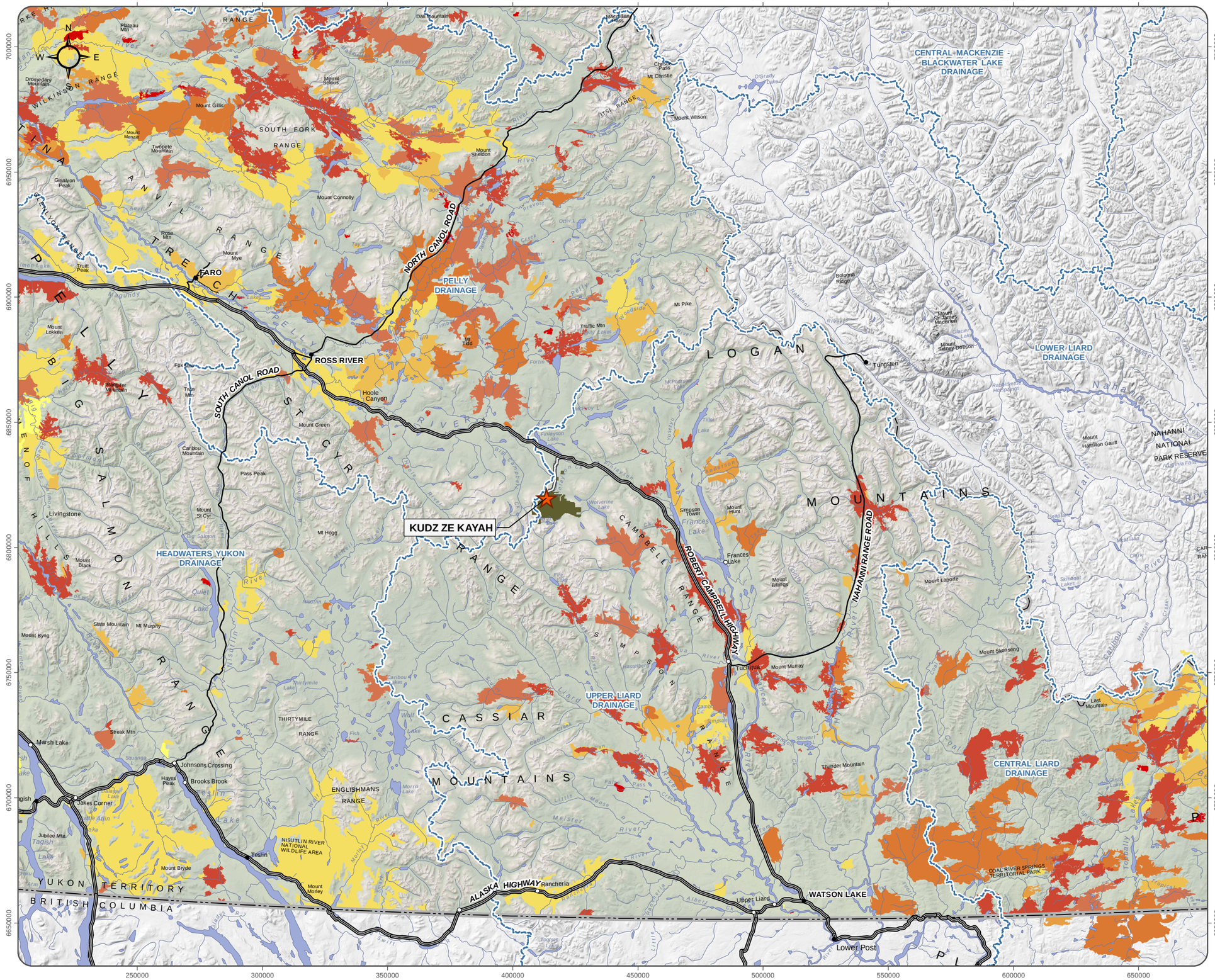
KUDZ ZE KAYAH PROJECT

FIGURE 16-3

FIRE HISTORY IN PROXIMITY OF KUDZ ZE KAYAH PROJECT AREA

NOVEMBER 2016



Kudz Ze Kayah Project Site

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Forest Fire History by Decade

- 1940
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010

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Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.
Fire history data received from wildland fire managment 2016

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1:1,500,000 when printed on 11 x 17 inch paper

0 20 40 60 80

Kilometres

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(*Last edited by: amatlashevska; 11/15/2016/15:39 PM*)

16.5.2 Mitigation Measures

The Project area will be mainly cleared of vegetation near infrastructure to reduce the risk of wildfire damaging Project components. A fire water distribution system will be installed around the processing plant site and camp area with wall hydrants at strategic locations, capable of delivering at a nominal rate of 400 m^3/hr of water for a two hour period. Fire water will be drawn from the raw water tank and will be provided by a skid-mounted system incorporating an electric main pump and jockey pump and diesel back-up pump. Other sources of water and equipment could also be utilized to support fighting wild fires in the area if needed (e.g., use of water trucks). Additionally, work restrictions will be in place during fire season to limit activities in high fire danger areas.

A Project emergency response team will be established and receive training in items such as rescue techniques, firefighting, hazardous materials handling and appropriate use of emergency response equipment. The conceptual Health, Safety, and Emergency Plan is provided in Section 18.15.

16.5.3 Effects Assessment

The sources of forest fires in Yukon are either lightning or human caused; therefore, either ignition source could occur in proximity to the Project. As discussed above there have been no recent fires on site and the likelihood is unlikely. Depending on the fire, the worst case severity of potential effects could be extreme. Damage to infrastructure is possible. Fires that affect road access could happen both on site or off site and would affect mining operations.

The Project has mitigation measures for forest fires to reduce the likelihood of an event impacting the Project. Therefore, no significant effects to the Project or Project timing are anticipated as a result of forest fires.

16.6 CLIMATE CHANGE

16.6.1 Assessment Context and Effects Characterization

Climate change is defined by the Intergovernmental Panel on Climate Change (IPCC) as “change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer” (IPCC, 2013). Global climate is unequivocally warming, and will continue to warm in the future (AMS 2012; IPCC, 2013). Heavy precipitation events have become more intense and frequent, and will continue to do so, although confidence in the sign and amount of change is lower than confidence for change in air temperature (AMS, 2012). Uncertainty increases when considering local effects and the effects of climate change on the environment, such as vegetation, glaciers, streamflow, and wildfires. Table 16-7 presents a summary of climate change related phenomena at the global scale and associated likelihood assessment (IPCC, 2013). The IPCC assesses the likelihood of an outcome as virtually certain, very likely, likely, as likely as not, unlikely, very unlikely, or exceptionally unlikely. The level of confidence is based on the available evidence and ranges from very low to very high.

Table 16-7: Global-scale assessment of recent observed changes, human contribution to the changes, and projected further changes for the early (2016–2035) and late (2081–2100) 21st century

Phenomenon and Direction of Trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	Very likely	Very likely	Likely	Virtually certain
Warmer and/or more frequent hot days and nights over most land areas	Very likely	Very likely	Likely	Virtually certain
Warm spells/heat waves Frequency and/or duration increases over most land areas	Medium confidence on a global scale Likely in large parts of Europe, Asia and Australia	Likely	Not formally assessed	Very likely
Heavy precipitation events Increase in the frequency, intensity, and/or amount of heavy precipitation	Likely more land areas with increases than decreases	Medium confidence More likely than not	Likely over many land areas	Very likely over most of the mid-latitude land masses and over wet tropical regions
Increases in intensity and/or duration of drought	Low confidence on a global scale Likely changes in some regions	Low confidence More likely than not	Low confidence	Likely (medium confidence) on a regional to global scale

Source: IPCC, 2013

Northern latitudes have experienced twice the rate of the global mean increase in surface air temperatures (McBean et al., 2005) and the North "is projected to warm most" (Collins et al., 2013). From 1950 to 1998, the Canadian western Arctic experienced warming of 1.5°C to 2.0°C (Zhang et al. 2000).

Example effects of climate change that have the potential to affect the Project include:

- Melting of permafrost potentially resulting instability in infrastructure;
- Increased forest fire risk due to increased temperatures, changes in precipitation, and increased thunderstorms;
- Increased extreme weather events (snow, rain, wind) potentially affecting Project infrastructure; and
- Changes to hydrological flow regimes in watercourses around the Project area affecting water conveyance and storage systems or surrounding infrastructure.

Table 16-8 below presents the global warming projections associated with the different Representative Concentration Pathways (RCP) scenarios used in the IPCC Fifth Assessment Report (AR5) Coupled Model Intercomparison Project Phase 5 (CMIP5). The scenarios describe four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. The four RCPs (i.e., RCP2.6, RCP4.5, RCP6, and RCP8.5) are named after a possible range of radiative forcing values in the year 2100 relative to pre-industrial

values (+2.6, +4.5, +6.0, and +8.5 Watts per square meter [W/m^2], respectively). The temperature ranges presented in Table 16-8 are considered likely (66 to 100% probability) by the IPCC. The level of confidence is rated as medium for the 2046-2065 global temperature projections. Temperature projections on a shorter term scale, corresponding to the Project operations period, are available for downscaled climate data discussed further below.

Table 16-8: Projected Change in Global Mean Surface Air Temperature for 2046-2065 Relative to the Reference Period of 1986-2005 (°C)

Scenario	Mean	*Likely* Range*
RCP2.6	1.0	0.4 to 1.6
RCP4.5	1.4	0.9 to 2.0
RCP6.0	1.3	0.8 to 1.8
RCP8.5	2.0	1.4 to 2.6

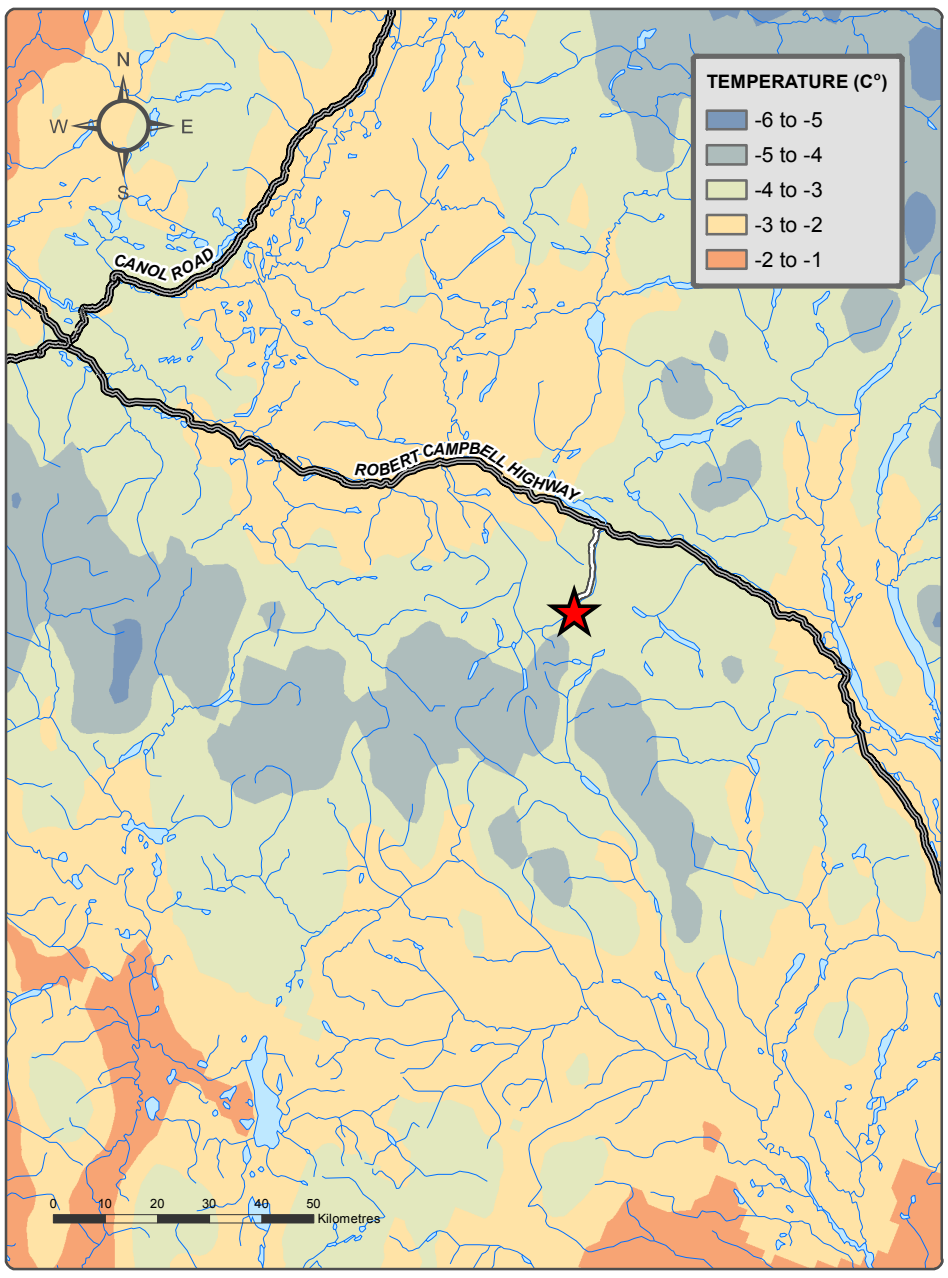
* Calculated from projections as 5–95% model ranges. These ranges are then assessed to be likely ranges after accounting for additional uncertainties or different levels of confidence in models. For projections of global mean surface temperature change in 2046–2065 confidence is medium, because the relative importance of natural internal variability, and uncertainty in non-greenhouse gas forcing and response.

Source: IPCC, 2013.

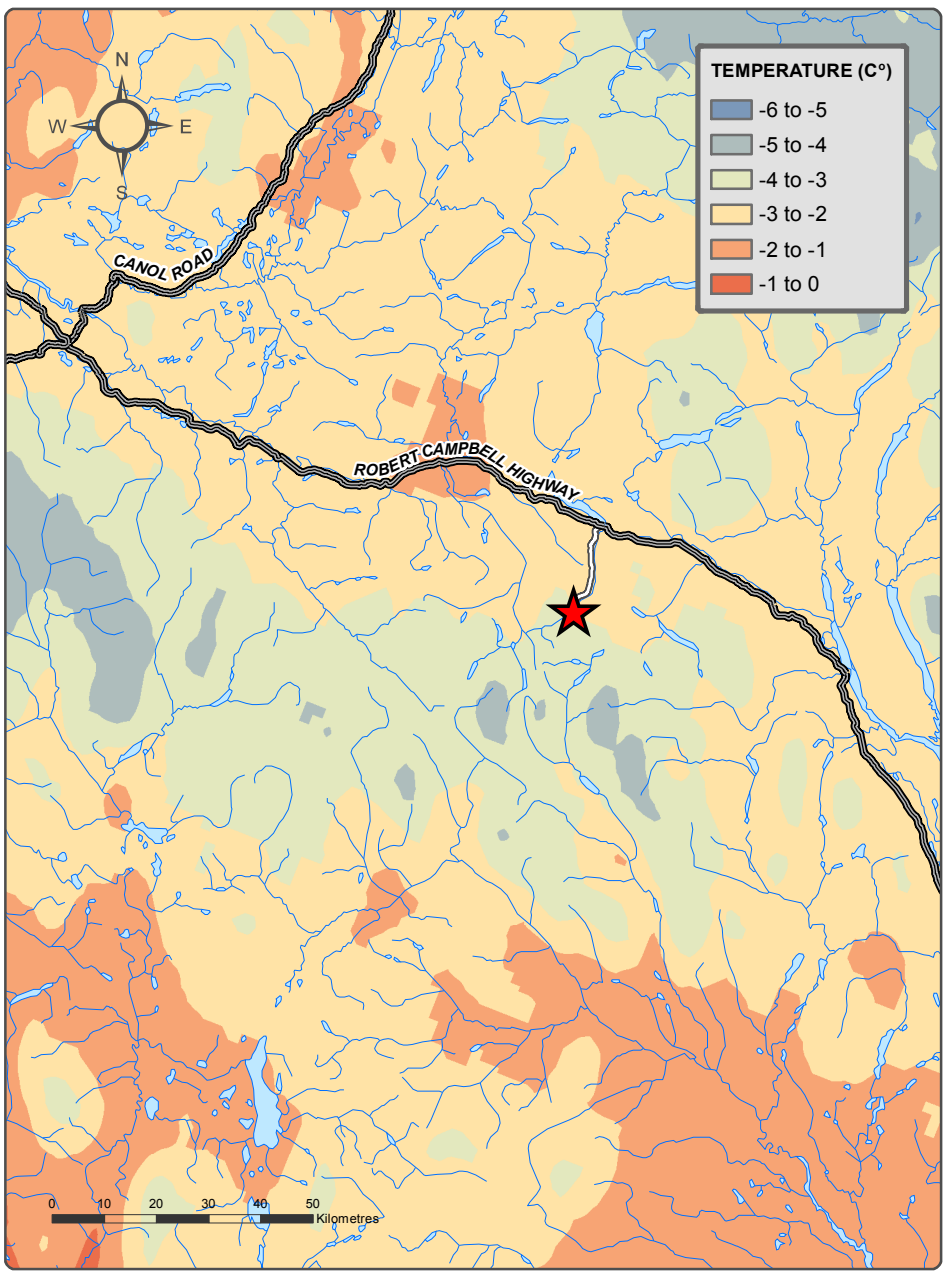
Figure 16-4 to Figure 16-7 show observed historical and projected mean annual temperature and precipitation data for the Project area. Data presented in Figure 16-4 to Figure 16-7 are from the first ensemble model run of the CMIP5 and were downscaled for sub-Arctic and Arctic regions of Alaska and Canada by the University of Alaska Scenarios Network for Alaska and Arctic Planning (SNAP). Results are shown for the RCP4.5 and RCP8.5, corresponding to low and high radiative forcing scenarios, respectively. Typically, precipitation varies more across time and space and is thus more uncertain than temperature (SNAP, 2016).

Depending on the scenario, mean annual temperature could increase by 1 to 2°C in the Project area over the Project's life. Figure 16-6 and Figure 16-7 show that the change in mean annual precipitation (MAP) over the Project's life may not be substantial, but surrounding mountainous areas could see an increase in MAP.

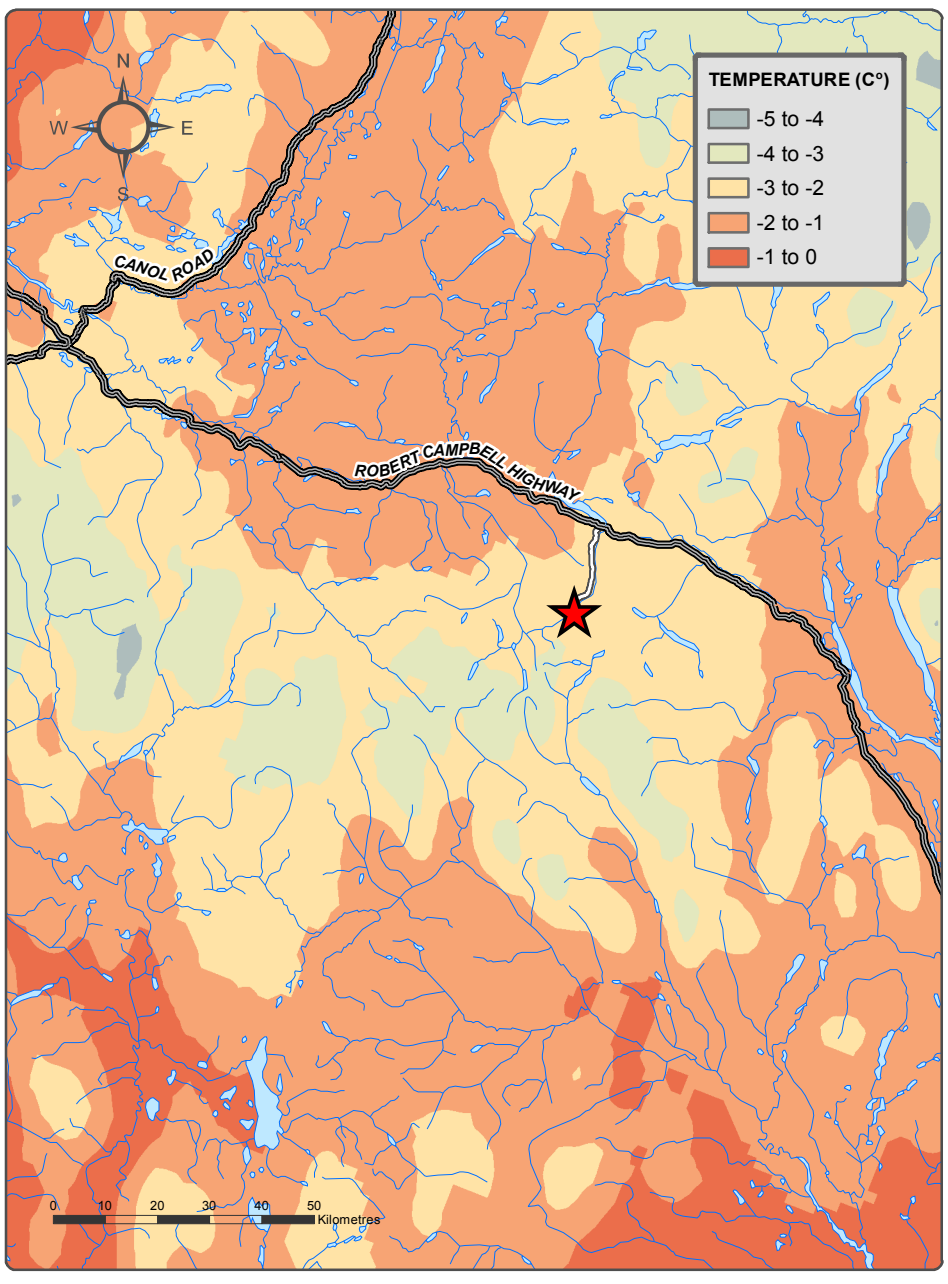
OBSERVED HISTORICAL MEAN ANNUAL TEMPERATURE, 2000-2009



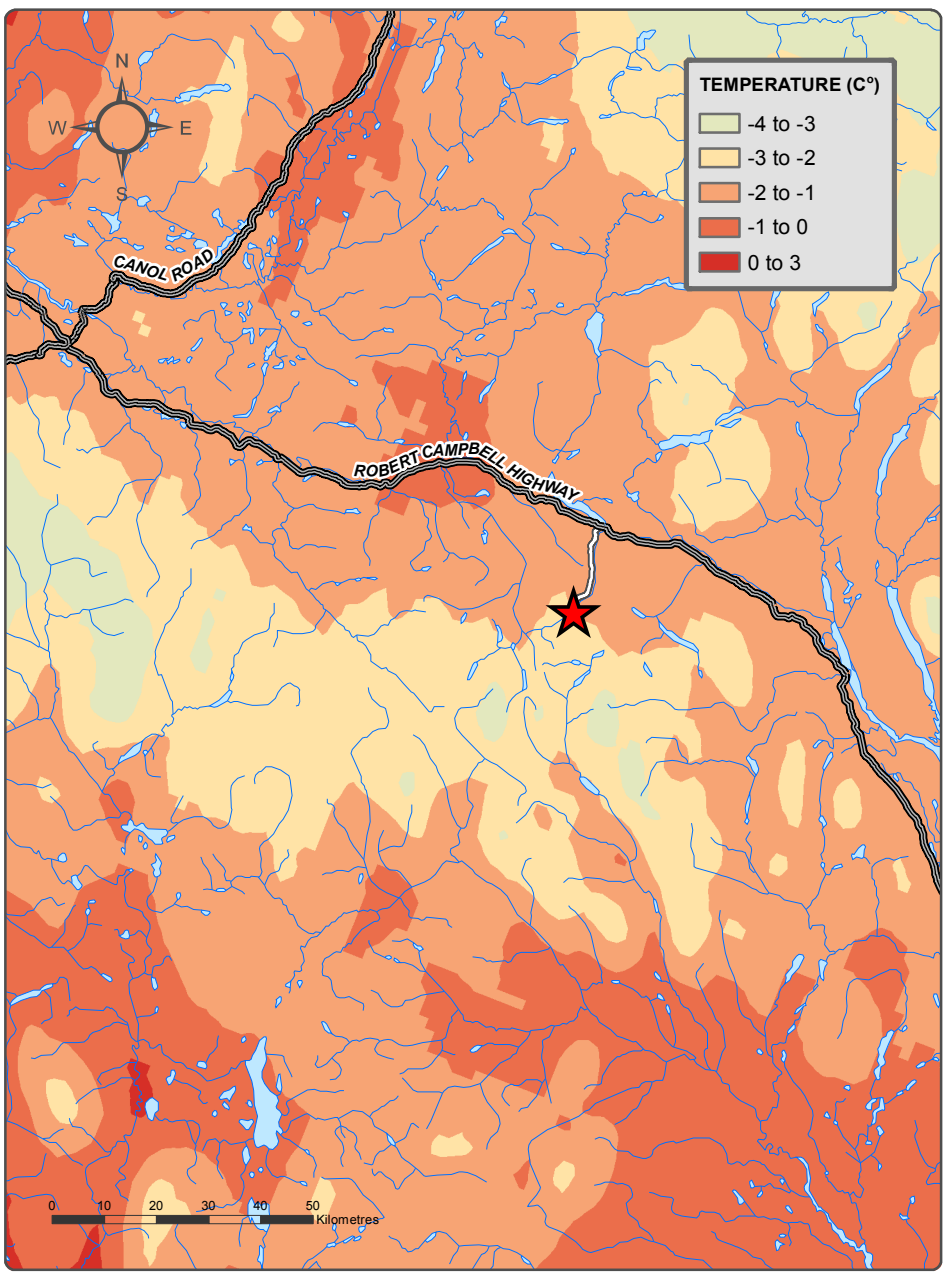
2020-2029 MEAN ANNUAL TEMPERATURE PROJECTION, RCP4.5 SCENARIO



2030-2039 MEAN ANNUAL TEMPERATURE PROJECTION, RCP4.5 SCENARIO



2040-2049 MEAN ANNUAL TEMPERATURE PROJECTION, RCP4.5 SCENARIO



Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

Annual Temperature Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

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KUDZ ZE KAYAH PROJECT

FIGURE 16-4

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL TEMPERATURE, RCP4.5 SCENARIO

FEBRUARY 2017

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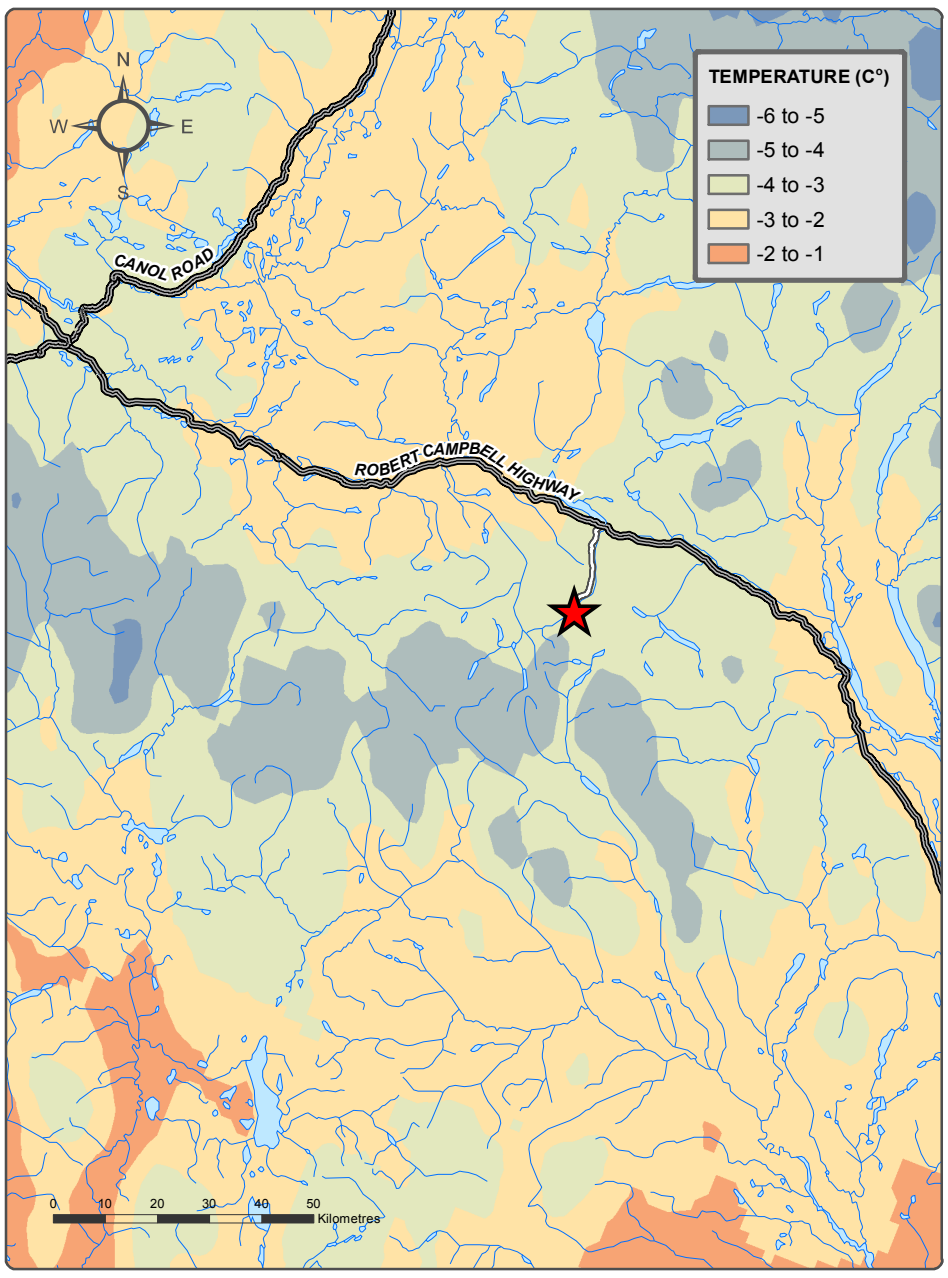
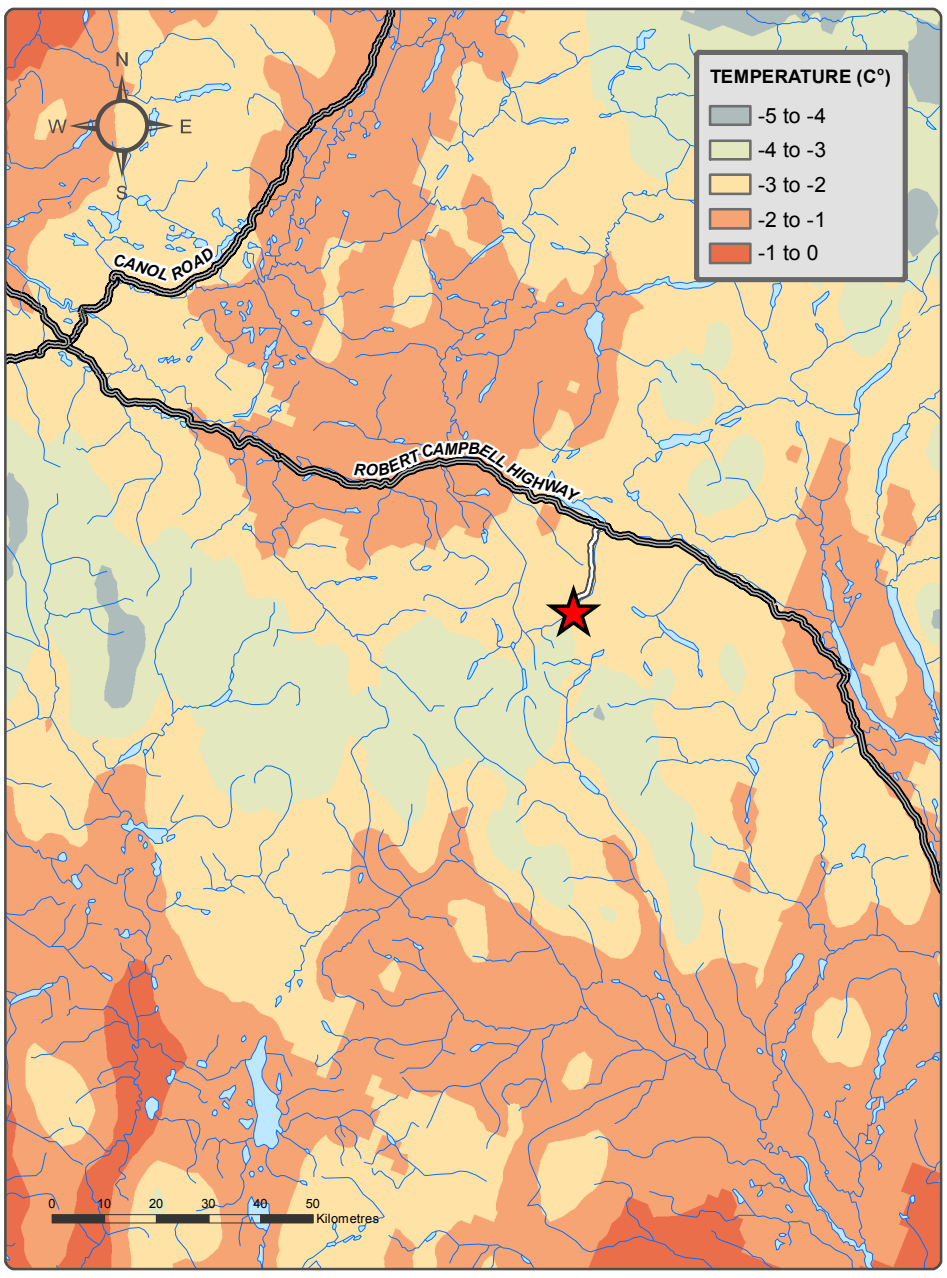
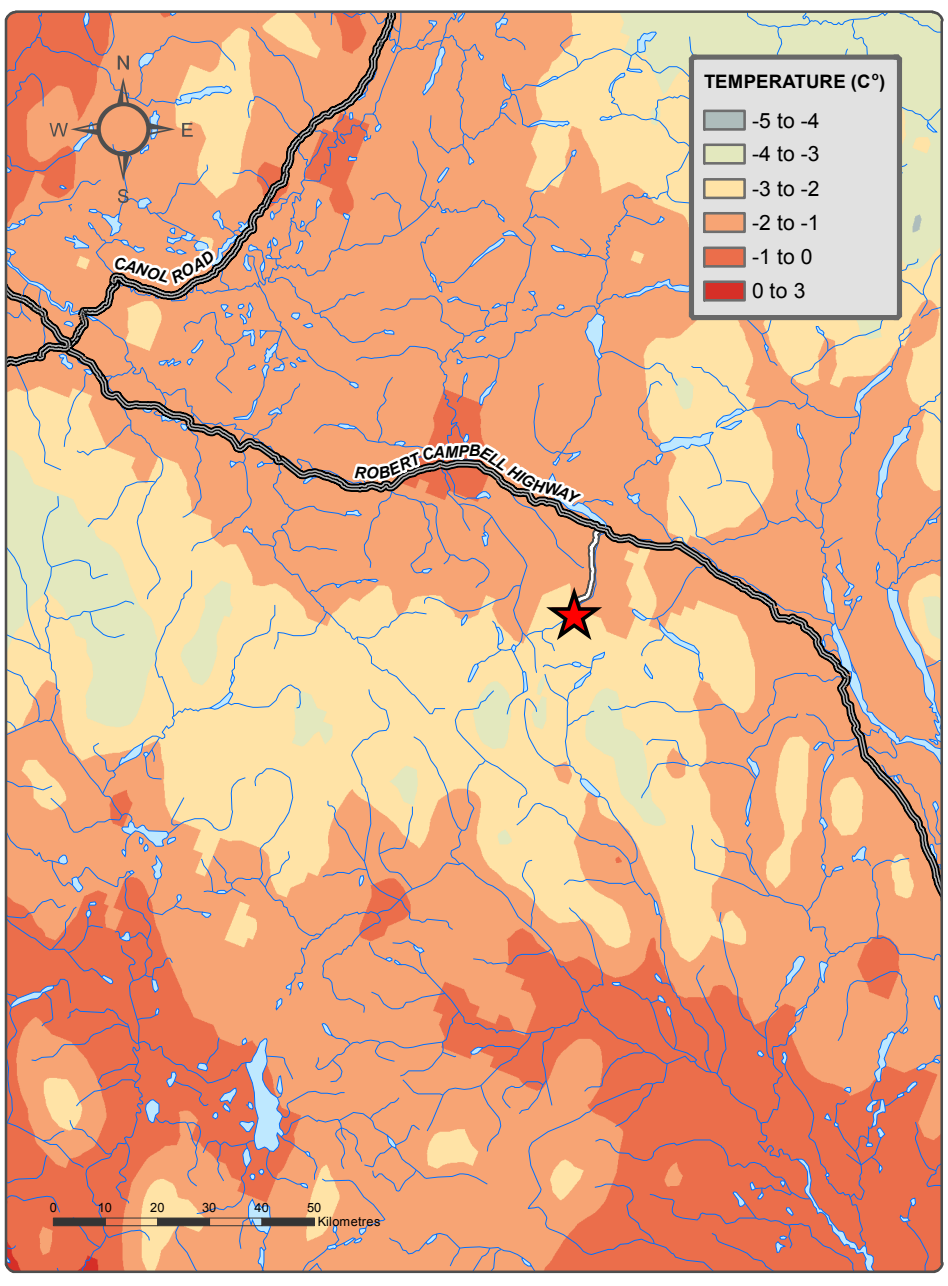
OBSERVED HISTORICAL MEAN ANNUAL TEMPERATURE, 2000-2009



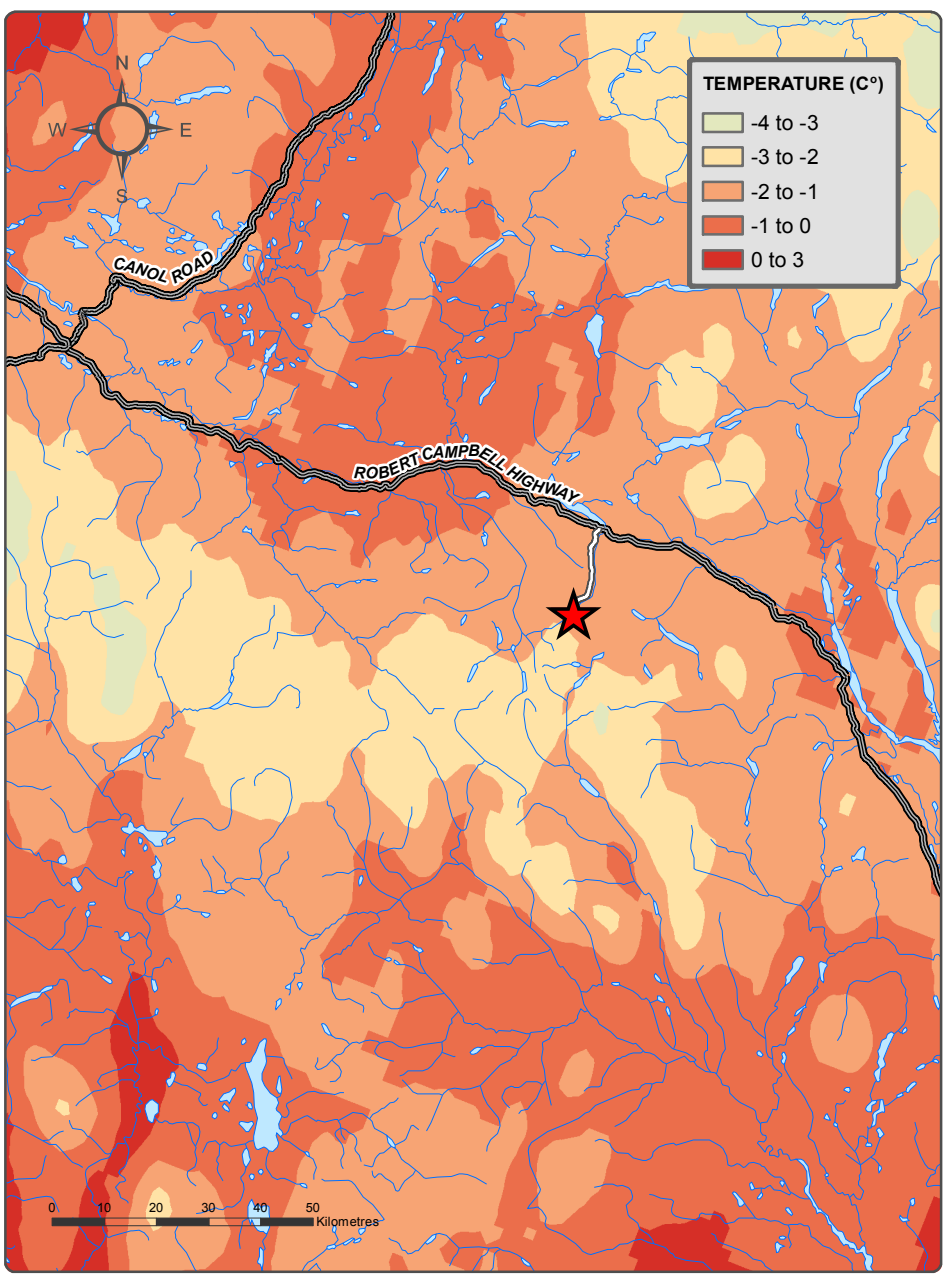
2020-2029 MEAN ANNUAL TEMPERATURE PROJECTION, RCP8.5 SCENARIO



2030-2039 MEAN ANNUAL TEMPERATURE PROJECTION, RCP8.5 SCENARIO



2040-2049 MEAN ANNUAL TEMPERATURE PROJECTION, RCP8.5 SCENARIO



Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

Annual Temperature Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

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KUDZ ZE KAYAH PROJECT

FIGURE 16-5

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL TEMPERATURE, RCP 8.5 SCENARIO

