KENO HILL SILVER DISTRICT OPERATIONS

BERMINGHAM DEVELOPMENT AND PRODUCTION PROGRAM

PROJECT PROPOSAL SUBMISSION TO YESAB

November 2017

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ACRONYMS

ABA	Acid Base Accounting
AKHM	Alexco Keno Hill Mining Corp.
AMP	Adaptive Management Plan
ANFO	Ammonium Nitrate/ Fuel Oil
AP	Acid generation potential
ARSA	Amended and Restated Subsidiary Agreement
BCMOE	British Columbia Ministry of the Environment
BEA	Baseline Environmental Assessment
CF	Cut and Fill
DSTF	Dry Stack Tailings Facility
EC	Environment and Climate Change Canada
EPA	Environmental Protection Agency
ERDC	Elsa Reclamation Development Company
EQS	Effluent Quality Standards
FNNND	First Nation of Na-cho Nyak Dun
ICP	Inductively Coupled Plasma
INAC	Indigenous and Northern Affairs Canada
IX	Ion Exchange
LH	Long hole stripping
LHD	Load Haul Dump (Loader)
MAP	Mean Annual precipitation
MMER	Metal Mining Effluent Regulations
N-AML	Non-Acid Metal Leaching
NIA	Noise Impact Assessment
NP	Neutralization Potential
NPR	Neutralization Potential Ratio
OCF	Overhand Cut and Fill
OH&S	Occupational Health and Safety
P-AML	Potential Acid Metal Leaching
QML	Quartz Mining License
RCP	Reclamation and Closure Plan
ROM	Run Of Mine
RTC	Registered Trapline Concession
SFE	Shake Flask Extraction
SWE	Snow Water Equivalent
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
UCF	Underhand Cut and Fill
UKHM	United Keno Hill Mines Ltd.
US	United States
VTF	Valley Tailings Facility
WRDA	(N-AML) Waste Rock Disposal Area
WRMP	Waste Rock Management Plan
WRSA	Waste Rock Storage Area

WRSF	(P-AML) Waste Rock Storage Facility
WTP	Water Treatment Plant
WUL	Water Use Licence
XRD	X-Ray Diffraction
YAAQS	Yukon Ambient Air Quality Standards
YEC	Yukon Energy Corporation
YESAA	*Yukon Environmental and Socio-Economic Assessment Act*
YESAB	Yukon Environmental and Socio-Economic Assessment Board
YG	Yukon Government
YWCHSB	Yukon Workers Compensation Health and Safety Board

EXECUTIVE SUMMARY

The purpose of the Project is to advance the Bermingham deposit towards development and mine production. This includes construction of surface and underground infrastructure, development of ore accesses, mining and processing ore through the Keno District Mill, deposition of waste rock on surface, treatment and release of water and deposition of tailings in the currently licenced Dry Stack Tailings Facility (DSTF). The Bermingham decline and associated activities were previously assessed by YESAB project #2017-0086.

Ore from the Bermingham deposit will either be comingled with ore from the Bellekeno, Flame and Moth, Onek 990 or Lucky Queen mines or milled separately through the Keno District Mill. Development and operation sequencing of the Bermingham mine, as well as the other mines permitted in the Keno Hill Silver District (KHSD), are largely driven by ore tenor, metal prices and other economic considerations. The project proposal presents the plan for development and operation of the Bermingham deposit as it is currently envisioned. The water encountered during the development and operation of the Bermingham underground workings will either be recycled back underground or discharged. Discharged water will meet the effluent quality standards as per the Metal Mining Effluent Regulations through a water treatment plant (as required). Tailings produced will be deposited on the permitted and existing DSTF.

The Waste Rock Management Plan has been updated to incorporate waste rock generated from Bermingham. An increase in the licenced total tonnage of waste rock stored on surface will not be required. Waste rock generated from the Bermingham mine will be used for underground backfill, construction of laydown pads, access roads and for general construction purposes.

The Project will require the amendment/renewal of the existing Type A Water Use Licence QZ12-053 and Quartz Mining License QML-0009, which triggers an assessment under the Yukon Environmental and Socio-economic Assessment Act (YESAA) at the Designated Office level.

1 INTRODUCTION

Alexco Keno Hill Mining Corp. (AKHM) continues to develop the mineral resources of the KHSD. Alexco proposes to advance the Bermingham deposit into development and operations in order to provide sustainable production in the KHSD mining operations, which includes the Bermingham, Flame and Moth, Bellekeno, Onek 990 and Lucky Queen Mines. The Bermingham deposit is located on Galena Hill within the Keno Hill District. The development and operations program for the Bermingham deposit includes the development of underground primary and secondary ore access declines and drifts, construction of surface and underground support facilities, mining and milling ore in the Keno District Mill, depositing waste rock on surface and depositing tailings in the DSTF. An underground exploration decline is currently in construction at Bermingham and will be followed by underground definition drilling, which was assessed by YESAB (project 2017-0086). Once the underground drilling is completed, additional development work is anticipated to take 3 months to complete followed by mining and processing ore, dependant on permitting authorizations and other economic factors.

This submission is intended to meet the requirements for evaluation pursuant to the Yukon Environmental and Socio-economic Assessment Act (YESAA) by the Yukon Environmental and Socio-economic Assessment Board (YESAB) Mayo Designated Office.

Alexco's Health, Safety and Environmental Policy is attached in Appendix A.

1.1 PROPONENT INFORMATION

Alexco has been actively developing the KHSD since 2006 under a unique contractual arrangement with the Government of Canada whereby it can enter into production at historic and newly discovered deposits within the district while it undertakes reclamation activities to remediate historic environmental impacts.

AKHM is a wholly owned subsidiary of Alexco and has been incorporated for operation of mineral extraction and development in the KHSD. Alexco continues to advance the development and eventual implementation of the District Wide Closure Plan which addresses the historic environmental liabilities of the district from past mining activities.