FEBRUARY 2017

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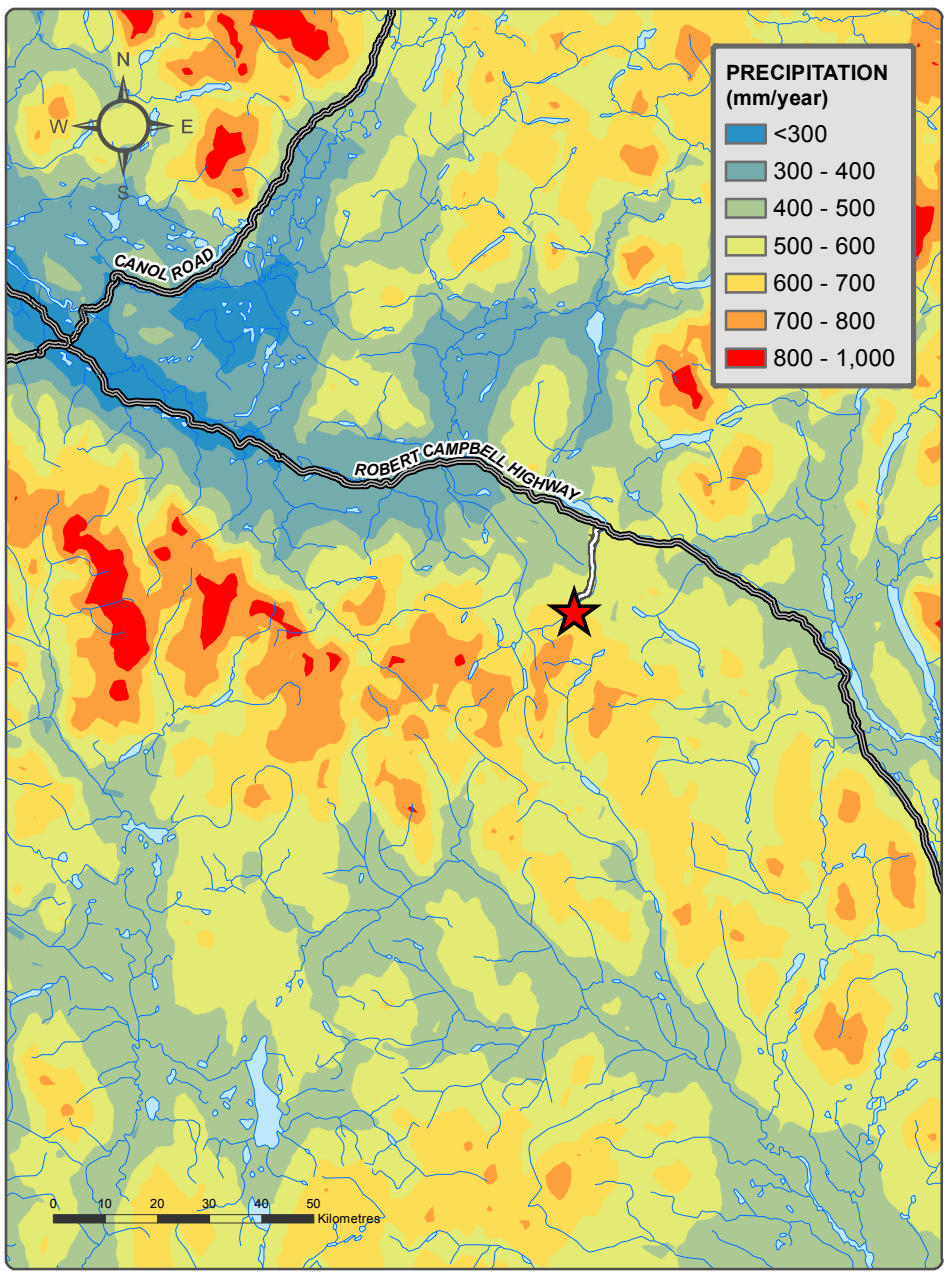
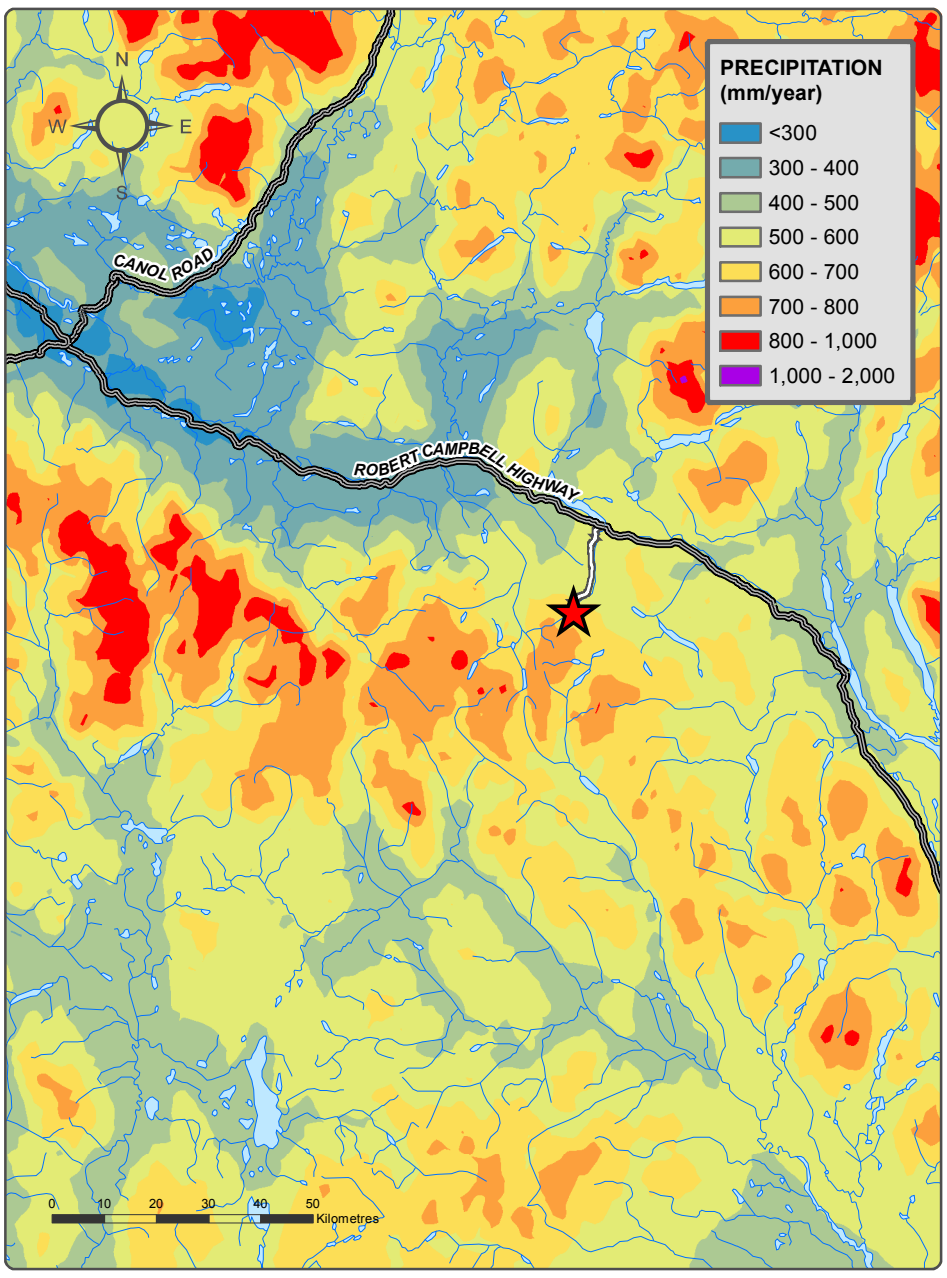
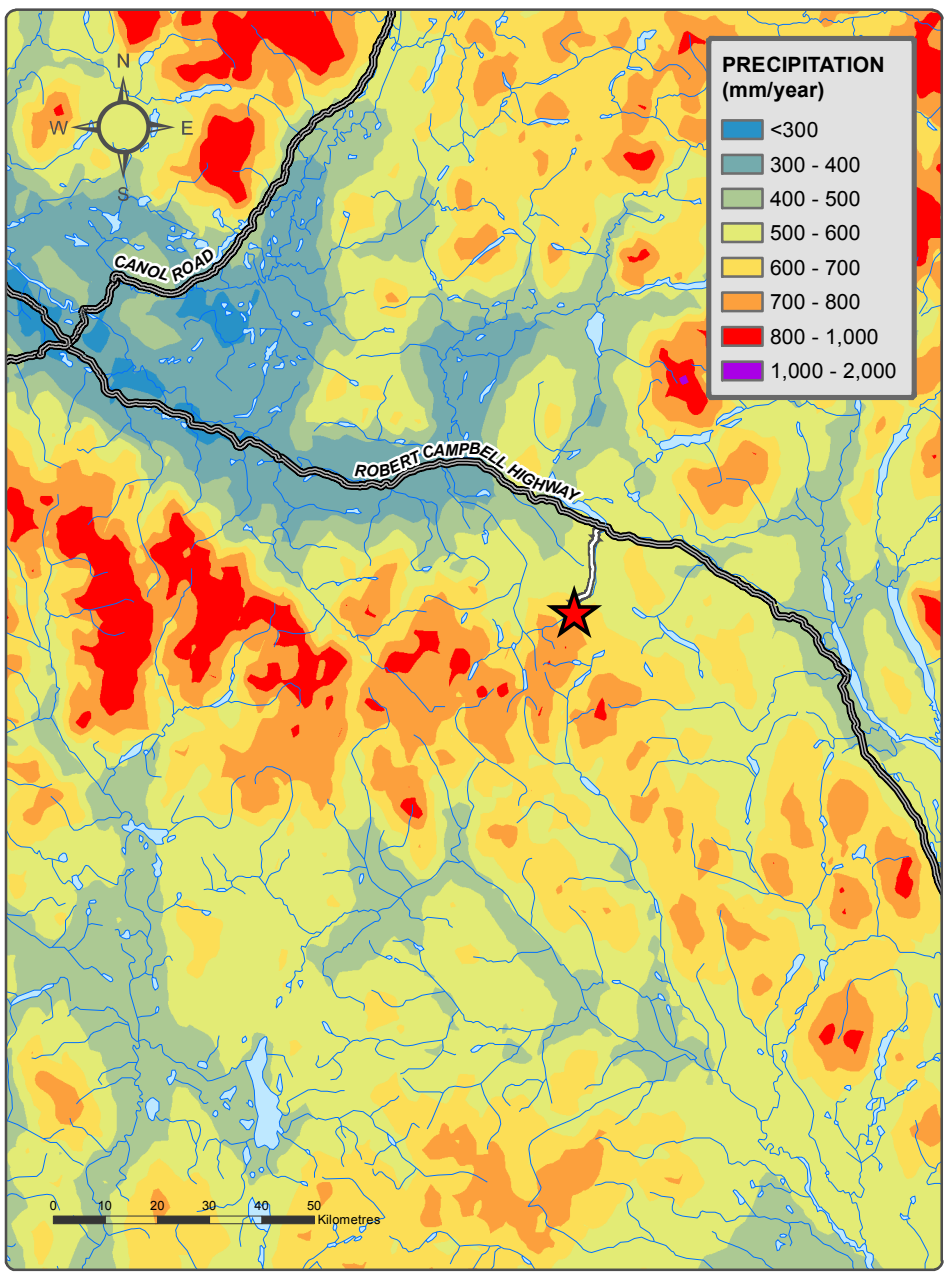
OBSERVED HISTORICAL MEAN ANNUAL PRECIPITATION, 2000-2009



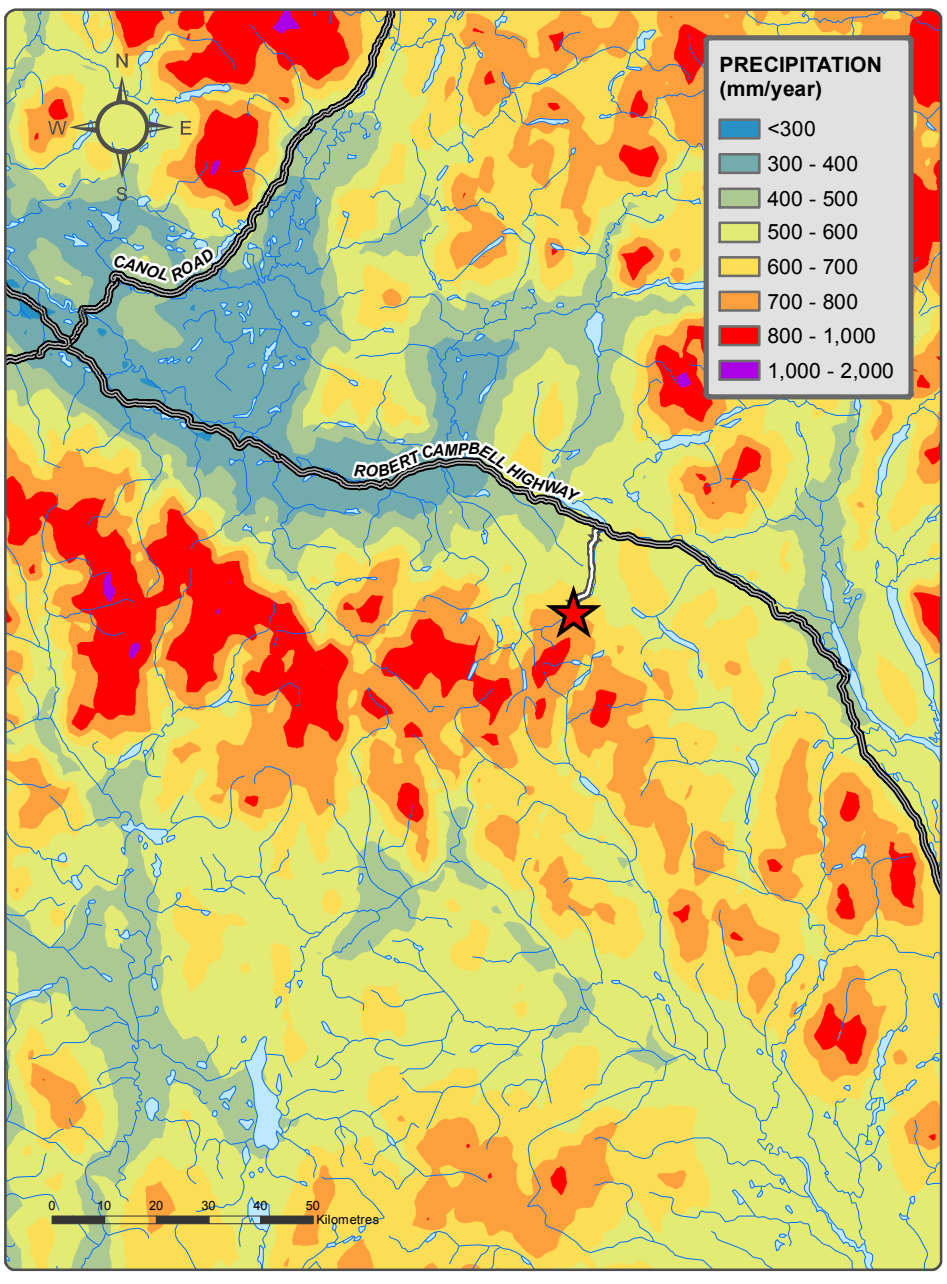
2020-2029 MEAN ANNUAL PRECIPITATION PROJECTION, RCP4.5 SCENARIO



2030-2039 MEAN ANNUAL PRECIPITATION PROJECTION, RCP4.5 SCENARIO



2040-2049 MEAN ANNUAL PRECIPITATION PROJECTION, RCP4.5 SCENARIO



Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

Annual Precipitation Data was derived from Scenarios Network for Alaska and Arctic Planning, University of Alaska. 2016. http://ckan.snap.uaf.edu/dataset

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KUDZ ZE KAYAH PROJECT

FIGURE 16-6

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL PRECIPITATION, RCP4.5 SCENARIO

FEBRUARY 2017

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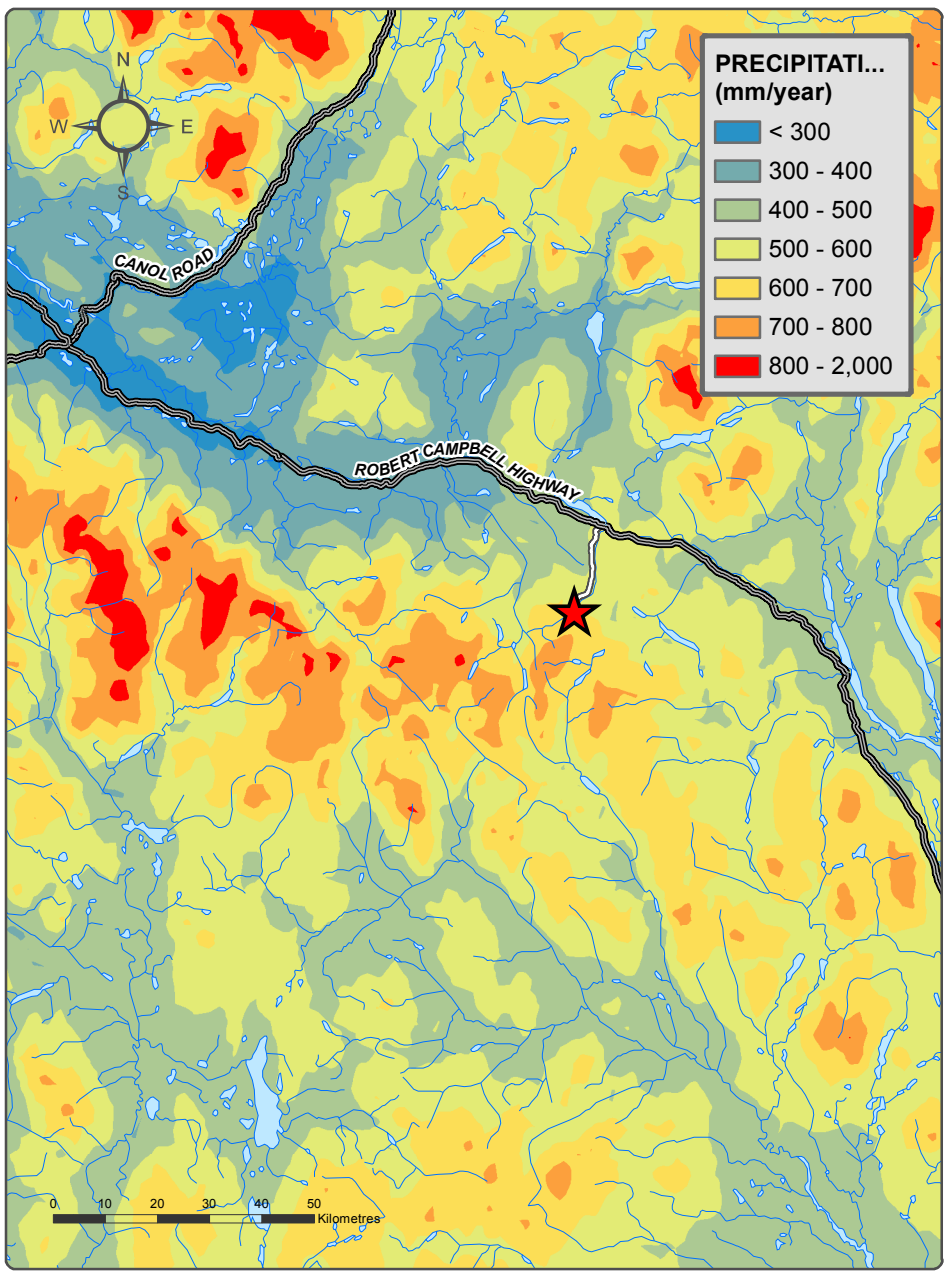
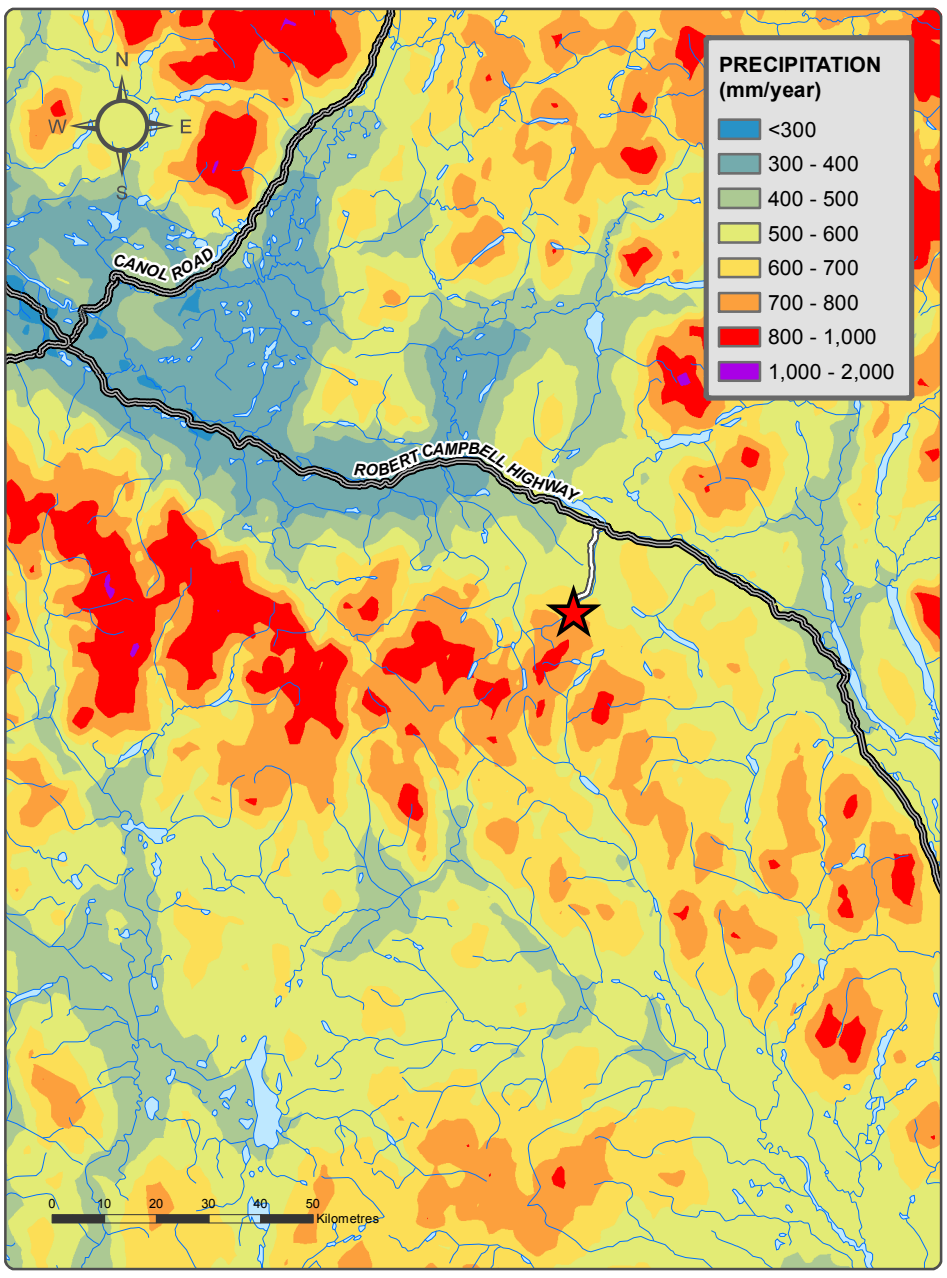
OBSERVED HISTORICAL MEAN ANNUAL PRECIPITATION, 2000-2009



2020-2029 MEAN ANNUAL PRECIPITATION PROJECTION, RCP8.5 SCENARIO



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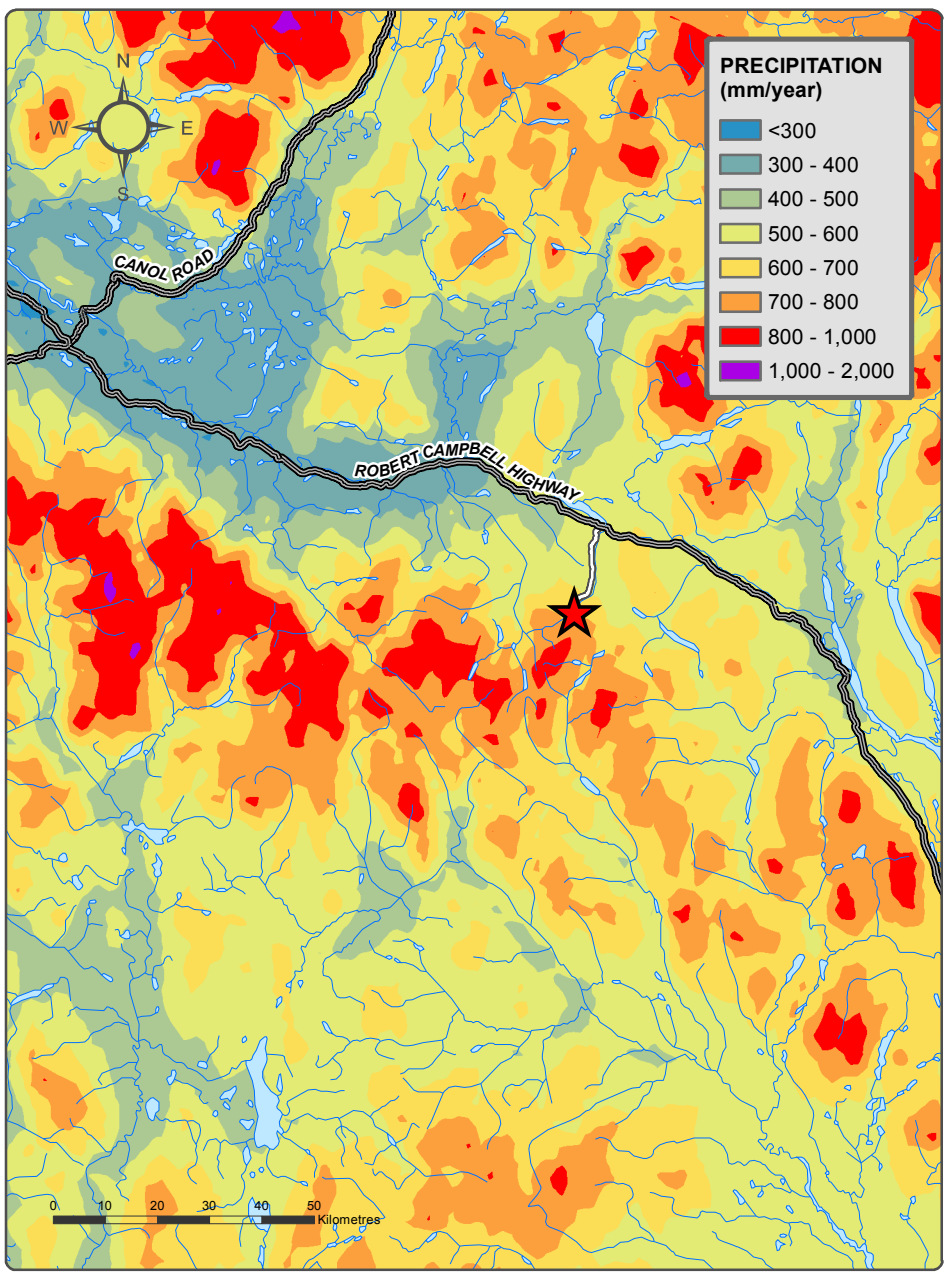

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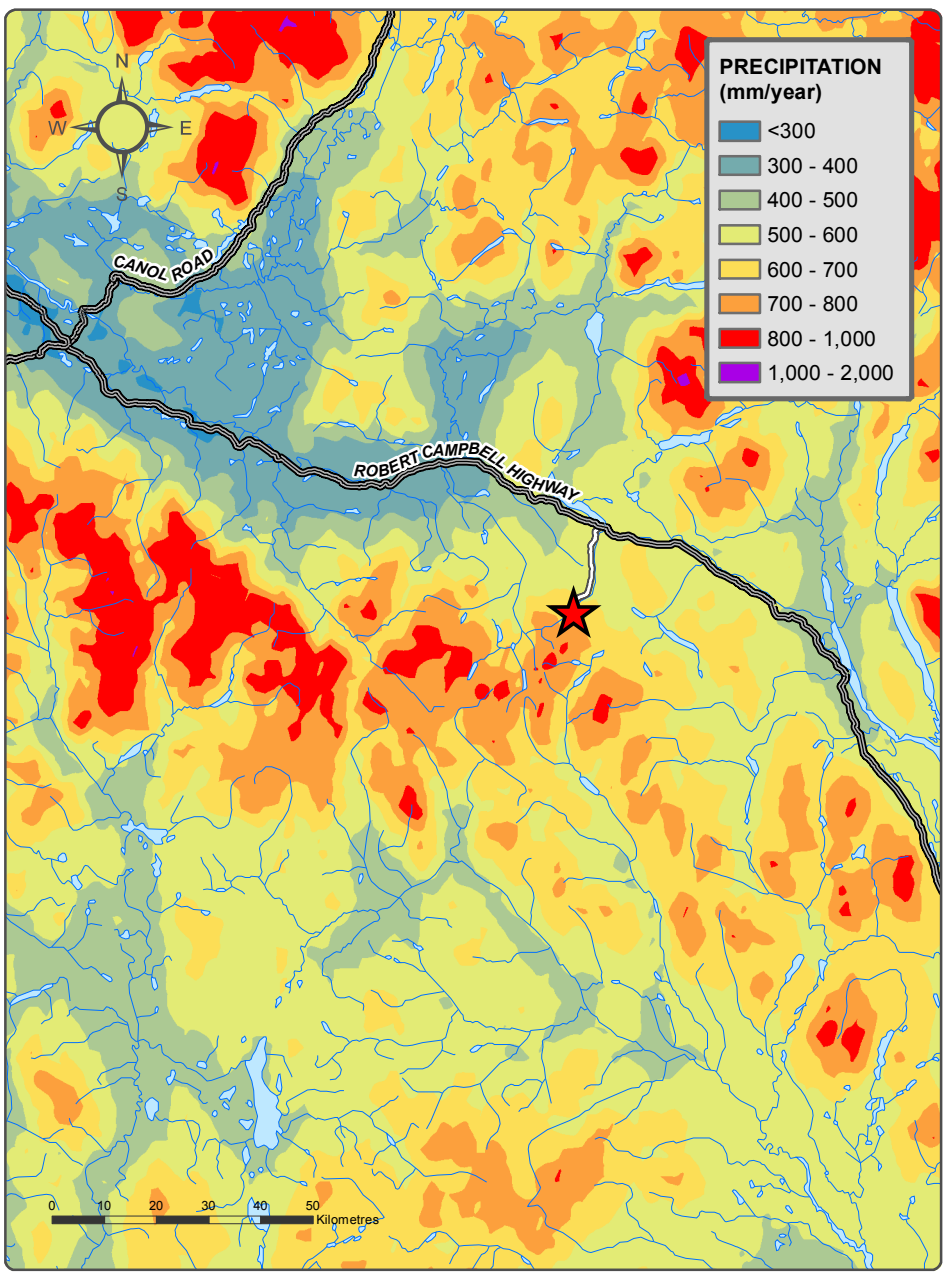

Kudz Ze Kayah Project

Tote Road/Proposed Access Road

Robert Campbell Highway

Watercourse

Waterbody

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KUDZ ZE KAYAH PROJECT

FIGURE 16-7

OBSERVED HISTORICAL AND MODEL PROJECTED MEAN ANNUAL PRECIPITATION, RCP8.5 SCENARIO

FEBRUARY 2017

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In 2015, a report was developed through the Northern Climate ExChange at the Yukon Research Centre; titled *Yukon Climate Change Indicators and Key Findings* which is a cross-sector, structured, evidence based assessment of Yukon climate change knowledge (Streicker, 2016). Table 16-9 provides a list of examples of some of the high and very high confidence findings, characterizing climate change in Yukon.

Table 16-9: Examples of Key Findings of Yukon Climate Change

Element	Finding
Climate	In Yukon, annual average temperature has increased by 2°C over the past 50 years.
	This increase is twice the rate of Southern Canada and the entire globe.
	Winters are warming more than other seasons: 4°C over the past 50 years.
Melt and Thaw	Warmer temperatures have resulted in widespread melting of glaciers and the rate of melt is increasing. The Alaska-Yukon icefields have shown retreat in glacier fronts and volumes, contributing to increased river flow and global sea level rise. Yukon has lost 22% of its glacial cover over the last 50 years.*
	Permafrost is degrading and more thawing is projected. Permafrost thaw typically occurs through an increase in the depth of the active layer.*
	Thawing ground will disrupt transportation, buildings, and other infrastructure. Permafrost degradation has potentially serious implications for those mine dams and tailing ponds which are dependent on permafrost berms.*
	Warming and thaw of permafrost are very likely to alter the release and uptake of greenhouse gases from soils, vegetation, and coastal oceans.
Water	Changes in the hydrologic response are driven by changes in temperature and precipitation. Increasing melt of glaciers, degradation of permafrost, variability in both rain and snow, earlier snowmelt, and late season fluctuations through the freeze-thaw cycle all affect the hydrologic regime. *
	Streamflow and groundwater flow patterns are changing. As permafrost degrades, pathways increase for groundwater, resulting in an increase in winter low flows.
	Flood risk is increasing. Rain and storm events are projected to increase; late season freeze-thaw cycles on rivers are creating ice which is more prone to ice-jam damming; heavy snowpack with warmer springs is leading to freshet flooding.
	Warming, degradation of permafrost, and increased flooding negatively impact water quality through increased turbidity and in some cases through contaminants.

* indicates very high confidence findings (Streicker, 2016)

16.6.2 Mitigation Measures

Predicted increases in mean annual temperature or mean annual precipitation are not expected to have major direct effects on the Project. Mitigations for indirect effects are discussed below.

Project design and contingency measures to address extreme weather events and forest fires (which are both predicted to increase in likelihood with climate change) are described in Section 16.4.2 and Section 16.5.2, respectively. Potential changes in hydrologic response or patterns were also integrated in the Project design with return period analysis of flood and low flows. Depending on the Project feature, design accommodates a 1 in 10 to a 1 in 200 year 24-hour flood event. Potential permafrost degradation that could result from climate change and associated terrain hazards were also considered in the Project design (Section 16.2.1).

16.6.3 Assessment Summary

The likelihood of climate change occurring is overall likely; however, changes will occur over the long term and the magnitude of changes likely to occur over the Project's life is small. The severity of potential effects is negligible given the short Project life and the fact that the Project specifications have considered the potential for climate change to affect the Project directly or indirectly. Therefore, no significant adverse effects to the Project or Project timing are anticipated due to climate change.

16.7 SUMMARY OF POTENTIAL EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Project design and management plans have taken into account potential range of environmental events, including those associated with climate change. Therefore, no significant effects of the environment on the Project are identified.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

17 MALFUNCTIONS, ACCIDENTS, AND UNPLANNED CLOSURE 17-1

17.1 METHODS 17-1
17.1.1 Scenario Identification 17-2
17.1.2 Effects Analysis and Risk Level Determination 17-3
17.1.3 Mitigation Measures 17-5
17.2 MALFUNCTIONS ASSESSMENT 17-5
17.2.1 ABM Open Pit 17-5
17.2.2 Underground 17-8
17.2.3 Storage Facilities 17-9
17.2.4 Process Plant Facility 17-14
17.2.5 Site Water Management 17-16
17.2.6 Power Generation Facility Failure (Power Outage) 17-21
17.3 ACCIDENTS ASSESSMENT 17-22
17.3.1 Explosives Accident 17-22
17.3.2 Spill or Leak During Transport 17-23
17.3.3 Spill or Leak on Site 17-24
17.3.4 Transportation Accident (On site and Off site) 17-25
17.3.5 Project-related Fire 17-28
17.4 UNPLANNED CLOSURE 17-28
17.5 SUMMARY 17-29

LIST OF TABLES

Table 17-1: Likelihood and Consequence Classifications 17-3
Table 17-2: Risk Level Classifications 17-4
Table 17-3: Valued Components with Potential Interaction from Accidents and Malfunctions 17-4
Table 17-4: Estimated Operations Traffic and Load Volumes 17-24
Table 17-5: Accidents, Malfunctions and Unplanned Closure Assessment Summary 17-30

17 MALFUNCTIONS, ACCIDENTS, AND UNPLANNED CLOSURE

This chapter identifies possible accidents and malfunctions associated with components of the Project. The *Yukon Environmental and Socio-economic Assessment Act* (*YESAA)* Section 42 requires that the assessment include the determination of the significance of any environmental or socio-economic effects resulting from accidents or malfunctions.

Accidents and malfunctions may occur from system failure, natural event, or human error. For the purposes of this proposal the definitions are:

- **Accident:** an unexpected occurrence or unintended action; and
- **Malfunction:** failure of a piece of equipment, a device, or a system to function normally.

In addition to the accidents and malfunctions assessment, the scope of this chapter also includes assessment of potential environmental and socio-economic effects as a result of unplanned closure.

17.1 METHODS

Professional judgment is used to identify, assess, categorize, and develop worst-case scenarios for potential accidents and malfunctions that may occur during the life of the Project. Only specific and major accidents and malfunctions that could have an effect on the environment or have a reasonable probability of occurrence are considered.

The methods used to assess the significance and likelihood of potential accident and malfunction scenarios follows the general approach and framework of a Failure Modes and Effects Analysis (FMEA). FMEA is a step-by-step process to identify the ways in which a component or process may fail (i.e., the failure modes) and assess the consequences of those failures (i.e., effects analysis). The assessment follows the following steps:

- **Scenario identification**: the major Project components are analyzed to identify potential failure modes, hazard scenarios and their potential causes to identify resulting accidents and malfunctions to be addressed in the assessment;
- **Effects analysis**: the likelihood of occurrence (i.e., probability) based on the project design and consequence (i.e., severity) based on the potential environmental effects are identified for each of the accidents and malfunctions scenarios;
- **Risk level determination**: the risk level is determined in the combination of the likelihood and consequence; and
- **Mitigation**: for the effects with high or unacceptable risk levels, mitigation measures are identified to bring the risk level to an acceptable level.

The assessment assumes that only one failure mode may exist at a time.

17.1.1 Scenario Identification

The scope of the assessment covers all major Project components and phases. Malfunctions assessment includes consideration of potential failure within the following major components of the Project during all phases of the Project:

- Open pit mining:
  - Slope failure;
  - Dewatering system failure; and
  - Reclamation measures failure.
- Underground mining:
  - Underground stope failure; and
  - Underground dewatering system failure.
- Storage facilities (Class A, B, C, and Overburden and Topsoil Stockpiles):
  - Failure of water collection systems (discussed in Water Management malfunctions below);
  - Slope failure;
  - Erosion control failure; and
  - Reclamation measures failure.
- Process Plant Facility:
  - Mechanical equipment failure; and
  - Pipes and pumps failure.
- Water Management:
  - Embankment or spillway failure of Operations Water Management Ponds;
  - Clean water diversion (including Fault Creek) failure;
  - Sediment and erosion control measures failure;
  - Storage facility water collection systems failure; and
  - Water treatment plant failure.
- Power generation facility failure (power outage).

Accident assessment considers the following accident scenarios:

- Explosives accident;
- Spill or leak during transport;
- Spill or leak on site;
- Transportation accident (on site and off site); and

- Project-related fire.

The unplanned closure scenario is also considered for potential environmental and socio-economic effects. The unplanned closure considers two scenarios: temporary closure and early permanent closure.

The effects of accidents and malfunctions on employee health and safety are not addressed as part of the scope of this chapter, and will be addressed as part of the Project health and safety program. The health and safety of employees will be addressed through the development of the Health, Safety, and Emergency Plan. The conceptual level detail of this plan is provided in Section 18.15.

Further description of potential malfunctions and accidents scenarios are provided in sections below.

17.1.2 Effects Analysis and Risk Level Determination

For each of the identified scenarios, risk is derived from the product of probability (i.e., likelihood of occurrence) and consequence (i.e., severity of occurrence). The likelihood rating is based on probability of occurrence and is derived from the level of design information available for the Project, review of historic or current events, and professional judgement. The consequence rating is determined based on the severity of the scenario and is derived from spatial and temporal effects. For each credible scenario, the Valued Components (VCs) likely to be affected and the type of effects are considered in determining the consequence rating. The likelihood and consequence ratings are described in Table 17-1.

Table 17-1: Likelihood and Consequence Classifications

Likelihood		Consequence	
Rating	**Description**	**Rating**	**Description**
Very unlikely	The event is not expected to occur during the life of the Project, no known occurrences on similar projects	Very low	Potential effects are localized and are readily reversible
Unlikely	The event is not likely to occur, very few known occurrences on similar projects	Low	Potential effects are within the Project area and are reversible in the short term (i.e., 1-5 years)
Likely	The event is probable during the life of the Project, known occurrences on similar projects	Medium	Potential effects are within the Project area and are reversible during the life of the Project, or potential effects extend beyond the Project area and are readily reversible/reversible in the short term
Very likely	The event is expected to occur during the life of the Project	High	Potential effects extend beyond the Project area and/or are not reversible during the life of the Project

The risk level for each scenario is determined through combination of likelihood and consequence ratings, as shown in Table 17-2. Risk grades range from low (i.e., negligible risk) to unacceptable. Scenarios ranked from low to moderate risk are considered not significant. Risk grades high and unacceptable are considered to have serious potential effects on VCs. The risk level classifications are shows in Table 17-2.

Table 17-2 Risk Level Classifications

Likelihood	Consequence			
	Very Low	***Low***	***Medium***	***High***
Very unlikely	Low	Low	Low	Moderate
Unlikely	Low	Moderate	Moderate	High
Likely	Low	Moderate	High	Unacceptable
Very likely	Moderate	High	Unacceptable	Unacceptable

The initial screening for potential interactions between VCs and general scenarios identified above is show in Table 17-3.

Table 17-3 Valued Components with Potential Interaction from Accidents and Malfunctions

Assessment Scenarios	Valued Components													
	Air Quality	Noise Levels	Surface Water	Groundwater	Aquatic Ecosystems and Resources	Terrain and Soils	Vegetation Cover and Composition	Wildlife and Wildlife Habitat	Heritage Resources	Economy and Sustainable Livelihood	Human Health and Well-Being	Community Vitality	Infrastructure and Services	Culture, History and Heritage
Malfunctions														
Open pit mining				X		X								
Underground mining				X		X								
Storage facilities (Class A, B, C and Overburden)			X		X	X	X							
Process Plant Facility			X		X	X								
Water Management			X	X	X	X	X	X						
Power Generation Facility			X								X			
Accidents														
Explosives accident	X	X					X	X					X	
Spill or leak during transport			X		X	X	X	X					X	
Spill or leak on site			X	X	X	X	X	X						
Transportation accident (on site and off site)								X					X	
Project-related fire	X						X	X					X	
Unplanned Closure														
Temporary closure			X	X	X	X	X	X		X		X		
Early permanent closure			X	X	X	X	X	X		X		X	X	
x = potential interaction that could result in an environmental or socio-economic effect (consequence)														

17.1.3 Mitigation Measures

The mitigation measures used by BMC throughout the life of the Project are described in the management plans (Chapter 18). The relevant environmental management plans, emergency responses, and design considerations to minimize risk are identified within the accidents and malfunctions assessed below. If the initial assessment identifies a risk rating of high or unacceptable then additional mitigation measures are required and introduced to lower the risk rating to moderate or low.

17.2 MALFUNCTIONS ASSESSMENT

17.2.1 ABM Open Pit

The Project consists of development of the ABM open pit, consisting of the ABM and Krakatoa Zones. All open pit mining is planned to be completed by a mining contractor with both zones of the ABM open pit mined with a common mining fleet. Due to the broad zones of mineralization evident in the ABM Zone, and in accordance with Yukon Occupational Health and Safety Regulations, it is expected that a bench height of 10 m will generally be adopted during mining. Mining of smaller benches may be required in specific locations where greater selectivity is required due to the orientation and width of mineralization.

Potential malfunctions assessed for open pit activites are:

- Slope failure;
- Dewatering system failure; and
- Reclamation measures failure.

17.2.1.1 Open Pit Slope Failure

As noted above, it is expected that a bench height of 10 m will generally be adopted during mining with smaller benches in specific locations. Haul roads in the pit have been designed to be 22 m wide at a maximum 1:9 gradient.

Pit slope designs are based on geotechnical assessment of the rock mass and overburden with appropriate bench face angles; bench height and width, and inter-ramp angles determined for each geotechnical domain. The bench height design will ensure stability and achieving adequate factor of safety (FOS) for dry and partially saturated conditions for deep seated type of failure. As design has been based on interpretation of drill hole data, detailed geotechnical mapping of the mined initial benches will be completed to assess the adequacy of slope design recommendations and revised where appropriate prior to excavation of the final pit walls. Horizontal drains will be utilized in the open pit where required to drain localized water that could affect open pit wall stability, while temporary in-pit sumps will be maintained to ensure that dry conditions are available at the operating pit floor. Controlled blasting will be used adjacent to pit walls to minimize damage from blasting.

Notwithstanding the above design parameters, some localized instability may be expected in surface operations through the life of the Project and the likelihood of localized ABM open pit slope failure is considered to be likely.

A failure in the overburden slope within the pit could extend beyond the open pit boundary and increase the footprint of the open pit as a result of slumping of the adjacent ground surface. Any terrain that slumps into the ABM open pit would be damaged and may result in soil and vegetation lost present at the perimeter of the pit. No surface water bodies or channels are present in close proximity to the ABM open pit and are not expected to be affected as a result of a failure in the overburden slope.

A slump that affects the haul road used to access the open pit would have to be re-established after stabilization. A slump in the western wall of the ABM open pit may effect the road and paste plant (or access to the past plant). Although the failure extending to this infrastructure is very unlikely. No other infrastructure is close enough to be at risk from slumps.

As the effects of the slope failure would be contained within the ABM open pit or within the immediate vicinity of the ABM open pit (in the event of the overburden slope failure), the consequence of the malfunction is considered to be very low but may be low if road and paste plant are affected.

The risk assessment for open pit slope failure identified a likelihood of likely (very unlikely for failure affecting paste plant) and a consequence of very low (low for failure affecting paste plant), resulting in a risk rating of low (per Table 17-2). Therefore, this potential malfunction is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.1.2 Open Pit Dewatering System Failure

Pumping systems for dewatering have been designed to meet the projected dewatering requirements for open pit mining operations. Groundwater flows will be monitored during initial stages of construction and operations to assess whether the projected dewatering requirements are appropriate. If they are found to not be appropriate, additional equipment will be sourced to adequately drain the open pit environment. During operations, should a component of the system fail, water will be allowed to accumulate on the pit floor until the component is repaired or replaced, with critical spares kept on site.

Mitigation measures for dewatering are discussed under the Surface Water Management Plan (Section 18.4), and include:

- The modified conceptual dewatering strategy for bedrock consists of a combination of fault-zone dewatering wells and a system of horizontal drains within the pit for dewatering and pit-wall depressurization;

- Dewatering wells are planned to intersect each of the three major fracture zones associated with the East Fault, the Northwest Fault and Fault Creek Lineation;
- For in-pit dewatering, competent bedrock will drain naturally through the high wall and end wall of the ABM open pit;
- Horizontal drain holes will be installed in areas of high pore pressure or structural instability; and
- Drainage from the walls and horizontal drains will be conveyed to sumps located on each of the bench levels and at the pit floor, with collected water pumped to surface were it can be routed to the water treatment or storage facilities.

The likelihood of the dewatering system failure is considered to be likely. The potential dewatering system failure may affect groundwater levels temporarily however, the effects are expected to be localized and short-term. The consequence of malfunction is expected to be very low.

The risk assessment for open pit dewatering system failure identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.1.3 Reclamation Measures Failure

Detail regarding reclamation measures is provided in Section 4.13 and Appendix H-1. During closure phase, the ABM open pit will be allowed to flood as dewatering will cease and the Fault Creek diversion will be removed with flow re-directed to the ABM open pit. The open pit and surrounding areas will undergo reclamation to the extent of ensuring that the pit walls are stable and pose no danger to the general public or local wildlife. Berms will be created around highwall edges to prevent access by people or wildlife. Batch treatment of the ABM pit lake will consist of addition of lime during the initial filling of the pit to address flushing of secondary mineralization related metal concentrations.

Water quality monitoring of the ABM lake will be used to evaluate pit chemistry and ensure that the concentrations of constituents which are expected to respond to lime treatment (e.g., zinc, cadmium, copper, lead, arsenic) are minimized.

An engineered spillway will be constructed to control outflow from the ABM lake. The wetland treatment system within Geona Creek downstream of the pit will provide both a contingency treatment for those constituents that may not be efficiently ameliorated by ABM lake lime addition (e.g., selenium, uranium, antimony) and a secondary polishing step for other constituents of potential interest (e.g., zinc, lead, cadmium, copper, and arsenic).

Given that the water treatment may be adjusted through the ongoing monitoring for water quality, the failure of reclamation measures is considered to be unlikely. As any water released will be contained prior to discharge to receiving environment, the consequence is considered to be very low.

The risk assessment for open pit reclamation measures failure identified a likelihood of unlikely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.2 Underground

Underground mining has only been considered for the Krakatoa Zone with access from the ABM open pit. Development will use standard mechanized mining equipment and methods. Haul trucks will be loaded by 14 tonne (t) underground loaders. These loaders will be fitted with remote capabilities and will be capable of mucking in the stopes and loading trucks.

Potential accidents and malfunctions assessed for underground mining activites are:

- Underground stope failure; and
- Underground dewatering system failure.

17.2.2.1 Underground Stope Failure

Stope failures have very limited potential to cause environmental effects as they occur underground, with interaction only identified for terrain and soils VC. The failure is mainly a safety hazard to workers as mine walls may fall on them or trap them.

Surface ground support in the form of wire mesh and rockbolts (and where appropriate shotcrete) will be utilised to support all underground excavations where entry of personnel is required. Longer cablebolts will be utilised where required to provide greater support. An ongoing geotechnical mapping program will be established to monitor and assess the effectiveness of the underground support design and will be revised where appropriate. Ventilation raises and emergency egress will be constructed from inside the open pit as needed to ensure worker safety.

Emergency response procedures will be developed as outlined in the conceptual Health, Safety and Emergency Response Plan (Section 18.15).

The likelihood of the underground stope failure is considered to be likely. The consequence is expected to be very low, as the potential effects on VCs are limited to terrain and soils VC, and would be very localized.

The risk assessment for underground stope failure identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.2.2 Underground Dewatering System Failure

As in the strategy for ABM open pit dewatering, the dewatering strategy for the underground workings involves the collection of seepage water via sumps and augmented by horizontal drains, as needed to reduce bedrock saturation near the tunnel face in the event of elevated flow rates or structural instability. Drainage from the walls and horizontal drains will be conducted to a series of sumps to be located at appropriate locations within the workings. As outlined above, should a component of the system fail, water will be allowed to accumulate until the component is repaired or replaced. Groundwater flows will be monitored during initial stages of mining to assess whether the projected dewatering requirements are appropriate. If they are found to not be appropriate, additional equipment will be sourced.

Mitigation measure for dewatering are discussed under the Surface Water Management Plan (Section 18.4). As in the strategy for in-pit dewatering discussed above, the dewatering strategy for the underground workings will involve the collection of seepage water augmented by horizontal drains, as needed, to reduce bedrock saturation near the tunnel face in the event of elevated flow rates or structural instability. Collected water will be pumped to surface were it can be routed to the water treatment or storage facilities. Spare pumps and critical spares for the pumps will be available on site and, if deemed necessary, the main pumping station will have an installed standby pump.

The likelihood of the dewatering system failure is considered to be likely.

The potential dewatering system failure may affect groundwater levels temporarily; however, the effects are expected to be localized and short-term. The consequence of malfunction is expected to be very low.

The risk assessment for underground dewatering system failure identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.3 Storage Facilities

Storage facilities and stockpiles include:

- Class A, B, and C Storage Facilities;
- Overburden Stockpile; and
- Topsoil Stockpiles.

The Class A Waste Storage Facility is designed to contain tailings and Class A waste rock. Class A material will be acid generating and metal leaching in the near term and therefore requires encapsulation to limit contact with oxygen and water. The Class B contains waste rock with potential acid generation and metal leaching over the longer term (after cessation of mining activities) and

requires encapsulation to limit contact with oxygen and water. The Class C material will not be acid generating and could even be acid consuming, and have low metal leaching potential.

Overburden from the open pit will be excavated and used for construction materials, excess overburden will be stockpiled and stored on the eastern side of the valley. Topsoil will be stripped from the Overburden Stockpile, Class A, B, and C Waste Storage Facilities and the ABM open pit footprint areas during construction.

Potential malfunctions assessed for storage facilities and stockpiles are:

- Slope failure;
- Erosion control failure; and
- Reclamation measures failure.

Water collection system malfunctions associated with these facilities and stockpiles are discussed under water management in Section 17.2.5.

17.2.3.1 Class A, B, and C Storage Facility Slope Failure

The main concern with release of mine rock or tailings from the contained area is the potential for metal leaching and acid rock drainage affected runoff (Class A, Class B) and covering habitat (Class A, Class B, and Class C). The increased chemical loading could affect aquatic life in nearby surface water. Environmental effects from ditch or pond failure are discussed in Section 17.2.5.

The design considerations to minimize the likelihood of slope failure for the Class A Facility is a FOS of 1.5 static and 1 seismic conditions with a slope of 4H:1V. Class A Storage Facility stability assessment is provided in Appendix C-4. For the Class B and C, the design considerations included the FOS of above 1.5 for static conditions and above 1.1 for seismic conditions with a slope of 3H:1V. Class B and C Storage Facilities, and Overburden Stockpile stability assessment is provided in Appendix C-6.

The Investigation and Design Manual Interim Guidelines (BC MWRPRC, 1991) provides recommendations for stability assessment of mine waste piles. These guidelines include a Dump Stability Rating (DSR) scheme. The DSR system provides a semi-quantitative method for assessing the relative potential of pile stability and recommends the appropriate level of pile investigation and design. Each facility was determined to have a moderate failure hazard level. A follow up stability analysis was completed using SLOPE/W (GEO-SLOPE, 2012), a limit equilibrium modelling program. A FOS of 1.5 was targeted for static conditions, and above 1 for seismic conditions was met by each facility under both static and seismic conditions (Appendices C-4 and C-6).

Permafrost is not ubiquitous throughout the Project area and was primarily observed in the northern boundaries of the Class C Facility. Shallow flow slope failure and slope creep caused by permafrost are not anticipated beneath the Class A Storage Facility, Class B Storage Facility, Class C Storage Facility, and Overburden Stockpiles for the following reasons:

- Permafrost was not observed within the Class A and B Storage Facilities foundation area;

- Available data indicates permafrost is limited in coverage, occurring within the Overburden Stockpile and northern Class C Storage Facility areas;
- The Class C Storage Facility is placed in a confined valley with a shallow basin grade, thus limiting the potential for movement; and
- The piles and stockpile foundations typically consist of sand and gravel soils with some silt. These soils are expected to consolidate at the same rate as thawing occurs, therefore exhibiting an effective shear strength similar to unfrozen soils during any thawing. Additionally, the stability model conservatively assumes fully saturated conditions for the foundation materials, which accounts for any buildup of fluid within the soil pores during thawing.

The Class A Facility will have a Class C material buttress and will be constructed for confinement at the downstream slope of the Class A Facility which improves the overall FOS of the facility. The buttress will be constructed with a 2.5H:1V upstream slope and 3H:1V downstream slope. Tailings material will be placed and compacted in controlled lifts.

General operations considerations are as follows:

- Rock fill and overburden materials will be transported from the pit using haul trucks. The material may be end dumped over the face or spread by dozers over the crest of the storage facilities;
- Trial sections may be constructed in the field during the initial stages of development to monitor rock fill pile stability and foundation performance. The various rock fill materials may be sampled for characterization and for durability test work to confirm the design parameters; and
- Rock fill material shall be end dumped over the crest to allow for maximum segregation of the coarser material at the base of each bench. For overburden materials, end dumping short of the crest and dozing over may be required.

Geotechnical inspections will be undertaken by an engineer licensed to practice in Yukon on an annual basis during operations for all storage facilities and water management infrastructure (Section 11.6). Physical inspections of all storage facilities and water management infrastructure will be conducted on a monthly basis during operations by site personnel.

Given the above considerations the slope failure for storage facilities is considered to have an unlikely likelihood rating.

If the slope failure is contained within the footprint of the storage facility, the consequences of this event are considered to be very low as no additional effects (to those already identified for the Project) are expected for any of the VCs. If the slope failure causes the waste material to travel downslope of the facility footprint, additional effects may be expected. The effects would be limited to the Project area, as any slope failure for any of the storage facilities would not be expected to result in materials travelling down the valley beyond the Operations Water Management Ponds during operations. Short term effects may be expected on surface water quality as the potential slope failure

may affect the water collection system and ponds. However, the discharge to receiving environment is not expected to be affected and any effects are expected to be limited to Project area with adjustments made to treat water as necessary prior to release. As the effects are expected to be limited in extent and short term, the consequence of the event is considered to be low.

The risk assessment for slope failure for storage facilities identified a likelihood of unlikely and a consequence of very low to low, resulting in a risk rating of low to moderate for the slope failure event that may extend beyond the footprint of the storage facility (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the moderate risk rating.

17.2.3.2 Overburden and Topsoil Stockpiles Slope Failure

Similar to the storage facilities, failure of the Overburden and Topsoil Stockpile slopes could be due to a pre-shearing event or major failure event. The Overburden Stockpile was modelled to have a 2.2H:1V slope. The stability analyses meet or exceed the target FOS of 1.5 for static and 1.1 for seismic conditions (Appendix C-6).

Topsoil stockpiles will be placed in localized stockpiles and windrows around site. Material will be placed and contoured to a 4H:1V slope. The stockpile surfaces will be revegetated during operations to stabilize the slope surfaces and control erosion from runoff.

Geotechnical inspections will be undertaken by an engineer licensed to practice in the Yukon on an annual basis during operations for all storage facilities and water management infrastructure (Section 11.6). Physical inspections of all storage facilities and water management infrastructure will be conducted on a monthly basis during operations by site personnel.

Given the above considerations the slope failure for overburden and topsoil stockpiles is considered to have an unlikely likelihood rating.

Overburden material is non-acid generating and therefore environmental effects due to chemical loading from a slope failure are of lesser concern. Physical blockage of ditching however, would need to be repaired as it could increase the sediment load. Any failure of the Overburden Stockpile will be contained within the Project Footprint. If a failure were to occur the stockpile would be re-contoured in place after the failure area has been secured. Any damage to drainage ditches would be repaired. To reduce the potential for sediment loads to enter the environment, the water from the runoff collection ditches reports to the Overburden Stockpile Collection Pond to allow sediment to settle. In an event of a major slope failure for the Overburden Stockpile potential increased sediment loads may be expected in the short term. As the effects are expected to be limited in extent and short term, the consequence of the event is considered to be very low.

The risk assessment for slope failure for Overburden and Topsoil Stockpiles identified a likelihood of unlikely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.3.3 Erosion Control Failure

Diversion and collection ditches are utilized to prevent erosion of the storage facilities and Overburden Stockpile. Surface runoff will be routed to Water Collection Ponds via appropriate grading and collection ditches to reduce sediment load to the environment.

The Class A Storage facility will be constructed at an overall slope of 4H:1V and will be progressively reclaimed with an engineered low permeability cover, and approximately three to five meters of Class C material for frost protection. Topsoil will be spread and the facility will be revegetated to mimic the current site conditions. The low permeability cover, frost protection, and revegetation efforts will protect and reduce the potential for erosion of the cover. For water that does make it through the cover, the risk of chemical loading to the environment is controlled by the collection of the seepage by using sumps to collect the water and subsequently treating the water at the Water Treatment Plant before discharge.

The Class B Storage Facility, similar to Class A Storage Facility, will also have a low permeability cover, frost protection and topsoil for vegetation. The frost protection and topsoil will reduce erosion of the facility and potential for chemical loading to the environment. Runoff from the Class B Facility is collected in the Class B Water Collection Pond and routed to the Water Treatment Plant. A seepage collection system will collect any water that does make it through the cover.

The Class C Storage Facility will have a slope of 3H:1V to help reduce erosion risks. Failure of erosion measures on the slope will be recovered by Class C Water Collection Pond.

The Overburden Stockpile will be constructed at an overall slope of 2.2H:1V for long-term physical stability. Failure of erosion measures on the slope will be recovered by Overburden Stockpile Collection Pond. Erosion measures for the Topsoil Stockpiles include a 4H:1V slope and revegetation during operations.

The potential failure of erosion control systems is managed through the mitigation measures outlined in the Sediment and Erosion Control Plan (Section 18.6). Any potential need for changes to the sediment and erosion control for the Project will be monitored through the Adaptive Management Plan developed during the permitting process. Based on the above design features, and mitigation and monitoring in place for the Project, the likelihood of erosion control failure is considered to be unlikely.

Potential effects to the environment as a result of the erosion control failure include increased sediment load in the surface water and potential effects in the downstream aquatic resources and habitats. However, considering a number of mitigations and monitoring in place, including collection ponds, it is not expected that the potential effects of erosion control failure extends downstream beyond the Project area. The consequence is therefore considered to be very low.

The risk assessment for erosion control failure identified a likelihood of unlikely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.3.4 Reclamation Measures Failure

The conceptual Reclamation and Closure Plan has been developed that outlines reclamation measures for each of the Storage Facilities (see Section 4.13 and Appendix H-1). The likelihood that some components of reclamation measures may fail and need adjustment through the life of the Project is considered to be likely.

Progressive reclamation will be undertaken progressively for Class A, B, and C facilities throughout operations through installation of a cover. Reclamation progress will be monitored and based on the early outcomes of the reclamation, subsequent reclamation planning may be adjusted if any of the elements are failing to perform. Given that reclamation measures may be adjusted through the operations phase, the consequence of reclamation measures failure is considered to be very low.

The risk assessment for reclamation measures failure identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.4 Process Plant Facility

The Process Plant Facility consists of crushing and grinding of the ore, separate sequential pre-float, rougher and cleaner flotation of copper, lead, and zinc and regrind of copper, lead, and zinc rougher concentrates. As described in Section 4.8, the proposed process plant design incorporates the following unit process operations:

- Primary crushing using a jaw crusher to produce a crushed product size of nominally 80% passing (P_{80}) 90 mm based on the soft nature of the ore;
- Stacking of ore onto a conical, covered stockpile with a nominal 12-hour live capacity;
- Comminution circuit including open circuit SAG mill and closed circuit ball mill grinding with potential to recycle of some of the cyclone underflow to the SAG mill, to produce a P_{80} grind size of 70 µm;
- Gravity gold recovery on part of the cyclone underflow in the grinding circuit using a Centrifugal concentrator, with secondary upgrade in the goldroom with a shaking table;
- Sequential flotation of copper, lead, and zinc using conventional pre-float, rougher and cleaner flotation cells;
- Regrinding of copper and zinc rougher concentrate with fine grinding mills;

- Thickening and filtration of the separate copper, lead and zinc concentrates;
- Storage of the concentrate and load-out via front end loader and truck;
- Dewatering of the flotation tailings by thickening and filtration prior to trucking to either the Class A Storage Facility for disposal or the paste plant for backfill paste production; and
- Concentrator water and air services and associated infrastructure.

Potential malfunctions for Process Plan Facility include:

- Mechanical equipment failure; and
- Pipes and pumps failure.

17.2.4.1 Mechanical Equipment Failure

An overview of the Process Plant is provided in Section 4.8 with further detail of mechanical equipment and control systems provided in the Prefeasibility Study Report (BMC, 2016). Critical spares (e.g., large motors) will be available on site. Preventative maintenance and condition monitoring will be designed to monitor the ongoing performance and reliability of equipment, with planned change out of equipment preferred to replacement of equipment once it has failed. Periodic planned shutdowns will be scheduled and resourced to ensure that major equipment items are kept in good operating condition.

Give the above mitigation measures, the mechanical equipment failure is considered to be unlikely. The consequence is considered to be very low, as any effects of equipment failure are expected to be contained on site and not result in any releases to the environment. The consequence of any potential spills is considered under accidents (Section 17.3).

The risk assessment for mechanical failure identified a likelihood of unlikely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.4.2 Failure of Pipes and Pumps

The processing plant has been designed to have duty and standby pumps available to ensure high availability of the processing facility. All wet areas of the processing plant have been designed to include sumps and containment bunding to ensure that in the event of a spill, spilled liquids and slurries will not be able to leave the designated wet area parts of the processing plant facility.

Given the above mitigation measures, the risk assessment for failure of pipes and pumps identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2).

No additional mitigation measures are warranted, given the low risk rating.

17.2.5 Site Water Management

As described in Section 4.10, BMC has designed the water management systems and associated facilities for the Project with the following objectives:

- Keep clean water clean, and
- Re-use water on site, were ever practicable, to reduce the volume required for discharge.

Water management will include: water collection; conveyance; storage; treatment; and release. Runoff will be controlled to minimize erosion in areas disturbed by construction activities and to prevent the release of sediment laden water to the receiving environment. This includes the collection and diversion of surface water runoff, and sediment and water collection ponds and pumping systems.

Potential malfunctions assessed for site water management are:

- Embankment or spillway failure of Operations Water Management Ponds;
- Clean water diversion (including Fault Creek) failure;
- Sediment and erosion control measures failure;
- Storage facility water collection systems failure; and
- Water treatment system failure.

17.2.5.1 Embankment or Spillway Failure of Operations Water Management Ponds

The Upper Operations Water Management Pond will temporarily store site runoff water from areas surrounding the Process Plant Facility, and the east side of Geona Creek including runoff from the Overburden Stockpile and Class C Facility that is unsuccessfully diverted around site. Settling of sediment and metals will occur in the Upper Operations Water Management Pond and the water will be decanted to the larger Lower Operations Water Management Pond where it will be stored for use as reclaim water for the Process Plant Facility, or discharged to the environment. The Operations Water Management Ponds will be constructed with geosynthetic liners, which can improve bank stability. The Operations Water Management Ponds have a design threshold of 1 in 200-year 24-hour storm event and 1 m design freeboard. The embankments for the ponds will be built with 2.5H:1V upstream and downstream slopes, with upstream slope lined with geomembrane liner (Section 4.10).

The discharge from the Lower Operations Water Management Pond will either be directly to Geona Creek or piped to Finlayson Creek. Water will be discharged year-round to Geona Creek at a minimum 3:1 ratio (receiving water: effluent) and piped to Finlayson Creek also at a minimum 2:1 ratio (receiving water: effluent).

Geotechnical inspections will be undertaken by an engineer licensed to practice in Yukon on an annual basis during operations for all water management infrastructure. Physical inspections of all

water management infrastructure will be conducted on a monthly basis during operations by site personnel.

Considering the design parameters and planned inspections, the likelihood of embankment or spillway failure of Operations Water Management Ponds is considered to be very unlikely.

Embankment or spillway failure of the Upper Operations Water Management Pond would result in uncontrolled discharge to the Lower Operations Water Management Pond. The Lower Operations Water Management Pond has a design threshold of 1 in 200-year 24-hour storm event and 1 m design freeboard, which are likely to contain additional inflow from the Upper Operations Water Management Pond. In an event of embankment or spillway failure of the Lower Operations Water Management Pond, uncontrolled discharge to Geona Creek would occur. As Operations Water Management Ponds are primarily used for additional sediment control and discharge rate control, there are no chemical load concerns in the event of a discharge as a result of a failure (see Section 4.10 for more information on Project water management). The potential effect of discharge from Lower Operations Water Management Pond could result in a temporary increase in flow and potential erosion of aquatic habitat in Geona Creek and potential downstream effects to Finlayson Creek. These effects are likely to extend beyond the Project area; however, they are reversible during the life of the Project. Therefore, the consequence is considered to be medium (as per Table 17-1).

The risk assessment for embankment or spillway failure of the Operations Water Management Ponds identified a likelihood of very unlikely and a consequence of medium, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.5.2 Clean Water Diversion (including Fault Creek) Failure

Diverting clean water around the Project is one of the main objectives of the water management strategy. Reducing the volume of contact water requiring management and treatment is critical to the success of the water management strategy for the Project. The Project includes three major diversions:

- The Fault Creek and associated southern diversions temporarily re-routes water that would otherwise flow into the ABM open pit and diverts it to South Creek during operations;
- The northwestern diversion routes water above the Class A Storage Facility, Process Plant and the Class B Storage Facility past the Operations Water Management Ponds into Geona Creek.; and
- The northeastern diversion routes water from above and the runoff from the Class C Storage Facility and Overburden Stockpile, which is directed into Geona Creek below the Lower Operations Water Management Pond.

The water balance has assumed the diversions have a nominal 50% efficiency rating other than the Fault Creek diversion which has assumed a nominal 100% efficiency rating. Air photo interpretation suggests that in recent geologic times, Fault Creek has flowed to the South via a paleochannel, located

where the temporary diversion would be developed. All diversion ditches will be designed to manage a 1 in 200-year flood event. Further detail on diversion design parameters is provided in Section 4.10.1.1.

Geotechnical inspections will be undertaken by an engineer licensed to practice in Yukon on an annual basis during operations for all water management infrastructure. Physical inspections of all water management infrastructure will be conducted on a monthly basis during operations by site personnel.

Considering the design parameters and planned inspections, the likelihood of clean water diversion failure below the efficiency ratings indicated above is considered to be very unlikely.

In the event of Fault Creek diversion failure, water will enter the pit where it will be collected via in-pit dewatering system and pumped to the Pit Rim pond. In the event of northwestern or northeastern diversion failure, water will be collected via Storage Facilities and stockpiles water collection systems and will be handled within those runoff streams. Collected water will be treated before release, if required. As indicated above, the water management system is designed to retain major storm events and would be able to accommodate short term water influx resulting from diversion failure until it is repaired. As no release of impacted water from the Project area is expected the consequence of this failure is expected to be low.

The risk assessment for clean water diversion failure identified a likelihood of very unlikely and a consequence of low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.5.3 Sediment and Erosion Control Measures Failure

A conceptual Sediment and Erosion Control Plan is provided in Section 18.6. The primary approaches to mitigate the introduction of sediment into downstream environments will include:

- Minimizing the generation of sediment at the source;
- Minimizing the volume of contact runoff capable of transporting the constituents of potential concern; and
- Collecting and treating the contact runoff as required, thus meeting downstream water quality requirements.

All water collection and conveyance systems (e.g., ditches, sumps, pumps, pipes, and flumes) will be designed by hydrotechnical engineers on the BMC design team. These systems will be designed to convey the necessary water flow and resist erosion under design inflow conditions.

Sediment ponds will also be designed by hydrotechnical engineers and these sediment ponds will be:

- Designed to trap sediment particles of 10 microns in size or larger with flow volumes equivalent to a 1 in 200-year, 24-hour rainstorm;
- Maintained by periodically removing accumulated sediment to ensure they have adequate capacity to function properly during a 1 in 200-year, 24-hour rainstorm; and
- Tested for suspended sediment concentrations in the effluent and managed further if required.

Water diversion berms or ditches will be constructed upslope of disturbed working areas, as appropriate, to reduce contact runoff water, as well as to reduce erosion and sediment transport.

Any potential need for changes to the sediment and erosion control for the Project will be monitored through the Adaptive Management Plan developed during the permitting process. The above design features, and mitigation and monitoring in place for the Project, will ensure that the failure of any sediment and erosion control mitigation is caught early; however, conservatively the likelihood of sediment and erosion control failure is considered to be likely.

In the event of potential failure of these measures, higher loads of sediment would be introduced to the system; however, with the water management infrastructure in place, it is not expected that additional sediment loads would be released to the environment. The consequence is considered to be very low.

The risk assessment for sediment and erosion control failure identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk rating.

17.2.5.4 Storage Facility Seepage Collection Systems Failure

A one metre layer of glacial till will be placed and compacted in smaller lifts, to provide a low permeability seepage barrier beneath the Class A and Class B Storage Facilities. No liner is required for the Class C Storage Facility and Overburden Stockpile as the seepage water quality is predicted to meet the water quality objectives.

The Class A and Class B Storage Facility Collection Ponds will be constructed with geosynthetic liners. The ponds have been sized to manage a 1 in 200-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. Water collected from the Class A Storage Facility Collection Pond will be directed to the Water Treatment Plant which will be located at the Process Plant Facility. The treated water will be directed to the Lower Operations Water Management Pond. The Class B pond water will be pumped to the Water Treatment Plant, for treatment prior to being directed to the Lower Water Management Pond.

The Overburden Stockpile and Class C Storage Facility Collection Ponds will be constructed with a compacted glacial till (low permeability) liner. The ponds have been designed to provide a 30-day storage period from seepage and surface runoff for the 1 in 10-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. Flow from the ponds will be conveyed downstream of the Lower Operations Water Management Pond and discharged into Geona Creek, as it is predicted to meet the water quality objectives for Geona Creek and not require treatment.

Groundwater will be monitored in wells situated downstream of the Class A, Class B, and Class C Collection Pond and the Water Management Ponds (Sections 18.4.3.7). On-going water quality monitoring will assess the effectiveness of the water collection systems. In the event that the water collection systems are found to not effectively recover seepage, it will be necessary to install additional seepage control provisions.

Due to the combination of ground water monitoring, liner construction, and design parameters for the Class A and B collection ponds, the seepage collection system failure is assessed as unlikely. Given the shorter return period design for the Class C Storage Facility and Overburden Stockpile collection ponds, as well as no liner under the stockpiles, the likelihood of failure for Class C Storage Facility and Overburden Stockpile is assessed to be likely.

Class A and Class B Storage Facility seepage is considered to require treatment; as a result, in the event of the collection system failure, effects to the groundwater and subsequently to surface water in Geona Creek may occur. As identified in Section 9.4.1.5, except for groundwater from the northernmost part of the Class A Storage Facility which may discharge to Geona Creek downstream of the Lower Water Management Pond, all potentially affected groundwater by leakage from the Class A and Class B Storage Facilities will be collected in the Water Management Ponds where it can be treated as necessary prior to discharge to the receiving environment. Progressive reclamation and placement of cover on the Storage Facilities will further limit infiltration and potential seepage. Given the small amount of water that has potential to enter receiving environment, the concentrations in Geona Creek are not expected to be affected. Any water from Class B Storage Facility will be captured in Upper Water Management Pond and can be treated from there. In the event of the complete failure of the water collection system, and some of the Class A Storage Facility water entering receiving environment, the consequences are considered to be medium.

As Class C and Overburden seepage is predicted to meet water quality objectives, even if the water collection system fails the consequences are expected be very low.

The risk assessment for water collection system failure for Class A Storage Facility identified a likelihood of unlikely and a consequence of medium, resulting in a risk rating of moderate (per Table 17-2). Therefore, this potential effect is considered not significant.

The risk assessment for seepage collection system failure for Class B and Class C Storage Facilities, and Overburden stockpile identified a likelihood of unlikely (Class B, Class C and Overburden), and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk ratings.

17.2.5.5 Water Treatment Plant Failure

A Water Treatment Plant, located at the Process Plant Facility, will be in place primarily to treat the runoff from the Class A Storage Facility. It will be sized to also treat water from the Class B Collection Pond, Run of Mine (ROM) Pad, and the Process Plant Facility area, as required to maintain dischargeable water quality in the Lower Operations Water Management Pond. The treatment will consist of pH adjustment, clarification, and any other processes that may be required to bring the water to a suitable standard for discharge to the environment. The treated effluent will either be discharged to the Lower Operations Water Management Pond or used in the Process Plant.

Conventional water treatment technologies will be used and water treatment plan effluent will be monitored prior to discharge.

In the event of the Water Treatment Plant failure, the storage capacity of the Class A Storage Facility Collection Pond and other collections ponds (if needed) can provide sufficient time to repair any failure.

Failure of the water treatment system is considered to be unlikely.

It is not expected that failure of the Water Treatment Plant would result in a release of water to the receiving environment that does not meet the water quality objectives. As such, the consequence is assessed to be very low. The event that results in release of untreated water to the receiving environment would also need to include other site water management system failure to release the water without capture in one of Operations Water Management Ponds. Such event is considered to be very unlikely though would result in high consequence. As noted in Section 17.1, the assessment generally assumes that only one failure mode may exist at a time.

The risk assessment for failure of the Water Treatment Plant identified a likelihood of unlikely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk ratings.

17.2.6 Power Generation Facility Failure (Power Outage)

The Project power supply will be a site based bi-fuel (natural gas and/or diesel) fuelled power plant, located adjacent to the processing plant facilities. The power plant will consist of six 4.2 megawatt (MW) continuous rated generators in an N+2 configuration. The engines will run a variable ratio of natural gas (NG) to diesel from 100% diesel to 99% NG giving great flexibility in fuel usage depending on fuel prices, or in instances of road closure or supply difficulties. The generators will be rated 3 phase, 60 Hz, 4,160 volts.

Power required for generator auxiliaries on black start operation (i.e., process of restoring an electric power station or a part of an electric grid to operation without relying on the external transmission

network) will be from a 150 kW black start generator. The camp will also be equipped with a 1,000 kW emergency generator.

Although the generators will be regularly inspected and maintained, unplanned power outage during the life of the Project is considered to be likely.

Power restoration procedures will be developed as part of Health, Safety and Emergency Response Plan (Section 18.15). As noted above, the camp will be equipped with an emergency generator. Other back-up generators will be in place for critical equipment.

With the back-up and emergency generators in place, no effects on the VCs are expected as a result of the power generation facility failure. The consequence is considered to be very low.

The risk assessment for power generation facility failure identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk ratings.

17.3 ACCIDENTS ASSESSMENT

The accidents identified for risk evaluation for the Project are:

- Explosives accident;
- Spill or leak during transport;
- Spill or leak during storage;
- Transportation accident (on site and off site); and
- Project-related fire.

17.3.1 Explosives Accident

To reduce the risk of explosive accidents the design of all storage facilities will meet government regulations and will be located according to required separation distances as regulated by the Explosives Regulatory Division of Natural Resources Canada (NRCan) under the *Explosives Act*. The minimum separation distance from inhabited buildings has been assessed as 960 m and the selected storage sites exceed this distance. Detonators will be stored in a separate facility. Earthen bunding will be placed around all explosives and detonators facilities in accordance with regulations. Explosives will not be manufactured on site. Bulk ammonium nitrate prill and bulk ammonium nitrate emulsion will be transported to site in 25 t bulk transport trailers and 20 t tanker trailers, respectively. Bulk products will be stored in separate prill and emulsion silos in the bulk explosive compound. The bulk explosive compound will also have a garage for the explosives loading trucks and a small office for explosives personnel.

Given the mitigation measures in place the likelihood of explosives accident during the life of the Project is considered very unlikely.

In an event of an explosives accident, the response procedures will be as per those developed in the Health, Safety and Emergency Response Plan (Section 18.15). The potential effects of an explosives accident include short-term air quality and noise effects, and depending on the scale of the event, may also have effects on vegetation, wildlife and socio-economic resources (infrastructure and services). As effects are likely to be reversible and mostly short term in nature, the consequence is considered to be low.

The risk assessment for an explosives accident identified a likelihood of very unlikely and a consequence of low, resulting in a risk rating of moderate (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the moderate risk ratings.

17.3.2 Spill or Leak During Transport

A number of fuel sources will be required for the Project including LNG, diesel, gasoline, and propane, with natural gas and diesel being the primary fuel sources. LNG will be required to be delivered every two days. Hazardous materials of concern to be used on site include processing reagents, explosives materials, and lubricants.

Fuel release during truck transport would typically be managed by the fuel provider. Depending on the proximity of the fuel release to the Project area, BMC's mine rescue personnel may be able to assist with containment and management of a potential spill.

As outlined in Hazardous Materials Management Plan (Section 18.3), transportation of dangerous goods and materials to the Project will comply with the *Transportation of Dangerous Goods Act and Regulations* (Government of Canada, 1992) which requires transporters to have a certified contractor and a spill response plan for all goods to be transported.

Depending on the potential location of a spill, soil will most likely be affected, with potential effects to vegetation and surface water quality (if spill occurs in proximity to a water body), as well as potential effects on infrastructure and services. During transport potential spills will be limited to the immediate area, as volumes are smaller (Table 17-4). The consequence of a spill is expected to very low (in isolated areas not in proximity to surface water or affecting vegetation) to low (in populated area or in proximity to surface water or affecting vegetation).

The risk assessment for spill or leak during transport identified a likelihood of likely and a consequence of very low to low, resulting in a risk rating of low to moderate (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk ratings.

Table 17-4: Estimated Operations Traffic and Load Volumes

Year 2-Year 9 average	Annual Requirement	Load/ Truck (average)	Trucks/ year
Reagents (t)	15,400	20	770
Operations Fuel (l)	10,201,000	43,900	232
Generator LNG (GJ)	991,200	1,500	661
Explosives (t)	6,400	20	320
Underground Paste Cement (t)	13,300	40	333
Miscellaneous (t)	5,000	20	250
Concentrates			
Cu/Zn -Tridem Trucking	250,000	44	5,682
Pb-Containerized Trucking	36,500	33	1,106

17.3.3 Spill or Leak on Site

Spill response procedures are described further in the Spill Contingency Plan (Section 18.5).

To reduce risk, all fuel storage locations on site will utilise either double walled storage tanks or concrete berms capable of containing 110% of the fuel storage volume (Section 4.11.6). Refuelling facilities on site will provide for refuelling over a concrete apron, with an integrated sump to collect any fuel spillage to prevent release to the environment. Refuelling of excavators and track dozers will take place in the pit or on waste dumps and will not be on a concrete apron. In the event of fuel spilled outside the concrete apron, the spill will be contained with spill absorbent materials stored on site, with any contaminated soil removed for remediation treatment. Aviation fuel will be stored adjacent to the helipad in a single fuel tank within a lined containment berm.

Processing reagents will be stored under cover, then mixed in reagent tanks and transferred to distribution tanks for process use. The reagent storage shed will be a steel framed structure with metal roofing; metal siding will be installed to keep reagents dry and protected from the sun. The floors will be slab-on-grade concrete with concrete containment walls to capture spills.

The separate concentrates of copper, lead, and zinc, will be thickened, filtered, and stockpiled on site. Copper and zinc concetrate will be bulk loaded into trucks and lead concentrate will be loaded into 30 t sealed containers for transport off site for further processing at third party smelters .

Chemical spills within contained facilities will be managed and cleaned up in accordance with the chemical manufacturer's MSDS guidance. If necessary, the chemical manufacturer will be consulted prior to cleanup. Depending on the nature of the spill, operating personnel may complete the cleanup, with BMC's mine rescue personnel available to complete cleanup if required due to hazardous conditions.

LNG and propane storage tanks are the main pressurised vessels to be used on site. All tanks will be located within concrete bunding capable of containing 110% of the storage volume. Should an LNG spill occur, the liquid will absorb heat from the environment and dissipate over time as it returns to

a gaseous state. Natural ventilation is expected to adequately disperse the resulting vapour cloud. Propane will also return to a gaseous state, however as it is denser than air, it may accumulate and require forced ventilation to adequately disperse.

Depending on the potential location of a spill, soil is most likely to be affected during spill or leak with potential effects on surface water and aquatic resources if spill reaches a water body, as well as potentially affecting vegetation in proximity of the spill. The implementation of the Spill Contingency Plan will limit environmental effects and such the consequence of the spill is considered to be very low.

The risk assessment for a spill or leak on site identified a likelihood of likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk ratings.

17.3.4 Transportation Accident (On site and Off site)

17.3.4.1 On site Accidents

Mine site haul roads will be radio controlled and constructed in the mine footprint to connect key parts of the site infrastructure.

To reduce the chance of vehicle collisions in the the pit the minimum mining width is planned to be 50 m, sufficient for truck turning and loading by excavators. Haul roads in the pit have been designed to be 22 m wide at a 1:9 gradient. Surface haul roads have been designed to be nominally flat where possible to maximize hauling productivities. Haul trucks will have right-of-way on all surface and in pit haul roads. All haul roads will be constructed in accordance with safety requirements such as roll over berms, as set out in the Yukon Occupational Health and Safety Regulations.

Any spill as a result of a transportation accident will be dealt in accordance with Spill Contingency Plan (Section 18.5). Assessment of spills is addressed under Section 17.3.3.

Despite the above design parameters, the likelihood of an on site transportation accident is considered to be likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). The consequence is considered to be very low as no VCs would be affected as a result of an accident. Therefore, this potential effect is considered not significant.

As noted in Section 17.1, the effects of accidents and malfunctions on employee health and safety are not addressed as part of the scope of this Chapter, and will be addressed as part of the Project health and safety program (Section 18.15).

No additional mitigation measures are warranted, given the low risk ratings.

17.3.4.2 Access Road Accidents

The Access Road connecting the Project to the Robert Campbell Highway is the main access for materials and equipment to the Project. The road has one bridge crossing and a number of small streams and low, wet swales alongside. The alignment climbs slowly from approximately 1,040 masl to 1,400 masl at the Project area. The L100 Bridge has a Gross Vehicle Weight rating of 91 t, and will be adequate for the construction, operations, and closure phases.

The Access Road will be completely radio controlled (i.e., all vehicles will have radio communication and there will be base stations at the gatehouse and security station at site near the camp). The road will be constructed to have a 5 m wide running surface, single lane, with pullouts at designated distances and where required. The designs were prepared for a maximum speed of 50 km/hr.

Any spill as a result of the transportation accident will be dealt in accordance with Spill Contingency Plan (Section 18.5). Assessment of spills is addressed under Section 17.3.3.

Despite the above design parameters, the likelihood of Access Road transportation accident is considered likely and a consequence of very low, resulting in a risk rating of low (per Table 17-2). The consequence is considered to be very low, as the only VC to potentially be affected is wildlife, if the accident involves collision with wildlife. Mitigation measures to minimize collisions with wildlife are discussed under Wildlife Protection Plan (Section 18.7). Therefore, this potential effect is considered not significant.

As noted in Section 17.1, the effects of accidents and malfunctions on employee health and safety are not addressed as part of the scope of this chapter, and will be addressed as part of the Project health and safety program (Section 18.15).

No additional mitigation measures are warranted, given the low risk ratings.

17.3.4.3 Finlayson Lake Airstrip Accidents

Air transport will be the preferred alternative to transport personnel due to its speed, safety, and relative cost effectiveness. The Finlayson Lake airstrip, located 12 km from the Access Road entrance, is owned and controlled by the Airport Branch of the Yukon Transportation Department. Estimated weekly flights to the Finlayson Lake airstrip is 6.

The Project air transport contractor will be responsible for ensuring compliance with all applicable safety regulations and demonstrate an exemplary safety record. With proper safety measures in place, aircraft accidents at the Finlayson Lake airstrip is considered to be unlikely.

In an event of an accident, the potential environmental effects would be limited to the immediate area of the accident. If the accident results in fire or explosion, soils, vegetation, and surface water may be affected. Given the localized extent and that effects are reversible in short term; the consequence is considered to be low.

The likelihood of a Finlayson Lake airstrip transportation accident is considered to be very unlikely and a consequence of low, resulting in a risk rating of moderate (per Table 17-2). Therefore, this potential effect is considered not significant.

As noted in Section 17.1, the effects of accidents and malfunctions on employee health and safety are not addressed as part of the scope of this chapter, and will be addressed as part of the Project health and safety program (Section 18.15).

No additional mitigation measures are warranted, given the moderate risk ratings.

17.3.4.4 Public Road Transportation Accidents

Transportation of copper and zinc concentrates from the Project to the port of Stewart in BC involves using Convey-Ore Transportation Equipment, while lead concentrates will be transported using containerized bulk carriers to meet the handling requirements of the port. Convey-Ore Transportation Equipment will be Tridem (three axle) tractor matched with bulk carriers on Super B style trailer.

During the spring thaw break up period (approximately a six-week period), haulage restrictions are in place on certain parts of the Robert Campbell Highway, limiting truck payloads to 50% with a resulting temporary increase in concentrate stocks held on site. This allows the winter frost to thaw and the road structure materials to restore to their natural load bearing capacity.

Transportation accidents will typically be managed by the transportation company. Depending on the proximity of the accident to the Project, BMC's mine rescue personnel may be able to assist with management of the accident and to address any cleanup requirements. BMC's procurement process will include an assessment of transportation provider procedures to ensure, as far as practicable, that applicable regulations, guideliens and pracitices in the securing of loads and transportation of goods will be utilised by transportation suppliers.

Any spill as a result of a transportation accident will be dealt in accordance with the Spill Contingency Plan (Section 18.5). Assessment of spills is addressed under Section 17.3.2.

Transportation accident may affect the wildlife VC, if the accident involves collision with wildlife. Mitigation measures to minimize collisions with wildlife are discussed under the Wildlife Protection Plan (Section 18.7). Infrastructure and services may also be affected if the accident results in temporary road closure. The consequence is considered to be very low as any effects are localized and are readily reversible.

Given the expected amount of traffic, the likelihood of a transportation accident is considered to be likely with a consequence of very low resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

As noted in Section 17.1, the effects of accidents and malfunctions on employee health and safety are not addressed as part of the scope of this chapter, and will be addressed as part of the Project health and safety program (Section 18.15).

No additional mitigation measures are warranted, given the low risk ratings.

17.3.5 Project-related Fire

To reduce the danger of infrastructure catching on fire, vegetation will be cleared around facilities such as the camp, processing plant, and explosives storage facility where there is a constant presence of personnel. A firewater distribution system will be installed throughout the processing plant facility with wall hydrants at strategic locations to mitigate fire risk within the facility. Mine water trucks will be utilised to provide water to areas remote from the fire water supply system. BMC mine rescue personnel will be trained in fire fighting techniques.

The likelihood of a fire within contained facilities is rated as unlikely but the consequence is rated as very low due to the fire water supply system installed in and around facilities, resulting in a risk rating of low (per Table 17-2). Therefore, this potential effect is considered not significant.

No additional mitigation measures are warranted, given the low risk ratings.

17.4 UNPLANNED CLOSURE

In Yukon, temporary closure at a mine site is defined as a closure that exceeds six months and is not expected to last longer than five years, and can include both planned and unplanned closure (Yukon Government, 2006). This condition assumes that the owner is still in active control of this site (i.e., not abandoned). The management of the Project in the event of a temporary closure is discussed in the Conceptual Reclamation and Closure Plan (Section 4.13 and Appendix H-1).

BMC's approach to temporary closure is based on maintaining the Project in a state of physical and chemical stability, while also ensuring the Project is secure, safe, and in compliance with all regulatory requirements and authorization obligations. While ensuring these conditions, the Project infrastructure will be maintained in such a manner so as to facilitate the resumption of mining operations in a timely manner. Site security will be maintained in a manner comparable to the operational period with access to the site controlled by consistent presence in the gatehouse.

The potential environmental effects will be managed through the measures described in the Conceptual Reclamation and Closure Plan (Appendix H-1). During temporary closure, the strategy from the Operational Water Management Plan will be maintained. The site will be monitored in compliance with the approved Environmental Monitoring, Surveillance, and Reporting Plan that will be approved during the Quartz Mining Licencing process. An updated plan with a reduced monitoring frequency may be developed and submitted for approval if a temporary closure period is expected to be longer than six months. With these mitigation and management plans in place, the environmental effects consequence as a result of unplanned closure is expected to be very low.

To prepare the site for temporary closure, assets not required during the temporary closure period will be secured and major contractors will be demobilized. Full-time staff will ensure a consistent site presence during temporary closure, and the camp will be prepared for a reduced staff. The staffing numbers on site at a given time are expected to range from six to ten people. The potential socio-economic effects from unplanned closure include reduced economic benefit, loss of wages and

reduced business opportunities. An unplanned closure would contribute to the creation of the boom and bust cycle of local economy. In the event of an unplanned closure, BMC will give as much advance notice as practicable so that employees will know well in advance that the closure will be taking place and can start looking for new employment. As described in Chapter 4, during operations of the Project, BMC will implement a health and well-being program for all mine employees. This program in part will include training programs (e.g., trades, apprenticeships, management) to promote progression in employee careers but also to promote transferable skills to enable employees to be more employable, which will facilitate any transitions from working on the Project to another mine or even a different industry. Also as part of the health and well-being program, all BMC employees will have the opportunity to take financial management training, which will teach employees about the importance of saving as well as debt avoidance. In additional, in the event that an unplanned closure is required, BMC will help all employees prepare resumes, practise interviews and facilitate in the job search, with the intent that employees would transition quickly to new employment. However, even with these programs and measures in place, the socio-economic effects consequence as a result of unplanned closure is expected to be medium as the effects are expected to be felt in the local communities and extend beyond the Project area (as per Table 17-1).

The likelihood of the temporary closure is rated as unlikely (based on the conservative assumptions in the financial assessment of the Prefeasibility Study for the Project).

In summary, the likelihood of temporary closure is considered to be unlikely with a consequence of very low for environment effects and of medium for socio-economic effects, resulting in a risk ratings of low and moderate, respectively for environmental and socio-economic effects. The potential environmental effects are considered not significant given the risk rating of low. The local communities have high resilience to boom and bust economies (Section 15.5.3). The socio-economic effects are not considered significant due to low magnitude of Project's effects on economic growth while in operation (Section 15.10.1.3) and mitigation measures identified above.

In the event that a commercial decision is made by BMC not to reopen the mine, the final Reclamation and Closure Plan will be executed to permanently close the site (with all the necessary regulatory approvals in place). The environmental effects consequence as a result of early permanent closure is expected to be very low. Early permanent closure will reduce the beneficial socio-economic effects (described in Chapter 15) as a result of the Project, as a result of shorter Project life, resulting in consequence of medium. Similarly, as noted above for temporary closure, the potential risk ratings of low and moderate are identified, respectively for environmental and socio-economic effects. Therefore, the potential environmental effects are considered not significant. The socio-economic effects are not considered significant due to low magnitude of Project's effects on economic growth while in operation (Section 15.10.1.3) and mitigation measures identified above to minimize effects from closure.

17.5 SUMMARY

The summary of the scenarios assessed, their likelihood and consequence and resulting risk rating is provided in Table 17-5.

Table 17-5: Accidents, Malfunctions and Unplanned Closure Assessment Summary

Assessment Scenarios	Likelihood	Consequence	Risk Rating
MALFUNCTIONS			
Open pit mining			
Slope failure	Likely	Very low	Low
Dewatering system failure	Likely	Very low	Low
Reclamation measures failure	Unlikely	Very low	Low
Underground mining			
Underground stope failure	Likely	Very low	Low
Underground dewatering system failure	Likely	Very low	Low
Storage facilities (Class A, B, C), and Overburden and Topsoil Stockpiles			
Slope failure: Storage Facilities	Unlikely	Very low to low	Moderate
Slope failure: Overburden and Topsoil	Unlikely	Very low	Low
Erosion control failure	Unlikely	Very low	Low
Reclamation measures failure	Likely	Very low	Low
Process Plant Facility			
Mechanical equipment failure	Unlikely	Very low	Low
Pipes and pumps failure	Likely	Very Low	Low
Water Management			
Embankment or spillway failure of Operations Water Management Ponds	Very unlikely	Medium	Low
Clean water diversion failure	Unlikely	Low	Low
Sediment and erosion control measures failure	Likely	Very Low	Low
Storage facility seepage collection systems failure: *Class A*	Unlikely	Medium	Moderate
Storage facility seepage collection systems failure: *Class B, C and Overburden*	Unlikely	Very Low	Low
Water treatment plant failure	Unlikely	Very low	Low
Power generation facility failure (Power outage)	Likely	Very low	Low
ACCIDENTS			
Explosives accident	Unlikely	Low	Moderate
Spill or leak during transport	Likely	Very low to low	Low to moderate
Spill or leak on site	Likely	Very low	Low
Transportation accident: on site	Likely	Very Low	Low
Transportation accident: Access road	Likely	Very low	Low
Transportation accident: Finlayson Airstrip	Unlikely	Low	Moderate
Transportation accident: Public Road Transportation	Likely	Very low	Low
Project-related fire	Unlikely	Very low	Low
UNPLANNED CLOSURE			
Temporary closure/ Early permanent closure	Unlikely	Environmental: Very low	Environmental: Low
		Socio-economic: Medium	Socio-economic: Moderate

Based on the likelihood and consequence ratings, none of the accidents, malfunctions, or unplanned closure scenarios were assessed to have high or unacceptable risk rating. Therefore, accidents, malfunctions, and unplanned closure are not considered to have a significant effect on any of the VCs.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

18 CONCEPTUAL MANAGEMENT PLANS 18-1

18.1 MANAGEMENT AND MONITORING FRAMEWORK 18-1

18.2 WASTE MANAGEMENT PLAN 18-3

18.2.1 Waste Management Regulatory and Management Context 18-3
18.2.2 BMC Waste Management Strategy 18-3
18.2.3 Waste Storage Locations and Disposal Methods 18-4
18.2.4 Waste Management Mitigation Measures 18-5

18.3 HAZARDOUS MATERIALS MANAGEMENT PLAN 18-6

18.3.1 Hazardous Materials Regulatory and Management Context 18-6
18.3.2 BMC Hazardous Waste Management Strategy 18-7
18.3.3 Hazardous Waste Management Mitigation Measures 18-7

18.4 SURFACE WATER MANAGEMENT PLAN 18-11

18.4.1 Surface Water Regulatory and Management Context 18-12
18.4.2 BMC Surface Water Management Strategy 18-15
18.4.3 Surface Water Management Mitigation Measures 18-20

18.5 SPILL CONTINGENCY PLAN 18-24

18.5.1 Spill Contingency Regulatory and Management Context 18-25
18.5.2 BMC Spill Management Strategies 18-26
18.5.3 Spill Prevention and Response Mitigation Measures 18-30

18.6 SEDIMENT AND EROSION CONTROL PLAN 18-33

18.6.1 Sediment and Erosion Control Regulatory and Management Context 18-34
18.6.2 BMC Management Strategies for Sediment and Erosion Control 18-35
18.6.3 Sediment and Erosion Control Mitigation Measures 18-37

18.7 WILDLIFE PROTECTION PLAN 18-39

18.7.1 Wildlife Protection Regulatory and Management Context 18-39
18.7.2 BMC Wildlife Management Policies and Strategies 18-40
18.7.3 Wildlife Protection Mitigation Measures 18-40

18.8 VEGETATION MANAGEMENT PLAN 18-49

18.8.1 Invasive Plant Management Plan 18-49
18.8.2 Rare Plant Chance Find Procedure 18-54

18.9 FISH AND AQUATIC HABITAT MANAGEMENT PLAN 18-55

18.9.1 Fish and Aquatic Habitat Regulatory Context 18-55
18.9.2 BMC Management Strategies for Fish and Aquatic Habitat 18-56
18.9.3 Fish and Aquatic Habitat Mitigation Measures 18-57

18.10 NOISE MANAGEMENT PLAN 18-60

18.10.1 Noise Regulatory and Management Context 18-60
18.10.2 BMC Management Strategies for Noise Reduction 18-60

18.10.3 Noise Reduction Mitigation Measures 18-61
18.11 AIR QUALITY MANAGEMENT PLAN 18-61
18.11.1 Air Quality Regulatory and Management Context 18-61
18.11.2 Dust Abatement and Air Quality Mitigation Measures 18-62
18.11.3 Operating Practices 18-63
18.12 TRAFFIC AND ACCESS MANAGEMENT PLAN 18-65
18.12.1 Traffic Management Regulatory and Management Context 18-66
18.12.2 BMC Traffic Management Policies 18-66
18.12.3 Traffic Management Mitigation Measures 18-67
18.12.4 Access Management 18-69
18.13 HERITAGE RESOURCES MANAGEMENT PLAN 18-75
18.13.1 Heritage Resources Regulatory and Management Context 18-75
18.13.2 BMC Heritage Resources Management 18-76
18.13.3 Heritage Resources Mitigation Measures 18-76
18.14 SOCIO-ECONOMIC EFFECTS MANAGEMENT PLAN 18-78
18.14.1 Employment Plan 18-78
18.14.2 Local Procurement Plan 18-79
18.14.3 Social and Cultural Well-being 18-80
18.14.4 Traditional Economic Activities 18-81
18.15 HEALTH, SAFETY AND EMERGENCY RESPONSE PLAN 18-82
18.15.1 Health, Safety and Emergency Response Management and Regulatory Context 18-82
18.15.2 BMC Health and Safety Management System 18-83
18.15.3 Emergency Response Mitigation Measures 18-85

LIST OF TABLES

Table 18-1: Environmental Management Plan Framework 18-2
Table 18-2: Waste Storage Location and Disposal Method 18-4
Table 18-3: Summary of Reagents 18-9
Table 18-4: Estimated Annual Precipitation and Evaporation Distribution for Kudz Ze Kayah 18-13
Table 18-5: Annual Operations Water Volumes (year 10) 18-18
Table 18-6: Pond Design Specifications 18-23
Table 18-7: Reportable Spill Thresholds 18-27
Table 18-8: Sensitive Seasonal Periods for Focal Wildlife and Mitigations 18-43
Table 18-9: Decision Matrix for Managing Problem Wildlife 18-48
Table 18-10: Yukon Invasive Plant Species 18-50

LIST OF FIGURES

Figure 18-1: Water Management Catchments 18-14

Figure 18-2: Operations Water Management Schematic 18-17
Figure 18-3: Example of General Spill Response Procedure 18-29
Figure 18-4: Example of Emergency Spill Response Procedure 18-30
Figure 18-5: Location of Observed Invasive Plant Species in KZK LSA 18-52
Figure 18-6: Access Road Potential Wildlife Crossings 18-70
Figure 18-7: Wildlife and Road Operation Decision Matrix 18-71
Figure 18-8: Key Wildlife Areas 18-74
Figure 18-9: Key Areas of the BMC Health and Safety System 18-83
Figure 18-10: Medical Evacuation Flowchart 18-88

18 CONCEPTUAL MANAGEMENT PLANS

The conceptual management plans for the Project are outlined in this chapter.