1.1.1 Contact Information

Proponent

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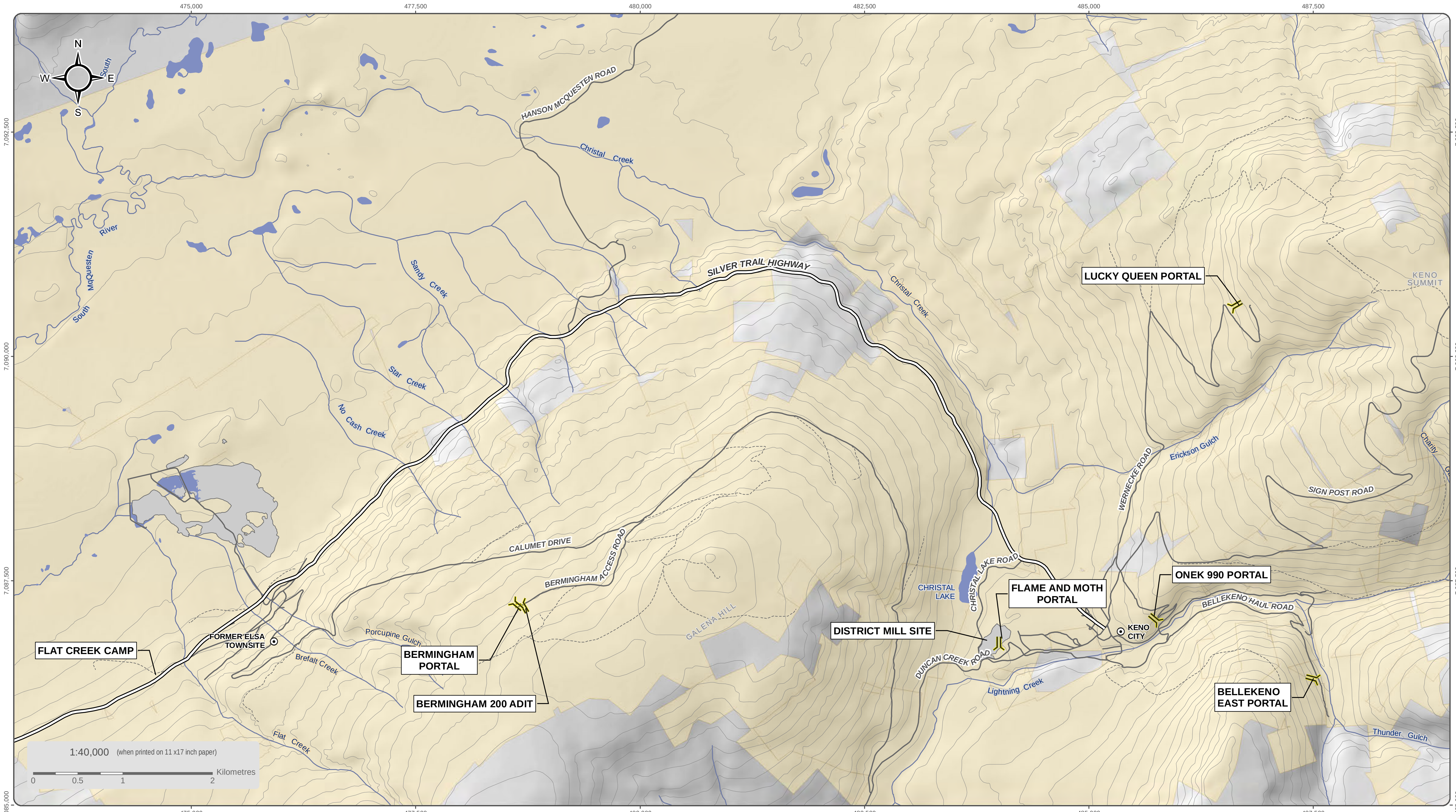
1.2 PROJECT PURPOSE

The Bellekeno Mine was commissioned in January 2011 and operated until September 2013 when operations were suspended due to a number of factors including a decline in commodity prices. The Lucky Queen and Onek 990 Mines were permitted in 2013, but have not yet been brought into production. The Flame and Moth Mine is in the final phase of permitting and has not been brought into production. The Bermingham decline was permitted in 2017 and initial development has been completed through the construction of surface facilities and an underground portal and decline. The history of the KHSD is one of numerous high grade but narrow vein deposits being mined simultaneously to supply ore to a single mill. This same operational approach is being developed by Alexco, through the incorporation of multiple mines supplying feed to a centralized flotation mill (Keno Hill District Mill). As new deposits are discovered in the district, the priority of each deposit will change and the Life of Mine plan will routinely be adjusted based on ore tenor, deposit location, investment return and permitting timelines.

1.3 PROJECT LOCATION

The KHSD is located in central Yukon (63° 54' 32" N, 135° 19' 18" W; NTS 105M/14 & 105M/13), 354 km due north of Whitehorse. Access to the property is via the Alaska, Klondike and Silver Trail Highways from Whitehorse to Mayo (407 km) and an all-weather gravel road northeast from Mayo to Elsa (45 km); a total distance of 452 km.

The KHSD is located on and around Galena Hill, Keno Hill and Sourdough Hill and are collectively known as the KHSD. The property lies along the broad McQuesten River valley with three prominent hills to the south of the valley. The Bermingham deposit is located on Galena Hill within the Keno Hill District (Figure 1-1, Figure 1-2 and Figure 1-3).



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Place of Interest
Adit
Valley Tailings
Alexco/ERDC Quartz Claims
Waterbody
Watercourse
Silver Trail Highway
Other Road
Limited-Use Road

AKHM
ALEXCO ENVIRONMENTAL GROUP

ALEXCO KENO HILL MINING CORP.
BERMINGHAM

FIGURE 1-1

KENO HILL SILVER DISTRICT MINING OPERATIONS AREA OVERVIEW

OCTOBER 2017

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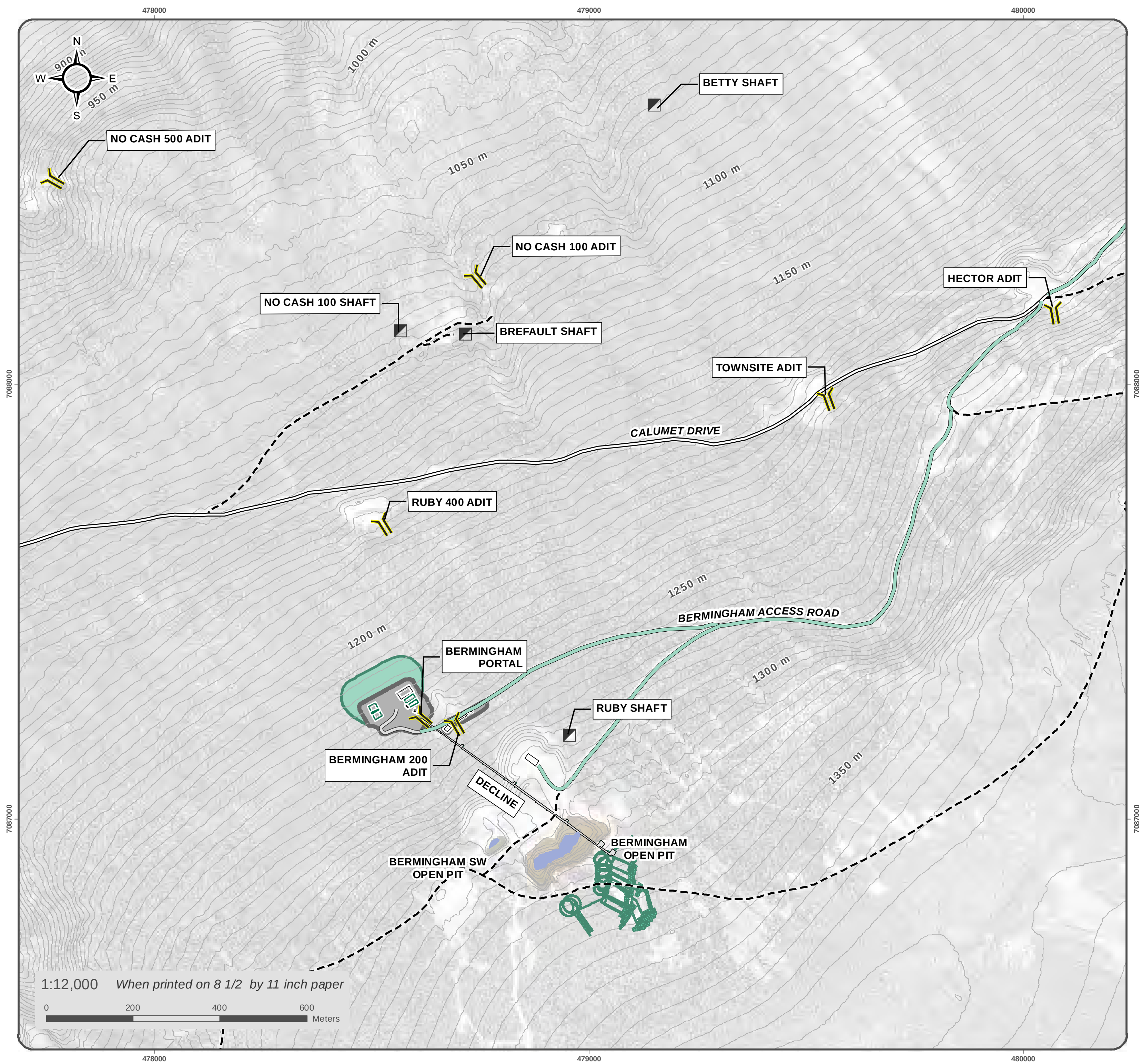
ALEXCO KENO HILL MINING CORP.
BERMINGHAM

FIGURE 1-2

BERMINGHAM PROJECT AREA

NOVEMBER 2017



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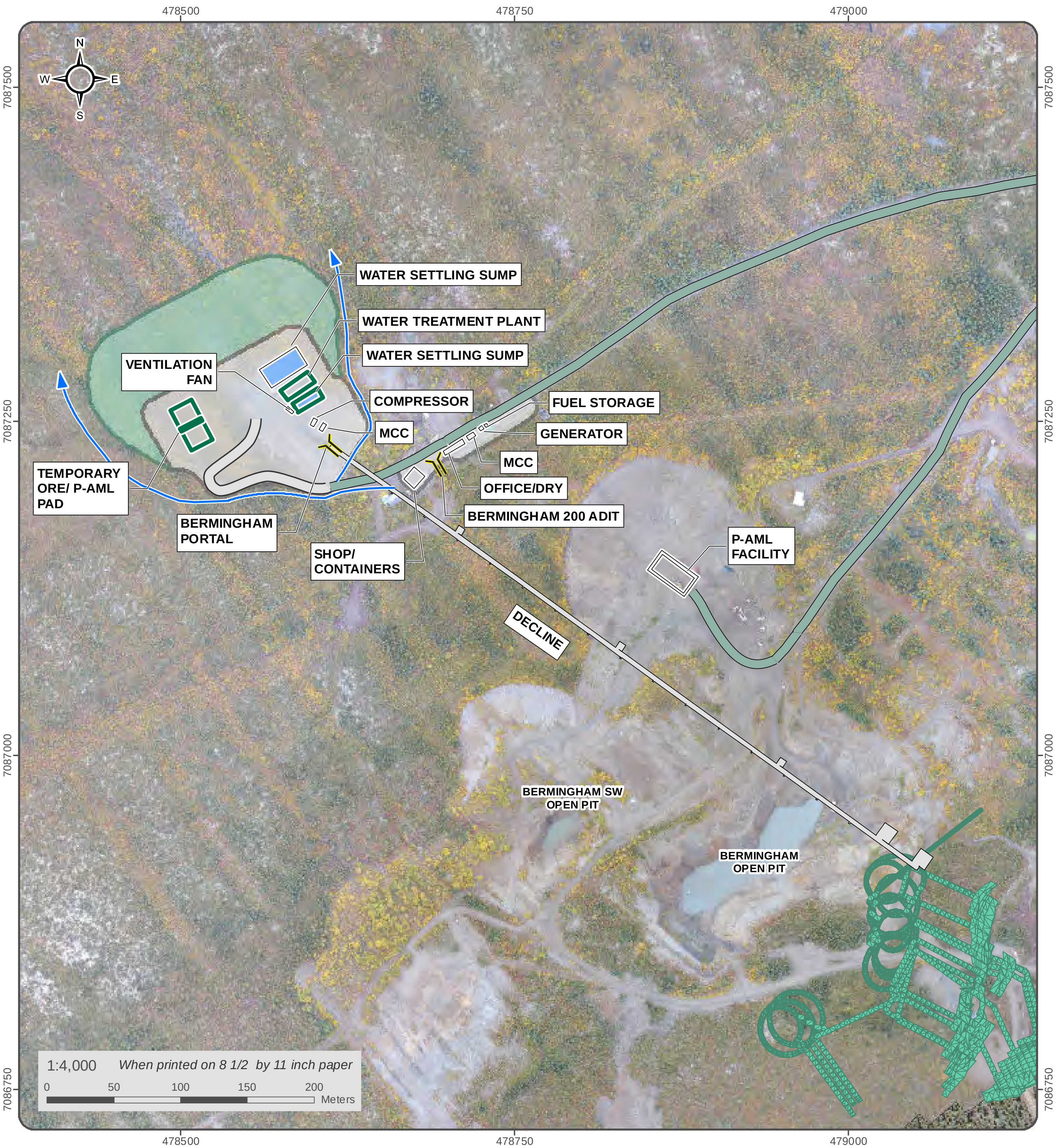

- Adit/Portal
- Diversion Ditch
- Permitted New Road
- Proposed Road Upgrades
- Proposed Underground Workings
- Permitted Mine Footprint
- Proposed Mine Footprint
- Permitted Mine Infrastructure
- Proposed Mine Infrastructure
- Decline

ALEXCO KENO HILL MINING CORP.
BERMINGHAM

FIGURE 1-3
BERMINGHAM MINE PROJECT LAYOUT

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AEG

AKHM

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1.4 ENVIRONMENTAL AND SOCIO-ECONOMIC CONTEXT

Table 1-1 summarizes existing environmental conditions in the Keno Hill project area. The KHSD lies within the Yukon Plateau – North Ecoregion, just south of the Wernecke Mountains. The terrain consists of concordant, rolling, upland areas separated by wide valleys. Alpine mountain peaks extend above the uplands locally. Many valleys include peatlands, palsas, fens and meadows of sedge tussocks. Upper slopes may be covered with scree material, with treeline occurring at 1,350 to 1,500 metres above sea level (masl). The area has been influenced by the latest glaciation but shows more subtle evidence of an earlier event as well.

Regional permafrost is irregularly distributed and its occurrence is dependent upon the elevation, hillside exposure, depth of overburden, soil types, amount of vegetative cover, and presence of flowing underground and surface water. At high elevations and on slopes with a northern exposure it is generally present. Geological conditions are presented in Appendix B.

The KHSD supports a variety of wildlife including ungulates, fur-bearers, small mammals, upland game birds and waterfowl. Moose are the most important subsistence animal in the area. Repeated survey work over the last 15 years indicates a healthy, stable moose population that has in recent years reached a maximum level of harvest (Lortie, 2009). Woodland caribou are not presently found in the immediate study area with the exception of the appearance, in summer, of fewer than 10-12 caribou scattered in very small groups in the Mt. Hinton and Bunker Hill areas. Sheep are not known to inhabit the Keno Hill area.