Management plans are the main mechanism for implementing environmental and socio-economic mitigation and management measures and ensuring construction, operations and closure are carried out in a manner that minimizes potential adverse effects.

Monitoring programs are designed and intended to:

- Determine the effectiveness of mitigation measures and the need for modification to those measures to ensure effect predictions remain valid;
- Test the accuracy of predicted effects and the value of recommended mitigation measures;
- Identify unexpected environmental problems; and
- Implement additional mitigation measures as per adaptive management plans.

Yukon Environmental and Socio-economic Assessment Board (YESAB) requires submission of conceptual management plans with the Project Proposal. The key conceptual management plans for quartz mining projects required for assessment and licensing processes are provided in this Chapter. These conceptual plans are intended to provide the initial planning framework and support YESAB assessment of the Project. Through the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA)* process, YESAB, the regulators, First Nations, and non-regulatory government agencies who will review the Project Proposal will be engaged for their feedback on the conceptual plans and expectations with respect to the final management and monitoring plans (which will be finalized during permitting and licensing). To support licensing, management plans will be further developed based on the *YESAA* process and its outcomes. Revised versions will be submitted during licensing to the Yukon Water Board (YWB), Energy Mines and Resources (EMR) and other regulatory agencies. The conceptual plans provided in this chapter have been developed following the YWB and Yukon Government's (YG) Plan Requirement Guidance for Quartz Mining Projects (Yukon Government, 2013) to ensure they will eventually meet Water Licensing and Quartz Mine Licensing standards.

18.1 MANAGEMENT AND MONITORING FRAMEWORK

The conceptual management plans for the Project are grouped under Environmental Protection Plans, Operational Plans and Socio-economic Management Plans (Table 18-1). The table also indicates where further information on each of the respective plans may be obtained and are listed below.

Table 18-1: Environmental Management Plan Framework

Plan Name	Plan Detail
Environmental Protection Plans	
Waste Management Plan	Conceptual plan information identified in Section 18.2
Hazardous Materials Management Plan	Conceptual plan information identified in Section 18.3
Surface Water Management Plan	Conceptual plan information identified in Section 18.4
Spill Contingency Plan	Conceptual plan information identified in Section 18.5
Sediment and Erosion Plan	Conceptual plan information identified in Section 18.6
Wildlife Protection Plan	Conceptual plan summarized in Section 18.7
Vegetation Management Plan	Conceptual plan summarized in Section 18.8
Fisheries and Aquatic Habitat Management Plan	Conceptual plan summarized in Section 18.9 including summary of Fisheries Offsetting Plan included as Appendix E-4
Adaptive Management Plan	Conceptual details for monitoring and management are described in each VC chapter (Chapters 6 through 15)
Environmental Monitoring, Surveillance and Reporting Plan	
Operational Management Plans	
Conceptual Construction Plan	Conceptual plan information provided in Appendix C-1
Mine Development and Operations Plan	Conceptual plan information provided in Section 4.6 and 4.7
Process Plant Facility Development and Operations Plan	Conceptual plan information provided in Section 4.8
Tailings Management Plan	Conceptual plan information provided in Section 4.9
Waste Rock and Overburden Management Plan	Conceptual plan information provided in Section 4.9
Road Construction Plan	Conceptual plan information provided in Section 4.12 and Appendix C-8
Conceptual Reclamation and Closure Plan	Conceptual plan information provided in Appendix H-1
Socio-economic Management Plans	
Consultation and Engagement Plan	Plan information is provided in Chapter 2 and Appendix B-2
Noise Management Plan	Conceptual plan information identified in Section 18.10
Air Quality Management Plan	Conceptual plan information identified in Section 18.11
Traffic and Access Management Plan	Conceptual plan information identified in Section 18.12
Heritage Resources Management Plan	Conceptual plan summarized in Section 18.13
Socio-economic Effects Management Plan	Conceptual plan summarized in Section 18.14
Health, Safety and Emergency Response Plan	Conceptual plan information identified in Section 18.15

18.2 WASTE MANAGEMENT PLAN

The objective of the conceptual Waste Management Plan (WMP) is to ensure that the handling, storage, transportation, and disposal of all wastes (i.e., solids, liquids, and Special Wastes) generated by the Project are conducted in such a manner as to reduce potential adverse environmental effects associated with waste materials, thereby ensuring that disposal is a last resort when no practicable alternatives exist. To achieve this objective, BMC Minerals (No. 1) Ltd. (BMC) will:

- Provide proper training for staff and contractors on policies and operations;
- Comply with all applicable territorial and federal waste management regulations;
- Minimize waste generation;
- Where practicable, reuse and recycle materials; and
- Transfer wastes in a safe and responsible manner.

18.2.1 Waste Management Regulatory and Management Context

The handling, storage, transportation, disposal, and treatment of hazardous and non-hazardous waste, excluding sewage, are regulated under the *Environment Act* (Yukon Government, 2016a) and its associated regulations. The *Environment Act* also governs the incineration or burial of waste materials, and the identification and management of contaminated waste. The management of sewage and sewage disposal and treatment systems are regulated under the *Public Health and Safety Act* (Yukon Government, 2013c).

Hazardous Waste is miscellaneous products, substances or organisms considered to be dangerous to life, health, property, or the natural environment and its management is covered in Section 18.3.

18.2.1.1 Applicable Guidance Documents

Applicable guidance documents used to develop the conceptual WMP include (but are not limited to) the following:

- A Best Practices Guide to Solid Waste Reduction (Canadian Construction Association, 2001); and
- Guidelines for Preparing Solid Waste Management Plans (Yukon Government, 2011).

18.2.2 BMC Waste Management Strategy

The final WMP will be required to address all applicable commitments made during the *YESAA* process, the decision document terms and conditions, and subsequent licence conditions applicable to this plan. As the Project proceeds and permits are obtained or amended that regulate the management and disposal of waste, this plan will be revised accordingly with approvals appended. A

copy of the plan will be kept at centers of operation at the mine site and in BMC's corporate and relevant regional offices.

18.2.3 Waste Storage Locations and Disposal Methods

The WMP identifies methods for disposal of Project related waste and identifies waste management strategies to manage potential effects on landfills in the region. Wastes considered under the Waste Management Plan include:

- Solid waste: includes refuse, ashes, garbage, domestic waste, compost or any other waste prescribed by regulation whether or not the waste has any commercial value or is capable of being used for a useful purpose;
- Special waste: includes waste requiring special handling, storage, or destruction and prescribed as Special Waste by regulation whether or not the waste has any commercial value or is capable of being used for a useful purpose (e.g., used reagent containers, batteries, paint);
- Putrescible waste: contains organic matter that is capable of being decomposed and may be capable of attracting or providing food for wildlife (e.g., kitchen waste);
- Non-Putrescible waste: means any waste that contains no more than trivial amounts of putrescible materials (examples include construction waste, cardboard, demolition debris); and
- Sewage: includes human sewage and grey water.

The plan does not consider the management of mine-related materials such as overburden, rock and tailings associated with the mining activities. The management of these is described in Section 4.9.

Table 18-2 presents the waste storage locations and disposal methods for the various wastes that will be generated by the Project. All of the disposal options will occur on site, unless otherwise stated.

Table 18-2: Waste Storage Location and Disposal Method

Type	On Site Storage Location	Disposal
Solid Waste		
Kitchen Waste	Bear-proof containers	Incinerator
Beverage Containers and other recyclables	Recycling Bins	Off site disposal
Office and Camp Garbage	Garbage Bins/Bear-proof containers	Incinerator
Untreated Wood	Open Burn Area	Open burned
Treated Wood	Waste Management Facility	Incinerator
Heavy Plastics	Waste Management Facility	Incinerator
Light Plastics/Cardboard	Waste Management Facility	Open burned/Incinerator
Steel/Copper/Rubber	Waste Management Facility	Off site Disposal facility
Ash from Incinerator/Open burn area	Ash Bin	Landfill

Type	On Site Storage Location	Disposal
Tires	Waste Management Facility	Off Site Disposal
Special Waste		
Waste Oil: used crankcase oil, used automatic transmission fluid, used hydraulic oil, used fuel oils #2, #4 and #5	Storage Tank by Mine Workshop	Waste Oil Burner
Batteries	Waste Management Facility	Shipped to licensed recycle or disposal facility on regular basis
Antifreeze (and used containers)	Waste Management Facility	Shipped to licensed recycle or disposal facility on regular basis
Solvents (and used containers)	Waste Management Facility	Shipped to licensed recycle or disposal facility on regular basis
Sewage		
Sewage and Grey water	Sewage treatment plant at camp	Treated water diverted to septic field Bio-solids dried and deposited in the landfill
Contaminated Wastes		
Contaminated Soils and Snow	Waste Management Facility	Land Treatment Facility (see sections 18.3.3.1 and 4.11.9 for more information)

18.2.4 Waste Management Mitigation Measures

18.2.4.1 General (Non-Hazardous) Waste

The following presents some of the measures BMC will take to manage general (non-hazardous) wastes:

- BMC will be responsible for the regular collection and disposal of all waste material generated during the course of the Project;
- BMC will take precautions to ensure waste is not inadvertently dumped into watercourses or in environmentally sensitive areas;
- BMC will establish regular clean-up and disposal programs so as to prevent the unnecessary accumulation of wastes. Procedures will be adopted to promptly collect and remove any accumulated debris;
- BMC will ensure these wastes are stored in suitable containers until such time as they are removed from site or incinerated;
- BMC will take the necessary precautions to ensure no loss of waste materials during transport from site; and
- All waste removed from site will be disposed of at an approved disposal facility, in compliance with applicable legislation and regulations.

18.2.4.2 Food Waste

All food waste and domestic garbage from all Project areas will be collected and placed in an appropriate receptacle in a timely manner with specific frequency depending on the material and quantity. Food waste and domestic garbage will be disposed of in an appropriate and safe manner. All food wastes will be stored and disposed of in a manner that does not attract nuisance animals. Food waste will be incinerated daily.

18.3 HAZARDOUS MATERIALS MANAGEMENT PLAN

The primary goal of the conceptual Hazardous Materials Management Plan (HMMP) is to outline proper hazardous materials handling procedures to ensure the safety of employees and the protection of the environment.

18.3.1 Hazardous Materials Regulatory and Management Context

The management of hazardous materials is governed by the *Dangerous Goods Transportation Act* (Yukon Government, 2013a) and the *Occupational Health and Safety Act* (Yukon Government, 2010) as well as the Special Wastes Regulation and Storage Tank Regulations of the *Environment Act* (Yukon Government, 2016a). This section provides a conceptual overview of the plan, with additional detail to be added for the final plan as part of Licensing.

18.3.1.1 Applicable Guidance Documents

Applicable guidance documents used to develop the conceptual HMMP include (but are not limited to) the following:

- *Transportation of Dangerous Goods Act* and Transportation of Dangerous Goods Regulation (Government of Canada, 1992, 2015);
- Environmental Emergency Regulations (Environment Canada, 2011);
- A Field Guide to Fuel Handling, Transportation and Storage (BC MWLAP, 2002);
- Standards and Best Practices for Instream Works (BC MWLAP, 2004);
- Hazardous Waste Legislation Guide (BC MOE, 2016a);
- Hazardous Waste Regulation (Government of BC, 2016);
- National Fire Code of Canada (National Research Council Canada, 2010);
- Ground Water Protection Regulation (Government of BC, 2004);
- Occupational Health and Safety Regulations (Yukon Government, 2003);
- Spills Regulations (Yukon Government, 1996); and
- Hazardous Products Regulations (Government of Canada, 2015).

18.3.2 BMC Hazardous Waste Management Strategy

The HMMP will be required to address all applicable commitments made during the *YESAA* process, the decision document terms and conditions and licence conditions applicable to this plan. As the Project proceeds and permits are obtained or amended that regulate the management and disposal of hazardous waste, the plan will be revised accordingly with approvals appended. A copy of the plan will be kept at centers of operation at the mine site and in BMC's corporate office.

Hazardous wastes include, but are not limited to, asbestos, fuels, used fuels, oils, oil filters, greases, bitumen, lubricants, solvents, cement, paints, batteries, cleaners, dust suppressants, PCBs, and used spill cleanup materials. Hazardous waste that is spilled could affect surface water quality, air quality, vegetation, fish habitat, or wildlife habitat. BMC's general management policies related to hazardous waste include the following requirements:

- Store, handle, and transport hazardous materials to avoid loss and to allow containment and recovery in the event of a spill in accordance with all applicable legislation, including, but not limited to the National Fire Code of Canada and the *Transportation of Dangerous Goods Act*;
- Designate on areas for the transfer and limited temporary storage of hazardous materials and wastes. The area(s) shall be located at least 15 m from the ordinary high water mark of any non-fish bearing water body and 30 m for fish bearing water bodies, clearly labelled and appropriately controlled;
- Adequately train site personnel in the handling and transportation of hazardous materials; and; and
- Dispose of hazardous wastes generated during construction in compliance with the *Environmental Protection Act*.
- Where Project activities involve the handling, storage, and removal of hazardous wastes, BMC will maintain the following records:
    - Inventories of types and volumes of wastes generated, stored, or removed;
    - Manifests identifying licensed waste haulers and disposal destinations; and
    - Disposal certification documents.

18.3.3 Hazardous Waste Management Mitigation Measures

18.3.3.1 Waste Management Storage Facility

The Waste Management Facility will contain all waste, recyclables, and contaminated materials, excluding waste oil (to be stored in a tank by the Mine Workshop). This facility will also include an incinerator, a small land treatment facility, and a small landfill area. The Waste Management Facility will be enclosed by an animal proof fence.

18.3.3.2 Hazardous Materials Inventory

As with any industrial undertaking, a number of hazardous materials will be used for various purposes and at various locations throughout the life of the Project. Primarily, these materials include fuels and lubricants used for the operation of equipment, chemicals for water treatment, process reagents, explosives, and laboratory chemicals. The final plan will outline typical dangerous goods and hazardous materials that may be present at the mine site and their storage locations.

Full inventory of dangerous goods and hazardous materials will be maintained at the mine site and will list all chemicals on site, including Material Safety Data Sheets (MSDS) and WHMIS information on the products to ensure that Project personnel have all the necessary information for their safe transportation, use, and disposal. The full inventory will be provided as an appendix to the plan and maintained and updated by site's safety manager or Environmental Manager. Before any chemical is brought to the site, the supplier or contractor will supply an MSDS for the product, and the chemical will be added to the inventory and master table. MSDS sheets for the Project will be kept with the plan.

18.3.3.3 Reagents

All process reagents will be stored in the reagent area with the exception of quick lime which will be stored in a silo adjacent to the Process Plant. The reagent storage tanks will be equipped with volume level indicators and instrumentation to ensure that spills do not occur during operation. The reagent mixing and distribution area has been designed as a wet area, with sloped concrete floors draining to sumps for containment. In addition, appropriate ventilation and fire and safety protection will be provided. Table 18-3 shows the reagents specified for use in the Project. Additional descriptions of storage areas and instrumentation is presented in Chapter 4 (Section 4.8.5).

Table 18-3: Summary of Reagents

Reagent	Shipping Form	Use	Storage Location
Lime	Received as dry powder in 40 tonne bulk delivery.	pH modifier	Silo adjacent to Process Plant Facility
Flocculant	Received as dry powder in 0.75 tonne bags; 26 bags to a container.	Flocculation of flotation tailings and flotation copper, lead and zinc concentrates in thickeners	Reagents storage area
Copper Sulphate	Received in pellet form in 1.2 tonne bulk bags; 16 bags to a container.	Zinc circuit activator	Reagents storage area
A208	Received in liquid form in 1,000 litre bulk box, 26 boxes to a delivery.	Zinc circuit collector	Reagents storage area
Methyl Isobutyl Carbin	Received as liquid in 1,000 litre bulk box, 26 boxes to a delivery.	Promotion and stabilization of froth bubbles in flotation cells	Reagents storage area
Sodium Metabisulphite	Received in pellet form in 1 tonne bulk bags, 20 bags to a container.	Copper circuit depressant	Reagents storage area
A3894	Received in liquid form in 1,000 litre bulk box, 26 boxes to a delivery.	Copper circuit collector	Reagents storage area
3418A	Received as liquid 1,000 litre bulk box, 26 boxes to a delivery.	Lead circuit collector	Reagents storage area
Sodium Cyanide	Received in pellet form in a 1 tonne bulk bag, 20 bags to a container.	Lead circuit depressant	Reagents storage area (sodium cyanide storage only)
Zinc Sulphate	Received in pellet form in 1.2 tonne bulk bags; 16 bags to a container.	Lead circuit depressant	Reagents storage area

18.3.3.4 Cement

Cement will be transported to site as dry powder as 40 tonne bulk deliveries. It will be used for mine backfill. The cement will be stored in a silo adjacent to paste backfill plant.

18.3.3.5 Transportation of Dangerous Goods and Materials

Transportation of dangerous goods and materials to the Project will comply with the *Transportation of Dangerous Goods Act* and Transportation of Dangerous Goods Regulations. Transportation of dangerous goods is regulated under the *Dangerous Goods Transportation Act*, which requires transporters to have a certified contractor and a spill response plan for all goods to be transported. The transporter will be required to ensure:

- MSDSs accompany all goods and materials;
- Non-compatible materials will be transported in separate shipments;
- Fire extinguisher and fire prevention materials will be adequate and appropriate for the material being transported;
- Containers will be appropriate for the material being shipped;
- Containers will be properly secured;

- Containers and trucks will be properly marked, labelled, and placarded;
- Manifests will be maintained in accordance with federal, territorial (Yukon), and provincial (BC) regulations;
- Spill response materials will be adequate and appropriate for the materials being transported; and
- Drivers will be adequately trained and equipped for spill first response, containment, and communication.

18.3.3.6 Storage of Hazardous Materials

Hazardous materials will be stored in appropriate containers in suitably contained areas and will comply with WHMIS. A figure outlining all hazardous material storage locations at the site will be provided in the final plan as part of Licensing.

General handling and storage measures that will be implemented to avoid, control, and mitigate risk include:

- Manufacturers will provide safe packaging and labelling for packaged materials, as a condition of purchase agreements;
- Storage areas will be appropriately climate-controlled, dry, and well-ventilated;
- Containers holding the materials will remain sealed to prevent accidental leakage and/or spillage;
- Incompatible chemicals will be stored separately to prevent deleterious chemical reactions and cross contamination;
- Chemical storage areas will be designated as non-smoking areas and located away from food storage areas;
- All personnel handling dangerous goods will be trained and provided with appropriate personal protective equipment (PPE); and
- All bulk chemical storage sites will be outfitted with concrete or lined floors and walls capable of containing 110% of the volume of the largest vessel in the area or as stipulated by appropriate legislation or permits.

Further details on BMC's spill response protocols are provided in the Spill Contingency Plan (Section 18.5). Further detail on storage of specific types of materials will be provided in the final plan during licensing.

18.3.3.7 Employee Training and Safety

All employees (and contractors) involved with handling hazardous materials will receive training on safe and appropriate use as per WHMIS from the Regulations of the *Occupational Health and Safety*

Act (OH&S) (Yukon Government, 2003). All employees will follow OH&S Regulations and use appropriate PPE as well as proper handling procedures when using hazardous materials. All new employees will receive an induction and appropriate training before being required to work with hazardous materials.

All employees are required to wear the appropriate company supplied PPE prior to being permitted to handle hazardous materials. Employees will be trained in proper use of PPE, as required. In the event of accidental exposure to the hazardous substance, first aid will be administered as directed in the MSDS and dependent on the severity of the exposure. Emergency response procedures are detailed further in the Health, Safety and Emergency Response Plan (Section 18.15).

Regular safety meetings with supervisors, safety officers, and employees and contractors will be mandated. Any changes in procedures, equipment, or hazards require will require immediate notification to employees and any other personnel operating in a specific area.

18.3.3.8 Routine Monitoring of Site Hazardous Material Storage

Monitoring and inspections of hazardous materials and hazardous materials storage facilities will be, at a minimum, conducted weekly by trained personnel reporting to either the nominated Department Manager, Safety or Environmental Manager as determined appropriate by the Senior Site Executive. During each inspection, a Hazardous Materials Inspection Form (to be developed) will be completed which will note the general observations, deficiencies, (i.e., improper storage of hazardous materials, spills of materials, potential hazards in storage areas) and required follow up. Following inspection, the form will be reviewed and signed off by the relevant Department Manager and the Environmental Manager with any defects noted and included into the Site Defects Corrective Action Report ("DCAR") for rectification. Outstanding DCAR's will be included in a monthly site wide Outstanding Actions report. Minimising outstanding corrective actions will form a critical part of the Key Performance Indicators for all Senior Managers on the Project. Further information on the requirements for the inspections will be provided in the final plan.

18.4 SURFACE WATER MANAGEMENT PLAN

The Project Surface Water Management Plan (SWMP) describes strategies and provides guidance for the control of water from the Project area during mine construction, operations, closure and reclamation and post closure. The objective of the SWMP is to manage site water collection, conveyance, storage, treatment, and release, in support of Process Plant water requirements while mitigating environmental effects to downstream receiving waters.

Runoff will be controlled to minimize erosion in areas disturbed by construction activities and to prevent the release of sediment laden water to the receiving environment (Erosion and Sediment Control Plan, Section 18.6). This includes the collection and diversion of surface water runoff, and sediment and groundwater seepage control ponds and pumping systems. This section outlines the water management strategies and infrastructure for the construction, operation and closure periods.

18.4.1 Surface Water Regulatory and Management Context

Key legislation for protection of water quality for the Project includes the federal *Fisheries Act*, which protects fish (Government of Canada, 1985), and Metal Mining Effluent Regulations (MMER) (Government of Canada, 2002a), which protects water quality.

Fisheries Act

Key sections in the *Fisheries Act* that must be followed include:

- Section 35(1) "no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery"; and
- Section 36(3) "... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish...".

***Metal Mining Effluent Regulations* (MMER)**

Key Sections in MMER Regulations that must be adhered to include:

- Prohibition on Diluting Effluent:
  - Section 6 "The owner or operator of a mine shall not combine effluent with water or any other effluent for the purpose of diluting effluent before it is deposited".
- Environmental Effects Monitoring:
  - Section 7(1) "The owner or operator of a mine shall conduct environmental effects monitoring studies of the potential effects of effluent on the fish population, on fish tissue and on the benthic invertebrate community in accordance with the requirements and in the periods set out in Schedule 5".
  - Section 7(2) "The owner or operator shall record the results of the studies and submit the reports and required information to the authorization officer as set out in Schedule 5".
  - Section 7(3) "The studies shall be performed using documented and validated methods, and their results interpreted and reported on in accordance with generally accepted standards of good scientific practice at the time that the studies are performed".

18.4.1.1 Catchments

The Project is situated in the Geona Creek catchment which is part of the Finlayson Creek watershed. The Geona Creek catchment has been subdivided into 11 sub-catchments (shown on Figure 18-1) which include the ABM open pit, Class A Storage Facility, Class B Storage Facility, Class C Storage Facility, Overburden Stockpile, Process Plant Facility, South Diversion, Northwest diversion, Northeast Diversion, Upper Water Management Pond, and Lower Water Management Pond sub-catchments. A watershed divide along the South Diversion sub-catchment separates the South

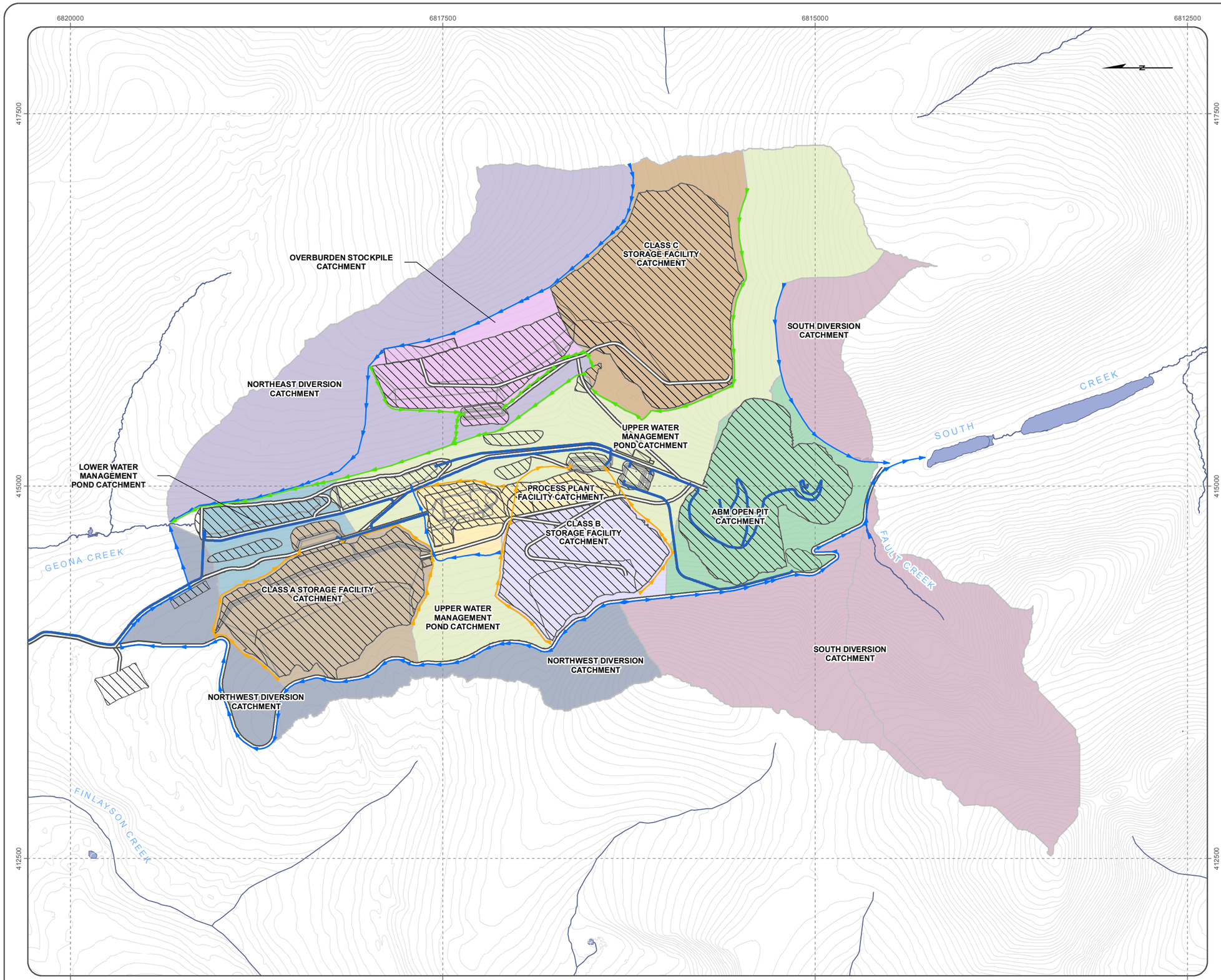
Creek catchment from the Geona Creek catchment. The South Creek catchment will receive water from the South Diversion catchment once diversions and ditches are in place.

18.4.1.2 Precipitation and Evaporation

Table 18-4 presents the monthly precipitation estimates based on the mean regional distribution and the estimated snow vs. rainfall distribution for the Project (Appendix D-2). In 2016, pan evaporation measurements were taken daily between May 21 to September 5, as conditions allowed. Monthly total pan evaporation for 2016 (after adjustments for rainfall) are shown in Table 18-4. The Campbell Scientific datalogger program at site incorporates the calculation of potential evapotranspiration using the American Society of Civil Engineers standardized reference evapotranspiration equation (Penman-Monteith) for a flat grassland. The calculated total potential evapotranspiration (PET) values for the KZK meteorological station have been provided in Table 18-4 (Appendix D-2).

Table 18-4: Estimated Annual Precipitation and Evaporation Distribution for Kudz Ze Kayah

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Total (mm)	44.9	33.5	29.7	20.7	39.9	65.5	84	74.2	68.2	52	51.7	47.2	611.5
Rain (%)	0	0	0	0	50	100	100	100	75	20	0	0	
Rain (mm)	0	0	0	0	19.9	65.5	84	74.2	68.2	10.4	0	0	322.3
Snow (%)	100	100	100	100	50	0	0	0	0	80	100	100	
Snow (mm)	44.9	33.5	29.7	20.7	19.9	0	0	0	0	41.6	51.7	47.2	289.2
Total PET (mm)	2.2	7.4	25	51.3	84.5	106.2	76.5	59.5	34	14.1	5	-1	464.7



BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 18-1

WATER MANAGEMENT CATCHMENTS

JANUARY 2017

Water Conveyance

- Pipeline
- Non Contact Diversion
- Contact Class A & B
- Contact Class C Diversion

Water Management Catchments

- Class A Storage Facility
- Class B Storage Facility
- Class C Storage Facility
- ABM Open Pit
- Process Plant Facility
- Lower Water Management Pond
- Upper Water Management Pond
- South Diversion
- Overburden Stockpile
- Northwest Diversion
- Northeast Diversion

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

Canvec compiled by Natural Resources Canada at a scale of 1:10,000 - 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83; Projection UTM Zone 9N

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18.4.2 BMC Surface Water Management Strategy

The Project will have a positive water balance; therefore, active water management including water treatment and discharge to the receiving environment will be required. The Project water management strategy is illustrated in Figure 18-2. The strategy includes diverting as much clean water as practicable to minimize the volume of contact water requiring management in the Project footprint.

The goal of the water management plan is to re-use water in the Project area to the maximum practicable extent. Surplus water will be stored on site in the Upper and Lower Water Management Ponds and used in the Process Plant (as required), with the excess water being released to Geona Creek and the remainder piped directly to Finlayson Creek (to meet the proposed discharge ratios to both water sources as discussed below).

The key components of the water management strategy are summarised below:

- Ditches and diversions will be established during the construction phase and will be maintained through operations. Three main diversions will be constructed, including the south diversion, northwest diversion and northeast diversion (Figure 18-1);
- Runoff from the Class A, Class B, and Class C Storage Facilities will be collected in a pond at the base of each storage facility. The routing of the water from each facility will be based on its quality;
- A water treatment plant will be in place to treat excess water as required to maintain dischargeable water quality in the Lower Water Management Pond;
- The water treatment plant will have the design capacity to treat Class A Storage Facility collection pond water as well as water from other less impacted sources such as the Class B Waste Storage Facility or ABM open pit water;
- The Class C Storage Facility and Overburden Stockpile runoff water will be conveyed from their collection ponds directly to Geona Creek downstream of the Lower Water Management Pond as it is predicted to be of similar or better than the water discharged from the Lower Water Management Pond (Appendix D-8);
- A two-stage water management pond will be constructed in the Geona Creek valley, where the Upper Water Management pond will be used to manage contact water (as required) and the Lower Water Management Pond will be used for settling and polishing prior to discharge to the receiving environment;
- Water will be discharged to both Geona Creek and Finlayson Creek at established water quality discharge standard concentrations and at discharge volume ratios no less than 3:1 (receiving water volume: effluent volume) for Geona Creek at KZ-37 and 2:1 for Finlayson Creek at KZ-15 to meet water quality objectives in the receiving environment. Energy dissipation structures such as rip rap channels will be constructed below the discharge locations to both Geona and Finlayson Creeks; and

- Groundwater and surface water intercepted during the construction and operation of the ABM open pit will be collected and pumped to the pit rim pond. The water will be conveyed to Geona Creek during construction or used for dust suppression. During operations the pit rim pond water may be conveyed to the Process Plant for use or to the Upper Water Management Pond prior to the release to the receiving environment.

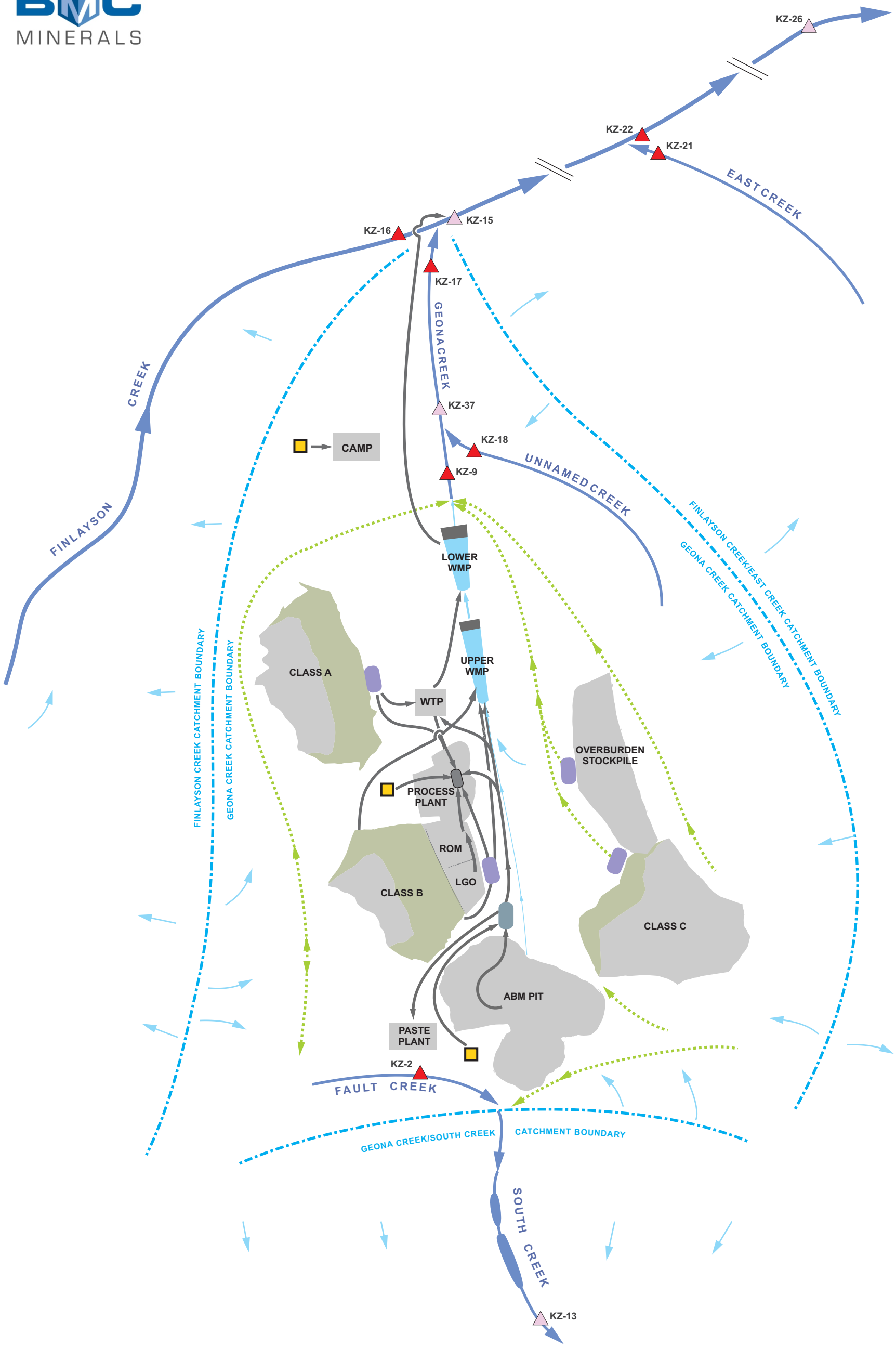
18.4.2.1 Project Water Balance

The Project water balance was prepared by Knight Piesold Ltd. (Appendix C-7) with contributions from the Tetra Tech EBA Inc.'s Hydrogeology Model Report (Appendix D-4) on groundwater rates into the open pit and underground workings, and hydrometeorology information from the Hydrometeorology Baseline Report (Appendix D-2). The water balance model has been prepared to provide information to guide the development of for the WMP. Table 18-5 provides the annual operations water volumes for year 10 for a dry (1:10 dry year), mean, and wet year (1:50 wet year) (Appendix C-7). It should be noted that the water balance results presented in Table 18-5 represent a conservative scenario (i.e., worst case) based on the following assumptions and water volumes to be managed for years 1-9 will be less as the water balance model for year 10 assumes full footprints for the mine features:

- All precipitation falling on the Storage Facilities becomes contact water, which will not be the case due to progressive reclamation planned on the slopes of the Storage Facilities prior to year 10; and
- Underground mining is not planned for year 10 of mining, but for conservatism the groundwater estimated to be encountered in the underground workings has been included, which represents approximately 21-31% of the total surplus.

Water sources for the Project include precipitation runoff from mine storage facilities, groundwater used for camp and ore processing, and water (groundwater and surface water) collected from the ABM open pit and underground workings.

BMC MINERALS



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CONCEPTUAL DRAWING AND FOR ILLUSTRATION PURPOSES ONLY; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

- Progressive Reclamation Footprint
- Mine Feature Footprint
- Process Plant Pond
- Storage Facility Collection Pond
- Pit Rim Pond
- Surface Water Monitoring Station
- Modelled Location
- Groundwater Well
- Water Management Pond
- Pipeline
- Watercourse
- Diversion Ditch
- Catchment
- Surface Flow Direction

WMP - Water Management Pond
WTP - Water Treatment Plant
ROM - Run of Mine
LGO - Low Grade Ore

KUDZ ZE KAYAH PROJECT

FIGURE 18-2
OPERATIONS WATER MANAGEMENT SCHEMATIC

DRAWN BY GIS	JANUARY 2017	VERIFIED BY KW

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Table 18-5: Annual Operations Water Volumes (year 10)

Average Case Precipitation Scenario																			
Month	No Treatment		Treatment Potentially Needed							Total Surplus	Process Water Use		Lower WMP Discharge		Total Surplus	Non-Contact Water Diverted Around Site			
	Upper WMP	Lower WMP	Underground Workings	Open Pit Dewatering			Process Plant Site Runoff	Class A	Class B		WTP	Pit Rim Pond	To Geona Creek	To Finlayson Creek		South	North (Wetland)		
			GW	GW	Surface	Total											Class C	Overburden Stockpile	Remainder
Jan	11,000	16,000	141,000	44,000	12,000	196,000	0	1,000	7,000	231,000	5,000	15,000	24,500	100,000	144,500	25,000	7,000	2,000	14,000
Feb	9,000	12,000	141,000	44,000	9,000	194,000	0	1,000	6,000	222,000	5,000	15,000	17,250	70,000	107,250	20,000	5,000	1,000	11,000
Mar	9,000	12,000	141,000	44,000	10,000	194,000	0	1,000	6,000	222,000	5,000	15,000	13,750	52,000	85,750	20,000	5,000	1,000	11,000
Apr	11,000	34,000	141,000	44,000	31,000	215,000	6,000	9,000	24,000	299,000	5,000	15,000	47,000	255,000	322,000	23,000	20,000	6,000	12,000
May	119,000	270,000	141,000	44,000	231,000	415,000	35,000	168,000	165,000	1,172,000	5,000	15,000	235,000	990,500	1,245,500	247,000	143,000	44,000	134,000
Jun	118,000	278,000	141,000	44,000	243,000	427,000	38,000	183,000	175,000	1,219,000	5,000	15,000	270,000	949,000	1,239,000	248,000	152,000	47,000	135,000
Jul	68,000	146,000	141,000	44,000	129,000	314,000	18,000	78,000	86,000	710,000	5,000	15,000	158,000	730,000	908,000	150,000	80,000	24,000	82,000
Aug	57,000	126,000	141,000	44,000	110,000	294,000	16,000	66,000	73,000	632,000	5,000	15,000	130,000	515,000	665,000	123,000	68,000	21,000	67,000
Sep	64,000	132,000	141,000	44,000	112,000	296,000	14,000	63,000	73,000	642,000	5,000	15,000	133,000	500,000	653,000	135,000	69,000	21,000	74,000
Oct	42,000	64,000	141,000	44,000	51,000	235,000	2,000	5,000	32,000	380,000	5,000	15,000	78,000	310,000	408,000	94,000	30,000	8,000	51,000
Nov	23,000	31,000	141,000	44,000	23,000	207,000	0	1,000	14,000	276,000	5,000	15,000	49,000	205,000	274,000	51,000	13,000	3,000	28,000
Dec	15,000	21,000	141,000	44,000	15,000	200,000	0	1,000	9,000	246,000	5,000	15,000	34,000	145,000	199,000	34,000	9,000	2,000	19,000
Annual (m^3/yr)	546,000	1,142,000	1,692,000	528,000	976,000	3,187,000	129,000	577,000	670,000	6,251,000	60,000	180,000	1,189,500	4,821,500	6,251,000	1,170,000	601,000	180,000	638,000

1:50 Year Wet Precipitation Scenario																			
Month	No Treatment		Treatment Potentially Needed							Total Surplus	Process Water Use		Lower WMP Discharge		Total Surplus	Non-Contact Water Diverted Around Site			
	Upper WMP	Lower WMP	Underground Workings	Open Pit Dewatering			Process Plant Site Runoff	Class A	Class B		WTP	Pit Rim Pond	To Geona Creek	To Finlayson Creek		South	North (Wetland)		
			GW	GW	Surface	Total											Class C	Overburden Stockpile	Remainder
Jan	16,000	22,000	141,000	44,000	17,000	201,000	0	1,000	11,000	251,000	5,000	15,000	28,500	85,000	133,500	35,000	10,000	2,000	19,000
Feb	13,000	17,000	141,000	44,000	13,000	197,000	0	1,000	8,000	236,000	5,000	15,000	21,000	60,000	101,000	28,000	8,000	2,000	15,000
Mar	13,000	17,000	141,000	44,000	14,000	198,000	0	1,000	8,000	237,000	5,000	15,000	17,250	42,000	79,250	28,000	8,000	2,000	15,000
Apr	16,000	48,000	141,000	44,000	44,000	228,000	9,000	20,000	35,000	356,000	5,000	15,000	66,000	320,000	406,000	33,000	28,000	9,000	18,000
May	170,000	384,000	141,000	44,000	327,000	512,000	49,000	249,000	238,000	1,602,000	5,000	15,000	335,000	1,264,000	1,619,000	350,000	204,000	63,000	191,000
Jun	170,000	399,000	141,000	44,000	345,000	530,000	54,000	270,000	253,000	1,676,000	5,000	15,000	405,000	1,196,750	1,621,750	352,000	216,000	67,000	192,000
Jul	98,000	211,000	141,000	44,000	184,000	368,000	25,000	121,000	126,000	949,000	5,000	15,000	356,000	960,000	1,336,000	213,000	113,000	34,000	116,000
Aug	82,000	181,000	141,000	44,000	156,000	340,000	22,000	103,000	107,000	835,000	5,000	15,000	179,000	695,000	894,000	174,000	97,000	29,000	95,000
Sep	91,000	188,000	141,000	44,000	159,000	343,000	20,000	99,000	107,000	848,000	5,000	15,000	215,000	815,000	1,050,000	192,000	98,000	29,000	105,000
Oct	60,000	91,000	141,000	44,000	72,000	256,000	3,000	13,000	46,000	469,000	5,000	15,000	95,000	253,000	368,000	133,000	42,000	11,000	73,000
Nov	32,000	44,000	141,000	44,000	33,000	217,000	0	2,000	20,000	315,000	5,000	15,000	58,000	176,000	254,000	72,000	19,000	5,000	39,000
Dec	22,000	29,000	141,000	44,000	22,000	206,000	0	1,000	13,000	271,000	5,000	15,000	39,500	123,000	182,500	48,000	12,000	3,000	26,000
Annual (m^3/yr)	783,000	1,631,000	1,692,000	528,000	1,386,000	3,596,000	182,000	881,000	972,000	8,045,000	60,000	180,000	1,815,250	5,989,750	8,045,000	1,658,000	855,000	256,000	904,000

1:10 Year Dry Scenario																			
Month	No Treatment		Treatment Potentially Needed							Total Surplus	Process Water Use		Lower WMP Discharge		Total Surplus	Non-Contact Water Diverted Around Site			
	Upper WMP	Lower WMP	Underground Workings	Open Pit Dewatering			Process Plant Site Runoff	Class A	Class B		WTP	Pit Rim Pond	To Geona Creek	To Finlayson Creek		South	North (Wetland)		
			GW	GW	Surface	Total											Class C	Overburden Stockpile	Remainder
Jan	9,000	13,000	141,000	44,000	10,000	194,000	0	1,000	6,000	223,000	5,000	15,000	17,500	75,000	112,500	20,000	6,000	1,000	11,000
Feb	7,000	10,000	141,000	44,000	8,000	192,000	0	1,000	5,000	215,000	5,000	15,000	12,500	53,000	85,500	16,000	4,000	1,000	9,000
Mar	7,000	10,000	141,000	44,000	8,000	192,000	0	1,000	5,000	215,000	5,000	15,000	10,000	39,000	69,000	16,000	4,000	1,000	9,000
Apr	9,000	27,000	141,000	44,000	25,000	209,000	5,000	7,000	19,000	276,000	5,000	15,000	37,000	235,000	292,000	18,000	16,000	5,000	10,000
May	95,000	215,000	141,000	44,000	184,000	369,000	28,000	130,000	130,000	967,000	5,000	15,000	189,000	1,040,000	1,249,000	197,000	115,000	35,000	107,000
Jun	93,000	221,000	141,000	44,000	195,000	379,000	31,000	142,000	138,000	1,004,000	5,000	15,000	212,000	1,000,000	1,232,000	198,000	121,000	37,000	108,000
Jul	53,000	116,000	141,000	44,000	104,000	288,000	14,000	58,000	67,000	596,000	5,000	15,000	108,000	490,000	618,000	120,000	64,000	19,000	65,000
Aug	45,000	100,000	141,000	44,000	88,000	272,000	13,000	48,000	56,000	534,000	5,000	15,000	97,000	450,000	567,000	98,000	54,000	16,000	53,000
Sep	51,000	105,000	141,000	44,000	89,000	274,000	11,000	46,000	56,000	543,000	5,000	15,000	97,000	400,000	517,000	108,000	55,000	16,000	59,000
Oct	33,000	51,000	141,000	44,000	41,000	225,000	2,000	4,000	26,000	341,000	5,000	15,000	57,000	225,000	302,000	75,000	24,000	6,000	41,000
Nov	18,000	24,000	141,000	44,000	19,000	203,000	0	1,000	11,000	257,000	5,000	15,000	35,500	155,000	210,500	41,000	11,000	3,000	22,000
Dec	12,000	17,000	141,000	44,000	12,000	197,000	0	1,000	7,000	234,000	5,000	15,000	24,500	106,000	150,500	27,000	7,000	2,000	15,000
Annual (m^3/yr)	432,000	909,000	1,692,000	528,000	783,000	2,994,000	104,000	440,000	526,000	5,405,000	60,000	180,000	897,000	4,268,000	5,405,000	934,000	481,000	142,000	509,000

18.4.3 Surface Water Management Mitigation Measures

The following section has been summarized from the Kudz Ze Kayah Hydrogeological Model Report (EBA, 2016) (Appendix D-4).

18.4.3.1 Overburden Dewatering

Prior to the initial mine development, overburden drainage will be conducted by excavating a trench to the top of the fractured/weathered bedrock approximately along the alignment of the former Geona Creek watercourse. Based on borings, the trench is expected to be approximately 15 to 20 m deep. Simulations have demonstrated that a trench excavated to the top of the weathered bedrock will permit efficient drainage of the overburden in the area of the proposed open pit. Excavation of the trench will begin near the northern-most extent of the ABM Zone in the form of a sump extending to bedrock and used to dewater the overburden. As water levels are reduced in the overburden by pumping from the sump, the trench will be further extended to the south along the channel of Geona Creek until it reaches the southern extent of the ABM open pit.

To more efficiently dewater the overburden two trenches, approximately 300 m long, will be excavated west of the central drainage trench. The establishment of the trench, which will extend the entire length of the eventual pit, will minimize the likelihood of the overburden re-saturating as drainage paths will be kept as short as practicable. Permanent sumps will be established at the north and south ends of the trench to remove water on a continual basis. A sump may also be excavated in the Krakatoa Zone area to enhance drainage of the overburden material in advance of the extension of the trench.

18.4.3.2 Pit Bedrock Dewatering

Dewatering of the underlying weathered/fractured bedrock is anticipated to be a longer-term sustained process, but one which may not benefit from systematic active dewatering of the general bedrock area. Initial simulations of weathered-bedrock dewatering using various configurations of dewatering wells showed that this strategy would likely be ineffective (EBA, 2016, Appendix D-4). The permeability of the weathered bedrock is low enough that dewatering wells would most likely have a very limited radius of dewatering influence in which the tight cone-of-depression would result in drawdown of about 5 m extending only as far away from the pumped location as 25 to 50 m.

Instead, the modified conceptual dewatering strategy for bedrock consists of a combination of fault-zone dewatering wells and a system of horizontal drains in the pit for dewatering and pit-wall depressurization. Dewatering wells are planned to intersect each of the three major fracture zones associated with the East Fault, the Northwest Fault and Fault Creek Lineation. Each of these wells will be drilled to a depth of 150 to 200 m. The current configuration of the groundwater model predicts that these wells should each be pumped at a rate of 20 to 40 gpm (US) for the six months of initial dewatering (EBA, 2016, Appendix D-4). As each of these faults is anticipated to represent a significant contribution of water flow to the pit, an early strategy of dewatering from the lineations

will likely result in less flow to the pit during later years. After the initial dewatering period, the rate at which each of these wells can be pumped will decrease as the saturated thickness declines. Higher permeability and more extensive fracture zones will likely produce at the higher end of this range.

The in-pit dewatering strategy is essentially unchanged from that originally proposed by Golder (1996). Competent bedrock will drain naturally through the high wall and end wall of the ABM open pit. Horizontal drain holes will be installed in areas of high pore pressure or structural instability. Competent, unfractured bedrock is not anticipated to generate significant rates of seepage due to its low permeability; however, it is anticipated that zones of fracturing are likely to be present and represent sources of higher rates of flow. Installation of horizontal drains in these zones will be used to dissipate the hydraulic head as necessary. Drainage from the walls and horizontal drains will be conveyed to sumps located on each of the bench levels and at the pit floor. Collected water will be pumped from the sumps to the surface where it can be routed to the water treatment or storage facilities.

18.4.3.3 Underground Dewatering

As in the strategy for in-pit dewatering, the dewatering strategy for the underground workings will involve the collection of seepage water augmented by horizontal drains, as needed, to reduce bedrock saturation near the tunnel face in the event of elevated flow rates or structural instability. Drainage from the walls and horizontal drains will be conducted to a series of sumps to be located at the deepest level of the workings. Collected water will be pumped from the sump to the surface Pit Rim Pond, from where it can be routed to the water treatment or storage facilities.

18.4.3.4 Process Plant and Mine Water Management

The three primary sources of water usage for Process Plant makeup water are groundwater well(s) at the Process Plant, water from the Class A collection pond, and effluent from the Water Treatment Plant. Alternative water sources include water from the Pit Rim Pond, the Class B collection pond, and Water Management Ponds. A Process Plant pond will be constructed to allow for surface runoff from the Process Plant footprint (including the run of mine and low grade ore stockpiles) to be collected as well as to a reclamation pond to recycle water for processing. Surface water collection in the Process Plant pond will generally only occur in April to October when runoff is occurring.

Water will be required for other components of the mine operations including drill water for the underground drilling rigs, dust suppression and equipment wash bays. Dust suppression will utilize water from the Lower Water Management Pond. The water quality of both facilities will be monitored regularly to ensure suitable quality for use. Dust suppression will only be required during the snow free months and would only occur as required to maintain air quality for the Project.

18.4.3.5 Camp Water

The Project includes a 250-person camp during operations. The camp will be supplied with potable water from a groundwater well at a rate of up to 3.7 m^3/hour (up to 350 people at 250 l/day, to acoomodate the construction worforce). The water will be pumped into a storage tank in camp and treated as required. The camp will be constructed with a sewage treatment plant that will include a septic field.

18.4.3.6 Mine Water Treatment

The water treatment plant (WTP) will be constructed at the Process Plant Facility and designed to treat:

- Class A contact water from the Class A Storage Facility collection pond;
- Class B contact water from the Class B Storage Facility collection pond; and
- Runoff from the Process Plant Facility site collected in the perimeter sumps, including LGO and ROM contact water.

The WTP will have additional capacity to treat ABM open pit dewatering, as required. The treatment will consist of pH adjustment, clarification, and any other processes that may be required to bring the water to a suitable standard for discharge to the environment. Additionally, a second stage process will be added to treat selenium such as reverse osmosis or biological treatment. The treated effluent will be discharged to the LWMP for final polishing before discharge to the receiving environment or may be used in the Process Plant circuit.

18.4.3.7 Water Management Structures

Diversions

Diverting clean water around the Project is one of the main objectives of the WMP. Reducing the volume of contact water requiring management and treatment is critical to the success of the water management strategy for the Project. The Project includes three major diversions (Figure 18-1 and Figure 18-2). The Fault Creek and associated southern diversions will re-route water that would otherwise flow into the ABM open pit and will divert it to South Creek. The northwestern diversion will route water above the Class A Storage Facility and the Class B Storage Facility past the water management ponds into Geona Creek. The northeastern diversion will redirect water above the Class C Storage Facility and Overburden Stockpile. The runoff from the Class C Storage Facility and Overburden Stockpile will also enter the northeastern diversion, which will be directed into Geona Creek below the Lower Water Management Pond. The water balance model has assumed the diversions have a nominal 50% efficiency rating other than the Fault Creek diversion which has assumed a nominal 100% efficiency.

Ponds

The Class A, Class B, and Class C Storage Facilities have each been designed with collection ponds to both store storm event water and provide primary settling of solids prior to water conveyance to other facilities or prior to discharge. The pond design specifications are provided in Table 18-6.

Table 18-6: Pond Design Specifications

Parameter	Class A Storage Facility Pond	Class B Storage Facility Pond	Class C Storage Facility Pond	Overburden Stockpile Pond	Lower Water Management Pond	Upper Water Management Pond	Pit rim pond
Volume	60,000 m^3	40,000 m^3	50,000 m^3	20,000 m^3	500,000 m^3	250,000 m^3	60,000 m^3
Design	1:200 year 24 hour storm event and freshet inflow	1:200 year 24 hour storm event and freshet inflow	1:10 year 24 hour storm event, freshet inflow and 30 days of storage	1:10 year 24 hour storm event, freshet inflow and 30 days of storage	1:200 year 24 hour storm event	1:200 year 24 hour storm event	1:100 year 24 hour storm event
Freeboard	1 m	1 m	1 m	1 m	1 m	1 m	1 m

The Class A and Class B Storage Facility Collection Ponds will be constructed with geosynthetic liners. The ponds have been sized to manage a 1 in 200-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow.

The Overburden Stockpile and Class C Storage Facility Collection Ponds will be constructed with a compacted glacial till (low permeability) liner. The ponds have been designed to provide 30 days' storage from seepage, surface runoff for the 1 in 10-year, 24-hour storm event (including a 1 m freeboard allowance) and the projected freshet inflow. Flow from the ponds will be conveyed downstream of the Lower Water Management Pond and discharged into Geona Creek.

Water collected in the Class A collection pond and from the Class B collection pond will be directed to the Water Treatment Plant which will be located at the Process Plant Facility. The treated water will either be directed to the Lower Water Management Pond or used in the Process Facility. Water from the Class C Pond and the Overburden Stockpile Pond will be directed to Geona Creek as it is predicted to be better or similar to the water quality of the Lower Water Management Pond.

Groundwater will be monitored in wells situated downstream of the Class A, Class B, and Class C Collection Pond and the Water Management Ponds. On-going water quality monitoring will be used to assess the effectiveness of the water collection systems. In the unlikely event that the water collection systems are found to not effectively recover seepage, it will be necessary to install additional seepage control provisions.

The Upper Water Management Pond will temporarily store site runoff water from the area surrounding the Process Plant Facility, and the east side of Geona Creek, including runoff from the Overburden Stockpile and Class C Facility, that is unsuccessfully diverted around site. Secondary settling of sediment and metals will occur in the Upper Water Management Pond and the water will be conveyed to the larger Lower Water Management Pond where it will be stored for use as reclaimed water for the Process Plant, or discharged to the environment.

The discharge from the Lower Water Management Pond will either be discharged to Geona Creek or piped to Finlayson Creek. Water will be discharged year-round to Geona Creek at a minimum 3:1 ratio (receiving water: effluent) and piped to Finlayson Creek at a rate no less than 2:1 ratio with Finlayson Creek (receiving water: effluent).

18.4.3.8 Reclamation and Closure

Following the completion of mining and processing, the site will be fully decommissioned with the exception of some water management features to ensure water quality is maintained in the receiving environment. The routing of water from various sources will be modified as reclamation activities are completed. The Fault Creek and south diversions will be removed to allow the ABM open pit to flood which is estimated to take approximately 16 years (Year 26). The Water Treatment Plant will remain in place and will continue to treat the water from the Class A and B ponds as required until the facility closure measures (i.e., storage facility covers) are meeting design objectives, or until the commissioning of wetlands to treat this water.

Wetlands will be constructed in Geona Creek as required to provide passive water treatment during the post-closure period. Ultimately, water management for the Project in the post closure phases will be almost entirely passive, with only long term monitoring and maintenance of structures and their performance required.

18.5 SPILL CONTINGENCY PLAN

The purpose of the conceptual Spill Contingency Plan (SCP) is to describe actions to be taken when responding to spills during Project construction, operations, and closure. The SCP also includes practices and planning requirements to further reduce the potential for environmental contamination and other spill-related effects. The SCP describes the fuels, chemicals, and other materials that will be used at the site, reporting thresholds for those materials, a spill action plan for responding to unintentional spills of those materials, reporting sequences and forms, training requirements, spill prevention activities, and routine monitoring and maintenance.

BMC will ensure that all requirements related to Spill Response and reporting in these regulated documents are implemented throughout the life of the Project. These statutory and regulatory responsibilities may change over time and will therefore result in updates to this SCP. Copies of the SCP will be kept on site at all times in the following (but not limited to) locations: Camp office, Process Plant, reagent storage areas, fuel storage areas, explosives storage area, paste plant, and maintenance shop.

The objectives of the SCP are to:

- Identify spill prevention measures;
- Establish a high order of preparedness in the event that a spill occurs;
- Ensure an orderly and timely decision-making, response and reporting process; and
- Describe current and planned protective measures for all areas of the site.

18.5.1 Spill Contingency Regulatory and Management Context

All spills trigger important obligations under various environmental statutes. At a minimum, each spill will be investigated to determine if any potential environmental effects were caused and whether it contaminated the soil, seeped into the groundwater, or migrated off the site. In each of these cases, it has the potential to cause adverse effects.

Key legislation for the protection of water quality for the Project includes the federal *Fisheries Act* (Government of Canada, 1985), which protects fish, and the Yukon *Environment Act* (Yukon Government, 2016a) which protects water quality.

Fisheries Act

Key sections in the Fisheries Act that are important to follow include:

- Section 36(3) "... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish..."

Yukon Environment Act

Key Sections in Yukon Environmental Regulations regarding spills that must be adhered to include:

- Spill thresholds:
  - A spill in excess of the amounts specified in Schedule A (Table 18-7) is a spill under the Act and must be reported.
- Spill reporting:
  - For the purposes of section 133 of the Act, a report to the Yukon Spills Report Centre will be considered a report to an environmental protection officer.

18.5.1.1 Definitions

The following definitions apply to the conceptual Spill Contingency Plan.

Dangerous Good - A product, substance, or organism included by its nature or by the regulations in any of the classes listed in the schedule to the *Transportation of Dangerous Goods Act* (Government of Canada, 1992).

Deposit out of the normal course of events - A deposit that can reasonably be expected to occur at the mine and that can reasonably be expected to result in damage or danger to fish habitat or fish or the use by man of fish, and the identification of the damage or danger (Metal Mining Effluent Regulations, Part 3, SOR/2002-222) (Government of Canada, 2002a).

Discoverer - The person that discovers an incident that could possibly result in a spill or has resulted in a spill.

Leak - Passing of a product through a breach, tear, or puncture in a container or receptacle.

Spill - A release of a substance into the natural environment that is abnormal in quantity or quality in light of all circumstances of the release; or is in excess of an amount specified in the regulations *(Environment Act, Part 11*) (Yukon Government, 2016a):

> **Emergency Spill** - A release of a hazardous product where there is potential for that product to enter a waterway or cause significant danger to life, health, or environment.
>
> **Non-Emergency Spill** - All spills that do not meet the criteria of an emergency spill or a spill of any diesel product, blasting agent, oil, lubricant, or coolant that the responsible party is competent to manage safely and efficiently in terms of assessment, prevention, containment, and clean-up.
>
> **Special Waste Spill** – is defined as any release of special waste equal to or greater than (in a 24-hour period); 500 grams (g) of solid special waste; 500 millilitres (ml) of liquid special waste; 500 g or 500 ml, whichever is less, of mixed solid and liquid special waste; (In a 30-day period) 5 kilograms (kg) of solid special waste; 5 litres of liquid special waste; 5 kg or 5 l, whichever is less, of mixed solid and liquid special waste.

Substance - A hazardous substance, pesticide, contaminant, or special waste often referred to as a "*deleterious substance*".

18.5.2 BMC Spill Management Strategies

18.5.2.1 Communication and Spill Reporting

Any spill that occurs at the Project will be reported through the internal reporting chain of command and will follow the procedures for assessment, prevention, containment, and clean-up, and will be reported using BMC's Spill Report Form.

Should a spill exceed the thresholds set by the Government of Yukon (Table 18-7), it will be reported to external authorities. A spill in excess of the thresholds outlined in Table 18-7, or any spill that is abnormal in quality or quantity, is considered a "*reportable spill*" under the Yukon Spill Regulations (O.I.C. 1996/193), pursuant to the *Environment Act* (Yukon Government, 1996).

Table 18-7: Reportable Spill Thresholds

Product and TDG[1] Code	Typical Products On Site	Threshold Quantity
Explosives (1.1)	Ammonium Nitrate	Any amount spilled outside of blast pattern
Flammable gases (2.1)	Propane Acetylene Liquefied Natural Gas	Any amount of gas from a container larger than 100 l, or where the spill results from equipment failure, error or deliberate action or inaction
Non-flammable gases (2.2)	Nitrogen Carbon Dioxide Oxygen	Any amount of gas from a container larger than 10 l, or where the spill results from equipment failure, error or deliberate action or inaction
Poisonous gases (2.3)	Sulphur dioxide	Any amount
Corrosive gases (2.4)	Ammonia	Any amount
Flammable liquids (3)	Diesel Gasoline Methyl Isobutyl Carbinol	> 200 l
Flammable solids (4.1)		> 25 kg
Spontaneously combustibles (4.2)		> 25 kg
Dangerous when wet (4.3)		> 25 kg
Oxidizers (5.1)	Lime Solution	> 50 kg or 50 l
Organic peroxides (5.2)		> 1 kg or 1 l
Poisonous substances (6.1)	Sodium Cyanide	> 5 kg or 5 l
Organisms that are infectious (6.2)	Organisms that are infectious or that are reasonably believed to be infectious and the toxins of these organisms as defined in sections 3.19(f) to 3.20(a) of the Federal Regulations	Any amount
Radioactive Materials (7)		Any discharge or a radiation level exceeding 10 mSv/h at the package surface and 200 mSv/h at 1 m from the package surface.
Corrosive materials (8)	Sodium Metabisulphite	> 5 kg or 5 l
Miscellaneous Dangerous Goods (9.1 and 9.2)	Copper Sulphate Zinc Sulphate	> 50 kg
Dangerous waste (9.3)	Waste Oil Hydraulic and/or Engine Oil Antifreeze Glycol	> 500 ml[2]

[1]TDG = Transportation of Dangerous Goods Regulations (Government of Canada, 1992).

[2]From Yukon Environment Special Waste Regulations (Yukon Government, 2016a).

18.5.2.2 Roles and Responsibilities

Roles and responsibilities to be fulfilled in response to a spill on the site will be developed as per Section 18.15.2.5 (Emergency Response Roles and Responsibilities). Figures 18-3 and 18-4 provide

examples of a structured response and a decision matrix to be followed in the event of a minor or major spill occurring.

18.5.2.3 Internal Reporting (All Spills)

All spills (whether reportable externally or not) will be reported as an incident by all Project personnel. Following the spill response, the designated personnel responsible for spill reporting will be required to document and review the spill using a Spill Reporting Form. The report requires inclusion of photos, a description of clean-up activities and subsequent actions, and identifies root causes and any required corrective and preventative actions.

18.5.2.4 External Reporting (Reportable Spills Only)

Under federal and territorial regulations, the Environmental Lead will call the 24-hour Yukon Spill Report Line should a spill of a reportable quantity occur. Although several government agencies at the federal, territorial, and municipal levels may ultimately be informed, only the Yukon 24-Hour Emergency Spill Response Number is required for reporting purposes.

BMC's designated Environmental Lead will ensure that the appropriate information is collected before reporting to the Spill Report line. Any spill of an amount greater than those listed in Table 18-7 or a spill of any amount that enters Geona Creek, Finlayson Creek or any of their tributaries is considered a "*reportable spill*".

The following information will be provided to the 24-Hour Spill Report line:

- Location of the spill or leak;
- Time of spill or leak;
- Severity of spill or leak;
- Type of spill;
- Product spilled;
- Nearest watercourse;
- Potential to enter surface water;
- Fire hazard;
- Hazard to life and limb, injuries;
- Environmental effect expected, if any;
- Equipment and clean-up consumables on hand; and
- Actions to contain the spill.

18.5.2.5 Spill Response Procedures

Implementation of the spill response procedures requires knowledge of spill response supplies and kit locations, spill response procedures, containment procedures, and clean-up protocols. In addition to the internal and external reporting requirements, spills will further be defined as "*emergency*" or "*non-emergency*" incidents as the action plans and reporting requirements will differ according to the type of spill. Figure 18-3 provides a flowchart for generalised response to both emergency and non-emergency spills.

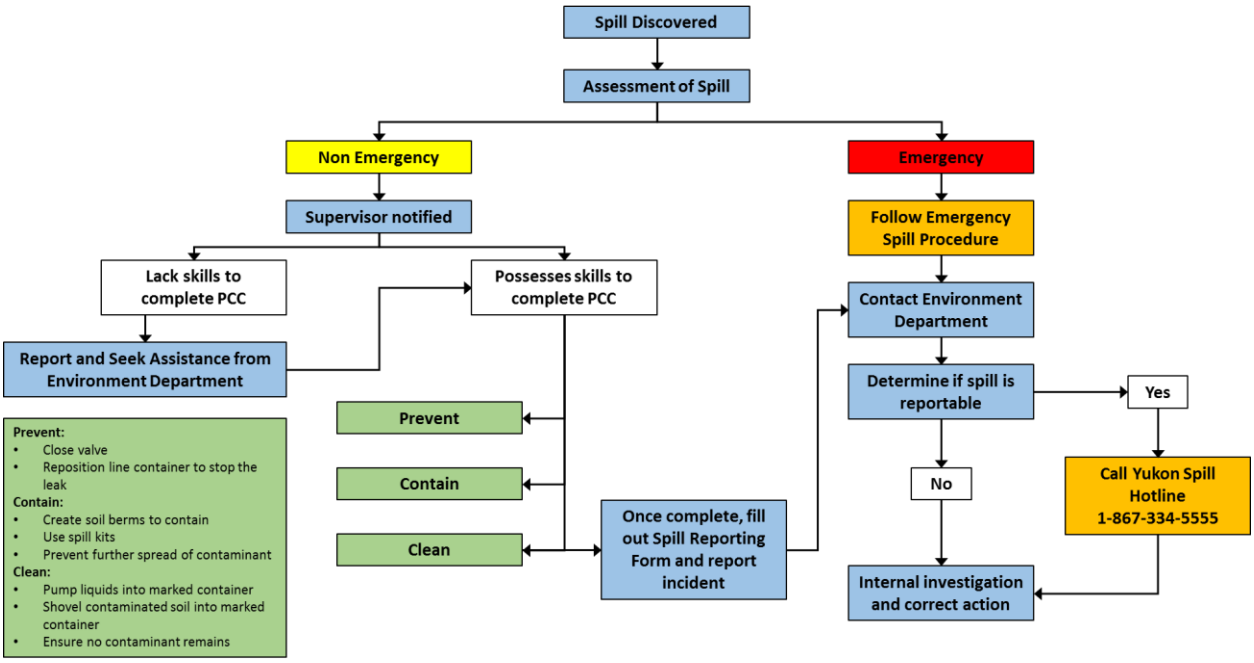


Figure 18-3: Example of General Spill Response Procedure

18.5.2.6 Non-Emergency Incidents

A non-emergency spill is defined as a spill of any product that the discoverer, or other personnel in close proximity to the incident, can competently, safely, and efficiently manage in terms of assessment, prevention, containment, and clean-up. This typically includes fuels, blasting agents, oils, lubricants, coolants, and many of the reagents involved in Process Plant operations.

18.5.2.7 Emergency Incidents

An emergency spill is a release of a hazardous product where there is potential for that product to enter a waterway or cause significant danger to life, health. or environment.

Figure 18-4 provides a flowchart for a typical command structure during an emergency spill response.

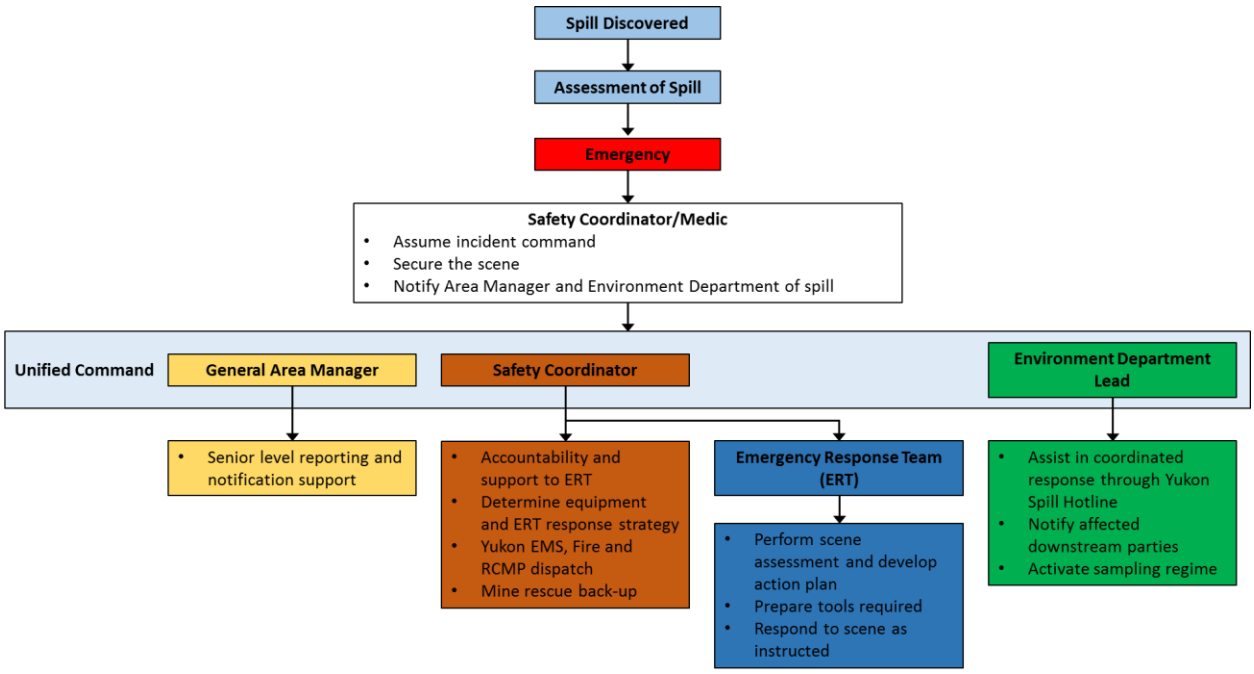


Figure 18-4: Example of Emergency Spill Response Procedure

18.5.3 Spill Prevention and Response Mitigation Measures

For each specific chemical, the spill response procedure is based on the product type, quantity, and environmental and safety conditions. MSDS will be available at the mine site in the Hazardous Materials Management Plan. The MSDS sheets will be referenced during any spill response to ensure that proper PPE is worn, that the chemical or product is handled safely, and that proper emergency and first aid procedures are adhered to. BMC's Emergency Response team will be properly trained on clean-up and disposal methods of each chemical and product used at the Project.

Both general spill response procedures and key material/structure specific procedures are provided below.

18.5.3.1 General Spill Response Procedures

The general spill response procedure is outlined below. Upon discovering a spill, the following actions will be undertaken immediately:

- Identify the substance spilled and hazards to human health, if possible (MSDS);
- Protect yourself and notify any others in the vicinity immediately;
- If safe to do so, turn off any potential sources of ignition and attend to any injuries. Leave the area if it is not safe to be there;
- Stop the discharge of the substance, if it is safe to do so;

- Contain the spilled substance;
- Inform management of the spill; and
- Report the spill following the established reporting procedure.

18.5.3.2 Domestic Sewage

Wastewater treatment infrastructure will be designed to limit the potential for wastewater entering a body of freshwater and to capture potential leaks in a containment structure.

18.5.3.3 Petroleum Hydrocarbon General Spill Response Procedures

A spill of petroleum hydrocarbons (PHC) is likely the most common incident that will be encountered at the Project requiring a spill response. Individual spill response procedures will be developed for varying types of PHC spills, including spills on water, land, and snow.

18.5.3.4 Ammonium Nitrate and Emulsion

The Health, Safety and Emergency Response Plan (Section 18.15) will be in place to coordinate a response to an explosives-related emergency situation. This plan will be registered with Transport Canada under the *Transportation of Dangerous Goods Act* and Transportation of Dangerous Goods Regulations (Government of Canada, 1992; 2015). The emergency procedures developed will inform control measures for any explosives-related environmental releases, including storage tank failure, spills from product delivery trucks, spills from raw material delivery trucks, process spills, and fire.

18.5.3.5 Concentrate Spills

Concentrates will be hauled from the mine site along the Access Road to the Robert Campbell Highway, and to other connecting regional highways. Control measures and MSDS sheets will be developed in conjunction with contractors to manage the handling and transportation of concentrate whilst in the Project area and on public highways.

18.5.3.6 Process Reagent Spills

Reagents will be transported to the Project in appropriate containers by contracted suppliers. The reagent mixing area on site will be a fully contained area equipped with sumps and sump pumps to return any spills to the appropriate stock tank. The reagent containment area will be designed to accommodate 110% of the volume of a spill from the largest stock tank or mix tank in the area. All reagent mixing and stock tanks will be equipped with level sensors to prevent overfilling. Any reagent spills on site will be responded to as per the MSDS and will be based on the product type, quantity, and environmental and safety conditions.

18.5.3.7 Spill Response Supplies and Equipment

Spill kits will be located at the following locations throughout the Project area (including but not limited to):

- Fuel Storage Areas;
- Machine Shop;
- Mining Operations;
- Process Plant;
- Paste Plant;
- Explosives Facility;
- Camp;
- Reagent mixing area; and
- Vehicles carrying hazardous materials including fuel.

Spill Response kits will include a yellow pack container labelled "*Spill Kit*" and placed at all previously noted locations. Additional smaller kits will be required in all site vehicles/equipment (where practicable, for instance some underground equipment do not have room for spill kits). Spill kits will all include at a minimum:

- Spill Instruction Sheet;
- Laminated List of Contents;
- Absorbent Pads (oil, gas, grease);
- Universal Absorbent Pads;
- Linkable oil booms;
- Oil Gator Absorbent;
- Absorbent socks;
- Leak repair putty;
- Heavy duty disposal bags;
- Protective Clothing – Gloves (Chemical Master Gloves), Coveralls (Tyvek splash suits); and
- Eye Protection.

Additional spill equipment will be available at the mine site for larger spills and will include:

- Heavy equipment and machinery (e.g., dozer, loader, excavator, Bobcat, grader, and dump truck);

- Shovels, rakes, axes;
- Pails and drums;
- Pumps and hoses;
- Emergency flagging and triangular reflectors; and
- Breathing Apparatus (as required).

18.5.3.8 Spill Prevention and Response Training

BMC will develop a detailed training program to ensure all employees and contractors are aware of their responsibilities and appropriate practices that everyone on site must adhere to. The emergency response team will receive training as necessary for immediate spill response. Spill response employees will be trained in:

- Workplace Hazardous Materials Information System;
- Transportation of Dangerous Goods;
- Spill Training (Spill Responder);
- Site specific spill orientation including site procedures, location of spill kits and type of substances stored and used on site;
- Safety orientation including reference to the location of the MSDS sheets and to proper chemical handling and storage procedures; and
- OH&S and regulations and use of appropriate PPE and chemical/product handling procedures.

18.5.3.9 Monitoring, Review and Improvement

The effectiveness of spill response mitigation and control measures will be monitored through a process of:

- Scheduled BMC audits of the SCP;
- Post-incident and emergency debriefs and reporting; and
- As part of a spill response incident or emergency close-out, incorporate any corrective or preventive action measures taken into revised plans, guidelines or procedures.

18.6 SEDIMENT AND EROSION CONTROL PLAN

The conceptual Sediment and Erosion Control Plan (SECP) has been developed to address project-wide erosion prevention and sediment control as part of a broad pollution prevention strategy consistent with the environmental policy of BMC. The main objectives of the SEC Plan are to:

- Control run-off;
- Minimize erosion on exposed slopes and substrates; and
- Prevent input of silt or sediment into watercourses during all phases of the Project.

Sediment has the potential to affect fish, fish habitat, riparian habitat, surface water quality, and land use. General project activities that may result in erosion and sediment deposition include:

- Vegetation and soil clearing;
- Blasting;
- Road construction;
- Water diversion and watercourse crossings;
- Drainage from stockpiles; and
- Runoff from disturbed work areas.

18.6.1 Sediment and Erosion Control Regulatory and Management Context

Key legislation for protection of water quality for the Project includes the federal *Fisheries Act,* which protects fish and fish habitat (Government of Canada, 1985).

Fisheries Act

Key sections in the *Fisheries Act* that apply to the Project are:

- Section 35(1) "no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery"; and
- Section 36(3) "... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish..."

Freshwater Intake End-of-Pipe Fish Screen Guidelines

Water pump intake must comply with the design and operating specifications in Fisheries and Oceans Canada's Freshwater Intake End-of-Pipe Fish Screen Guidelines (Fisheries and Oceans Canada, 1995), including the requirement for intakes to be placed in a manner that minimized entrainment of sediment.

Water Quality Guidelines

The Canadian Council of Ministers of the Environment (CCME) has set Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2015). Additionally, the Project has established water quality objectives for the receiving environment (Geona Creek, Finlayson Creek and South Creek) defining the water quality requirements for the Project.

18.6.2 BMC Management Strategies for Sediment and Erosion Control

Good operating practices will be the primary tool used to mitigate erosion and sedimentation risks throughout the life of the Project. Multiple control methods outlined in this Section provide options that will be tailored to the type of erosion and sedimentation to be prevented or reduced. The specific control methods will depend on a variety of factors, with the most appropriate applied.

Effective sediment and erosion control measures will be installed before starting construction to reduce the potential for introduction of sediment into watercourses in accordance with Land Development Guidelines for the Protection of Aquatic Habitat (Fisheries and Oceans Canada, 1993), unless otherwise specified in the Construction Environmental Management Plan (to be developed prior to construction). The following BMC Sediment and Erosion Control management strategies have been included in the overall Project design.

18.6.2.1 Sediment Control

Sediment control measures are as follows:

- Control runoff and manage stormwater (e.g., rainfall or snow melt) and direct it away from construction areas where excavation, soil placement, and staging activities occur;
- Develop site-specific measures to reduce changes to the existing hydraulic balance and downstream wetland functions (if applicable), prior to construction of the Project access and site roads;
- Silt fences, berms, swales, ditches, check dams, settling ponds, and other sediment and erosion control facilities will be installed prior to construction at site-specific locations, as required; and
- Contingency supplies of sediment and erosion control materials will be maintained and workers will be sufficiently trained in their appropriate installation and maintenance.

Sediment and erosion control measures will be:

- Inspected regularly at a frequency commensurate with the risk, nature, location, and seasonality of the work;
- Adapted or revised, as appropriate;
- Repaired as necessary in a timely manner, commensurate with the risk, nature, location, and seasonality of the work;
- Maintained until construction is completed and the affected areas are sufficiently stabilized and revegetated so there is minimal risk of erosion or sedimentation at the site as a result of construction activities;
- Storage and disposal of construction wastes, overburden, soil, or other substances in such a manner as to reduce the potential for entry into any streams or watercourses;

- Stockpiles of materials will be located at least 15 m from the ordinary high water mark of any non-fish bearing water body or wetland, and 30 m for fish bearing water bodies, unless otherwise deemed to pose a low risk of sediment entry into any water body;
- Cover stockpiles of erodible materials such as soil with plastic sheeting or tarps, or establish vegetative cover, to prevent erosion;
- Manage equipment production rates (if required) to reduce the amount of sediment generated;
- Isolate in-stream work areas from flowing water to prevent sediment from entering the downstream environment; and
- Use clean rock materials for riprap construction to reduce the amount of sediment that is introduced into the aquatic environment.

18.6.2.2 Erosion Control

Erosion control measures are as follows:

- Control site runoff by ditching, grading, sedimentation ponds, check dams, or effective alternatives;
- Stabilize slopes by maintaining ground cover or using materials such as geotextiles/erosion control cloth;
- Manage vegetation and soil stripping, taking into consideration slope stability and the proximity to sensitive habitats such as wetlands or fish habitat, maintaining 30 m riparian buffers adjacent to fish bearing waterbodies and 15 m riparian buffers adjacent to non-fish bearing waterbodies, where practicable;
- Identify natural drainages that occur in cleared areas and incorporate appropriate sediment and erosion control measures into site planning;
- Incorporate perimeter channels, as required, to catch and transport site runoff from new construction sites and equipment staging areas;
- Install water bars to direct road surface runoff away from access and site roads in a safe manner;
- Where required, install appropriately sized culverts to reduce road failure through erosion and to manage hydrological balance and wetland function;
- Maintain ditches along access and site roads, as required, to control surface runoff and sediment transport;
- Operate machinery on land above the high water mark in a manner that reduces disturbance to the banks of watercourses;
- Remove sediment control measures, such as plastic sheeting and silt fencing, when no longer required;

- Salvage and stockpile clean surface soils for site restoration;
- Establish and maintain vegetative cover on the soils stockpiled to prevent erosion; and
- Restore disturbed areas to a stable vegetated condition as soon as possible.

18.6.3 Sediment and Erosion Control Mitigation Measures

The primary approaches to mitigate the introduction of sediment into downstream environments will include:

- Minimizing the generation of sediment at the source;
- Minimizing the volume of contact runoff capable of transporting contaminants; and
- Collecting and treating the contact runoff, as required, meeting downstream water quality requirements.

A system of education and training as part of Site Orientation for all Project employees and contractors will be implemented.

18.6.3.1 Erosion Prevention and Sediment Control – Surface Runoff

General measures BMC will use to minimize suspended sediment generation due to surface erosion from overland surface water runoff are listed below. More detailed surface erosion prevention plans will be developed for work areas determined to have a high environmental risk.

The general measures BMC will use to minimize suspended sediment generation due to surface erosion from overland surface water runoff include:

- Avoiding work where possible, in 15 m of the ordinary high water mark of non-fish bearing watercourses, and 30 m from fish bearing watercourses;
- Using existing roads where practicable;
- Establishing lay-down and storage areas at least 15 m from the ordinary high water mark of non-fish bearing watercourses, and 30 m from fish bearing watercourses;
- Using clean riprap and construction materials;
- Diverting runoff around disturbed work areas and collecting runoff in sediment ponds for settling and testing prior to discharge to the downstream environment;
- Using erosion-resistant cover material including compacted granular material on steeper slopes in ditches to increase resistance to erosion;
- Vegetating exposed surfaces where possible to provide long-term erosion resistance in accordance with the Reclamation and Closure Plan;
- Vegetating and/or installing erosion control matting on disturbed areas, where possible; and

- Installing and maintaining silt fencing and sediment control structures (e.g., straw wattles) to minimize sediment transport.

18.6.3.2 Water Management and Sedimentation Ponds

Sedimentation ponds are structures incorporated into the base of a decline to collect runoff from areas of high sedimentation potential during construction. Sediment collected in the ponds can be allowed to settle and the less turbid water naturally overflows to the surrounding environment, or can be pumped to other areas for further settling or, if necessary, treatment prior to discharge. During the early phases of construction, sedimentation ponds will be constructed in several areas to allow water to settle prior to discharge into the surrounding environment.

For operations, the Class A, Class B, and Class C Storage Facilities and Overburden Stockpile have been designed with a pond at the base of each facility to manage and control sediment. In addition, the pit rim pond will manage sediment for any water pumped from the ABM open pit.

BMC will collect the contact runoff generated in the Project area and convey it to sediment ponds before further treatment or discharge to the downstream environment.

All water collection and conveyance systems (e.g., ditches, sumps, pumps, pipes, and flumes) will be designed by hydrotechnical engineers on the BMC design team. These systems will be designed to convey the necessary water flow and resist erosion under design inflow conditions.

Sediment ponds will also be designed by hydrotechnical engineers and these sediment ponds will be:

- Designed to trap sediment particles of 10 microns in size or larger with flow volumes equivalent to a 1:200 year, 24-hour rainstorm for the Class A and Class B Storage Facilities Collection ponds and 1:10 year, 24-hour rainstorm for the Class C Storage Facilities Collection and Overburden Stockpile ponds;
- Maintained by periodically removing accumulated sediment to ensure they have adequate capacity to function properly to design criteria; and
- Tested for suspended sediment concentrations in the effluent and managed further if required.

Water diversion berms and ditches will be constructed upslope of disturbed working areas, as appropriate, to reduce contact water runoff water, as well as reducing erosion and sediment transport.

18.6.3.3 Erosion Prevention and Sediment Control – Instream Works

Specific measures BMC will follow during any in-water works (including but not limited to draining ponds over the proposed open pit and the diversion of Fault Creek) will include:

- Diverting streams/seeps and isolating work activities wherever practicable;

- Operating equipment in a manner that minimizes sediment release where work areas cannot be isolated;
- Instream sediment control structures (e.g., silt curtains);
- Installing water diversion pump intakes in a manner that prevents entrainment of sediments; and
- Installing water diversion discharge points in a manner that prevents erosion of the downstream substrates.

18.7 WILDLIFE PROTECTION PLAN

The purpose of the Wildlife Protection Plan (WPP) is to detail BMC's procedures for minimizing and managing effects to wildlife and their habitat. The WPP draws on the most recent wildlife surveys completed by AEG in 2015 and 2016 (Appendix E-8), the Initial Environmental Evaluation (IEE) completed by Norecol, Dames & Moore Ltd. (1996), and input by Yukon Government biologists, and technical experts.

18.7.1 Wildlife Protection Regulatory and Management Context

The following legislation, regulations and existing wildlife guidance documents were reviewed and integrated into the development of this WPP:

Federal Legislation

- Canada *Migratory Birds Convention Act* (1994) (Government of Canada, 1994);
- Canada *Species at Risk Act* (SARA) (2002) (Government of Canada, 2002b); and
- Canadian *Environmental Protection Act* (1999) (Government of Canada, 1999).

Territorial Legislation

- Yukon *Wildlife Act* (2002) (Yukon Government, 2014b);
- Yukon *Environment Act* (2002) (Yukon Government, 2016a); and
- Yukon Hunting Regulations for 2016-17 (Yukon Government, 2016e).

Yukon Management Practice Guidelines and Industry Standards

Management practice guidelines, industry standards and other documents used to develop this WPP include (but are not limited to):

- Yukon *Quartz Mining Act* (Yukon Government, 2016d) and Quartz Mining Land Use Regulations (Yukon Government, 2003);
- Yukon Chamber of Mines' Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide;

- Management Plan for the Northern Mountain Population of Woodland Caribou (*Rangifer tarandus caribou*) in Canada (Environment Canada, 2012);
- Guidelines for Industrial Activity in Bear Country (MPERG, 2008a);
- Staying Safe in Bear Country (Yukon Government, 2016b);
- Flying in Caribou Country (MPERG, 2008b);
- Flying in Sheep Country (MPERG, 2008c);
- Proponent's Guide: Assessing and Mitigating the Risk of Human-Bear Encounters (Yukon Government, 2012b); and
- Kaska Dena Land Use Framework and Management Practices (Dena Kayeh Institute, 2010).

18.7.2 BMC Wildlife Management Policies and Strategies

The WPP will be the primary document that BMC will use to implement wildlife and habitat protection. The WPP is a "*living document*" that will undergo review on an annual basis and be adjusted to ensure an appropriate level of wildlife protection is achieved. As more information is gathered through monitoring the presence and behaviour of wildlife interactions with the KZK Project and personnel, additional mitigation measures may be developed and integrated into the WPP.

BMC's main policies related to wildlife protections include:

- Environment Policy (Appendix A-4);
- No Firearms Policy (Appendix A-8); and
- No Feeding of Animals Policy (Appendix A-9).

18.7.3 Wildlife Protection Mitigation Measures

In recognition of the potential disturbances and effects that construction, operation and closure of the Project may have on wildlife and habitat, BMC will implement mitigation measures to prevent or reduce such effects. Some mitigation measures may be general in nature and applicable to all species, areas and phases of the Project. Other mitigations may be phase, species, area, or time-specific. Mitigations will be subject to monitoring and modification as necessary to ensure ongoing efficacy.

18.7.3.1 Minimize Effects by Design

Wildlife habitat considerations have been, and will continue to be, integrated into the Project design as the Project moves forward into detailed design and construction. The following wildlife habitat protection measures have been, or will be, incorporated in the Project:

- The Project footprint was designed to cover as little area as practicable to minimize habitat loss and disturbance;

- Clearing of the Overburden Stockpile, Class A, B, and C Facilities will be progressive, to minimize total area of disturbance at any given time;
- Clearing will be kept to a minimum and only include areas needed to safely and efficiently construct and operate the Project;
- Dry stack tailings will be progressively reclaimed;
- Buttresses will be reclaimed following construction;
- Equipment laydown areas will be distant from known wildlife trails or wildlife road crossings;
- Ancillary facilities including waste storage, camp, Upper and Lower Water Management Ponds, and all water collection ponds with engineered liners will be surrounded by wildlife proof fences or emergency egress ramps; and
- Construction of new roads will be minimized (e.g., Tote Road will be upgraded to Access Road largely in the existing alignment).

Additional design measures for the Access Road and Tote Road are described in Section 4.12.1.

18.7.3.2 Minimize Effects by Planning

The following mitigation measures are commitments made by BMC to be completed during detailed design and construction planning:

- Clearing will be planned to minimize disturbance to bird nesting, where practicable;
- Activities will be planned to avoid sensitive habitat areas and times for focal species, where practicable; and
- A guard at the gatehouse on the Access Road will continue to restrict hunter and other unauthorized access to the Project area.