The Bermingham project site lies within the traditional territory of the First Nation of Na-cho Nyak Dun (FNNND) and over 6 km from Keno City and 40 km from Mayo. The area has been shaped by mineral development over the past hundred years. Silver and lead ore deposits were discovered on Keno Hill in the early 1900s and the area has since seen fluctuating levels of ongoing quartz and placer mining and exploration ever since. Today, the area supports not only mineral development, but also tourism, recreation, traditional pursuits, as well as the local people.

Keno City is a small community situated at the end of the Silver Trail Highway with a population of approximately 12 permanent residents. The community was originally established to support mining operations in the area and the community's population has fluctuated over the last hundred years in response to local mineral development activity. Today, Keno City is a small community with residences, a few small businesses, the Keno City Mining Museum, and the Keno City Alpine Interpretive Centre.

The community of Mayo is located approximately 40 km from the project site. Mayo has a population of approximately 450 people and serves as a distribution and service centre for the surrounding area, supporting mineral development, tourism and other activities. Mayo is also the administrative centre for the FNNND. In addition to being a tourist destination, the community is a base for wilderness and mining tourism, canoeing, hiking, big-game hunting and fly-in fishing.

Table 1-1: Keno Hill District Environmental Setting Summary

Drainage Region	Stewart River drainage region
Significant Watersheds	McQuesten River, No Cash Creek and Stewart River Watershed
Ecoregion	Yukon Plateau (North)
Study Area Elevation	900-1350 masl
Vegetation Communities	Northern boreal forests occupy lower slopes and valley bottom; spruce, pine and alder; grasses and sedges, mosses occupy forest floor; heavy moss and lichen growth resident as ground cover understory of shrub willow; open and forest fringe areas of willow and scrub birch, and various flowering plant species.
Wildlife Species	Moose, grizzly and black bear, caribou, beaver, wolf, lynx, marten, wolverine, western tanager, magnolia warbler, white-throated sparrow, bald eagle, furbearers and small animals. Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed species include: Common Nighthawk (Threatened); Rusty Blackbird and Olive-Sided Flycatcher (Special Concern).
Fish Species	Bering and Beaufort Sea salmonids and freshwater species, including: Arctic grayling, Arctic char, lake trout, trout perch, lake whitefish, broad whitefish, burbot, inconnu, Arctic Cisco, Northern pike, slimy sculpin

Characterization and management of potential effects on environmental valued components have been incorporated into Sections 6, 8, 9 and 10, as appropriate. Potential impacts on fish, wildlife and vegetation have not been considered. The Project is not anticipated to affect these components, because Bermingham is situated in close proximity to previous and current disturbance a minimal footprint extension is proposed. As described in Section 8, the Project is not expected to impact surface water.

Section 10 presents the socio-economic effects assessment and outlines mitigation and management measures.

1.5 ASSESSMENT AND REGULATORY CONTEXT

Alexco and its subsidiaries undertake a variety of activities at the KHSD, including care and maintenance, water treatment of historic adit drainages, site closure planning, mining exploration and development, ongoing environmental monitoring, and production of new deposits. These activities are authorized under a suite of project approvals. Table 1-2 lists the relevant existing approvals.

The proposed project will require the amendment of the existing mine production Water Use Licence QZ09-092 and Quartz Mining License, QML-0009.

Table 1-2: Relevant Keno Hill Silver District Assessment and Regulatory Approvals

Purpose	YESAA Approval	Quartz Mining Act Approval	Water Use Licence
Bermingham Advanced Exploration Project	Project # 2017-0086 Decision Document	Class 4 Mining Land Use Approval (LQ00240, expires 2018)	N/A
Flame and Moth Mine Production	Project # 2013-0161 Decision Document	Amended Quartz Mining Licence (QML-0009, expires 2031)[a]	Type A Water Use Licence QZ09-092 amendment 2– process ongoing
Onek and Lucky Queen Mines Production	Project # 2011-0315 Decision Document	Amended Quartz Mining Licence (QML-0009, expires 2031)[a]	Type A Water Use Licence QZ09-092 amendment 1 – QZ12-053, expires 2020[b]
Bellekeno Mine Production	Project # 2009-0030 Decision Document	Quartz Mining Licence (QML-0009, expires 2031)[a]	Type A Water Use Licence QZ09-092, expires 2020[b]
Bellekeno Advanced Exploration	Project # 2008-0039 Decision Document	Class 4 Mining Land Use Approval (LQ00240, expires 2018)	Type B Water Use Licence QZ07-078/Amendment 1 QZ10-0606, cancelled
Care & Maintenance	Project #2012-0141 Project #2006-0293	N/A	Type B Water Use Licence QZ12-057 (renewal) expires 2018[b] Type B Water Use Licence QZ06-074/Amendment 1 QZ08-082[b]

Notes: [a] http://www.emr.gov.yk.ca/mining/pdf/mml_keno_qml-0009_flamemoth_amendment.pdf
[b] *www.yukonwaterboard.ca/waterline*

2 PROJECT DESCRIPTION

2.1 PROJECT AND ASSESSMENT SCOPE

The general scope of the project is outlined and provided in Table 2-1 and specific details are provided in the following subsections. Subsequently, activities related to the project but not included within the scope are described in Section 2.1.1. The Bermingham deposit is currently permitted for an underground advanced exploration program including the construction of a portal, surface facilities, deposition of waste on surface. These activities that will become part of the Bermingham production project are not included in the scope of this Project Proposal as they have already been assessed, permitted and constructed.

The principal project activities include:

- Construction of surface infrastructure to support underground development and operations (shop trailers, water treatment infrastructure, electrical power lines and distribution, Run-of-mine (ROM) ore storage facility);
- Upgrade of ~12 km by 9m haul road from the Bermingham portal to the Keno District Mill via Calumet Road using Bermingham and historic N-AML waste rock as required;
- Transportation of Bermingham ore to Keno District Mill and backhaul tailings for underground backfill;
- Construction of a ventilation and secondary escape raise and ongoing construction of primary and secondary underground ore access drifts;
- Underground diamond drilling;
- Mining of ore and waste, milling of ore at the Keno District Mill;
- Use of N-AML waste rock (non acidic or metal leachate) for road building, laydown pad construction, and general construction purposes;
- P-AML (potentially acidic or metal leachate) waste rock storage on surface;
- Storage of tailings in the DSTF and backfill underground;
- Use of explosives;
- Construction and operations of water treatment infrastructure to support underground development and operations; and
- Dewatering and water management activities and storage, treatment and discharge of water.

All of these activities described above and as part of the Bermingham project are similar or identical to activities already occurring in the Keno Hill District under current authorizations.