18.7.3.3 Minimize Effects: Construction

Construction of the Project will create sensory stimuli that will disturb wildlife. Construction will occur along the Geona Creek valley, resulting in the removal and alteration of wildlife habitat. These changes will result in some habitat being temporarily unsuitable for use resulting in wildlife being displaced, altering their movement patterns, or increasing energy use that could affect animal health. Therefore, during the construction phase the following mitigation measures will be implemented to reduce potential effects on wildlife:

- Adhere to the policy of no feeding, harassment, or hunting of wildlife by employees and contractors;

- Present a wildlife protection component in employee, contractor, and visitor orientation/induction program to communicate wildlife policies, safety, and protection measures;
- Implement a regular vehicle and equipment maintenance program to minimize noise and emissions;
- Establish protective buffer zones around riparian areas (i.e., creeks) to prevent sedimentation of aquatic habitats and minimize disturbance to movement corridors including 30 m adjacent to fish bearing waterbodies and 15 m adjacent to non-fish bearing waterbodies, where practicable;
- Ongoing revegetation of affected areas as construction is completed (with an approved native plant seed mix and/or salvaged material);
- Discourage and limit on site vehicle and equipment idling (where practicable);
- Follow Yukon flying guidelines including no-fly and flight height restrictions, especially for focal species, as outlined in Table 18-8;
- Follow designated flight and landing route for flights to Finlayson Lake airstrip during winter that stay 1.5 km away from animals and maximize height above ground as long as practicable at landing and takeoff (Dena Kayeh Institute, 2010) that minimizes herd disturbance;
- Use water spray or approved dust suppressant (environmentally-friendly that does not contain salts that would attract wildlife) to control dust generation from construction activities, storage piles, and exposed soils/surfaces;
- Avoid construction in and around sensitive areas, such as calving grounds, raptor nesting sites, den sites, or mineral licks during the seasonal periods outlined in Table 18-8 (where practicable);
- Manage waste to minimize wildlife attractants;
- Work areas will be kept free of garbage and spills;
- All uncontained garbage or spills will be cleaned up immediately;
- Improperly disposed garbage, especially food or camp wastes, will be cleaned up and reported to the Environmental Manager as soon as practicable;
- Keep snowbanks less than one-metre high, and provide wildlife passageways through banks along the Access Road and around site;
- Stop activities if ungulates, bears, or wolverines are encountered during Project activities, or as long as it is safe to do so, until the animal(s) has left the area. Wildlife will be given the right of way;
- Enforce vehicle speed limits on employees and contractors and use radios to report wildlife on roads to reduce the incidence of collisions;

- Machinery and personnel will be required to remain in the defined Project area and along defined roads;
- If work is required in the backcountry, personnel will be expected to minimize disturbance (e.g., no littering, retain natural vegetation, address any spills immediately, shut off equipment/vehicles when not in use, report all wildlife observations and incidents to management);
- Complete wildlife observation forms and add to the wildlife log that will be maintained to provide information regarding presence of wildlife and potential changes in land use over time;
- Site personnel (employees and contractors) will be instructed not to attempt to handle nuisance or problem wildlife without specific direction from the Conservation Officer (district office in Faro 867-994-2862 or Watson Lake 867-536-3210); and
- Implement mitigation measures in the Surface Water Management Plan (Section 18.4) to avoid direct effects to water bodies and the wildlife that use them.

Table 18-8: Sensitive Seasonal Periods for Focal Wildlife and Mitigations

Species	Approximate Dates	Sensitivity	Mitigations or Activities to Avoid
Ungulates	January 1 – March 31	Late-winter conditions	Give ungulates right of way; where practicable do not block movement corridors; minimize disturbance to animals during this time of year; keep snow banks less than 1 m and create passages in banks where trails and tracks are evident at least every 100 m.
Caribou	May 1 – May 31	Calving period	Minimize working in alpine areas during this period to the extent practicable.
Raptors	May 1 – July 31	Nesting period	Blasting to be restricted to the active mine and crushing Project area and if required outside that area.
Breeding Birds	June 1 – July 31	Nesting period	Conduct breeding bird surveys prior to clearing during the nesting period; establish 15 m buffers around active nests.
Caribou	September 25 – October 31	Rutting period	Minimize working in alpine and subalpine areas during this period to extent practicable.
Bears	1 Nov – 15 April	Denning period	There are bear dens located approximately 4.5 km from site. A preconstruction survey will be undertaken for bear dens and appropriate set back distances from the construction area will be applied until the bears leave the den, if bear dens are observed. During operations, the area will be monitored. Periodic checks will be conducted around the ABM open pit perimeter during the pre-denning period. If bears are observed in the vicinity of the ABM open pit, the conservation officer and RRDC will be contacted to discuss deterrence measures to prevent bears from denning in close proximity to the work areas.

Should it be required that clearing occur during the breeding bird nesting season, BMC will undertake breeding bird surveys in nesting areas prior to clearing. This is to ensure compliance with the *Migratory Birds Convention Act* 1994 which prohibits the disturbance or destruction of migratory bird nests and eggs in Canada (Government of Canada, 1994).

18.7.3.4 Minimizing Effects: Operations

The WPP will be updated annually to accommodate changes in conditions and work phases. During the operations most of the mitigations listed for construction will also apply (including, but not limited to):

- A wildlife protection component will be presented in the employee, contractor and visitor orientation/induction program to communicate wildlife policies, safety, and protection measures;
- All employees, contractors and visitors will be required to adhere to all company policies including environment and wildlife related policies;
- Fugitive dust will be controlled using water sprays or approved dust suppressant (environmentally-sound that do not contain salts that would attract wildlife) to minimize the Project's zone of influence over the surrounding landscape;
- Keep snowbanks less than one-metre high and provide wildlife passageways through banks along the Access Road and around site;
- Stop activities if ungulates, bears, or wolverines are encountered during Project activities, as long as it is safe to do so, until the animal(s) has left the area. Wildlife will be given the right of way;
- Enforce vehicle speed limits on employees and contractors and use radios to report wildlife on roads to reduce the incidence of collisions;
- Follow designated flight and landing route for flights to Finlayson Lake airstrip during winter that stay 1.5 km away from animals and maximize height above ground as long as practicable at landing and takeoff (Dena Kayeh Institute, 2010) that minimizes herd disturbance;
- Surface runoff from site will be controlled and directed away from natural areas to reduce potential contamination, sedimentation, and smothering of vegetation;
- Complete wildlife observation forms and add to the wildlife log, that will be maintained to provide information regarding presence of wildlife and potential changes in land over time;
- Machinery and personnel will be required to remain in the Project area. If work is required in the backcountry, personnel are expected to minimize disturbance; e.g., no littering, retain natural vegetation, address any spills immediately, shut off equipment/vehicles when not in use, report all wildlife observations and incidents to management;
- New nest site construction surveys will be conducted throughout the nesting season and mitigated as necessary. Potential sites, for example, include old nests, tall inactive equipment (e.g., crane booms), and building ledges under eaves;
- Use of new or well-maintained heavy equipment and machinery with mandatory fully functional emission control systems/ muffler/ exhaust system baffles, engine covers; and

- The operating areas will be monitored daily for wildlife, particularly areas where animals may become entrapped (e.g., storage facilities, ponds, and open buildings).

18.7.3.5 Minimizing Effects: Closure

BMC anticipates that mitigation measures for wildlife during closure and post-closure to be less intense due to reduction in mining activities. However, wildlife may start to reutilize the site as disturbance is lessened. Mitigation that will be applied during reclamation and closure includes:

- Enforce vehicle speed limits on employees and contractors and use radios to report wildlife on roads to reduce the incidence of collisions;
- Surface runoff from site will be controlled and directed away from natural areas to reduce potential contamination, sedimentation, and smothering of vegetation;
- Decommissioning of roads that are no longer required such that passage of vehicles is prevented;
- An approved seed mixture composed of native species will be used for revegetation in accordance with surrounding vegetation, to the extent practicable. Exception to this method of revegetation will only occur if natural regeneration is deemed desirable by regulatory/decision bodies;
- The operating areas will be monitored daily for wildlife, particularly areas where animals may become entrapped e.g., storage facilities, ponds, and open buildings;
- Direct placement of materials to be used for capping purposes during reclamation rather than stockpiling for later use; and
- Include wildlife habitat enhancement considerations in site rehabilitation and restoration planning.

18.7.3.6 Access Management

Wildlife Mitigations to limit effects from access to the Project area have been addressed in the Traffic and Access Management Plan (Section 18.12).

18.7.3.7 Attractants Management

To mitigate potential effects of attractants (i.e., food, waste, fuel, and other attractants), BMC will implement the following mitigation measures:

Food Management

- BMC's no feeding wildlife policy (Appendix A-9) will be implemented for all employees and contractors;
- Frozen food will be kept in freezers, with fresh food kept in refrigerators;

- The camp and kitchen areas will be kept clean, and free of refuse;
- While waiting to be burned, garbage will be kept in a bear proof container so that bears will not be able to access it;
- Garbage will be burned in an incinerator daily, to prevent the accumulation of waste;
- The incinerator will likely be the highly effective "*SmartAsh*" model Cyclonic Barrel Burner incinerator, or something similar, which can be used as fuel-fired or forced-air depending on the type of garbage being burned;
- Non-combustible garbage (e.g., metal, recycling) will be back-hauled off site and disposed of at the municipal dump and/or recycle centre;
- If food is taken out into the field (i.e., lunches) field crews will required to bring all garbage back with them for disposal;
- All food and cooking supplies will be stored securely in the containers or removed from site during times when the camp is closed; and
- Camp kitchens will contain stack scrubbers in the venting system to reduce cooking odours.

Waste Management

- The Waste Management Facility (details presented in Chapter 4, Section 4.11.9) will be enclosed by an electrified fence;
- Work areas will be kept clean and free from litter;
- Wildlife-proof garbage bins may be placed at strategic locations on site and will be emptied regularly; and
- Signs will be posted around to remind personnel not to litter.

Fuel Management

- Gasoline, diesel, lubricants, oils and other petrochemicals may act as animal attractants (particularly bear), therefore, will be stored in appropriate facilities (as per the Waste Management Plan, Section 18.2);
- Fueling of vehicles will be limited to designated areas, to control odours and minor spills;
- Vehicle maintenance will be conducted only in designated areas (i.e., maintenance shop). Vehicles with fuel or oil leaks will be identified and repaired in 24 hrs of the leak being identified (where practicable);
- Fuel spills will be reported promptly and will be handled as per the Spill Contingency Plan (Section 18.5); and
- Despite clean-up efforts, odours will remain at spill areas, which should be treated as 'high-risk' bear encounter areas following the spill incident.

Other Attractants

- Paints, solvents, cleaning chemicals, and other products with strong odors will be stored indoors or in suitable, enclosed or fenced areas and will follow the same mitigation measures as fuel;
- Solid wastes not incinerated on site will be stored securely and removed to an approved facility on a regular basis; and
- Waste disposal or storage sites will be inspected regularly to ensure anti-wildlife measures are effective.

18.7.3.8 Management of Human-Wildlife Interactions

Many procedures contained in this WPP directly or indirectly reduce the likelihood of wildlife-human interactions. General procedures include the following:

- As part of safety training, all personnel and contractors will be provided wildlife safety and awareness training, including bear awareness and how to avoid disturbing sensitive species such as caribou;
- Site personnel will not attempt to handle nuisance or problem wildlife without specific direction from the Conservation Officer (district office in Faro 867-994-2862 or Watson Lake 867-536-3210);
- All work areas will be kept free of garbage and spills. All uncontained garbage or spills will be cleaned up immediately. Improperly disposed garbage, especially food or camp wastes, will be cleaned up and reported to the Environmental Manager as soon as possible. With proper waste management, bears will be less likely to be attracted to the camp and work areas;
- Wildlife interactions (e.g., traffic accidents) and nuisance or problem animals will be reported to the Environmental Manager immediately. Observations of wildlife behaving abnormally will be reported in 24 hours. A wildlife incident form will be completed followed by an investigation; and
- Warnings signs will be erected in locations where frequent wildlife sightings occur. These will be altered seasonally or as necessary.

BMC will use a risk and probability decision matrix similar to that shown in Table 18-9 to assess and manage problem wildlife encounters.

Table 18-9: Decision Matrix for Managing Problem Wildlife

Interaction	Actions and Management Response					
	Monitor	***Post Warnings***	***Area Closure***	***Contact CO***	***Aversive Conditioning to Change Behaviour***	***Relocate***
Sighting reported (low risk)	x					
Animal behaves normally (i.e., feeding) but could come in conflict with humans (moderately low risk)	x	x				
Animal reacts defensively and could come in conflict with humans (moderate risk)	x	x	x			
Animal tolerates human disturbance, ignores people/facilities but could come in conflict with humans (moderate risk)	x	x	x			
Animal displays repeated active interest in people/facilities and could come in conflict with humans (moderately high risk)	x	x	x		x	
Animal is clearly habituated to people/facilities and could come in conflict with human (high risk)	x	x	x	x	x	x
Animal displays aggressive behaviour and is a threat to safety (high risk)			x	x		x

18.7.3.9 Personnel Training on Wildlife Protection and Safety

As part of the work site orientation, all site personnel will undertake wildlife awareness training. This training will include the following information:

- BMC has a no hunting and fishing policy by all site personnel who work at the mine site or on any claims and leases at any time;
- Personal firearms will not be permitted at the mine site at any time. This includes the transport, storage and use of firearms. If required, only designated personnel will use a firearm to manage dangerous human-wildlife conflicts;
- The harassment of wildlife is prohibited under the *Yukon Wildlife Act*. Attempts to chase, catch, divert, follow, or otherwise harass wildlife by on-road or off-road vehicles, boats, aircraft, or on foot will not be permitted at any time;
- Personal wildlife deterrents (e.g., air horns, bear spray, bear bangers) will be issued and carried by all field personnel, as well as functioning radios. Training on wildlife deterrents will be completed prior to issuance and use. Workers will follow scheduled check-in times;
- If ungulates, bears or wolverines, are encountered while carrying out project activities, the activities shall stop, as long as it is safe to do so, until the animal(s) has left the area. Wildlife will be given the right of way; and

- Feeding wildlife is prohibited at all times, and includes travel to and from the mine site.

18.7.3.10 Wildlife Records Program

A "*wildlife observation"* is considered to be wildlife seen more than 1 km from the Project area perimeter, or more than 100 m from any area of human activity. In contrast, a "*wildlife incident"* is considered to be a wildlife observation in 1 km of the mine perimeter, or less than 100 m from any area of human activity. A "*wildlife incident*" also includes problem or nuisance/aggressive wildlife, and a wildlife-vehicle collision or near miss. Best judgement will be used when deciding between the two types of observations.

All wildlife encounters will be entered on the BMC Wildlife Observation Forms and Wildlife Incident Forms. Information gleaned from these forms, will be summarized in a wildlife observation log. The wildlife observation log will be compiled annually and distributed to Ross River Dena Council, YG Regional Biologist, and Regional Conservation Officer. Any documented sightings of SARA-listed species will be reported to the Yukon Conservation Data Centre.

Wildlife log data will be used in the adaptive management program to help assess the efficacy of mitigation measures implemented to reduce Project effects on wildlife and habitat.

18.8 VEGETATION MANAGEMENT PLAN

18.8.1 Invasive Plant Management Plan

This section provides the conceptual details of the Project's Invasive Plant Management Plan (IPMP). The goal of the IPMP is to define a protocol to prevent, control and monitor the spread of invasive plants in the Project area.

The objectives of the IPMP are to:

- Provide good operating practice for preventing the colonization and spread of invasive plants;
- Provide good operating practice for controlling the spread and removal of invasive plants; and
- Outline monitoring strategies for evaluating prevention and control success in the future and identification of new infestations.

Activities that may facilitate the introduction of invasive plants include:

- Fill material introduction;
- Construction and maintenance activities that disturb sites and create exposed soil;
- Long-term exposure of disturbed ground;

- Invasive plant seeds carried by the movement of heavy equipment and trucks to the area; and
- Removal of native vegetation during clearing operations in a manner that exposes soil and thereby removes competition for invasive plants.

Areas that will be of high risk for invasive plant establishment are sites where natural vegetation will be cleared and soils disturbed, including (but not limited to):

- Along the Access Road, associated pullouts and borrow areas;
- Camp area and parking lot;
- Site roads; and
- Areas surrounding infrastructure.

18.8.1.1 Invasive Plant Regulatory and Management Context

Details in this IPMP are provided in support of the information provided by the Yukon Invasive Species Council (YISC, 2016). An IPMP was developed and implemented during exploration. It is expected that this plan will evolve as Project permitting advances.

Invasive plants are species that spread extensively and rapidly, are undesirable (e.g., noxious to wildlife), and very difficult to control. Invasive species are a concern for land and resource managers throughout Canada, including Yukon. Invasive plants and animals are the second greatest threat to biodiversity after habitat loss (IUCN, 2017). In other North American jurisdictions many invasive plants are responsible for habitat damage, loss of subsistence resources, and economic growth. However, not all introduced plant species are invasive. In Yukon, there are 154 introduced plant species; however, only 20 are considered invasive (Line et al., 2008). The most aggressive invasive species are of the greatest concern and will be considered a management priority. The plant species are ranked in order of invasiveness as provided by the YISC and are shown in Table 18-10.

Table 18-10: Yukon Invasive Plant Species

Invasive Plant Species[1]	
1.	Dalmatian Toadflax (*Linaria dalmatica)*
2.	Scentless Chamomile (*Tripleurospermum inodorum)*
3.	Smooth Brome (*Bromus inermis)*[2]
4.	Creeping Thistle (*Cirsium arvense)*
5.	Narrow-leaf Hawksbeard (*Crepis tectorum)*[2]
6.	Crested Wheatgrass (*Agropyron pectiniforme)*
7.	Quackgrass (*Elymus repens)*
8.	Leafy Spurge (*Euphorbia esula)*
9.	Altai Wild Rye (*Leymus angustus)*
10.	Lucerne (*Medicago falcata)*

Invasive Plant Species[1]
11. Yellow Sweetclover (*Melilotus officinalis)* and White Sweetclover (*Melilotus albus)*
12. Reed Canary Grass (*Phalaris arundinacea)*
13. Perennial Sow Thistle (*Sonchus arvensis)*
14. Spotted Knapweed (*Centaurea stoebe)*
15. Bird Vetch (*Vicia cracca)*
16. Oxeye Daisy (*Leucanthemum vulgare)*[2]
17. Common Tansy (*Tanacetum vulgare)*
18. Common Toadflax (*Linaria vulgaris)*
19. Orange Hawkweed (*Hieracium aurantiacum)*
20. Tall Hawkweed (*Hieracium piloselloides)*

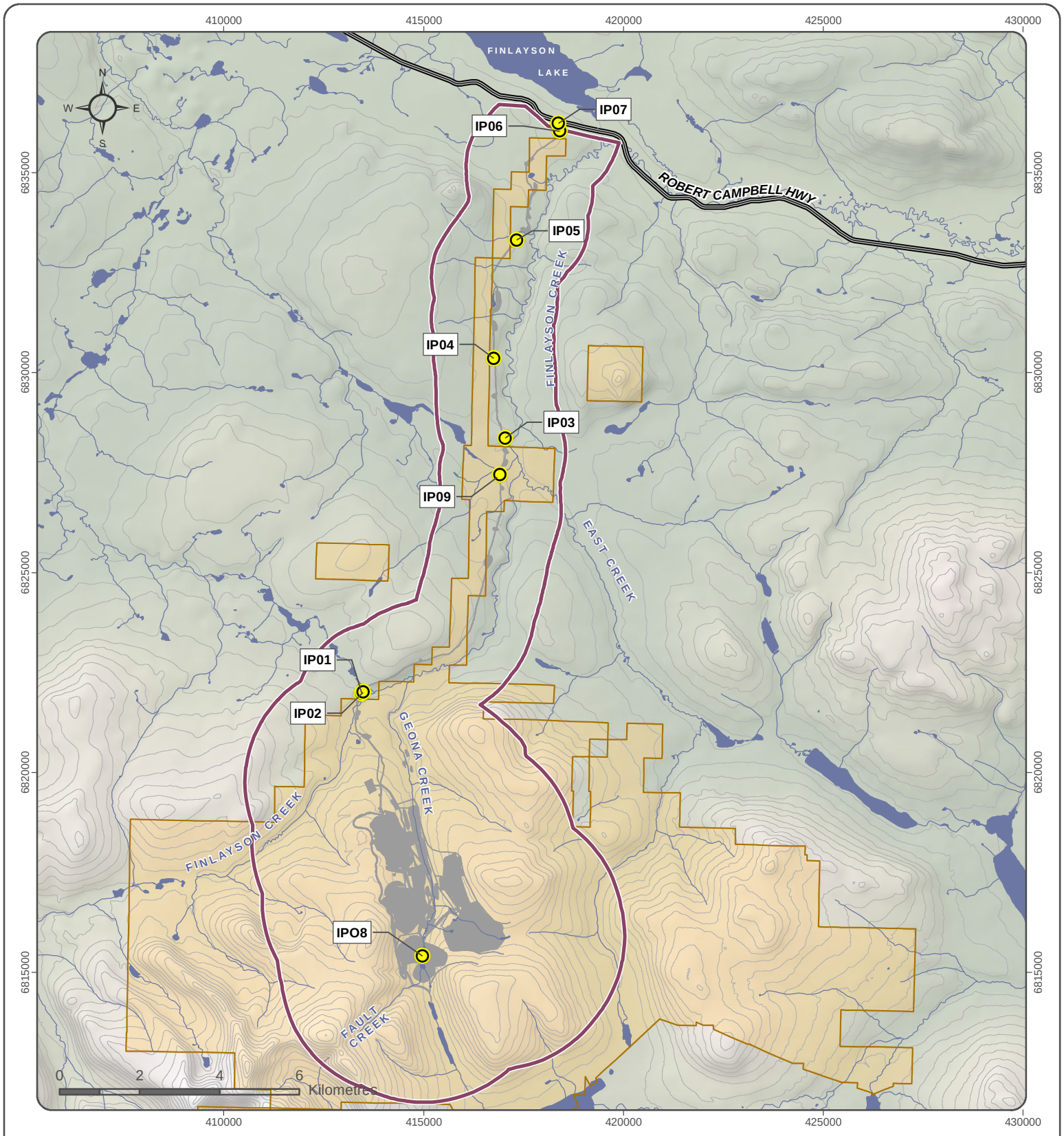
[1]Listed in Order of Invasiveness (YISC, 2016)

[2]Smooth brome, narrow-leaf hawksbeard and oxeye daisy were all found at the KZK Project area during the 2015-16 invasive species survey

Land development is a common pathway for invasive species to become introduced to a new area. During development, native plant communities are often removed and soils are often exposed resulting in competition between native species and invasive plants, which are adept at exploiting disturbed areas to flourish. The vehicular traffic usually associated with resource development also serves to transport invasive plant material and seeds from other areas.

Currently, Yukon does not have specific legislation regarding invasive species management; however, re-vegetation requirements do exist for sites disturbed during natural resource extraction under the *Quartz Mining Act* (Yukon Government, 2016d), the *Placer Mining Act* (Yukon Government, 2016c) and under the Land Use Regulations (C. 17) of the Territorial *Lands (Yukon) Act* (2014a). These regulations require vegetated areas disturbed by operational activities to be returned to a state that either allows re-vegetation by native plants or the site should be left in a state that closely resembles the pre-disturbance conditions. Therefore, invasive plants will be managed in order that appropriate revegetation can take place during site progressive reclamation and final reclamation and closure. During the life of the Project, BMC is committed to the following measures to prevent the spread and introduction of Invasive Plants:

- Managing known populations of invasive species;
- Avoiding introducing new invasive plants from off site;
- Preventing invasive species from becoming established;
- Minimizing seed dispersal in the site; and
- Preventing unnecessary damage to established native vegetation.



- Location of Observed Invasive Plant
- Local Study Area
- Location of Proposed Mine Infrastructure Fotprint
- BMC Minerals (No.1) Ltd. Claim Areas
- Waterbody
- Contour (40 m interval)
- Watercourse

KUDZ ZE KAYAH PROJECT

FIGURE 18-5

LOCATION OF OBSERVED INVASIVE PLANT SPECIES WITHIN THE KZK LSA

MARCH 2017

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(*Last edited by: amatlashevska; 01/03/2017/16:00 PM*)

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Datum: NAD 83; Projection: UTM Zone 9N

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18.8.1.2 Invasive Plant Mitigation Measures

Prevention

Prevention is the most cost effective form of invasive plant management (YISC, 2016). Therefore, BMC will implement the following prevention measures to manage the spread of invasive plants to and in the Project area:

- Minimize disturbance of the natural vegetation and exposure of soils around the Project footprint;
- Allow disturbed and reclaimed areas to revegetate naturally to the extent practicable to reduce the risk of introducing invasive plant species to the area;
- Re-use salvaged soil for reclamation to promote successful regeneration of the natural seed bank;
- Collection and use of local seeds for reclamation;
- If and when necessary, procurement of seeds will be done from reputable seed suppliers with quality control programs;
- Transplant seedling to disturbed ground to encourage quick regeneration of ground cover and reduce likelihood of invasive species colonization;
- If concerns of an invasive species infestation are immediate, establish a vegetation cover as soon as practicable after ground disturbance using a native grass seed mix;
- Where practicable, limit vehicle use to existing roads and trails to limit additional ground disturbance and therefore potential introduction of invasive species;
- Ensure equipment, vehicles, and personnel clothing are free of invasive plants prior to entering the Project by way of a check station at the Access Road gate house. Check station will include information on invasive species, instructions for proper disposal, and a disposal bin;
- All new equipment/vehicles entering site, will need to be weed free prior to site access; and
- Ensure employees are briefed on proper invasive species prevention strategies during induction.

Education and understanding of invasive plants is key to preventing the colonization and spread of these plants in any area. Annual training in environmental management will occur for site personnel, which will include non-invasive species identification and proper management options for control and removal. Posters identifying potential and identified invasive plants will be displayed in the camp area, as well as informational posters produced by YISC, current information on invasive species at the Project area, and an invasive plant survey baseline memorandum.

Control

If preventative measures are unsuccessful at stopping the spread of invasive plants to the Project operations area, BMC will take action to control the spread and removal of the invasive species. BMC commits to using Yukon recommended invasive plant management methods for the control of invasive plants. Non-chemical methods for controlling the spread and removal will include hand pulling and digging out the root system, followed by revegetation. All plants and seeds removed will be placed in bags and incinerated. Following the control effort, the areas will be monitored to assess the efficiency and condition of the site and revegetation success. BMC will continue to carry out follow-up inspections and efforts to minimize invasive plants. Furthermore, BMC will remain responsive, and if one method or attempt is not successful, another will be selected. For example, if hand-pulling and digging are not effective, other methods can be applied, such as controlled burns (in consultation with Yukon Environment), matting or mowing.

BMC will engage the Territorial Highways and Public Works Department regarding their maintenance and weed control on the Robert Campbell Highway right-of-way (if required).

Control methods used to treat an infestation and the date and location of the control effort will be recorded in the invasive plant log. Tracking the level of success in the application of different control methods used in battling invasive plant infestations will assist in developing an effective control program.

18.8.2 Rare Plant Chance Find Procedure

A chance find procedure will be followed for rare plants, similar to the chance find procedure for heritage resources. Information for recognition and identification of rare plants will be included in the induction program and clearing protocols for equipment operators. The most likely locations for rare plants are in rare ecosystems near cliffs and wetlands. As presented in Appendix E-6, potential rare plant species in the Project area include: Parry's Arnica, also known as Nodding Leopardbane (*Arnica parryi*); Northern Beech Fern (*Phegopteris connectillis*); Leafy Thistle (*Cirsium foliosus*); Mount Sheldon Ragwort (*Senecio sheldonensis*); Spiny-spored Quillwort (*Isoetes echinospora*); Maritime Quillwort (*Isoetes maritima*); Water Mudwort (*Limosella aquatica*); Common River Grass (*Scolochloa festucacea*); Blunt-leaf Pondweed (*Potamogeton obtusifolius*).

If equipment operators (or anyone else) encounters a potential rare plant, clearing in that area will stop immediately, the plant and surrounding vegetation will be cordoned off, and the site environmental officers will be notified. The environmental officers will then have the identification confirmed by a qualified person. If the plant is determined not to be rare, then the environmental officers will give approval to continue work in that area. If the plant is confirmed to be rare, the Environmental Manager will contact Yukon Environment and the designated RRDC environmental contact to determine the appropriate mitigation measures to be taken if the area cannot be avoided.

18.9 FISH AND AQUATIC HABITAT MANAGEMENT PLAN

This Fisheries and Aquatic Habitat Management Plan (FAHMP) will minimize Project-wide fisheries and aquatic habitat effects during construction, operation and closure of the Project. This plan complements the Surface Water Management Plan and Erosion and Sediment Control Management Plan. Fisheries and aquatic resources are susceptible to two main categories of effects from Project activities:

1. Alterations to aqueous geochemistry of surface waters, and
2. Alteration of physical attributes of surface waters that affect habitat and/or functionality.

Management planning for the protection of fisheries and aquatic resources needs to consider both of these pathways of potential effect.

Development of the Project will cause direct and indirect effects on fisheries and aquatic habitat and riparian areas. Potential effects include alteration of aquatic habitat, direct mortality of fish and aquatic organisms (e.g., acute effect), and reduction of fish health and survival (e.g., chronic effect).

18.9.1 Fish and Aquatic Habitat Regulatory Context

Key legislation for protection of Fish and Aquatic Habitat for the Project includes the federal *Fisheries Act*, which protects fish, and Water Quality Guidelines for the Protection of Aquatic Life (Government of Canada, 1985; CCME, 2015).

Fisheries Act

Key sections in the Fisheries Act that govern Project development include (but are not limited to):

- Section 35(1) “no person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery”; and
- Section 36(3) “... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish...”.

Freshwater Intake End-of-Pipe Fish Screen Guidelines

Water pump velocity and end-of-pipe intake screens used in fish-bearing waters must be designed with appropriate consideration of the design and operating specifications in Fisheries and Oceans Canada’s Freshwater Intake End-of-Pipe Fish Screen Guidelines (Fisheries and Oceans Canada, 1995). Some of the specifications in these guidelines include:

- End-of-pipe intake screens be sized appropriately to protect fish - maximum 2.54 mm mesh to protect fish ≤ 25 mm fork length;
- Intake velocities must be low enough to prevent entrainment of fish;

- Intake design and material must be designed to withstand potential effects;
- Screens must be maintained and cleaned; and
- Intakes must be placed in a manner that minimized entrainment of sediment and benthic organisms.

Water Quality Guidelines

The Canadian Council of Ministers of the Environment (CCME) has set Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2015).

The applicable water quality regulations and guidelines that apply to the Project include:

- Metal Mining and Effluent Regulations (Government of Canada, 2002a);
- Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2015); and
- British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture (BC MOE, 2016b).

18.9.2 BMC Management Strategies for Fish and Aquatic Habitat

Aqueous geochemical effects will be mitigated through careful control of Project discharge water quality. Appendix D-8 outlines the development of site specific receiving water quality objectives. Water discharged from the Project will be managed to ensure that these objectives are met.

Project development and operations will effect fish and fish habitat; therefore, a *Fisheries Act* Authorisation (FAA) will be required. In support of the FAA approval, BMC has developed a Fisheries Offsetting Plan (FOP) that describes the direct effects to fish and fish habitat that are predicted from the Project development (Appendix E-4). The FOP also describes the avoidance and mitigative measures that will be undertaken to minimize those effects and measures BMC will undertake to offset the effects that cannot be avoided. The offsetting measures in the FOP involve habitat replacement in lower Geona Creek and modifications to culverts on Finlayson Creek (at the Robert Campbell Highway) to improve fish passage. These measures require construction activities that could further effect fish and fish habitat and thus a number of specific mitigation measures have been developed to minimize further effects and are described in the FOP and include:

- Erosion and sediment control;
- Fish salvage and strategy to minimize salvage requirements;
- Instream construction timing windows; and
- Geochemical control of construction materials for in-stream works.

A conceptual fish and fish habitat monitoring plan has also been developed to quantify and monitor the effects that result from Project development and operations and measure the efficacy of the offsetting measures developed (Section 10.6).

18.9.3 Fish and Aquatic Habitat Mitigation Measures

Additional mitigation measures specific to protecting fish and aquatic habitat are presented in the following sections.

18.9.3.1 Aquatic and Riparian Habitat Protection

BMC will protect aquatic and riparian habitat by:

- Other than at the site of the ABM open pit and construction of water management infrastructure, keeping machines out of, and avoiding work in 15 m of the ordinary high water mark adjacent to non-fish bearing waterbodies and 30 m adjacent to fish bearing waterbodies, where practicable;
- Using existing roads where practicable;
- Establishing lay-down and storage areas at least 15 m from the ordinary high water mark adjacent to non-fish bearing water bodies and 30 m adjacent to fish bearing water bodies, where practicable;
- Preventing deleterious substances and other debris from entering watercourses; and
- Screening pump intakes in accordance with the *Fisheries Act*.

18.9.3.2 Erosion Protection and Sediment Control

BMC will address sediment control as described in the Sediment and Erosion Control Plan (Section 18.6). Measures that will be used to minimize suspended sediment generation due to surface erosion from overland surface water runoff include:

- Using clean riprap and construction materials;
- Diverting runoff around disturbed work areas and collecting runoff in sediment ponds for settling and testing prior to discharge to the downstream environment;
- Using erosion-resistant cover material including compacted granular material on steeper slopes to increase resistance to erosion;
- Vegetating disturbed surfaces to provide long-term erosion resistance in accordance with the Site Reclamation and Closure Plan (Appendix H-1);
- Vegetating and/or installing erosion control matting on disturbed construction areas, where practicable; and
- Installation and maintenance of silt fencing and sediment control structures (e.g., straw wattles) to minimize sediment transport outside of the work area.

Construction and operations sedimentation ponds will be:

- Designed to trap sediment particles of 10 microns in size or larger with flow volumes equivalent to a 1:200 year, 24-hour rainstorm for the Class A and Class B Storage Facilities Collection ponds and 1:10 year, 24-hour rainstorm for the Class C Storage Facilities Collection and Overburden Stockpile ponds;
- Maintained by periodically removing accumulated sediment to ensure they have adequate capacity to function properly to design criteria; and
- Tested for suspended sediment concentrations in the effluent and treated further if required.

Additional sediment control mitigations and monitoring are included in the Sediment and Erosion Control Plan (Section 18.6).

18.9.3.3 Contact Runoff Management

BMC will manage water that has come in contact with the Project area by:

- Collecting the contact runoff generated in the Project area and conveying it to sediment ponds before further treatment or discharge to the downstream environment; and
- Runoff from areas outside the main Project area will be diverted into ditches and, where possible, sediment ponds for testing and treatment prior to discharge to the downstream environment.

These sediment ponds will be:

- Designed to trap sediment particles of 10 microns in size or larger with flow volumes equivalent to a 10-year, 24-hour rainstorm;
- Maintained by periodically removing accumulated sediment to ensure they have adequate capacity to function properly during a 10-year, 24-hour rainstorm;
- Tested for suspended sediment concentrations in the effluent and treated further if required; and
- Tested for water quality and treated if required to meet acidity (pH) and metal concentration specifications.

Additional details are provided in the Surface Water Management Plan (Section 18.4).

18.9.3.4 Water Crossings and In-water Works

Specific mitigation measures BMC will adhere to during any in-water works will include:

- Avoiding in-stream construction in fish-bearing watercourses whenever practicable, and respecting the work timing windows described in FOP when avoidance is not practicable;
- Completing water crossings and in-water works in accordance with approvals and permits;

- Completing water crossings in accordance with Measures to Avoid Causing Harm to Fish and Fish Habitat (Fisheries and Oceans Canada, 2013) and the Fish-Stream Crossing Guidebook (BC MOE, 2012);
- Diverting streams and isolating work activities wherever practicable;
- Installing water diversion pump intakes in a manner that prevents entrainment of sediments;
- Installing water diversion discharge points in a manner that prevents erosion of the downstream substrates; and
- Removing temporary structures and restoring the area when such structures become redundant, wherever possible.

18.9.3.5 Fish Salvage and Relocation

BMC will relocate and/or salvage fish in the open pit area before the start of construction activities in accordance with the FOP (Appendix E-4). Specific measures will include:

- Excluding fish in advance of works using a temporary fish barrier and/or stop-nets (or similar) well downstream of the construction area;
- Maintaining fish barriers during in-stream works;
- Capturing fish using seining or trapping in isolated areas;
- Electrofishing after seining or trapping;
- Using alternate approaches, such as capturing less mobile populations or life stages, or backpack or boat electrofishing, in areas where exclusion is not expected to be feasible, such as the ponds located over the proposed ABM open pit; and
- Relocating fish downstream of the Project area.

BMC will carry out fish salvage activities in accordance with fish collection permits to be issued by Department of Fisheries and Oceans (DFO) and the FAA. During release of captured fish, BMC will take into account habitat suitability and capacity.

18.9.3.6 Invasive Species

BMC will manage aquatic and other invasive species. Specific measures will include:

- Cleaning equipment (at its point of shipment) before transport to site;
- Unloading equipment away from watercourses;
- Environmental staff will inspect all equipment to ensure that it is free of soil and vegetation during unloading;
- Inspection results will be documented on an equipment inspection form; and

- Contaminated equipment will either be rejected or cleaned, and any material that may contain invasive species will be properly disposed.

18.9.3.7 Fish Habitat Offsetting and Mitigation Measures

As previously discussed (Section 18.9.2) the Project will have potential to impact local fish and fish habitats, and a Fisheries Offsetting Plan has been developed to offset these losses (Appendix E-4). BMC will obtain a FAA and will adhere to all conditions outlined in the FAA.

18.10 NOISE MANAGEMENT PLAN

The Noise Management Plan describes the practices to reduce noise generated by the Project. The objective of the Noise Management Plan is to reduce Project noise levels.

18.10.1 Noise Regulatory and Management Context

Key guidance documents for the management of noise are:

- BC Oil and Gas Commission standards (BC Oil and Gas Commission, 2009);
- Alberta Energy Resources Conservation Board Directive 038 (Energy Resources Conservation Board, 2007);
- Code of Practice for Metal Mines (Environment Canada, 2009)
- Noise Pollution Control (NPC) NPC-119 Blasting (Ontario MOE, 1978)
- Guidelines for Industrial Activity in Bear Country (MPERG 2008a);
- Flying in Caribou Country (MPERG, 2008b); and
- Flying in Sheep Country (MPERG, 2008c).

18.10.2 BMC Management Strategies for Noise Reduction

Noise reduction design measures that BMC will implement as part of the Project design include (but are not limited to):

- Process Plant Shielding – mineral crushing, grinding, conveyor transfers, tailings and concentrate loading and will occur inside a building, which typically accounts for a 10 dB reduction in noise level (U.S. Department of Transportation, 2006); and
- Dampening Enclosures for other Equipment – all generators, boiler, and compressors will be enclosed in a steel enclosure or steel panelled building.

18.10.3 Noise Reduction Mitigation Measures

Multiple control methods outlined in this section provide options that can be tailored to the site-specific condition. On site application of mitigation measures will be determined based on a variety of factors, and a combination of the most appropriate measures will be implemented. An important component of the Plan will be to ensure that practices are understood and adhered to by all mine employees and contractors.

The following operating practices for noise control will be implemented during all phases of the Project:

- Equipping facility related vehicles including heavy and light trucks with appropriate mufflers;
- Ensuring all internal combustion engines are fitted with appropriate muffler systems;
- Ensuring regular equipment maintenance, including lubrication and replacement of parts by following manufacturer's recommendations;
- Keeping noisy equipment inside of buildings and sheds whenever practicable;
- Adhering to BMC's blasting management protocols that include controlled blasting procedures and optimizes blasting operations, maximizes localised rock breakage and minimizes non-productive noise, vibration and flyrock effect;
- Imposing speed limits for all vehicles (Section 18.12 - Traffic and Access Management Plan);
- Avoiding engine idling (where practicable);
- Maintaining Project roads regularly to minimize vehicle noise associated with vibration; and
- Considering noise control factors when procuring equipment.

18.11 AIR QUALITY MANAGEMENT PLAN

The Air Quality Management Plan (AQMP) incorporates strategies for effective dust abatement and air quality management for the Project. The main objectives of the AQMP are to:

- Minimize fugitive dust;
- Minimize emissions of and exposure to emmissions; and
- Control and as far as is practicable, reduce emissions of greenhouse gases during all phases of the Project.

18.11.1 Air Quality Regulatory and Management Context

The federal government has set National Ambient Air Quality Objectives (NAAQOs) and Canada-wide standards under the *Canadian Environmental Protection Act* (1999). The Canada-wide standards are intended to be achievable targets that will reduce health and environmental risks in a specific timeframe, whereas NAAQOs identify benchmark levels of protection for people and the

environment. Environment Yukon also implemented Ambient Air Quality Standards (YAAQS) for SO_2, TSP, CO, $PM_{2.5}$ and NO_2 in 2010, and more recently for PM_{10} (Yukon Government, 2014c).

- The applicable standards relating to the Project include:
- YAAQS (Yukon Government, 2014c);
- NAAQOs (CCME, 1999); and
- Canada-wide standards (CCME, 2000).

18.11.1.1 Emission Sources and Modelling

Potential stationary and mobile sources of air contaminants and fugitive dust were identified as part of the air dispersion modelling work conducted for the Project. Estimated emission rates were used in conjunction with meteorological and terrain data to produce ambient concentrations predictions during the construction, operation and closure phases of the Project. Details of the air dispersion model are presented in the *KZK Project Air Dispersion Modelling Report* (Appendix E-1).

Emission sources for the contaminants modelled (SO_2, TSP, CO, $PM_{2.5}$, PM_{10} and NO_x) include stationary equipment such as generators, boiler, crusher, SAG and ball mill, and incinerators, and mobile sources such as light and heavy vehicles, bulldozers, cranes, loaders, graders, forklifts, excavators. Fugitive dust sources include material handling and transfer, wind erosion of exposed surfaces and vehicle traffic on unpaved roads.

18.11.2 Dust Abatement and Air Quality Mitigation Measures

Key mitigation measures were incorporated into the Project design and the Air Quality Model (CALPUFF integrated Lagrangian puff model) are discussed in the following sections. Additional practices that were not modelled but that BMC is committed to implementing are also discussed below.

18.11.2.1 Enclosures

To reduce fugitive dust emissions, the crusher will be enclosed in a ventilated building, and material handling and transfers at the process plant facility will occur indoors. The only transfer point in the process circuit that is not indoors will be the conveyor used to discharge coarse ore to the coarse ore stockpile. However, there will be a partial cover over the stockpile.

Theoretically, a total enclosure would reduce dust emissions by close to 100% (WRAP Handbook, 2006); however, a control efficiency of 75% was assumed in the model, for conservatism and to account for traffic in and out of the building and other potential fugitive sources.

18.11.2.2 Progressive Reclamation

Areas exposed to wind erosion will be progressively reclaimed by establishing permanent areas of vegetation, or by the temporary seeding of hardy, fast growing species, that can offer short or long term wind erosion control. Following construction of mine infrastructure, revegetation can be immediately implemented on areas disturbed during construction, but which are no longer required for operations (e.g., Overburden Stockpile, buttresses, along the Access Road and site roads).

18.11.2.3 Road and Exposed Surfaces Watering

BMC commits to watering unpaved roads and exposed surfaces and stockpiles as required. The control efficiency of such measures varies with the rate and frequency of application, traffic volume, and prevailing meteorological conditions. For PM_{10}, the estimated control efficiency of road watering ranges between 10% and 74% (Countess Environmental, 2006). The average value of 42% was used in the model.

18.11.3 Operating Practices

Good operating practices will be an important tool used to mitigate fugitive dust, air quality degradation and greenhouse gas emissions. On site application of mitigation measures will be determined based on a variety of factors, and a combination of the most appropriate will be implemented. An important component of the Air Quality Management Plan will be to ensure that practices are understood and adhered to by all Project employees and contractors. Proposed operating practices are presented in the following sections.

18.11.3.1 Fugitive Dust Control Measures

The following management practices for fugitive dust control will be implemented during all phases of the Project:

- Minimize land clearing activities to the extent practicable;
- Construction of the Access Road and site roads to appropriate engineering standards to reduce silt generation as far as is practicable;
- Implement speed limits for all mobile equipment;
- Watering of Overburden Stockpile, borrow areas, and large cleared areas (if necessary);
- Orientation of material stockpiles so that the length is parallel with prevailing winds where practicable;
- Establish waste rock storage area final surfaces early to enable re-vegetation;
- Construction of windbreaks or stationary mister (water-mist dust control system) (if necessary);

- Visual inspections to identify and address potential dust emissions;
- Timely maintenance of engineered dust control measures; and
- Record of dust suppression activities.

During the operations phase, mitigation measures specific to ore handling and processing may include:

- The use of sleeves and proper chute design to prevent air entrainment of the dust;
- Dust extraction with conveyance to and processing in dust collectors;
- Covering or enclosure of conveyors or conveyor galleries; and
- Installation of water sprays at conveyor transfers for use (as required).

18.11.3.2 Air Contaminant Emissions Control Measures

The following strategies for gaseous and particulate air contaminants emission control will be implemented during all phases of the Project:

- Avoid engine idling (where practicable);
- Ensure vehicles and equipment are maintained according to manufacturers' guidelines;
- Use filters, scrubbers, and other pollution control devices at processing facilities; and
- Use appropriate catalytic or other control systems on diesel engines.

Although included in the Waste Management Plan (Section 18.2), methods relating to the incinerator operation that also benefit air quality, are:

- Waste reduction at source and recycling;
- Waste segregation (exclude items such as batteries, aerosol cans, oil filters, hazardous waste, steel and large pieces of wood from waste incineration);
- Incinerator operation for optimum combustion (waste stream separation based on heating value); and
- Regular inspection and maintenance.

18.11.3.3 Air Quality Contingency Measures

If weather conditions or forecast show strong winds and/or dry conditions, preventative dust management actions will be taken. Ambient monitoring results above YAAQS will trigger contingency measures, which may include:

- Increased frequency of watering/dust suppressant application to road and other exposed areas;

- Traffic re-routing and work reduction in areas where dust is generated;
- Early surface preparation and scheduling of revegetation activities for disturbed areas so that they may be seeded as early as possible; and
- Adjust timing of dust generating activities to reduce cumulative effects;
- Consider reducing drop heights from conveyors, if practicable;
- Limit material transfer points;
- Installation of additional sprinklers/misters along conveyor;
- Pre-watering of areas prior to earthworks;
- Screening material with a porosity of 50% is optimum for controlling dust;
- Review of dust control equipment, control measures and overall management plan as needed; and
- Wind barrier (windrow) construction such as crushed rock, soil berms or fences upwind of roads and exposed areas.
- The following methods would be considered when placing barriers to prevent dust emissions:
- Wind barriers are most effective when placed perpendicular to the direction of the prevailing wind, but will have little or no effect when the wind direction is parallel to the barrier;
- When choosing wind barriers, solid barriers provide significant reductions in wind velocity for relatively short leeward distances, whereas porous barriers provide smaller reductions in velocity for more extended distances;
- Wind barrier height (i.e., greater than 2 metres);

Air quality concerns and corrective actions will be periodically reviewed by the Environmental Manager to determine if additional contingency measures and/or Project design, or operational changes are required.