Table 2-1: Scope of the Assessment

	Bermingham	Project Proposal Section
Mine Operations	Daily mining rates up to 400 tonnes per day (tpd), total ore mined over the life of the project of 221,000 tonnes	Sec. 3
Mining Development	New development of underground workings 3.7m wide by 3.7m tall Development of ventilation raise, safety bays, loadout bays and sumps Haulage to surface using 15 t trucks	Sec. 3
Maximum Approximate Waste Rock Tonnages to surface	Up to 10,000 t P-AML Up to 165,000 t N-AML	Sec. 6
P-AML Waste Rock Storage	Temporary storage on surface until used as underground backfill	Sec. 6
N-AML Waste Rock Disposal	Construction of portal pad and laydown area, expanded coarse ore stockpile General construction and road upgrades Underground backfill	Sec. 6
Tailings management	Deposition of tailings on the licenced Dry Stack Tailings Facility is outside the scope of this assessment – refer to Section 2.1.1 Backfill of tailings underground	Sec. 5
Water use and management	Water use up to 140.1 m^3/d (112.1 m^3/d plus 25% contingency) from underground workings Contingency sources include a groundwater well. Onsite Total Suspended Solids (TSS) management through a proposed primary and second storage/settling pond Dewatering of underground workings at a rate up to 1,200 m^3/day for a monthly average Discharge to No Cash Creek via pond decant (KV-114) and water treatment (as required) to Metal Mining Effluent Regulation Standards	Sec. 8
Access/Ore Transport	No new roads are required to access the Bermingham Portal. ~12 km of existing roads will be upgraded to accommodate 35 tonne haul truck traffic.	Sec. 7.6
Footprint extension	Bermingham haul road upgrade (12 km by 9 m, 48,000 m^2) and waste rock storage facility expansion, 13,000 m^2	Sec. 5.2 & 7.6
Personnel requirements	No additional staff required (as standalone operation)	Sec. 10
Power	Grid power and diesel back-up	Sec. 7.1
Fuel Storage	Up to 30,100 L (two Envirotanks: 28,000 L main storage tank and 2,100 L day tank)	Sec. 7.9
Auxiliary facilities	Operation of portal facilities (plant services, miners' dry area, offices, trailers, portal, water treatment plant, settling ponds, fuel and explosives storage) Explosives storage and use	Sec. 7

2.1.1 Activities Outside the Assessment Scope

Because this project involves amendments to only certain portions of existing licences for the development activities, Table 2-2 describes proposed project activities that have been previously assessed as part of other Keno Hill District Development projects, and are therefore outside the scope of this assessment. Accompanying rationale and applicable authorizations are outlined for each activity.

In Alexco's interpretation, YESAA Section 42 (1) (b), the "existing project" clause, was meant to capture modifications to pre-existing projects that were never assessed under this legislation. We take the view that because the DSTF and mill have already been assessed under YESAA, and has since been licenced and made operational, this is not an "existing project" as defined in YESAA. We note that as we continue to develop the KHSD, it would become unwieldy over time to have to continually reassess key existing project components. Continual reassessment will hinder development in the KHSD.

Table 2-2: Activities Outside the Scope of the Assessment

Activity	Rationale	Applicable Authorization(s)
Current mining operations	The proposed project does not include any changes to mining operations at the Flame and Moth, Bellekeno, Onek or Lucky Queen deposits.	QML-0009
		QZ09-092
Operation of the mill	Bermingham ore will be milled at the licenced Keno District Mill, involving only minor operations adjustments. No changes to water use/ management are proposed for the purpose of milling.	QML-0009: 15.6; Schedule B: Mill Development and Operations Plan; Noise Abatement Plan
		QZ09-092: 14(h-k)
Operation of the Dry Stack Tailings Facility	The total tonnage of tailings deposited on the already authorized DSTF will not change. Apart from any operational changes that may be implemented as a result of the monitoring and surveillance program, there are no planned changes to operation of the DSTF proposed as part of this project.	QML-0009: 15.10; 15.12; Schedule B – Dry Stack Tailings Facility Development and Operations Plan
		QZ09-092: 14l
Initial development of Bermingham Portal	The Bermingham portal and access to underground has been constructed under mining land use approval LQ00240 and no changes are required for production at Bermingham.	LQ00240

2.1.2 Mine Site Liability

Responsibility for the historic environmental liabilities within the KHSD lies with the Government of Canada, as outlined in the Amended and Restated Subsidiary Agreement (ARSA) between Alexco/ERDC and Government of Canada. The ARSA contains a Production Unit provision that addresses the question of historic environmental liability if/when Alexco brings historic mines back into production and operation. A Production Unit is a surface area footprint that encompasses the required infrastructure and facilities included in a proposed mining production area. Under the ARSA, any historic terrestrial (i.e. waste dumps, roads, etc.) and water related liabilities that are within the Production Unit become the responsibility of Alexco.

A Baseline Environmental Assessment (BEA) has been completed prior to initiating development of the Bermingham deposit to establish the environmental baseline conditions associated with remnant liabilities.

2.2 EXISTING SITE CONDITIONS

The original Bermingham underground mine was first developed in 1920's. Open pit mining commenced which was followed up by open pit mining o in the late 1970s to recover the crown pillar material left from the underground mining operation. The Bermingham open pits and waste rock storage areas remain and are immediately adjacent to the newly constructed Bermingham portal for underground advanced exploration (Figure 1-2). An advanced underground exploration program at Bermingham commenced in Q2 2017 through an amendment to the company's Class IV authorization. Newly installed surface support facilities are in place and an underground portal and decline has been established.

2.3 PROJECT SCHEDULE

Table 2-3 outlines the schedule for undertaking the key components of the Project. The Bermingham mine will be a satellite deposit that will be mined and processed simultaneously with the Flame and Moth mine. Once mining of the Bermingham deposit is complete, the Flame and Moth and Lucky Queen mines will continue to operate for an additional 2 years as part of an overall 8-year mine plan as it is currently envisioned.

Table 2-3: Bermingham Project Timeline

Activity	2017	2018				2019-2024	2025-2035
	Q4	Q1	Q2	Q3	Q4	Q1-Q4	Q1-Q4
Advanced Underground Exploration							
Construct Facilities (roads, power, buildings)							
Underground Development							
Mining/Ore Processing							
Interim Reclamation							
Reclamation, Post-Closure monitoring							

3 BERMINGHAM DEVELOPMENT AND OPERATIONS PLAN

3.1 INTRODUCTION

The first claims in the Bermingham area were staked in 1921, within a decade of commercial production starting in the Keno Hill district. Shallow underground workings were initiated in 1923 with the discovery of vein float and limited production of high grade silver and lead from the Bermingham Vein ensued. The Treadwell Yukon Company optioned the ground in 1928, and completed additional underground workings and identified a fault offset vein portion, but dropped the lease in 1930 due to low silver prices and a lack of ore grade material. United Keno Hill Mines (UKHM) purchased the property as part of the district consolidation, and between 1948 and 1951 drove an adit and drift about 30 foot (ft) below the Treadwell workings where considerable milling ore appeared available. In 1952, many of the old Treadwell workings were surveyed and sampled, but the adit level was subsequently abandoned in 1954 after very little ore grade material was realized. During this time, UKHM milled 5165 ton of ore at 47.3 oz/ton (opt) Ag, 8% Pb, and 1.3% Zn, of which all but 60 ton was recovered from the old dumps.

Between 1965 and 1982, 874 overburden drill-holes totalling 65,390 ft (19,931 m), and 27 core holes totalling 7898 ft (2407 m) were drilled in the Bermingham area, a small portion of which occurred in the present resource area. Poor ground conditions prevented many of these holes from adequately penetrating the vein zone, however they outlined an open pit resource and stripping began in 1977. The open pit mine produced 91,104 tons at 16.7 opt Ag. The southwest extension of the Bermingham Vein, as offset by the Mastiff Fault, was tested by several historic shafts sunk by the Treadwell Yukon Company Ltd. The vein was reported to be 8 ft (2.44 m) wide and to consist mainly of siderite with small bunches of galena, although no mineable ore was encountered. A small open pit was operated on this segment of the vein by UKHM in the mid-1980s. A further 150 m along strike to the southwest, an intended second pit with an estimate resource of 274,000 oz silver was stripped to bedrock in 1983. The historical mineral resource estimate does not use mineral resource categories stipulated by NI43-101. SRK is not aware of the parameters and assumptions used in preparing this estimate. The historical estimate should not be relied upon; it is only stated here for historical completeness. Although drilling indicated shallow mineralization exists, the exposed veins appeared weak and un-mineralised, and the pit was never initiated. In total, the Bermingham property produced 186,266 ton at 20.3 opt Ag, 4.2% Pb, and 0.6% zinc, or, 3,777,932 oz of silver (Cathro, 2006).

The exploration conducted by Alexco is the first comprehensive exploration effort in the district since 1997. The first holes drilled by Alexco in the Bermingham area were in 2009 (two core holes totalling 523m), targeting the Bermingham Vein at depth in the hangingwall of the Mastiff Fault below an area with a historic shallow open pit resource. Results of this drilling were sufficiently encouraging to continue exploration in 2010 and 2011. Alexco conducted surface diamond drilling programs at Bermingham in 2012 and again in 2014, with 61 holes drilled totaling 18,699 m. In 2015 and 2016 a further 20,018 m were drilled in 58 holes and in 2017 13,000 m were drilled in the Bermingham deposit and surrounding area.

Mineral Resource

Mineral Resources have been determined by SRK Consulting and a summary of the 43-101 compliant Mineral Resources is shown in Table 3-1.

A longsection showing the Bermingham mineral resource is presented in Table 3-1.

Table 3-1: Mineral Resource Statement for the Bermingham Deposit, December 30, 2016**

Class	Tonnes	Ag (gpt)	Au (gpt)	Pb (%)	Zn (%)
Indicated*	858,210	628	0.13	2.4	1.7
Inferred*	220,293	770	0.15	2.1	2.2

* Mineral resources are not mineral reserves and have not demonstrated economic viability. All figures have been rounded to reflect the relative accuracy of the estimates.

** Reported at an NSR cut-off of $185 (US$0.96 = C$1)/tonne using consensus long term metal prices (US$) and recoveries developed for the nearby Bellekeno deposit (Ag US$20.00/oz, recovery 96%; Pb US$ 0.90/lb, recovery 97%; Zn US$ 1.00/lb, recovery 88%; Au US$ 1,300/oz, recovery 72%).

3.2 LAYOUT AND PORTAL LOCATION

The portal and underground access already constructed and in development for the advanced underground exploration at Bermingham will be used for mine development and operations access as well. The surface infrastructure already in place for the underground exploration program will also be used for operations and upgraded as necessary. These common surface support facilities include a dedicated mine office, dry/lunch room, maintenance shop, fuel storage tanks and laydown yard. Water management ponds will also be constructed adjacent to the portal. The layout of the surface facilities for Bermingham is presented in Figure 1-3 while the current portal location is shown below in Figure 3-1.

Figure 3-1: Current Bermingham Layout

In order to reach the mineralization of the Bermingham deposit, the underground exploration decline will be extended a further 120 metres and will serve as the primary ingress/egress and development/production haulage and transportation route. The primary decline is 3.7 m wide by 3.7 m high (for mechanized development and production mining) driven at a grade of approximately -15%. The current Bermingham exploration portal is shown in Figure 3-2. The decline will include safety bays and remucks as required for decline development work. The preliminary portal is located at UTM 7,087,231N and 478,612E (zone 8).

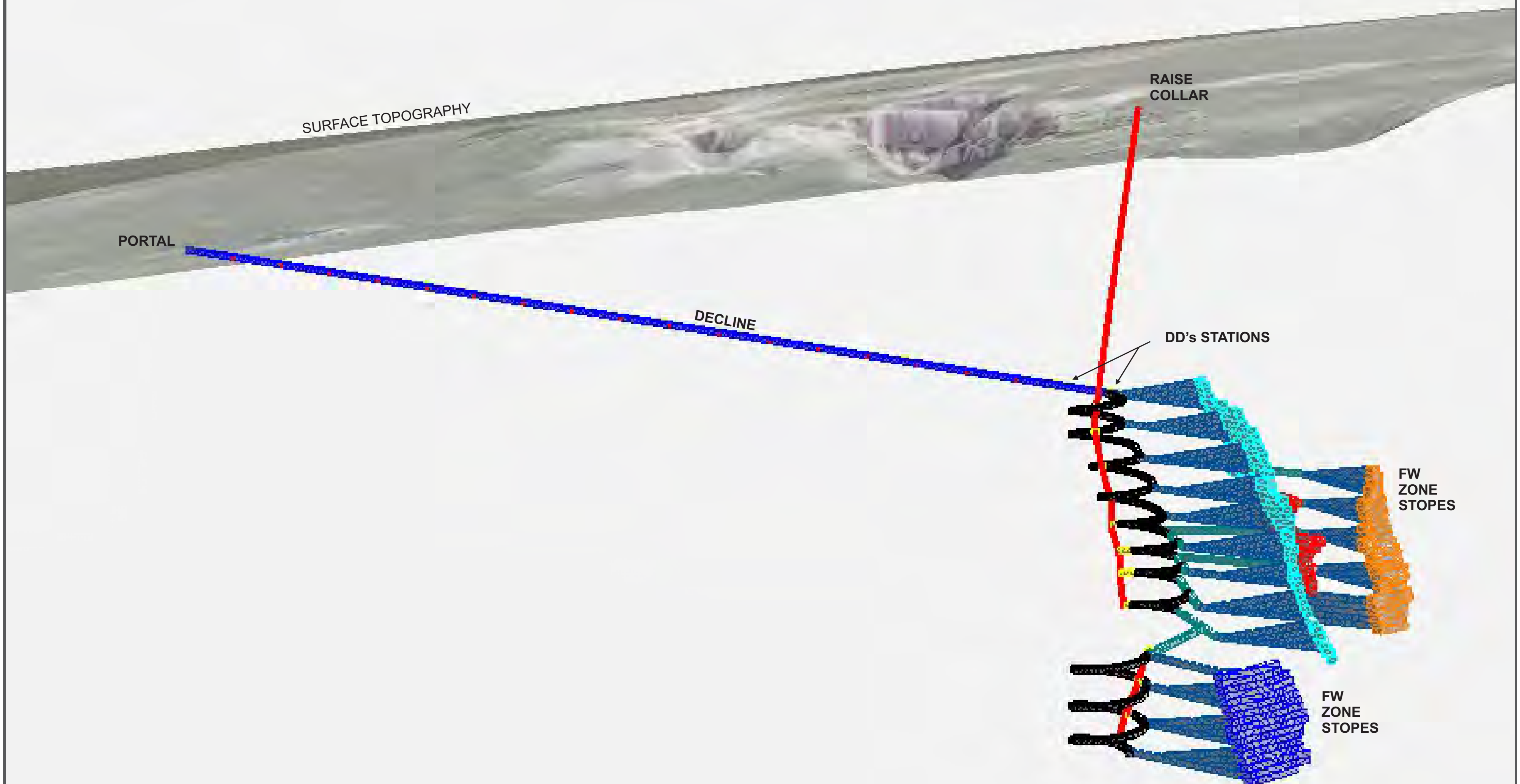
The decline will be driven using Alexco's owned mechanized equipment; specifically, rubber tire load-haul-dump scoops, 15 ton trucks, a jumbo and mechanized roof bolter. This fleet will be supported by a fleet of mechanized utility equipment.