18.12 TRAFFIC AND ACCESS MANAGEMENT PLAN

The objective of the conceptual Traffic and Access Management Plan (TMP) is to provide an overview of the control measures that will be put in place to manage access on the Tote Road/Access Road, site roads and haul roads for the Project area, minimize potential adverse effects to wildlife and the environment, and to ensure the health and safety of road users and Project personnel is not compromised.

The existing Tote Road is approximately 24 km in length and extends south from the Robert Campbell Highway to the Project (Figure 18-6). The Tote Road in its present state is not suitable for the vehicular traffic anticipated during the construction and operations phase of the Project. The work proposed to upgrade the Tote Road to an Access Road includes:

- Improving horizontal and vertical alignment;
- Drainage improvements;
- Watercourse crossing upgrades; and
- All weather surfacing.

A more detailed description of the proposed upgrades of the road are presented in Section 4.12.1.

Haul roads will be designed for, and used by, haul trucks and will link the ABM open pit to the Process Plant, the Waste Storage Facilities and the Overburden Storage Facility. Haul trucks will have right of way on all surface and in pit haul roads. All haul roads will be constructed in accordance with safety requirements such as roll over berms, as set out in the Yukon Occupational Health and Safety Regulations.

18.12.1 Traffic Management Regulatory and Management Context

The security station and gate at the access point to the Tote Road from the Robert Campbell Highway has been seasonally manned and controlled by the Project owners since 1995 by employing a member of the Ross River community. Only authorized vehicles are allowed on the Tote Road in accordance with lease conditions imposed by the Yukon Government.

During construction, operations and closure the gatehouse attendant will provide a road safety orientation and truck orientation to all personnel who are approved to pass through the gate. In addition, signage will be placed at the entrance of the access road to inform drivers of safety and responsibilities including public access restrictions, warnings of narrow road and large vehicle use, two-way radio requirement with channel frequencies, rules of the road, and the condition to report all wildlife sightings. Access along the road will continue to be managed in this fashion for the duration of the Project.

The subsections below contain specific mitigations for the Tote Road/Access Road and haul roads for the Project. The final TMP will be developed in accordance with the existing permit requirements and with all applicable legislative acts and regulations, including the following Yukon Acts:

- *Environment Act* (2002, c.76); and
- Transportation of Dangerous Goods Act (1992, c.34).

18.12.2 BMC Traffic Management Policies

The TMP will be carried out in conjunction with other management plans included in this submission and relevant to Project access, transportation of goods and wildlife protection, including:

- Wildlife Protection Plan;
- Waste Management Plan;

- Hazardous Materials Management Plan;
- Spill Contingency Plan; and
- Health and Safety Plan.

18.12.3 Traffic Management Mitigation Measures

BMC will establish mitigation and control measures to prevent or reduce the potential adverse effects of vehicular transport or traffic during Project construction, operation and closure. Some mitigation measures may be specific to a Project phase, activity, area or duration. Monitoring and revision of mitigation effectiveness and control measures will be a continuous process to be carried out at scheduled intervals.

Mitigation measures will develop and evolve as the Project continues to progress through the permitting and design process. A number of mitigation measures relevant to traffic management have already been established and are outlined elsewhere in the accompanying conceptual management plans, including:

18.12.3.1 Wildlife Protection

- Implementing Driver education;
- Implementing the Fitness for Work Policy;
- Restricting access to authorized vehicles only;
- Setting and enforcing speed restrictions during the migration periods;
- Adjusting speed and frequency of traffic during particularly high risk periods;
- Travel speeds on along the Tote/Access road will be restricted to a maximum of 50 km/hr for daytime travel, and reduced during nighttime or hazardous weather conditions (as appropriate);
- Travel speeds on haul roads will typically be 30 km per hour; however, reduced speed limits will be enforced at selected locations (i.e.: four primary destinations for hauling material from the pit);
- Minimum traffic levels will be maintained along the Tote Road to the extent practical. Convoys of 2 or 3 vehicles will travel together along the Access Road to reduce periods of sensory disturbance, when practicable.
- Signage will be posted in high collision risk areas (e.g., blind or obstructed turns, water and wildlife crossings; Figure 18-5). Tote/Access Road travel speeds will be reduced to 30 km/hr in these areas. The signs will instruct drivers to reduce speed, remain alert, stop for wildlife, and wait for wildlife to move away (Figure-18-6). Wildlife will have the right-of-way along all roads;

- Individual or groups of animals standing on the road will be allowed to move off the road unalarmed;
- Wildlife incidents (e.g., collisions) will be reported to the Environmental Manager in 24 hours or as soon as possible, and an investigation will try to identify the cause and remedial actions;
- Wildlife observations will be recorded on observation cards and submitted to the Environmental office;
- Radio communication among road users will be required to communicate information such as sightings of large animal species;
- Debris, such as fallen trees, will be removed from roadways as soon as practicable; and
- The use of all-terrain vehicles (for recreation) will be prohibited in the Project area.

The Tote/Access Road will be upgraded during construction. Parts of the road will be expanded to include pull out areas to facilitate two-way traffic and increased ease of passing. The following design features will be implemented to accommodate increased vehicle traffic and size:

- Tote Road will be upgraded to avoid blind spots and reduce potential for wildlife collisions; and
- Embankments will be graded to a low slope (1:5, where practicable) and have fine fill that replicates natural trail conditions. Surfaces will be smooth, compact and constructed with finer fill (less than 100 mm) to avoid leg entrapment.

18.12.3.2 Waste Management

Take the necessary precautions to ensure no loss of waste materials during transport from site.

18.12.3.3 Hazardous Materials Management

Transportation manifests will be maintained in accordance with federal and provincial regulations and drivers will be adequately trained and equipped for spill first response, containment, and communication.

18.12.3.4 Spill Contingency

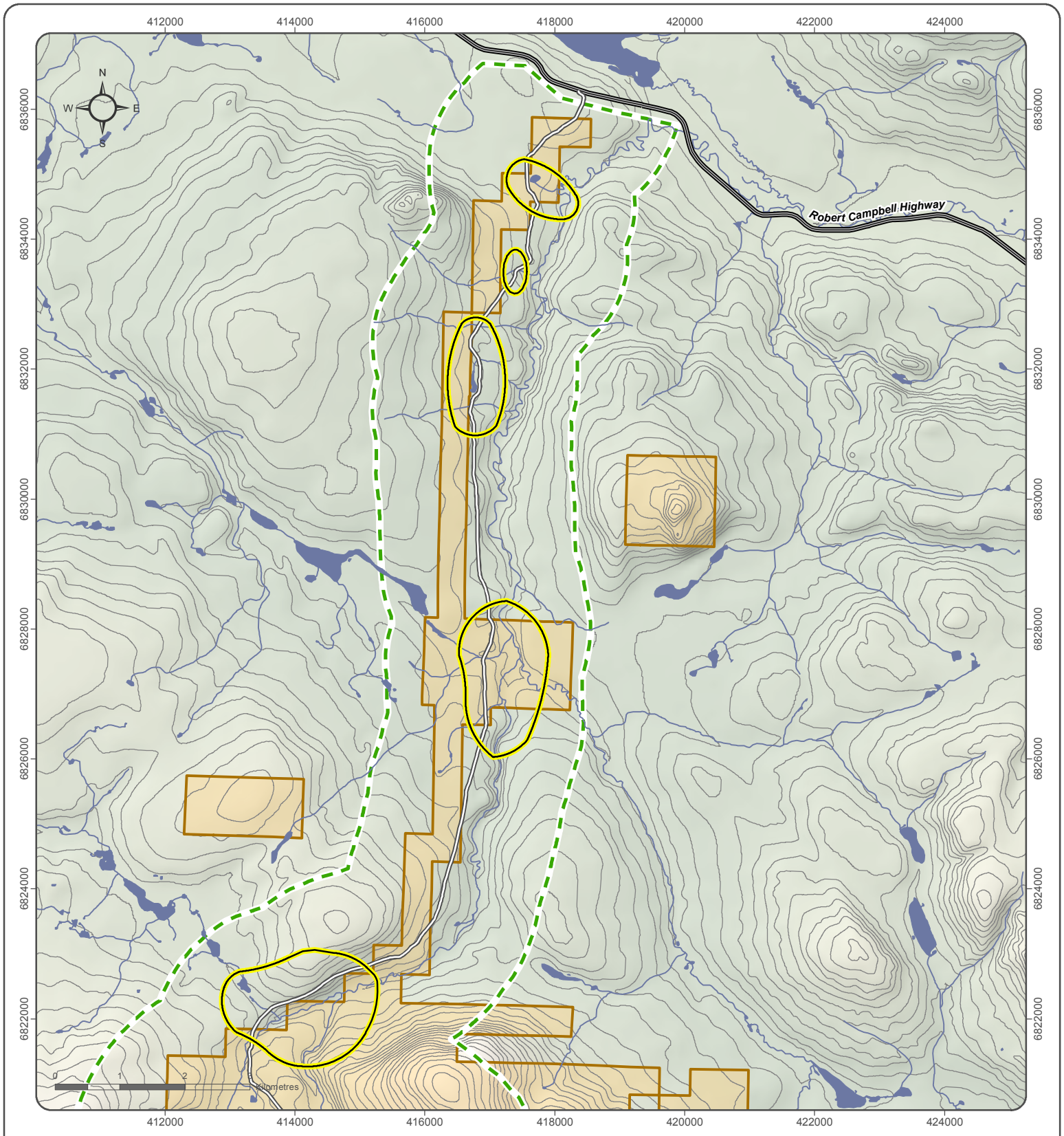
Spills on roadways will be handled as per the Spill Contingency Plan (Section 18.5).

18.12.3.5 Invasive Plant Management

Where practicable, limit vehicle use to existing roads and trails to limit additional ground disturbance and therefore potential introduction of invasive species and all new equipment/vehicles entering site, will need to be weed free prior to site access.

18.12.4 Access Management

Increased access to the traditional range of the Finlayson caribou herd, especially along their migration route to winter range, has been identified as the primary concern by Yukon Government and the Ross River Kaska Dena (Norecol, Dames & Moore Ltd., 1996). Wildlife Mitigations to limit effects from access to the Project include the guarded gate house for the Access Road.



Potential Wildlife Crossing

Local Study Area

BMC Minerals (No.1) Ltd. Mineral Claim Areas

Waterbody

Watercourse

Tote Road/Proposed Access Road

Contour (20 m interval)

KUDZ ZE KAYAH PROJECT

FIGURE 18-6

ACCESS ROAD POTENTIAL WILDLIFE CROSSINGS

MARCH 2017

National topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen, as represented by the Minister of Natural Resources Canada. All rights reserved.
Datum: NAD 83; Projection: UTM Zone 9N

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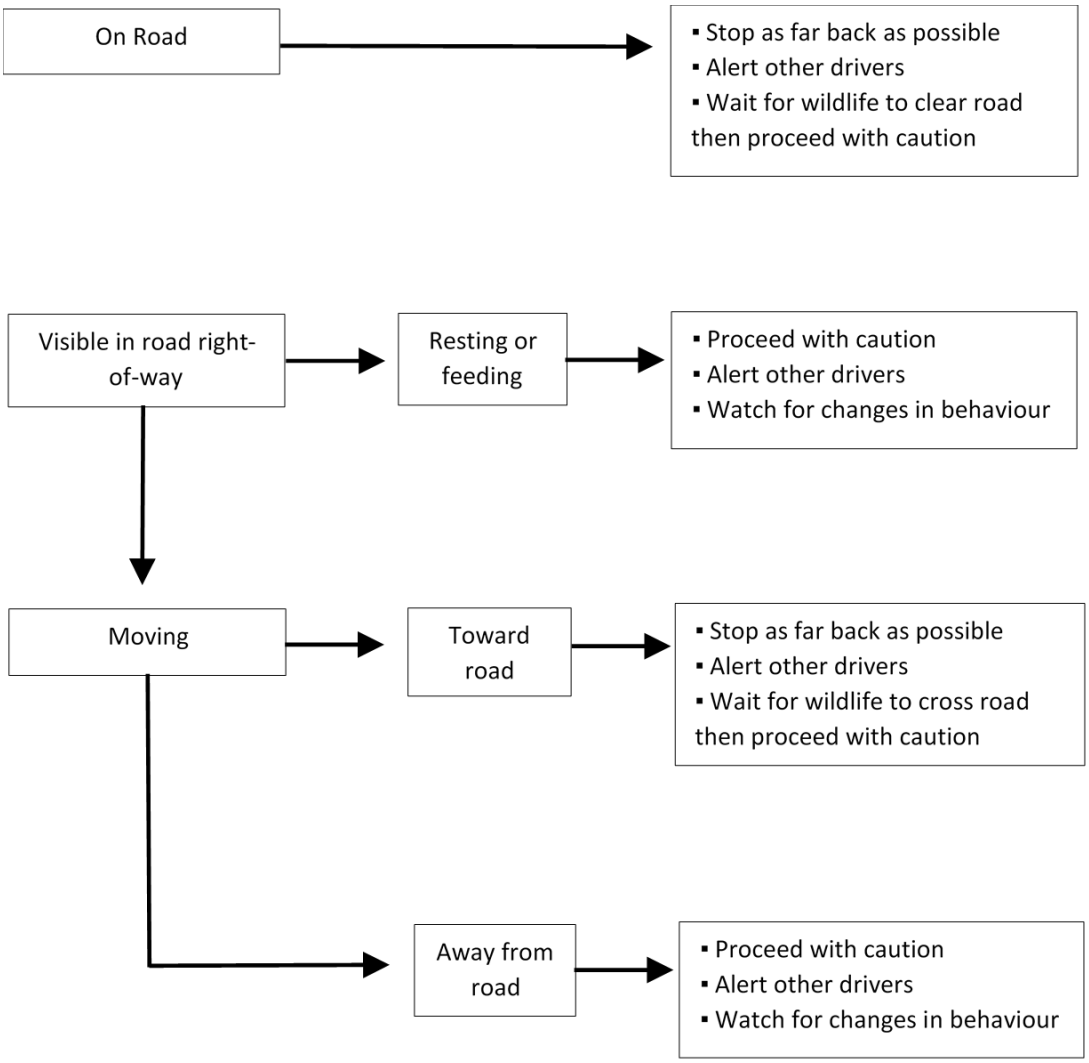


Figure 18-7: Wildlife and Road Operation Decision Matrix

18.12.4.1 Road Maintenance

Road maintenance will incorporate strategies to reduce barriers to wildlife so there is safe passage across roads. The following mitigation measures will be implemented to increase wildlife safety around the Access Road and haul roads:

- In winter, roads will be plowed so that snow banks are less than 1 m in height;

- Limit snow plowing of access and Project roads to only those required for current operations, maintenance and/or emergency access;
- Breaks in snow banks will be placed every 50 to 100 m on both sides of the Access Road to enable passage of large mammals, as practicable;
- Gravel and/or sand will be used on compacted snow or ice to improve road safety. Salt will not be used as it is a wildlife attractant;
- In summer, vegetation along roads will be cleared about 10 m back to remove browse and forage, and improve visibility. Clearing will be done early in the season;
- Road embankments will be low profile to prevent the road acting as a barrier to, or channel for, wildlife movement (as described above); and
- Native seed mixtures will be used to prevent erosion along roadsides. Seed mixtures will contain minimal attractive/palatable vegetation to bears and ungulates (such as legumes).

Various native seed mixtures will be studied as part of reclamation research, which will be undertaken in collaboration with Ross River Dena Council (RRDC). The results of the studies will be discussed with YG to confirm seed mixes to be used for reclamation.

18.12.4.2 Air Access

The Finlayson Lake airstrip will be used for servicing of the Project, primarily for transporting crews. There is also the potential to use helicopters during construction. As such, the guidelines developed by the Mining and Petroleum Environmental Research Group (MPERG) will be adopted to minimize wildlife harassment from aircraft and helicopter use. All personnel, pilots and contractors will be required to follow the guidelines as set out in "*Flying in Caribou Country: How to minimize disturbance from aircraft*" (MPERG, 2008b). Key mitigation measures include the following:

- Flight path routes will be determined that best avoid disturbing wildlife and active hunting areas. Consultation with the Kaska Nation and Outfitters will be ongoing to aid in avoiding sensitive areas;
- Flying will be avoided, where possible, over areas where wildlife has been observed in past seasons (based on publicly available information from the Yukon Zinc studies in the vicinity of the Project and Yukon Government data), and areas sensitive to wildlife at certain times will be avoided;
- Flights will be conducted at minimum of 300 m (1,000 ft.) above ground level elevations to minimize disturbance to wildlife, except where required for work, safe landing approaches/ flight path;
- If flying height is required below 300 m, flights will be timed so as to not interfere with sensitive species and seasons (refer to Table 18-8);
- Purposefully flying helicopters towards, hovering and circling wildlife will not be permitted;

- The closest known Dall sheep area is 6 km southeast of the Project area, which is a nursery site and a mineral lick is situated at the east end of North Lake. Air traffic coming from the south, will avoid these two areas by approaching Project area from southwest; and
- Sensitive wildlife habitat areas and flight timing restrictions are presented in Figure 18-8. This map will be updated annually and provided to air service contractors.

KUDZ ZE KAYAH PROJECT

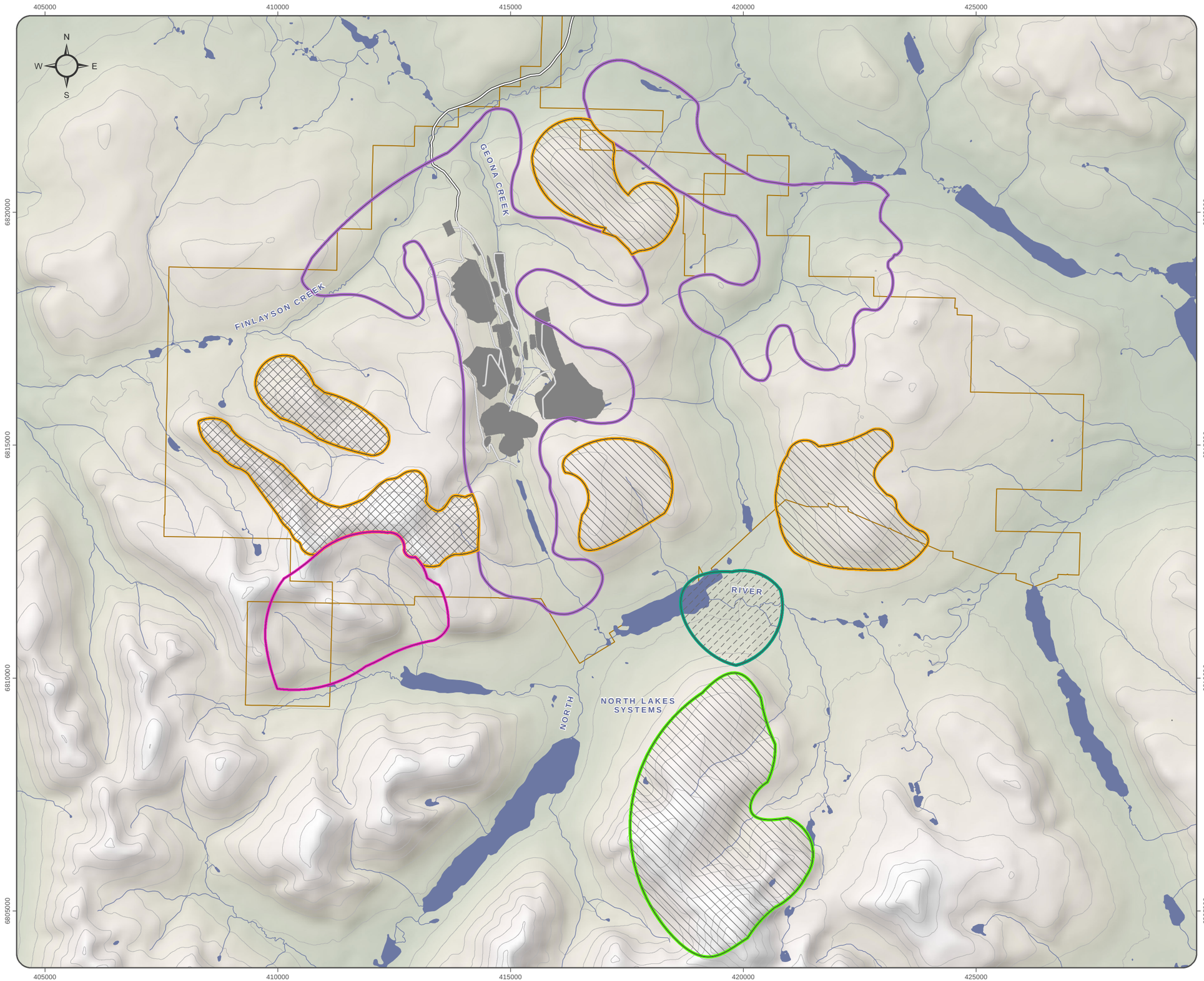
BMC MINERALS

KUDZ ZE KAYAH PROJECT

FIGURE 18-8

WILDLIFE KEY AREAS

NOVEMBER 2016



- Grizzly Bear Den
- Moose Late Winter Season Habitat
- Caribou Post Calving Season Habitat
- Caribou Rut Season Habitat
- Sheep and Caribou Rut Season Habitat
- Mineral Lick
- BMC Minerals (No.1) Ltd. Mineral Claim Areas
- Location of Proposed Mine Infrastructure
- Tote Road/Proposed Access Road
- Proposed Project Site Road
- Contour (100 m interval)

ALEXCO ENVIRONMENTAL GROUP

Digital elevation model created by the Yukon Department of the Environment interpolated from the digital 1:50,000 Canadian National Topographic Database (NTDB Edition 2) contour and watercourse layers. Obtained from Geomatics Yukon.

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18.13 HERITAGE RESOURCES MANAGEMENT PLAN

This Heritage Resources Management Plan (HRMP) includes the proposed mine site and the Access Road from the mine site to the Robert Campbell Highway. The action items and communication protocols presented here are intended to be used for the entire Project life.

The proposed Project mine area and access road have been the subject of previous heritage resources impact assessments in 1995 (Rutherford, 1995a, 1995b), 1996 (Rutherford, 1996), 2015 (Mooney and Bennett, 2016), and 2016 (Bennett, 2016).

18.13.1 Heritage Resources Regulatory and Management Context

Heritage resources in Yukon are protected under the Yukon *Historic Resources Act* (Yukon Government, 2012a) and protected and managed under provisions of the Yukon First Nations Umbrella Final Agreement (UFA). The Heritage Resources Unit of the Yukon Government prepared an operational policy that communicates the Yukon Government's position on ownership and management of heritage resources.

Besides the *Historic Resources Act,* the HRMP was prepared with the following additional legislation in mind so that heritage resources may be protected and managed including chance finds:

- The Quartz Mining Land Use Regulations (Yukon Government, 2003) – under the *Quartz Mining Act* (Yukon Government, 2016d) specifically Schedule 1 Operating Conditions, Section E regarding historic objects and burial grounds; and
- The Land Use Regulation under the *Lands Act* – specifically Section 9 (Prohibitions) (Yukon Government, 2014a).

Heritage resources (with the exception of heritage sites identified in First Nation Final Agreements, and ethnographic objects) on non-settlement Yukon lands are considered the property of all Yukoners, are held in trust for all Yukoners, and are managed by the Yukon Government.

Heritage resources on First Nation Settlement lands are owned and managed by the First Nation. In this case the Project and the road from the mine site to the Robert Campbell Highway do not cross over any First Nation Settlement lands or interim settlement lands. A parcel of Interim Protected Land (RRDC-R15A) adjoins the southern boundary of the Project but no ground disturbing effects are planned near this area.

Under the *Historic Resources Act* and the Archaeological Sites Regulations heritage contractors prepare required written reports as well as artifacts and materials collected in the field for long-term record keeping and artifact curation (Yukon Government, 2012a). This includes preparing artifact catalogs, labeling artifacts, packaging and preparing artifacts to meet specific long term curation goals as needed. To ensure proper completion of permit requirements, heritage contractors submit interim and final reporting as well as collected materials to the Yukon Heritage Resources to review. After the permit reporting and artifact curation preparation requirements are met, then the Heritage

Resources Unit would submit materials to appropriate First Nations as requested for further management or continue to hold the materials at the direction of the First Nations.

18.13.2 BMC Heritage Resources Management

Two heritage resources were identified and recorded in the Project area (Appendix F-1). As sites were found in the field they were assessed for their site significance and the potential effects by proposed developments and management recommendations were presented on a site-by-site basis. Archaeologists in the field flagged the locations of these sites at time of discovery, however flagging tape is not permanent and as time passes it could be destroyed by weather, disturbed by wildlife or removed by humans.

The HRMP incorporates communications between BMC, the Heritage Resources Unit, RRDC and Liard First Nation (LFN). These actions and protocols are intended to be carried forward throughout construction development, reclamation, and closure of the Project.

Effects to recorded historic and prehistoric resources should be avoided were possible, or mitigation efforts should be completed prior to construction effects. A site specific management recommendation for site JiTp-1 was presented in the 2015 Heritage Resources Impact Assessment (HRIA) Report conducted by Ecofor in 2015 (Mooney and Bennett, 2016) and completed by Ecofor in 2016 (Appendix F-1). The remains of this site are planned to be destroyed by construction activities and as such, was the subject of systematic data recovery prior to construction and is considered fully managed/mitigated. There is currently one remaining heritage resource site (JjTp-1) to be managed near the currently proposed Project (continued avoidance).

18.13.3 Heritage Resources Mitigation Measures

Prior to any new ground disturbing activities, the on site Environmental Manager will review the location of the planned disturbance against previously conducted heritage resource impact assessment efforts and recorded heritage site locations. If the area of planned effects has not been the subject of an HRIA, then an HRIA effort will be required prior to ground disturbance. This HRIA effort will incorporate known TK to guide field work and include Kaska field participants in all fieldwork. If any sites have been recorded in or near the planned ground disturbance location the Environmental Manager will review the location of the heritage sites with the equipment operators in the field, on foot, and provide directions to avoid effects to the identified sites with a 30 m buffer area.

18.13.3.1 Chance Find Procedures

Guidelines to respond to the discovery of either disturbed or intact archaeological materials, historic, paleontological, and/or human remains during development activities are covered under BMC's Chance Find Procedure. The Chance Find Procedure applies to situations where archaeological sites or resources are found where they are not known during the course of construction, or identified during further exploration efforts, baseline environmental efforts, and ground disturbing activities.

The purpose of the Chance Find Procedure is to minimize disruption to the construction schedule, as well as promoting the preservation and proper management of archaeological resources that may be identified. However, the locational data regarding any heritage chance finds or existing known heritage resources, are not to be made accessible to the general public, and should not be included in public access documents or mapping.

These heritage resources may range in size from small flakes and chips of lithic debitage remaining from stone tool manufacturing, up to large historic structures such as cabins and workshops. Other possible heritage resources include paleontological resources, culturally modified trees, fire cracked rock, historic adits, cache pits, house pits, paleontological remains, isolated prehistoric tools of wood, bone, antler, and isolated historic items.

If any additional heritage resources are identified, be it intact or disturbed, all work in the immediate area will cease. The resources will be left in place, recorded with the Chance Finds Report Form (see below and Appendix F-1), and the area of the find will be protected from further effects with a minimum 30 m buffer. The Environmental Manager will be notified of the type, amount, and location of the find. Information collected and passed on regarding the chance find will include:

- GPS location of the find;
- Date and time when the find was identified;
- Approximate size of find and type of materials present;
- Description of setting and access to the location of the find; and
- Digital photographs of the find(s) and general area of the find.

The Environmental Manager will then contact the Heritage Resources Unit to discuss further management options and notify the appropriate RRDC and LFN contacts. If the area can be protected and immediate salvage operations are not required, then a resource specific or site specific mitigation plan may be developed to recover data and information under direction of the Heritage Resources Unit and the RRDC and LFN. If the remains include paleontological remains, then the Yukon Paleontologist will also be contacted.

If human remains are identified during operations, all work in the area will immediately cease and further effects to the area will be prevented. The Royal Canadian Mounted Police (RCMP) will be notified. If the RCMP and Coroner determine that the remains are from a historic burial, the First Nation(s) and Yukon Heritage Resources Unit will be notified, as per the Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in Yukon. Personnel should recognize that the appropriate course of action may vary depending on whether the remains are found in an archaeological context (i.e., in association with artifacts) or found without direct context to historical resources.

As part of the ongoing and continuing efforts to increase awareness of the possible heritage resources that may be found in the area, and those that have been recorded, BMC will notify staff and visitors during site induction and leave multiple copies of the booklet entitled Handbook for the Identification

of Heritage Sites and Features (Gotthardt and Thomas, 2005), and the Chance Find Report Form (Appendix F-1), at the Project Camp to be shared with current and future management and staff.

18.13.3.2 Planned Impact of Known Sites

Some heritage sites that are planned to be impacted prior to construction, must be approved by the Heritage Resources Unit. In most cases sites to be impacted will be subjected to a data recovery mitigation plan and fieldwork efforts. In the case of prehistoric archaeological sites, detailed block excavation of a significant sample of the site is often used to collect and record information from the site prior to site effect. In the case of historic resources more detailed photographic, ethnographic, informant, and archival research may also be used to document a resource before it is impacted.

Each heritage resource at the Project will be flagged for avoidance as noted above. If any sites have received data recovery excavations and/or other mitigation efforts these efforts and results must be reviewed by the Heritage Resources Unit and applicable First Nations prior to final approval for the site to be impacted. Until such approval, each site will remain flagged to avoid additional impacts. Only after approval for impact has been granted may the site be impacted. Sites located on non-settlement lands are managed by the Yukon Government, while sites located on settlement lands are managed by First Nations. The Project area and associated road to the Robert Campbell Highway do not include any First Nation settlement or interim settlement lands. A parcel of Interim Protected Land (RRDC-R15A) adjoins the southern boundary of the Project but no ground disturbing effects are planned near this area.

18.13.3.3 Continued Communication with First Nations and the Heritage Resources Unit

Communications regarding newly recorded heritage sites and resources, or effects to heritage sites or resources will be immediately relayed to the Heritage Resources Unit, RRDC, and LFN.

18.14 SOCIO-ECONOMIC EFFECTS MANAGEMENT PLAN

The purpose of the Socio-economic Effects Management plan is to manage the effects of the Project on the potentially affected First Nations and communities. The Project has a Socio-economic Participation Agreement (SEPA) with the Ross River Dena Council.

18.14.1 Employment Plan

18.14.1.1 Recruitment Commitments

BMC is committed to honour the terms of the SEPA by working with the Kaska to fill openings at the Project (for both BMC and its contractors) for qualified persons, and to the extent permitted by law, give preference to qualified job applicants in the following priority:

- Ross River Dena Council citizens;

- Other Kaska citizens;
- Other Yukon First Nation citizens;
- Other Yukon residents; and
- Others.

18.14.1.2 Education and Skills Training

BMC views the long-term development of education levels and transferable skills as one of the long-term benefits the Project will offer to employees and their communities.

The Project's employability enhancement measures include:

- BMC's Kaska Education Scholarship Program;
- BMC's Mentor Program;
- General workplace training for employees;
- Trades apprenticeships; and
- Summer employment for Kaska students.

18.14.2 Local Procurement Plan

Kaska companies will be offered the right to submit a first proposal on the following contracts for goods and services (part of SEPA):

- Winter road construction;
- Site clearing for the permanent access road;
- Access road security;
- Miscellaneous "civil" work (e.g., back hoe, cat hauling);
- Camp catering;
- Reclamation work such as re-seeding;
- Janitorial services;
- Laundry and linen services;
- Line-cutting;
- Concentrate haulage;
- Expediting; and
- Mine site fuel supply.

The list is not to be considered exhaustive. In addition, the SEPA statement includes the provision that BMC will ensure that all its sub-contract tender documents contain a "local benefits" component and that BMC will give the local benefits component meaningful consideration when evaluating tender bids. This will benefit both Kaska and non-Kaska businesses.

In order to achieve the requirements of the Community Relations Policy (Appendix A-2) and further support local participation, BMC will:

- Encourage the participation of local communities, local Indigenous Peoples and associated businesses in its projects wherever practicable; and
- Develop and implement community relations management procedures and strategies that includes business alliances, employment and training initiatives on safety in the workplace and practical operating skills.

18.14.3 Social and Cultural Well-being

To help employees and their families maintain good health, BMC will negotiate on behalf of all employees for favourable arrangements with suppliers of life and property insurance to significantly reduce the costs of these products and offer a dental and health plan for employees.

BMC will also support the provision of information regarding health and wellness education programmes and will initiate an Employee Assistance Program (EAP) to ensure that access to counselling services will be made available to all employees and employee families as required.

BMC intends to mitigate possible family stress of its employees through;

- Extensive screening of employees before hire to gauge their suitability for shift work and to help educate them on its potential effects;
- The point of hire being Yukon reduces travel time of employees to get back to their families.
- To provide assistance and education through its EAP to all employees and their families as required including:
  - Financial management training;
  - Drug and alcohol counselling (including time off for employees who need treatment);
  - Marriage counselling; and
  - Healthy living education (i.e., benefits of diet and exercise);
- BMC will host annual family days at the mine site to show spouses and children of the employees the mine and associated facilities;
- Communications at the site will be via microwave (to maximize bandwidth) and individual connections in each room to ensure that employees can easily communicate via Skype/Facetime etc. with their spouses and children in the privacy of their room rather than in a communal area;

- BMC will provide recreational facilities at the site and all meal times will have healthy food options, to promote health and well-being of employees while on-shift (with the intent that this would also extend to off-shift healthy living);
- Training of employees (e.g., trades, apprenticeships, management) to promote progression in their careers (which may enhance job satisfaction);
- Bereavement leave will be available to all employees; and
- The 2 week in and 1 week out shift rotations, when combined with the four weeks of annual holiday available after the first year of employment, will allow employees to take one month off twice per year.

The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter (see BMC's Fitness for Work Policy in Appendix A-5). BMC will also support the provision of information regarding health and wellness education programmes and access to counselling services will be made available to all employees and employee families through its EAP, as required.

Gathering traditional medicine in the operating area of the Project will not be permitted during operation of the mine due to the Tote Road licence requirements and BMC's commitment to public health and safety however the Company will work with local elders to find a way to allow collection in other areas where safety will not be compromised. As part of the progressive reclamation and final reclamation planning, BMC has committed to working with RRDC in identifying the species that will be used for the reclamation purposes and developing a seed collection program and seed bank in Ross River.

To support culture, history, and heritage BMC will strictly enforce its Employment and Anti-Discrimination Policy (Appendix A-3) and its Community Relations Policy (Appendix A-2) BMC states: *We will strive for the improvement of cross-cultural awareness through the induction, training and education of our personnel in local Indigenous Peoples culture and workplace relationships*. Furthermore, BMC is committed to hiring Kaska citizens through the SEPA and will be hiring two community mentors to assist Kaska employees while on-shift and off-shift. These mentors are intended to support Kaska culture so Kaska employees will be comfortable and supported in speaking Kaska while at work.

18.14.4 Traditional Economic Activities

BMC will be implementing several mitigation measures to reduce any adverse effects of the Project on traditional economic activities, including:

- All firearms are prohibited at the mine site unless otherwise authorized by BMC management (Appendix A-8);

- All hunting of wildlife or recreational shooting by employees, contractors and visitors is strictly prohibited, as outlined in the No Firearms Policy (Appendix A-8); this policy will be communicated to all employees and contractors during the site orientation;
- Recreational use of all-terrain vehicles (ATVs) and snowmobiles is prohibited in the Project area (Appendix A-11);
- Access and use of the Tote Road has been strictly controlled since the 1990s and there will be ongoing access control to the Project area, as per the requirements of the Tote Road Licence. Use of the Access Road during Project operations to access recreational areas for ATV and snowmobile use will be strictly prohibited;
- Implementation of the Traffic and Access Management Plan (see Section 18.12) will mitigate the adverse effect of increased traffic on area wildlife; and
- As part of the Socio-economic Participation Agreement (SEPA) BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights under the registered group trapline, and operated trap lines in the Project area.

18.15 HEALTH, SAFETY AND EMERGENCY RESPONSE PLAN

The objective of the BMC Health, Safety and Emergency Response Plan (HSERP) is to provide a framework for developing general safety and emergency response procedures that will enable Project personnel to contribute to a safe working environment and be better prepared to deal with emergency situations when they occur. This preparedness will be established through a process of continuous improvement to raise awareness of Project plans and procedures in line with individual roles and responsibilities.

18.15.1 Health, Safety and Emergency Response Management and Regulatory Context

The HSERP will be developed in accordance with the following Yukon Acts:

- Occupational Health and Safety Act (2002) (Yukon Government, 2010);
- *Public Health and Safety Act* (2002) (Yukon Government, 2013c);
- *Quartz Mining Act* (2003) (Yukon Government, 2016d);
- *Environment Act* (2002) (Yukon Government, 2016a); and
- *Dangerous Goods Transportation Act* (2002) (Yukon Government, 2013a).

Development of the HSERP will be carried out in conjunction with other management plans included in this submission and relevant to emergency situations, including:

- Waste Management Plan;
- Hazardous Materials Management Plan;

- Spill Contingency Plan;
- Traffic Management Plan; and
- Health and Safety Plan.

Drafting of the HSERP will be based on the key components of the BMC Occupational Health and Safety Policy (Appendix A-5). This policy sets out the core corporate objective of implementing a Health and Safety Management System to:

- Recognise 'Duty of Care' to provide a safe workplace and foster safe working practices;
- Treat others with dignity and respect during discussions on health and safety to recognise and control hazards;
- Meet or exceed applicable health and safety legislation with emphasis on appropriate training and processes;
- Report and investigate incidents/accidents to ensure development of corrective actions and continuous improvement; and
- Systematically review safety management and risk management practices.

18.15.2 BMC Health and Safety Management System

Development of the Project-specific Health and Safety Management System (HSMS) will be based on three key areas; Planning, Implementation and Monitoring, in a circle of continuous improvement.

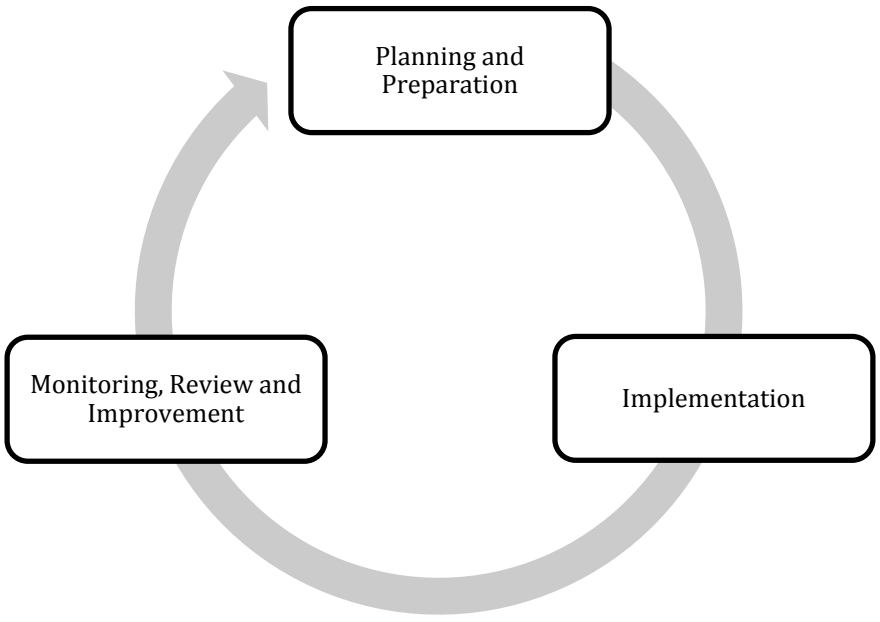

Figure 18-9: Key Areas of the BMC Health and Safety System

18.15.2.1 Planning and Preparation

Planning and preparation of the HSMS will be conducted through a process of risk identification, assessment and the subsequent establishment of risk mitigation control measures. Planning and preparation will be undertaken before the commencement of each phase of Project permitting, construction and operations. Keys steps in the planning and preparation process include:

- Identification of potential risks;
- Assessing the likelihood and severity of the risk using a risk matrix;
- Identification of appropriate measures for controlling risks (e.g., through action plans, guidelines); and
- Identification of resources required to implement mitigation controls.

18.15.2.2 Implementation

Implementation begins with the preparation, modification, or updating of the safety and emergency response plans, guidelines and the "*on the ground*" or working documentation required to satisfy the requirements of the Project. The working documents required for the Project will include but are not limited to:

- A finalized HSERP, to be updated as required;
- Training material to make Project personnel aware of the HSERP; and
- Development of occupational, safety, and emergency response overview materials to be displayed throughout the Project area to act as a quick-reference tool or in the event of an emergency.

18.15.2.3 Monitoring, Review and Improvement

As part of the continuous improvement process, monitoring of the HSERP effectiveness will be achieved through:

- Scheduled BMC audits of the HSERP and HSMS;
- Post-incident and emergency debriefs and reporting; and
- As part of a specific incident or emergency close-out, incorporate any corrective or preventive action measures taken into revised plans, guidelines or procedures.

18.15.2.4 Emergency Classification

BMC have defined three levels of emergency, depending on the severity or circumstances surrounding an incident or situation. Levels are defined by various criteria as outlined below:

- Level 1 (Low): A Level 1 incident is an emergency that can be dealt with by on site personnel and facilities;
- Level 2 (Serious): A Level 2 incident is an emergency that could be beyond the capabilities of the site operations and may require the activation of additional support or third party contractors. The incident may require reporting and/or limited assistance from YG emergency support services;
- Level 3 (Severe): A Level 3 incident is a highly serious situation with the possibility of developing into a crisis involving fatalities or multiple serious injuries. Level 3 emergencies may or may not easily escalate into a crisis. This situation will require the active involvement and/or assistance from YG emergency support services. The actual or potential consequences of a Level 3 emergency are such that the Company Senior Management needs to be immediately informed; and
- Crisis Management: An emergency may be so severe that it reaches a level 3 emergency, and could escalate to a situation involving fatalities or multiple serious injuries. In these rare occasions, a Crisis Management Plan (CMP) is required. The CMP will be put into place in conjunction with the HSERP.

18.15.2.5 Emergency Response Roles and Responsibilities

The roles and responsibilities of key Project personnel in an emergency will be detailed in the HSERP. Roles and responsibilities will be outlined in two distinct categories:

- General Project Personnel; and
- Initial Emergency Responding Personnel.

In practice, some of these responsibilities may be delegated to specific individuals or contract leads; however, the responsibility for ensuring execution of the tasks will remain with personnel holding the roles listed.

As potential incident or emergency scenarios are identified, the mitigation and control measures established to respond to these emergencies may require the development of specific roles and responsibilities to be carried out where appropriate. Each variation of these emergency roles and responsibilities to be assumed in a given emergency will be detailed in the HSERP.

18.15.3 Emergency Response Mitigation Measures

Through the identification and assessment of risks related to emergency response and management, control measures will be developed for items including, but not limited to:

- Site evacuation plan;

- Evacuation procedures will be developed and Project personnel will receive training and conduct regular drills to become familiar with the warning system and steps to be taken to safely evacuate the site.

- Emergency response/rescue equipment;
  - An inventory of emergency rescue equipment will be maintained and Project personnel will be trained in the appropriate use of equipment as necessary.
- Personnel training plan;
  - Training plans will be developed for all Project personnel and adequate health, safety and emergency response training will be provided based on the requirements of individual roles and responsibility.
- Emergency response/rescue team;
  - An emergency rescue plan will be developed for situations in which Project personnel must lead or participate in a rescue situation. An emergency response team will be established and receive training in items such as rescue techniques, firefighting, hazardous materials handling and appropriate use of emergency response equipment.
- Missing persons or vehicle;
  - A site check-in/check-out procedure will be developed outlining the daily planned activities, location and anticipated activity completion time for all Project personnel.
- Emergency contact list;
  - A list of key Emergency contacts will be maintained and displayed throughout the Project area as a quick reference tool to be used in the event of an emergency.
- Spill Response;
  - Contingency plan details outlined in Section 18.5.
- Explosives management;
  - Control measures will be established involving the safe handling, transport, storage, and use of explosives during the life-cycle of the Project. Any non-compliance with these control measures will prompt an immediate investigation.
- Extreme weather conditions;
- Power failure;
  - Back-up generators and power restoration procedures will be developed.

- Wildlife encounters; and
- Medical evacuation.

The medical evacuation flowchart (see Figure 18-10) was developed as a decision making tool to be followed in the event of a medical emergency requiring transportation from the Project area. This flowchart is included as an example of the detail to be included in a medical evacuation flowchart for the HSERP.