Figure 3-2: Bermingham Exploration Portal

3.3 MINE PLAN

Figure 3-3 shows the 3D mine plan model of the Bermingham deposit.

The mine model view shows only the centre lines of the planned ramps, crosscuts, and raises.



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CONCEPTUAL DRAWING; FEATURES ARE NOT TO SCALE

AKHM

ALEXCO KENO HILL MINING CORP.
BERMINGHAM

FIGURE 3-3
BERMINGHAM UNDERGROUND MINE PLAN

SEPTEMBER 2017

D:\Project\AllProjects\Keno_Area_Mines\BERM\Maps\09-ArcScene\Underground

3.4 MINING METHODS

The relevant characteristics of the deposit from a mining method selection perspective are:

- The deposit is offset by approximately 65 m of apparent right lateral movement along the west-northwest trending post-mineral Cross Fault. The Cross Fault dips approximately 60° to the southwest. Bear and West-Dip Vein mineralization is mainly situated within the hanging-wall block and Footwall Vein mineralization is located on both sides;
- The deposit area is covered by thin soil and regolith that ranges in depth from 1 to 20 m;
- It is a vein-type deposit consisting of several anastomosing vein-fault surfaces that split and rejoin, primarily the Aho, Bear, Bermingham, Footwall and West Dip Veins, current planned mine areas predominantly target the veins where they dip approximately 70°;
- Vein widths vary from less than 1 to 10 m. The selected mineable portions of the veins are mainly in the range of 1 to 5 m wide;
- It is a high grade, high value deposit requiring good mining recovery;
- Mining depths ranging from 170 m below bedrock surface to a current maximum depth of 350 m;
- Vein continuity is expected to be reasonably good with contacts that can be visually identified; and
- Wall rock strength is good with the vein material being of fair to weak. Vein material strength is expected to be much improved when dewatered.

Planned mining methods are predominantly cut and fill, similar to the mining methods currently used at Bellekeno (Table 3-2). There are limited areas that may be amenable to longhole mining methods that were also used at Bellekeno.

Table 3-2: Mining Method Selection

Selected Mining Methods	Justification
Overhand Cut and Fill	Selected for less competent rock, less dilution, better ground control and optimized ore recovery
Long Hole	Selected for more competent rock and to extract the remaining pillars towards the end of the mine life

A brief description of each main mining method is given in the following pages.

Cut and Fill (CF) mining is a method of short hole mining used in a wide range of deposit geometries. There are two main methods of cut and fill (CF) mining; overhand cut and fill (OCF) and underhand cut and fill (UCF). In the case of Bermingham, only OCF is anticipated.

OCF typically uses uncemented fill and mining begins at the bottom of a mining block and advances in “slices” of “lifts” upwards. Stoping begins from an access ramp driven off the main level to the bottom of the mineralized zone to be accessed. Using development mining techniques, a drift is driven through the mineralized zone to the defined limit of mining. Upon completion, the drift (or "cut") is filled with cemented back-fill, which would consist of tailings or waste rock. Once the stope is filled the ore access off the main haulage ramp is driven down to access the next lift on top of filled cut. This process continues until the top of the stope is reached. See Figure 3-4 for a typical CF schematic. The majority of ore mined from the Bellekeno mine to date has been through OCF and cemented rock fill mining methods and is well demonstrated.

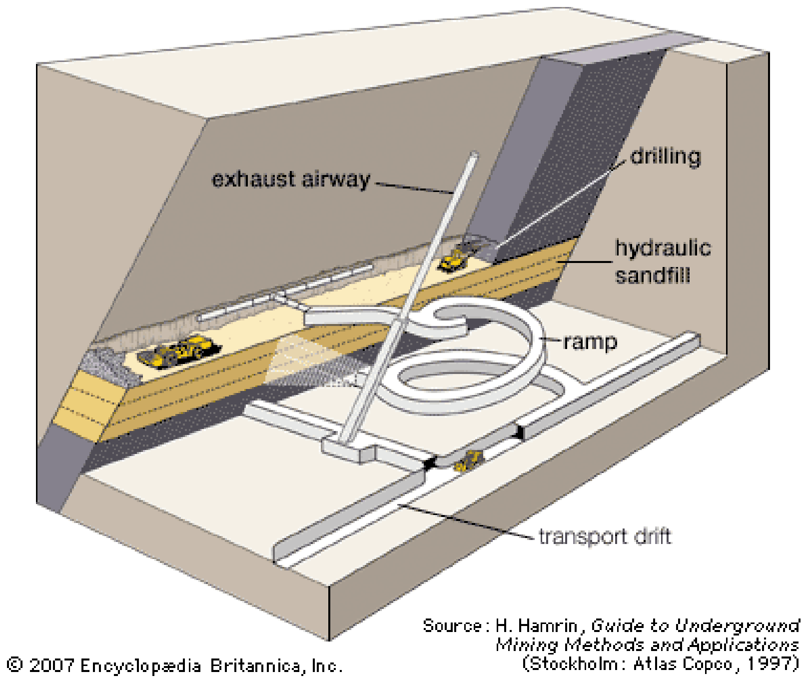


Figure 3-4: Overhand, Mechanized Cut & Fill Mining Methods (Source: Atlas Copco)

Long hole stoping ("LH") is normally used where large blocks of continuous mineralization can be identified and the surrounding rock is reasonably strong (Figure 3-5). Access to the top and bottom of the mineralized block is provided with drifts. A vertical opening (slot raise) is created within the stope block from the top of the block to the bottom. Long holes are drilled to blast vertical slabs off the mineralized block which is then scooped from a lower drawpoint by an Load Haul Dump (LHD) loader.

The depth on blast holes in the production sequence will be approximately 10-15 metres long. Blind raises or slot raises will be drilled with the LH drill unit, blasted and the stope block will be retreated out by drilling and blasting successive rings. Typically LH blocks will be pulled last unless they are in an area that would not conflict with ongoing operations. They could also be filled if they are located too close to mine infrastructure.