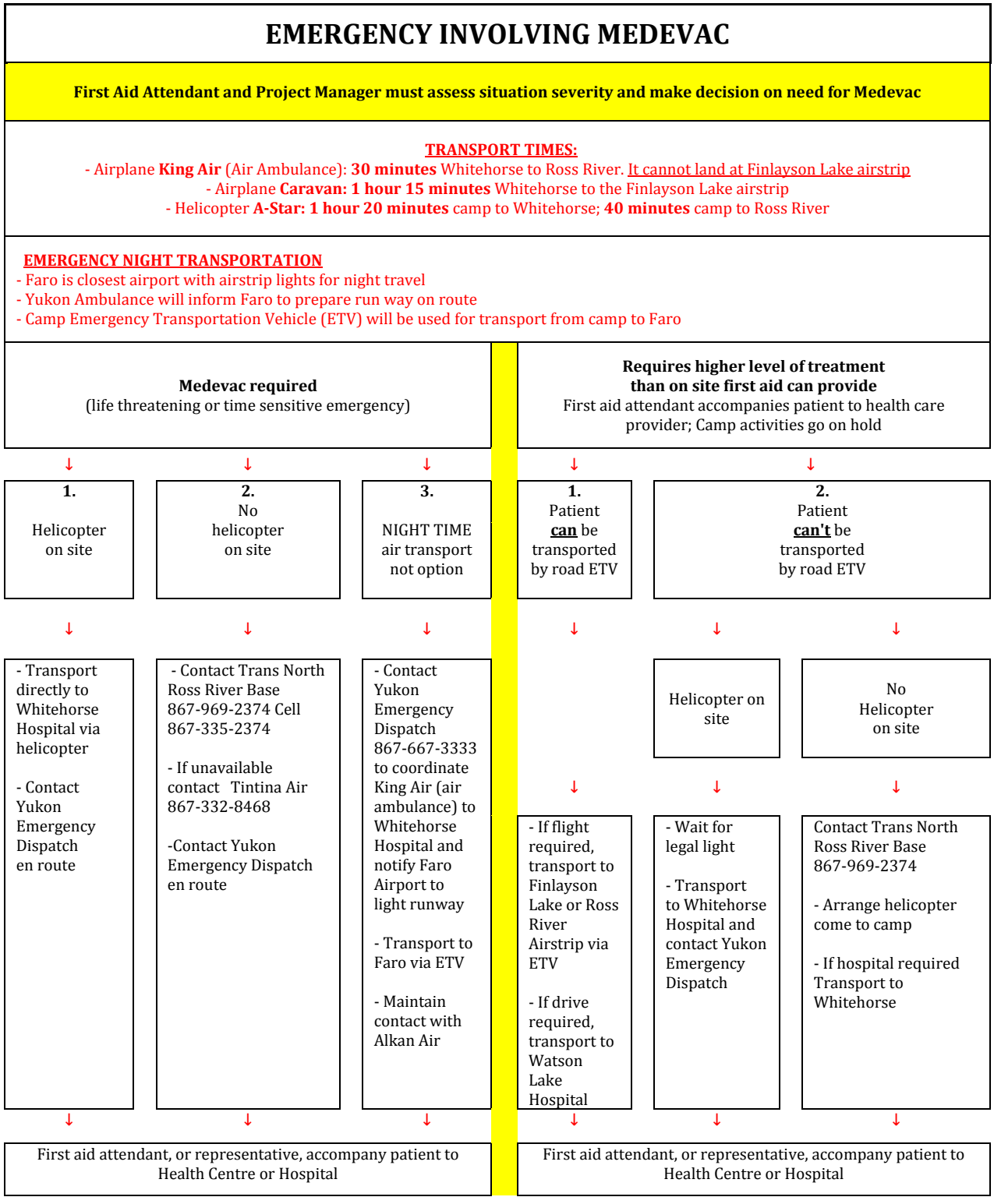

Figure 18-10: Medical Evacuation Flowchart

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

19 SUMMARY AND CONCLUSIONS 19-1

19.1 SUMMARY OF CONSULTATION 19-1
19.2 SUMMARY OF RESIDUAL PROJECT AND CUMULATIVE EFFECTS 19-2
19.3 EFFECTS OF ENVIRONMENT ON THE PROJECT 19-14
19.4 MALFUNCTIONS, ACCIDENTS AND UNPLANNED CLOSURE 19-14
19.5 ENVIRONMENTAL MANAGEMENT AND MONITORING 19-16
19.6 CONCLUSIONS 19-17

LIST OF TABLES

Table 19-1: Project and Cumulative Effects Summary 19-3
Table 19-2: Conceptual Management Plans 19-16

19 SUMMARY AND CONCLUSIONS

This submission and its appendices (the Project Proposal) have been developed to meet the requirements for a screening pursuant to the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*) by the Yukon Environmental and Socio-economic Assessment Board (YESAB) Executive Committee. The proponent, BMC Minerals (No.1) Ltd (BMC), seeks to gain territorial and federal approvals to develop and to operate a mining project at the Kudz Ze Kayah (KZK or the Project) which will produce copper, zinc and lead concentrates for sale to Canadian and export markets.

Environmental and socio-economic studies for the Project were completed in 1994/1995 by original owners Cominco Inc. (Cominco) to support the Initial Environmental Evaluation (IEE) under *Canadian Environmental Assessment Act* (submitted for regulatory review in March 1996 and approved in December 1997). In 1998, Type A Water Licence QZ97-026 was issued to Cominco, providing approval to commence development of a mining project, this was subsequently taken over by Teck Resources Inc. (Teck). When the property was purchased by BMC from Teck (January 19th, 2015), the Water Licence was transferred to BMC as Licence QZ97-026-01. Since 1998, environmental baseline data for the Project has also been collected bienially (until 2014) as part of the requirements of the Project's existing Type A Water Licence. In addition, through the previous permitting processes, Yukon residents in potentially effected communities were extensively consulted. Since the acquisition of the Project in 2015, BMC has built on these environmental studies and re-initiated the consultation and engagement process for the Project. The Project footprint is also largely the same as that which was proposed during the 1990s.

Hence, the development of the Project Proposal for KZK, has relied on extensive long term data sets, that include results from the previous assessments and permitting processes, analysis and interpretation, in order to evaluate potential effects of the Project. In addition to the historical data set, the Project Proposal includes the extensive work carried out by BMC in 2015 and 2016. The assessment has also included integration of Traditional Knowledge (TK) and consideration of issues and concerns raised from the Kaska First Nation (Kaska), the broader community, government agencies and boards, and other interested parties. This chapter provides a summary of the effects assessment completed in this Project Proposal.

19.1 SUMMARY OF CONSULTATION

BMC has built on the strong relationship with local communities and the Kaska that was initially developed between Project's previous owners Cominco, and subsequently Teck. BMC commenced consultation and engagement initiatives with Kaska (through RRDC) prior to purchasing the property. Facilitated by Teck, BMC held two meetings with RRDC in 2014 with the aim of introducing parties and to allow BMC to confirm with Kaska that their support for the KZK Project as expressed in the 2004 Socio-economic Participation Agreement (SEPA) would be extended to BMC once that agreement was assigned by Teck. Following their satisfaction at the response from RRDC, BMC made the decision to purchase the Project. This respectful and open approach has continued and underpins the good relationship that BMC enjoys with the Kaska (through RRDC) today.

For this Project the two primary Kaska Nations consulted are Ross River Dena Council (RRDC) and Liard First Nation (LFN), with RRDC acknowledged as the lead agency under the Kaska Collaboration Agreement. Kaska Dena Council, representing citizens of all Kaska First Nations, has also been consulted, as have the local communities of Ross River, Watson Lake, Faro, and Whitehorse.

The means of consultation have included:

- Meetings and communications with Chief and Councillors;
- Meetings with Chief and Elders;
- Public open houses;
- Quarterly newsletters; and
- Virtual Open House.

To complement the community open houses, BMC developed a Virtual Open House which is hosted on the KZK Project website (www.kudzzekayah.com/kudz-ze-kayah-proposal-community-information), for those who were either unable to attend one of the community meetings, or who desired more detailed and contemplative review of the Project material.

BMC has also committed to ongoing community and First Nations engagement throughout the life of the Mine. This approach is a core element of BMC's corporate philosophy, is codified in BMC's policies and has been endorsed by the BMC Board of Directors.

19.2 SUMMARY OF RESIDUAL PROJECT AND CUMULATIVE EFFECTS

During the studies carried out in support of this submission, BMC identified and assessed fourteen Valued Components (VCs) for potential Project and cumulative effects. During the studies and in this Project Proposal, a number of measures have been proposed in order to mitigate or minimize adverse effects, and enhance any beneficial effects. With the Project design and proposed mitigation measures in place, no significant residual effects or cumulative effects were identified; whereas, several beneficial socio-economic effects were identified. A summary of the effects assessment for each of the VCs is presented in Table 19-1. It is noted that only the key mitigation measures are presented in Table 19-1, with further detail provided in each of the VC chapters.

Table 19-1: Project and Cumulative Effects Summary

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
Air Quality (Chapter 6)						
Criteria Air Contaminants	Increase in Ambient Concentrations of Particulate Matter (TSP, PM_{10}, $PM_{2.5}$) at camp receptor	Construction, operations, closure	Crusher enclosure, and material handling and transfers at the process plant facility occurring indoors. Cover over the coarse ore stockpile. Progressive reclamation of disturbed areas. Road and Exposed Surfaces Watering. Use of dust collectors and proper chute design to prevent air entrainment of dust. Dust extraction with conveyance to and processing in dust collectors. Covering or enclosure of conveyors or conveyor galleries. Installation of water sprays at conveyor transfers for use. Minimizing land clearing activities. Construction of the Access Road and site roads with appropriate material. Set speed limits for all mobile equipment. Orientation of material stockpiles so that the length is parallel with prevailing winds where practicable. Establish waste rock storage area final surfaces early to enable re-vegetation. Construction of wind breaks or stationary misters. Visual inspections to identify and address potential dust emissions	Yes	Not Significant	No residual cumulative effect identified
	Increase in Ambient Concentrations of Criteria Air Contaminants (TSP, PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2) at camp receptor	Construction, operations, closure	Use filters, scrubbers, and other pollution control devices at processing facilities. Avoid engine idling (where practicable). Ensure vehicles and equipment are maintained according to manufacturers' guidelines. Use catalytic control systems on diesel engines.	Yes	Not Significant	No residual cumulative effect identified
Greenhouse Gases	Emission of Greenhouse Gases contributing to territorial and national inventories	Construction, operations, closure	Waste reduction at source and recycling. Waste segregation. Incinerator operation for optimum combustion. Regular inspection and maintenance of incinerator.	Yes	Not Significant	Not Significant
Noise Levels (Chapter 7)						
Daytime Noise Level	Increase in Daytime Noise Level at camp receptor	Construction, operations, closure	Dampening enclosures for boiler, generators and compressor. Crusher, grinder, conveyor shielding (enclosed building). Equipping all vehicles and internal combustion engine with appropriate muffler systems. Ensuring regular equipment maintenance including lubrication. Keeping noisy equipment inside buildings or sheds and/or near ground level whenever possible. Imposing speed limits for all vehicles. Avoiding engine idling. Maintaining natural cover (vegetation) between noise sources and sensitive receptor. Maintaining the Project roads regularly to minimize vehicle noise associated with vibration. Maintaining a noise control standard when procuring equipment.	Yes	Not Significant	No residual cumulative effect identified
Night-time Noise Level	Increase in Night-time Noise Level at camp receptor	Construction, operations			Not Significant	No residual cumulative effect identified
Blasting Noise	Blasting Noise Perceptible at camp receptor	Operations	Adhering to BMC's blasting plan that implements controlled blasting procedures, optimizes blasting operations, and minimizes non-productive noise.	Yes	Not Significant	No residual cumulative effect identified
Surface Water Quality (Chapter 8)						
Surface Water Quantity	Changes in surface water quantity as a result of Water Diversions and Dewatering activities during Construction in Geona Creek at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Construction	Diversion of Fault Creek to South Creek. Diversion of Geona Catchment above Project footprint to KZ-9 (North Diversions).	Yes	Not Significant	No residual cumulative effect identified

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
	Changes in surface water quantity as a result of Water Management and Discharge during Operations in Geona Creek at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Operations	Diversion of Fault Creek to South Creek. Diversion of Geona Catchment above Project footprint to KZ-9 (North Diversions).	Yes	Not Significant	No residual cumulative effect identified
	Changes in surface water quantity as a result of Flooding of ABM Open Pit at Closure and ABM lake Formation in Geona Creek at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Closure	Removal of diversions to return baseline catchment boundaries. Installation of low permeability covers with natural vegetation to approximate natural cover and runoff.	Yes	Not Significant	No residual cumulative effect identified
	Changes in surface water quantity as a result of Water Management and Discharge during Closure in Geona Creek at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Closure	Removal of diversions to return baseline catchment boundaries. Installation of low permeability covers with natural vegetation to approximate natural cover and runoff.	Yes	Not Significant	No residual cumulative effect identified
Surface Water Quality	Changes in surface water quality as a result of Water Diversions and Dewatering activities during Construction at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Construction	Manage Pit development water in Pit Rim Pond to settle TSS and aerate water. Lined Fault Creek diversion ditch. Energy dissipation structure at diversion outlet to South Creek catchment.	Yes	Not Significant	No residual cumulative effect identified
	Changes in surface water quality as a result of Water Management and Discharge during Operations at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Operations	Water treatment plant. Discharge at minimum dilution ratio to Geona Creek (3:1) and Finlayson Creek (2:1). Class A and B Storage Facilities will be constructed with a compacted low-permeability till liner. Upper Water Management Pond, Lower Water Management Pond, Pit Rim Pond, Class A and B Storage Facilities Water Collection Ponds will be constructed with an impermeable HDPE liner. Progressive reclamation of Class A, B and C Storage Facilities.	Yes	Not Significant	No residual cumulative effect identified
	Changes in surface water quality as a result of Flooding of ABM Open Pit at Closure and ABM lake Formation at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Closure	ABM lake treatment with lime and carbon source as it fills.	Yes	Not Significant	No residual cumulative effect identified
	Changes in surface water quality as a result of Water Management and Discharge during Closure at KZ-37, Finlayson Creek at KZ-15, Finlayson Creek at KZ-26, and South Creek at KZ-13	Closure	ABM lake treatment with lime and carbon source as it fills. Constructed wetland treatment system. Low permeability covers for Class A and B Storage Facilities. Water treatment plant will remain onsite and available until Storage Facilities and constructed wetland treatment system meeting design objectives.	Yes	Not Significant	No residual cumulative effect identified
Groundwater Quality (Chapter 9)						
Groundwater Quality	Effects on groundwater quality in mine workings (explosive residues, contact with exposed rock)	Operations	Assessed under Surface Water Quality.	n/a	n/a	n/a
	Effects on groundwater quality from ABM lake discharge	Post closure	Assessed under Surface Water Quality.	n/a	n/a	n/a

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
	Effects on groundwater quality by seepage from Class A and B Storage Facilities, Water Management Ponds, or Waste Management Facility	Operations, post closure	Class A and B Storage Facilities will be constructed with a compacted low-permeability till liner. Upper and Lower Water Management Ponds, Pit Rim Pond, and Class A and B Facility Water Collection Ponds will be constructed with an impermeable synthetic (HDPE) liner. Waste Management Facility will be constructed and operated in accordance with applicable regulations and guidelines (e.g., Land Treatment Facility will be constructed in accordance with the Yukon *CSR*).	No	n/a	n/a
	Effects on groundwater quality by effluent from the sewage disposal system	Operations	Sewage disposal system will be constructed and operated in accordance with applicable regulations (*Waters Act, Waters Regulation* and *Sewage Disposal Systems Regulation*) and guidelines (*Design Specifications for Sewage Disposal Systems*) that considerations for protection of the environment.	No	n/a	n/a
Groundwater Quantity	Lowering of groundwater table for dewatering of mine workings	Operations, post closure	Dewatering system will be designed to minimize the required groundwater extraction and associated drawdown of the groundwater table.	Yes	Not significant	No residual cumulative effect identified
	ABM lake formation and long-term effects on groundwater table	Post closure	Re-divert Fault Creek into Geona Creek watershed and the ABM lake for accelerate the filling of the open pit.	Yes	Not significant	No residual cumulative effect identified
	Residual drawdown from mine dewatering and effects on flow in Geona Creek and South Creek	Operations, closure, post closure	Dewatering system will be designed to minimize the required groundwater extraction and associated drawdown of the groundwater table.	Yes	Not significant	No residual cumulative effect identified
	Drawdown of groundwater table and reduced baseflow to Geona and Finlayson Creek due to groundwater extraction for camp potable water use and reagent mixing at Process Plant.	Operations	Water wells for groundwater supply to camp and Process Plant will be designed and constructed to maximize well performance and minimize drawdown of the groundwater table and associated effects.	Yes	Not significant	No residual cumulative effect identified
Aquatic Ecosystems and Resources (Chapter 10)						
Fish (Arctic grayling)	Changes in Arctic grayling population CPUE or condition factor	Construction, operations, closure	Implementation of Fisheries Offsetting Plan. Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Yes	Not significant	No residual cumulative effect identified
	Sublethal effects to fish	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	No	n/a	n/a
Aquatic habitat	Changes to habitat availability, distribution and connectivity.	Construction, operations, closure, post closure	Implementation of Fisheries Offsetting Plan.	Yes	Not significant	No residual cumulative effect identified
	Changes in Total Suspended Solids	Construction, operations, closure	Implementation of Sediment and Erosion Control Plan.	Yes	Not significant	No residual cumulative effect identified
	Changes in surface water quantity	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	Yes	Not significant	No residual cumulative effect identified
	Changes in surface water quality	Construction, operations, closure, post-closure	Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Yes	Not significant	No residual cumulative effect identified
	Changes in water temperature	Construction, operations, closure	Implementation of Surface Water Management Plan.	No	n/a	n/a
	Changes in stream sediment chemistry and particle size distribution	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment). Implementation of Sediment and Erosion Control Plan.	Yes	Not significant	No residual cumulative effect identified
Benthic invertebrates, periphyton and aquatic plants	Change in benthic invertebrate community	Construction, operations, closure	Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Sediment and Erosion Control Plan. Implementation of surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Yes	Not significant	No residual cumulative effect identified

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
	Change in abundance and diversity of periphyton communities	Construction, operations, closure	Implementation of Fisheries and Aquatic Habitat Management Plan. Implementation of Sediment and Erosion Control Plan. Implementation of Surface Water Management Plan (including water treatment). Implementation of Hazardous Materials Management Plan and Spill Contingency Plan.	Yes	Not significant	No residual cumulative effect identified
	Change in Chlorophyll *a*	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	Yes	Not significant	No residual cumulative effect identified
	Sublethal effects	Construction, operations, closure	Implementation of Surface Water Management Plan (including water treatment).	No	n/a	n/a
Terrain and Soils (Chapter 11)						
Terrain Stability	Increase in geohazards due to temporarily increased slope instability	Construction, operations, closure	Mine design to minimize risk including: • Slope stabilization techniques in areas characterized by highly erodible soils or long, steep slopes and; • Construction of waste storage facilities involving considerations related to base foundation (excavation to bedrock, removal of permafrost lenses), nominal slopes 3H:1V (for long-term physical stability and allowing recontouring for closure and reclamation). Soil erosion and control measures. Geotechnical and soil erosion monitoring.	Yes	Not significant	No residual cumulative effect identified
Soil Quantity	Loss of soil under infrastructure footprint	Construction, operations, closure	Minimize land clearing to the areas necessary for Project Footprint. Soil salvage, storage and stockpiling.	Yes	Not significant	No residual cumulative effect identified
Soil Quality	Degradation of soil quality	Construction, operations, closure	Dust suppression techniques. Soil stockpiling techniques that conserve soil quality. Minimizing the number of times the soil is moved, reducing vehicle traffic over the stockpile surface, and avoiding handling soils when they are too dry or too wet. Erosion monitoring and prevention program. Reclamation methods that reduce equipment traffic during soil redistribution and placement.	Yes	Not significant	No residual cumulative effect identified
Vegetation Cover and Composition (Chapter 12)						
Wetland and Riparian Ecosystems	Loss of wetland and riparian ecosystems	Construction, operations, closure, post-closure	Reclamation; construct wetland and riparian areas during construction (part of fish habitat offsets) and at closure (part of water treatment).	Yes	Not significant	No residual cumulative effect identified
Old Growth Forest	Loss of old growth forest	Construction, operations, closure, post-closure	Limit initial Project disturbance of old growth forest through design.	Yes	Not significant	No residual cumulative effect identified
Rare Plants	Loss of rare plants	Construction, operations	Additional, focussed rare plant survey prior to construction; information to recognize and identify rare plants will be included in the induction program and in clearing protocols for equipment operators.	No	n/a	n/a
Invasive Plants	Invasive plants outcompeting native vegetation	Construction, operations, closure, post-closure	Implementation of invasive species management plan.	Yes	Not significant	No residual cumulative effect identified
Metal concentrations in Traditional Use and Wildlife Browse Plants	Metal increase in traditional use plants or wildlife browse	Construction, operations	Implementation of air quality management plan.	Yes	Not significant	No residual cumulative effect identified
Wildlife and Wildlife Habitat (Chapter 13)						
Finlayson Caribou Herd	Direct rut and post calving habitat loss	Construction, operations, active closure, post-closure	Reclamation. Minimize activities in alpine and subalpine during rut period. Minimized Project Footprint.	Yes	Not significant	Not significant
	Indirect rut, calving, and post calving habitat loss	Construction, operations, active closure	Minimize activities in alpine during the calving period. Minimize activities in alpine and subalpine during rut period. No hunting policy. Regularly scheduled blasting.	Yes	Not significant	Not significant

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
	Movement barrier between rut and wintering habitat from infrastructure and roads	Construction, operations, active closure	Speed limits. Radio controlled Access Road. Convoys of two or three vehicles to reduce sensory disturbance.	Yes	Not significant	Not significant
	Direct mortality from collisions with vehicles	Construction, operations, active closure	Speed limits. Clearing vegetation from right-of-way. Radio controlled Access Road. Implement protocol for vehicle-ungulate encounters. Signage along road in areas with high frequency of ungulate crossings and reduced speed limits in these areas. All other requirements currently included in the existing Tote Road Licence.	Yes	Not significant	Not significant
	Direct mortality from incidents with infrastructure	Construction, operations, active closure, post-closure	Fencing or provision of egress ramps from HDPE-lined facilities. Plough regular breaks in the snowbank along the road and around the Project Footprint. Leave haul road in pit to provide egress from ABM lake. Permanent wildlife barrier around ABM lake.	No	n/a	n/a
	Mortality from increased hunting pressure from available access	Construction, operation, active closure, post-closure	No hunting policy. Manned gate to prevent access to hunters. Decommission and reclaim road.	No	n/a	n/a
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access control.	No	n/a	n/a
	Disturbance of late winter range from aircraft	Construction, operations	Follow designated flight and landing route for flights to Finlayson Lake airstrip during winter that stay 1.5 km away from animals and maximize height above ground as long as practicable at landing and takeoff that minimizes herd disturbance.	Yes	Not significant	Not significant
Moose	Direct early winter and late winter habitat loss	Construction, operations, active closure, post-closure	Progressive reclamation. Minimized Project Footprint. Final reclamation at closure.	Yes	Not significant	Not significant
	Indirect early winter and late winter habitat loss	Construction, operations, active closure	Progressive reclamation. Minimized Project Footprint. Final reclamation at closure.	Yes	Not significant	Not significant
	Movement barrier in wintering habitat from infrastructure and road	Construction, operations, active closure	Speed limit. Radio controlled Access Road. Convoys of two or three vehicles to reduce sensory disturbance but maintaining 15 second distance between vehicles for human health and safety.	Yes	Not significant	Not significant
	Direct mortality from collisions with vehicles	Construction, operations, active closure	Speed limit. Clearing vegetation from right-of-way. Radio controlled Access Road. Implement protocol for vehicle-ungulate encounters. Signage along road in areas with high frequency of ungulate crossings. All other requirements currently included in the existing Tote Road Licence.	Yes	Not significant	Not significant
	Direct mortality from incidents with infrastructure	Construction, operations, active closure, post-closure	Fencing or provision of egress ramps from HDPE-lined facilities. Plough regular breaks in the snowbank along the road and around the Project Footprint. Leave haul road in pit to provide egress from ABM lake. Permanent wildlife barrier around ABM lake.	No	n/a	n/a
	Mortality from increased hunting pressure from available access	Construction, operation, active closure	No hunting policy. Manned gate to prevent access to hunters. Decommission and reclaim road.	No	n/a	n/a

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls.	No	n/a	n/a
	Disturbance of late winter range from aircraft	Construction, operations	Follow designated flight and landing route for flights to Finlayson Lake airstrip that minimizes herd disturbance.	Yes	Not significant	Not significant
Grizzly bear	Direct and indirect growing season habitat loss	Construction, operations, active closure	Progressive reclamation and final reclamation at closure.	Yes	Not significant	Not significant
	Direct and indirect denning habitat loss	Construction, operations, active closure	Pre-denning surveys and mitigations to prevent indirect effects.	Yes	Not significant	Not significant
	Mortality from human-bear conflict	Construction, operations, active closure	Implementation of wildlife protection plan with key procedures to manage garbage and bear awareness training for employees and contractors	No	n/a	n/a
	Mortality from increased hunting pressure from available access	Construction, operation, active closure, post-closure	No hunting policy. Manned gate to prevent access to hunters until road is decommissioned.	No	n/a	n/a
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls	No	n/a	n/a
Grey wolf	Prey reduction due to ungulate loss of habitat	Construction, operations, active closure	Reclamation.	Yes	Not significant	No residual cumulative effect identified
	Direct mortality from collisions with vehicles	Construction, operations, active closure	Speed limits. Clearing vegetation from right-of-way. Radio controlled Access Road. Ploughed breaks in snowbanks along road.	Yes	Not significant	n/a
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls.	No	n/a	n/a
Wolverine	Habitat avoidance from road density	Construction, operations, active closure	Decommission inactive roads. Site clearing will be kept to a minimum.	Yes	Not significant	No residual cumulative effect identified
	Direct mortality from collisions with vehicles	Construction, operations, active closure	Reduce travel speeds. Clearing vegetation from right-of-way.	No	n/a	n/a
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls.	No	n/a	n/a
Collared pika	Loss of highly suitable habitat	Construction, operations, active closure	Minimize site clearing. Reclamation. Noise minimization.	Yes	Not significant	No residual cumulative effect identified
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls.	No	n/a	n/a
Little brown bat	Loss of highly suitable habitat	Construction, operations, active closure	Reclamation. Site clearing of Access Road will be kept to a minimum.	Yes	Not significant	No residual cumulative effect identified
	Direct mortality from collisions with vehicles	Construction, operations, active closure	Reduce travel speeds.	No	n/a	n/a
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls.	No	n/a	n/a
Cliff-nesting raptors	Loss of highly suitable habitat or disturbance of nests	Construction, operations, active closure	Reclamation. Site clearing will be kept to a minimum.	Yes	Not significant	No residual cumulative effect identified
	Disturbance to known nest sites	Construction, operations, active closure	Apply appropriate buffer to nest sites.	No	n/a	n/a

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
	Health effects from ingestion of impacted water or plants	Construction, operations, active closure	Dust management. Pond access controls.	No	n/a	n/a
Passerines (Olive-sided flycatcher)	Loss of highly suitable habitat	Construction, operations, active closure	Reclamation. Site clearing will be kept to a minimum.	Yes	Not significant	No residual cumulative effect identified
	Direct mortality from collisions with vehicles	Construction, operations	Perform nest surveys prior to clearing.	No	n/a	n/a
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management. Pond access controls	No	n/a	n/a
Waterfowl	Loss of highly suitable habitat	Construction, operations, closure	Reclamation. Site clearing will be kept to a minimum. No-clearing buffer zones around wetlands. Creation of new wetlands for fish habitat compensation.	Yes	Not significant	No residual cumulative effect identified
	Health effects from ingestion of impacted water or plants	Operations, active closure	Dust management in the Air Quality Management Plan. Pond access controls.	No	n/a	n/a
Bumble bees	Direct habitat loss	Construction, operations	Progressive reclamation.	Yes	Not significant	No residual cumulative effect identified
Heritage Resources (Chapter 14)						
Paleontological Resources	Impacts to unidentified sites or resources	Construction, operations, and closure	Heritage Resource management Plan (HRMP) including the Chance Finds Procedure.	No	n/a	n/a
Archaeological Resources	Impacts to unidentified sites or resources	Construction, operations, and closure	HRMP including the Chance Finds Procedure.	No	n/a	n/a
Historic & Built Structural Resources	Impacts to unidentified sites or resources	Construction, operations, and closure	HRMP including the Chance Finds Procedure	No	n/a	n/a
Human Remains	Impacts to unidentified human remains	Construction, operations, and closure	HRMP including the Chance Finds Procedure	No	n/a	n/a
Economy and Sustainable Livelihood (Chapter 15)						
Traditional economic activities — hunting, fishing, trapping, food gathering	Potentially reduced opportunity to pursue traditional economic activities.	Construction, operations, active closure	Two four-week periods of annual vacation/time off plus regular time off on rotation.	Yes	Not Significant	No residual cumulative effect identified
	Easier access to area for hunting and fishing: reduced wildlife stocks.	Construction, operations, closure	BMC policies include no firearms, no hunting, and no fishing by employees while on rotation. No hunting by anyone allowed on site and no public use of Access Road.	No	n/a	n/a
	Increased traffic and industrial activity in the region may act to drive wildlife away.	Construction, operations, closure	Recreational use of all-terrain vehicles (ATVs) and snowmobiles is prohibited at the Project site. No public use of Access Road. Implement traffic and access management plan.	Yes	Not Significant	No residual cumulative effect identified
	Disruption and loss of access.	Construction, operations, closure	BMC has agreed to pay a land use interruption supplement to mitigate the effects of the Project on the RRDC citizens who hold trapping rights.	Yes	Not Significant	No residual cumulative effect identified
Economic growth	The Project will provide economic growth to Yukon.	Construction, operations, closure	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honor the SEPA provisions for providing business opportunities to local and Yukon companies.	Yes, beneficial	Beneficial	n/a
	The Project will provide economic growth to the communities.	Construction, operations, closure	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honor the SEPA provisions for providing business opportunities to local and Yukon companies.	Yes, beneficial	Beneficial	n/a
Diverse and stable economy — discouraging boom and bust	Creation of boom and bust cycle through relatively short Project life, particularly in small communities.	Construction, operations, closure	BMC will continue to explore its property for further reserves and attempt to extend the operating life of the mine.	Yes	Not Significant	Not Significant

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
Employment	The Project will provide Kaska citizens and other Yukon residents employment during the construction phase.	Construction	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	Yes, beneficial	Beneficial	n/a
	The Project will provide Kaska citizens and other Yukon residents employment during the operations phase.	Operations	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	Yes, beneficial	Beneficial	n/a
	The Project will provide Kaska citizens and other Yukon residents employment during the decommissioning and reclamation phase.	Closure	The point of hire for the Project will be Yukon. BMC and its contractors will continue to honour the SEPA provisions of preferential hire.	Yes, beneficial	Beneficial	n/a
Employability — education, training and experience	The Project has the potential to improve education levels.	Construction, operations, closure	BMC will continue to offer its Kaska Education Scholarship Program.	Yes, beneficial	Beneficial	n/a
	The Project has the potential to offer training to Kaska and Yukon employees.	Construction, operations, closure	BMC will continue its Mentor Program. BMC and its contractors will offer general workplace training for employees. Trades apprenticeships will be part of the Project.	Yes, beneficial	Beneficial	n/a
	The Project has the potential to offer work experience to Kaska and Yukon residents.	Construction, operations, closure	BMC will offer summer employment for Kaska students when the Project requires summer help.	Yes, beneficial	Beneficial	n/a
Broad participation in economic development	Potential to continue the direct beneficial effect through the Project providing jobs and business opportunities to the entire cross-section of Yukon society.	Construction, operations, closure	BMC will continue to apply its Kaska hiring preference and will continue to honour its SEPA commitments to Kaska business. Rigorous application of BMC's Employment and Anti-Discrimination Policy.	Yes, beneficial	Beneficial	n/a
Business opportunities	Potential to continue the direct beneficial effect through the Project providing business opportunities to Kaska and Yukon businesses.	Construction, operations, closure	BMC and its contractors will continue to honor both the letter and the spirit of its SEPA with the RRDC.	Yes, beneficial	Beneficial	n/a
Government revenues	Potential beneficial effect of increased government revenues at the municipal, territorial and federal level through various taxes, fees, royalties, and other payments.	Construction, operations, closure	None.	Yes, beneficial	Beneficial	n/a
Human Health and Well-being (Chapter 15)						
Individual health	The Project has the potential to provide a small beneficial effect by offering steady and well-paid employment, and education and skills development.	Construction, operations, closure	BMC will be offering a dental and extended health plan to all BMC employees at the Project. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Yes, beneficial	Beneficial	n/a

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
Family stress	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have adverse effects on family health and well-being.	Construction, operations, closure	Steady employment and increased incomes are strongly correlated with a greater sense of self-worth and better family stability and health. Extensive screening of employees before hire to gauge their suitability for shift work and to help educate them on its potential effects. Point of hire being Yukon in reduces travel time of employees to get back to their families. Provide assistance and education to all employees and their families as required including: • Financial management training; • Drug and alcohol counselling (including time off for employees who need treatment); • Marriage counselling; and • Healthy living education (i.e. benefits of diet and exercise). BMC will host annual family days at the mine site to show spouses and children of the employees the mine and associated facilities (BMC's experience is that families are more comfortable with their spouses being away if they have seen the site and facilities first hand). Communications at the site will be via microwave (to maximize bandwidth) and individual connections in each room to ensure that employees can easily communicate via Skype/Facetime etc. with their spouses and children in the privacy of their room rather than in a communal area. BMC will provide recreational facilities at the site and all meal times will have healthy food options, to promote health and well being of employees while on-shift (with the intent that this would also extend to off-shift healthy living). Training of employees (e.g., trades, apprenticeships, management) to promote progression in their careers (which may enhance job satisfaction). Bereavement leave will be available to all employees. The 2 week in and 1 week out shift rotations, when combined with the four weeks of annual holiday available after the first year of employment, will allow employees to take one month off twice per year.	Yes	Not Significant	No residual cumulative effect identified
Reducing alcohol and drug abuse	Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	Construction, operations, closure	The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Yes	Not Significant	No residual cumulative effect identified
Gathering traditional medicine	Possible reduction in traditional medicine gathering and use due to rotation shift work and loss of gathering areas.	Construction, operations, closure	As part of the progressive reclamation and final reclamation planning, BMC has committed to working with RRDC in identifying the species that will be used for the reclamation purposes and developing a seed collection program and seed bank in Ross River.	Yes	Not Significant	No residual cumulative effect identified
Public health and safety — increased traffic, hazardous material transport	Significant increases in highway traffic and therefore accidents.	Construction, operations, closure	Traffic and Access Management Plan, including: Use only experienced, professional drivers. Equip all trucks with two-way radio communications. Implement design, safety and operating procedures proven by similar trucking systems utilized in Yukon.	No	n/a	n/a
	The possibility of a spill or accident that will have a potential public health or safety effect along with an adverse environmental effect.	Construction, operations, closure	BMC will implement its Traffic and Access Management Plan; Hazardous Materials Management Plan and Spill Contingency plan.	No	n/a	n/a
	Possible improper disposal of sewage and garbage.	Construction, operations, closure	BMC will follow all relevant regulations concerning potable water, food safety, and the disposal of sewage and garbage under the oversight of the Environmental Health Services Branch of YG.	No	n/a	n/a
Workplace health and safety	Potential adverse effects of workplace accidents.	Construction, operations, closure	BMC and its contractors will follow all applicable safety laws and regulations in every aspect of operations. BMC and its contractors will provide every employee with the training required to safely do their work. Implementation of BMC's Occupational Health and Safety Policy and Safety, Health, And Environmental Management Plan.	No	n/a	n/a

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
Community Vitality (Chapter 15)						
Population — number of children	The Project may attract new residents and their families to the Yukon. Increased population, and especially families with children is desired in Faro and Watson Lake.	Construction, operations, closure	BMC's decision to make the Yukon the point of hire for employees creates an incentive for employees from elsewhere to move to the territory.	Yes, beneficial	Beneficial	n/a
Healthy local business sector — reducing the cost of living	The Project has the potential to improve the health of the local business sector.	Construction, operations, closure	Higher incomes locally may lead to greater demand for goods and services, encouraging the diversification and growth of existing businesses and the establishment of new ones.	Yes, beneficial	Beneficial	n/a
Reducing crime	The Project can potentially reduce crime through employment opportunities. But if increased incomes lead to increases in alcohol and drug abuse, then crime levels are likely to rise.	Construction, operations, closure	The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted. BMC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. BMC supports the provision of information regarding health and wellness education programs and access to counselling services will be made available to all employees.	Yes	Not Significant	No residual cumulative effect identified
Reducing discrimination and racism	The Project has the potential to reduce discrimination and racism.	Construction, operations, closure	BMC will strictly enforce its Employment and Anti-Discrimination Policy prohibiting any form of discrimination or racism in the workplace. Complaints will be treated seriously and dealt with immediately. BMC and its contractors will continue to honour the SEPA provisions of preferential Kaska and other First Nation hire. BMC will hire two Kaska community mentors.	Yes, beneficial	Beneficial	n/a
Political structure	No potential effects identified	n/a	None. No effect expected.	No	n/a	n/a
Community events and volunteerism	The Project has the potential to beneficially affect community events through sponsorship.	Construction, operations, closure	BMC will continue to support community events and projects as the Project proceeds.	Yes, beneficial	Beneficial	n/a
Recreational facilities and opportunities	The Project has the potential to beneficially affect recreation facilities and opportunities through donations and sponsorship. .	Construction, operations, closure	BMC will consider supporting recreation projects as the Project proceeds.	Yes, beneficial	Beneficial	n/a
Infrastructure and Services (Chapter 15)						
Housing and land availability	The Project has the potential to have a beneficial effect on the oversupply of housing in Faro and, to a lesser extent, Watson Lake through the relocation of employees to these communities.	Construction, operations, closure	No additional enhancement measures, beyond the point of hire policy, have been identified.	Yes, beneficial	Beneficial	n/a
Transportation infrastructure — roads and airports	Potential beneficial effect on the Robert Campbell Highway through highway improvements making it easier for people to travel between the communities of Ross River and Watson Lake.	Closure	Project provides continued incentive for YG Highways to continue highway improvements.	Yes, beneficial	Beneficial	n/a
	Potential beneficial effect on Finlayson airstrip through improved infrastructure.	Construction, operations, closure	BMC will improve the airstrip making it more accessible for long term use.	Yes, beneficial	Beneficial	n/a
Municipal services — water, sewer, solid waste	If significant numbers of employees relocate, small communities' services may be stressed. Potential adverse effect if the Project uses municipal solid waste facilities.	Construction, operations, closure	BMC will not use municipal solid waste facilities.	No	n/a	n/a
Healthcare services	No potential effects on healthcare services identified.	n/a	None. No effect expected.	No	n/a	n/a
Police services	No potential effects on police services identified.	n/a	None. No effect expected.	No	n/a	n/a

Subcomponent	Potential Effect	Project Phase	Proposed Key Mitigation or Enhancement Measures	Residual Effect (Yes/No)	Significance of Residual Project Effect	Significance of Residual Cumulative Effect
Child care	No potential effects on child care identified.	N/A	None. No effect expected.	No	n/a	n/a
Culture, History and Heritage (Chapter 15)						
Language preservation and restoration	First Nation employees have less time to use and help restore their languages.	n/a	Employment and Anti-Discrimination Policy. Community Relations Policy. BMC will hire two Kaska mentors.	No	n/a	n/a
Traditional knowledge and practice preservation and restoration	First Nation employees have less time to practice and restore traditional knowledge.	n/a	Shift rotations will allow for some time to still practice and restore traditional knowledge. Ability to take two four-week periods off work each year will assist in providing time.	No	n/a	n/a
Heritage and historic sites	See Heritage Resources VC (Chapter 14)					

Notes:

n/a not applicable (identifies when the project phase is not considered as no potential effect is identified, significance of residual or cumulative effect is not considered as no residual effect is identified)

Cumulative effects were not assessed for beneficial effects

19.3 EFFECTS OF ENVIRONMENT ON THE PROJECT

The main environmental events which were considered to have a potential to affect the Project components and activities during all Project phases include:

- Site-specific terrain hazards;
- Seismic activity;
- Extreme weather events;
- Forest fires; and
- Climate change.

Terrain hazards include landslides, which have occurred in the past; however, these are likely to be small in scale and localized. Stability assessments and geotechnical characterization were used to support the designs of the Storage Facilities and the Process Plant as part of the applied design mitigations strategies, such that potential effects from terrain hazards were assessed to be not significant.

Seismic activity can trigger a variety of natural hazards; ground vibrations, large landslides, avalanches, liquefaction of saturated sediment and surface ruptures. Even though the Project is located in an area of low seismic activity all buildings and facilities on site were designed with seismic conditions in mind. The severity of seismic activity on the Project is anticipated to be negligible and potential effects were assessed to be not significant.

Extreme weather events such as severe rainstorms and flooding have been incorporated into the design of the Project and the effects of such an event on the Project were assessed not to be significant. Forest fires are unpredictable and potential effects will be minimized through clearing of vegetation around key infrastructure, installation of fire water distribution system, and suitable training of an emergency response team.

The likelihood of climate change occurring is overall probable; however, this change will occur over a long period, and in this context the magnitude of changes likely to occur over the Project's life is small. The severity of potential effects is therefore assessed as negligible given the short Project life, and the Project designs aspects that have taken climate change into consideration. Therefore, no significant adverse effects to the Project were identified due to climate change.

19.4 MALFUNCTIONS, ACCIDENTS AND UNPLANNED CLOSURE

Malfunctions assessment included consideration of potential failure within the following major components of the Project during all phases of the Project:

- Open pit mining (slope failure; dewatering system failure; and reclamation measures failure);
- Underground mining (underground stope failure; and underground dewatering system failure);

- Storage facilities (Class A, B, C, and Overburden and Topsoil Stockpiles) (slope failure; erosion control failure; and reclamation measures failure);
- Process Plant Facility (mechanical equipment failure; pipes and pumps failure, reclamation measures failure);
- Water Management (embankment or spillway failure of Operations Water Management Ponds; clean water diversion (including Fault Creek) failure; sediment and erosion control measures failure; storage facility water collection systems failure; and water treatment plant failure); and
- Power generation facility failure (power outage).

The risk rating of low was identified for all of the above malfunction scenarios with the exception of slope failure for storage facilities and storage facilities seepage collection system failure for the Class A Storage Facility, for which risk rating of moderate was identified. The risk rating of low for those identified malfunction scenarios was applied due to the unlikely likelihood of an event occurring (i.e., the event is not expected to occur during the life of the Project, no known occurrences on similar projects) and/or a very low consequence of an event (i.e., potential effects are localized and are readily reversible).

The two malfunction scenarios assessed as having a moderate risk rating, storage facility slope failure and seepage collection system failure, were both identified as unlikely to occur. The malfunction event of slope failure for storage facilities was assessed as low consequence as evidence of the slope failure would be easily visible and readily rectifiable, effects may occur in the short term on surface water quality as the potential slope failure may affect the water collection system and ponds (but limited to the Project site). The risk rating of moderate for the malfunction event of storage facilities seepage collection system failure for Class A Storage facility was assessed as medium consequence rating and was identified conservatively, as in the event of the complete failure of the water collection system some of the Class A Storage Facility water may enter receiving environment.

Accident assessment considered the following accident scenarios:

- Explosives accident;
- Spill or leak during transport;
- Spill or leak on site;
- Transportation accident (on site and off site); and
- Project-related fire.

Of the above, explosives accident, spills or leaks during transport, and transportation accident at Finlayson airstrip were considered to have moderate environmental risk rating as they have potentially low environmental consequences. All other accident scenarios were assessed to have low risk rating as they were assessed to have very low consequences.

The unplanned closure scenario was also considered for potential environmental and socio-economic effects. Two unplanned closure scenarios were considered: temporary closure and early permanent closure. The environmental effects of an unplanned closure were assessed to be low and not significant in part because of the early and progressive reclamation strategy that BMC intends to adopt. The potential socio-economic effects of an unplanned closure were assessed to have a moderate risk rating in part because of the high resilience historically demonstrated by local communities to economic growth and decline (i.e., boom and bust) cycles, and because BMC has committed to several mitigation measures to facilitate employee job readiness in the event of temporary closure or early permanent closure. The job skill training programs proposed by BMC will provide work skills that are transferable across mine projects and industries. Thus, the socio-economic effects of an unplanned closure are not considered significant and this type of event was considered unlikely, resulting in an overall risk rating of moderate.

Based on the likelihood and consequence ratings, none of the accidents, malfunctions, or unplanned closure scenarios were assessed to have a high or unacceptable risk rating. Therefore, accidents, malfunctions, and unplanned closure were not assessed to have a significant effect on any of the VCs.

19.5 ENVIRONMENTAL MANAGEMENT AND MONITORING

The conceptual management plans that have been developed for the Project are listed in Table 19-2.

Table 19-2: Conceptual Management Plans

Environmental Protection Plans	Operational Management Plans	Socio-economic Management Plans
Waste Management Plan	Conceptual Construction Plan	Consultation and Engagement Plan
Hazardous Materials Management Plan	Mine Development and Operations Plan	Noise Management Plan
Surface Water Management Plan	Process Plant Facility Development and Operations Plan	Air Quality Management Plan
Spill Contingency Plan	Tailings Management Plan	Traffic and Access Management Plan
Sediment and Erosion Control Plan	Waste Rock and Overburden Management Plan	Heritage Resources Management Plan
Wildlife Protection Plan	Road Construction Plan	Socio-economic Effects Management Plan
Vegetation Management Plan	Reclamation and Closure Plan	Health, Safety and Emergency Response Plan
Fisheries and Aquatic Management Plan		
Adaptive Management Plan		
Environmental Monitoring, Surveillance and Reporting Plan (conceptual monitoring programs)		

Conceptual monitoring programs are also proposed for the Project. The key disciplines for which conceptual monitoring programs have been developed are:

- Meteorology;
- Surface water;
- Groundwater;

- Aquatic environment;
- Terrestrial environment (soil and plant tissue);
- Wildlife; and
- Mine infrastructure monitoring program.

19.6 CONCLUSIONS

The thorough assessment of the Project has identified no significant residual or cumulative environmental or socio-economic effects. Indeed, the Project will provide employment, and economic opportunities for the local communities including Kaska, and residents of Yukon and Canada. The significant benefits available for all local communities will be in the form of direct employment, business development and opportunities, training and education funding, and direct financial payments to Kaska through the application of the socio-economic participation agreement (SEPA). The benefits of the Project will be achieved in an environmentally and socially responsible manner encompassing BMC's corporate policies and objectives which recognise that BMC has a fundamental requirement to conduct activities in an environmentally responsible and ethical manner with due regard to the legacy of the company's actions. BMC will undertake the Project in line with the commitments made in this document and the SEPA, through the implementation of identified mitigation and enhancement measures, management plans and monitoring programs. These management systems have been designed to minimise pollution, maximise the efficient use of energy and continually improve processes so as to minimise waste and conserve natural resources.

KUDZ ZE KAYAH PROJECT
PROJECT PROPOSAL FOR YESAB EXECUTIVE COMMITTEE SCREENING
BMC Minerals (No.1) Ltd.
MARCH 2017

1. Introduction
2. First Nation and Community Consultation
3. Project Location
4. Project Description
5. Effects Assessment Methods
6. Air Quality
7. Noise Levels
8. Surface Water Quality and Quantity
9. Groundwater Quality and Flow
10. Aquatics Ecosystems and Resources
11. Terrain and Soils
12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

20 ACKNOWLEDGEMENT 20-1

20 ACKNOWLEDGEMENT

As required under YESAB's Guide to Executive Committee Information Requirements, this chapter provides acknowledgement by BMC Minerals (No.1) Ltd. of the information provided in this Project Proposal. Project Proposal Authors' names, certifications and signatures are included at the front of the Project Proposal.

The information submitted in this Project Proposal is required for the purpose of conducting a screening under the *Yukon Environmental and Socio-economic Assessment Act*. I acknowledge that, pursuant to section 119 of the Act, a copy of this Project Proposal will be placed on a public register and be available to any member of the public to review.

I understand that misrepresenting or omitting information required for the evaluation may cause delays in the screening or render the recommendation invalid.

I certify that the information provided is true and correct to the best of my knowledge and belief.

Proponent`s Signature

MARCH 1, 2017.
Date

KUDZ ZE KAYAH PROJECT
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12. Vegetation Cover and Composition
13. Wildlife and Wildlife Habitat
14. Heritage Resources
15. Socio-economic Effects Assessment
16. Effects of the Environment on the Project
17. Malfunctions, Accidents, and Unplanned Closure
18. Conceptual Management Plans
19. Summary and Conclusions
20. Acknowledgement
21. References

TABLE OF CONTENTS

21 REFERENCES 21-1

21 REFERENCES

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