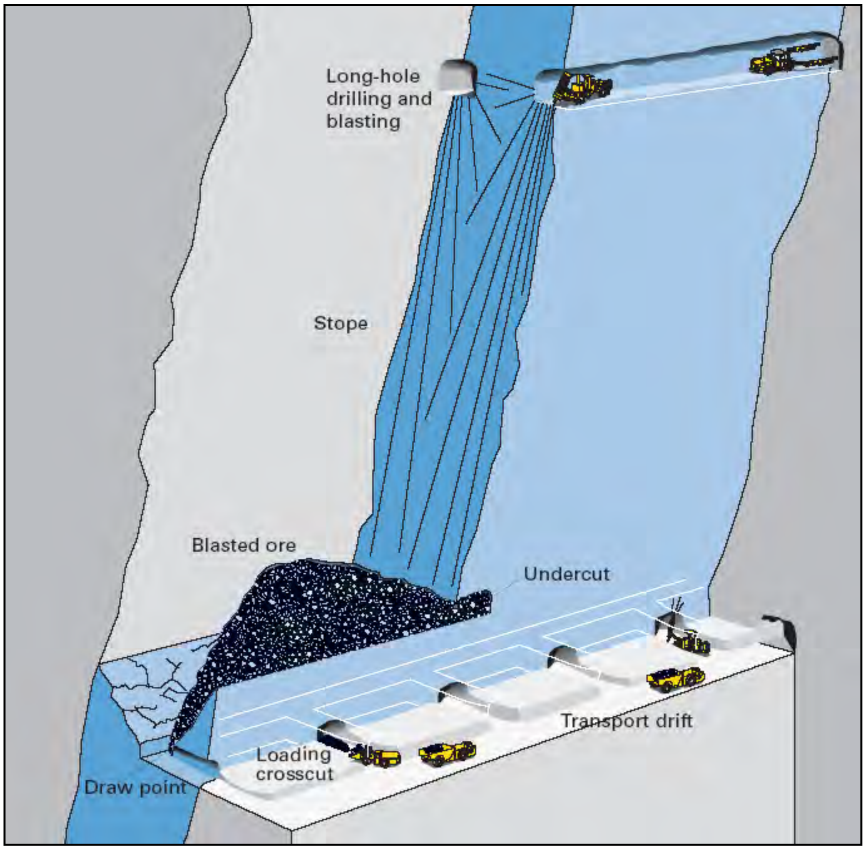


Figure 3-5: Long Hole Mining Method (Source: Atlas Copco)

3.4.1 Development and Production Schedules

A development and production schedule has been prepared for the Bermingham deposit (Table 3-3). The schedule tracks and reports development metres and vein production material. The schedule shown is based on various assumptions; including commodity prices, economic parameters, development costs and productivity constraints. This schedule is a snapshot of Bermingham based on these parameters. As these parameters change in the future, the various production rates and timing will vary as well.

The schedule assumes a development rate of 4 metres per day for the main ramp.

The production schedule includes some time allowances for vein water drainage after the vein has been intersected by access crosscuts. One month or more has been allowed for drainage before mining in the vein begins. Another constraint is that production stoping is not scheduled to begin until a second route out of the mine has been established to that location.

The sequence of underground development will entail shooting line and grade, marking up the face for jumbo drilling, drilling, loading holes for blasting, excavation and transportation of broken rock to pre-determined destinations, roof and rib bolting after the mucking sequence, assessment and sampling of the new face by a geologist and then repetition of the drill, blast, muck, bolt and assessment cycle. Utility piping, power cable and ventilation will be installed as the decline progresses.

Table 3-3: Bermingham Production Schedule

Category	2018	2019	2020	2021	2022	2023	Total
Metres Development (Ramp, Access, X-Cut, Raise)	733	1,301	1,667	1,327	547	153	5,728
Tonnes Ore Mined/Milled	7,211	51,096	51,096	51,096	51,096	8,442	220,037
Tonnes Waste Broken	32,732	52,598	68,690	54,509	21,881	7,461	237,871
Tonnes Concentrate Produced	1,073	5,300	4,472	4,515	4,919	621	20,900
Tonnes Tailings Generated	6,138	45,796	46,624	46,581	46,177	7,821	199,137

The Bermingham deposit is smaller than Bellekeno in terms of average vein width and anticipated production rates although the ore grade is significantly higher in value. The primary decline will be smaller than Bellekeno and ROM ore will be stored on surface in a covered enclosure rather than underground as was done at Bellekeno. The smaller underground haulage trucks (15 t) will come directly to surface and place the ROM ore temporarily until it is hauled to the Keno District Mill using larger 35 tonne haul trucks. The main decline and associated development heading dimensions are provided below:

Decline/Development 3.7 m W x 3.7 m H

Ore Access 3.7 m W x 3.7 m H

Ventilation Raise 3.0 m diameter raise bore above 1031 elevation, 2.4 m Alimak raise below 1019 elevation

3.4.1.1 Backfilling

Backfill materials consisting of development waste rock (N-AML and P-AML) and dry filtered tailings will be placed into empty stopes by LHD or 15-tonne trucks. The mix of these materials is flexible and will be varied to minimize the surface environmental impact while optimizing the most efficient and cost effective back filling sequence. For cut and fill stopes, the backfill will be pushed up tight to the back using an LHD equipped with a rammer jammer.

Cemented backfill at approximately 5% cement by weight will be used in longhole stopes. The cement, rock and water will be mixed by LHD bucket in a small sump-like cut out near the empty stope. Cement will be transported underground in bulk bags.

A waste rock and tailings materials balance for Bermingham is shown in Table 3-4. Waste rock will be brought to surface when immediate backfill locations are not available. Depending on backfill cycles, stockpiled waste on surface will be re-handled and brought back underground for use as backfill. The initial N-AML waste rock produced during the early development phase will be used for various construction projects including; the portal pad, laydown areas, haul road and coarse ore stockpile. The amount of rehandle will be minimized as much as possible to reduce the surface stockpile as well as reducing operating costs from rehandling. Vein material and waste will be handled by 15-tonne capacity haulage trucks underground and on surface. A temporary surface stockpile will be required for storage of P-AML waste. The first priority for backfill material will be the P-AML waste stored on the surface stockpile. It is expected that 100% of all P-AML waste will be used as backfill underground.

Under the current mine plan, waste rock broken underground is estimated at 238,000 tonnes. Approximately 101,000 tonnes of this waste rock is needed for Bermingham backfill, along with 37,000 tonnes of dry filtered tailings. The amount of waste rock used for surface construction and final deposition in the Waste Rock Storage Area (WRSA) is estimated to be up to 137,000 tonnes (165,000 tonnes with 20% contingency). Some will be used for the haul road upgrades. All waste rock will be inspected and tested as per the updated Waste Rock Management Plan, which segregates all waste rock as either potentially acidic/metal leaching (P-AML) or not (N-AML).

Table 3-4: Waste Rock and Tailings Material Balance

Category	2018	2019	2020	2021	2022	2023	Total
Sources							
Tonnes Waste Rock Broken	32,732	52,598	68,690	54,509	21,881	7,461	237,871
Tonnes Tailings Generated	6,138	45,796	46,624	46,581	46,177	7,821	199,137
Tonnes Backfill Required	4,378	30,270	31,999	34,134	38,874	7,461	147,115
Destinations							
Waste Tonnes to Backfill	3,284	22,702	23,999	25,601	20,000	5,596	101,182
Tailings Tonnes to Backfill	1,095	7,567	8,000	8,534	9,718	1,865	36,779
Waste Tonnes to WRSA/Construction	29,448	29,896	44,691	28,908	1,881	1,865	136,689

3.4.1.2 Mine Dewatering

A comprehensive hydrogeological investigation was completed at the Bermingham deposit to assess the hydrological conditions associated with development of the deposit. The details of the program are included as Appendix C. The hydrogeological investigation estimates that up to 11.5 lps (13.9 L/S with 20% contingency) of groundwater inflow could be expected and encountered during the operation of the Bermingham mine. Management of mine inflows at Bermingham is planned to be via underground sumps and pumps, similar to the water management program at the Bellekeno Mine. Figure 3-6 shows the relationship between mine inflow and depth from surface.

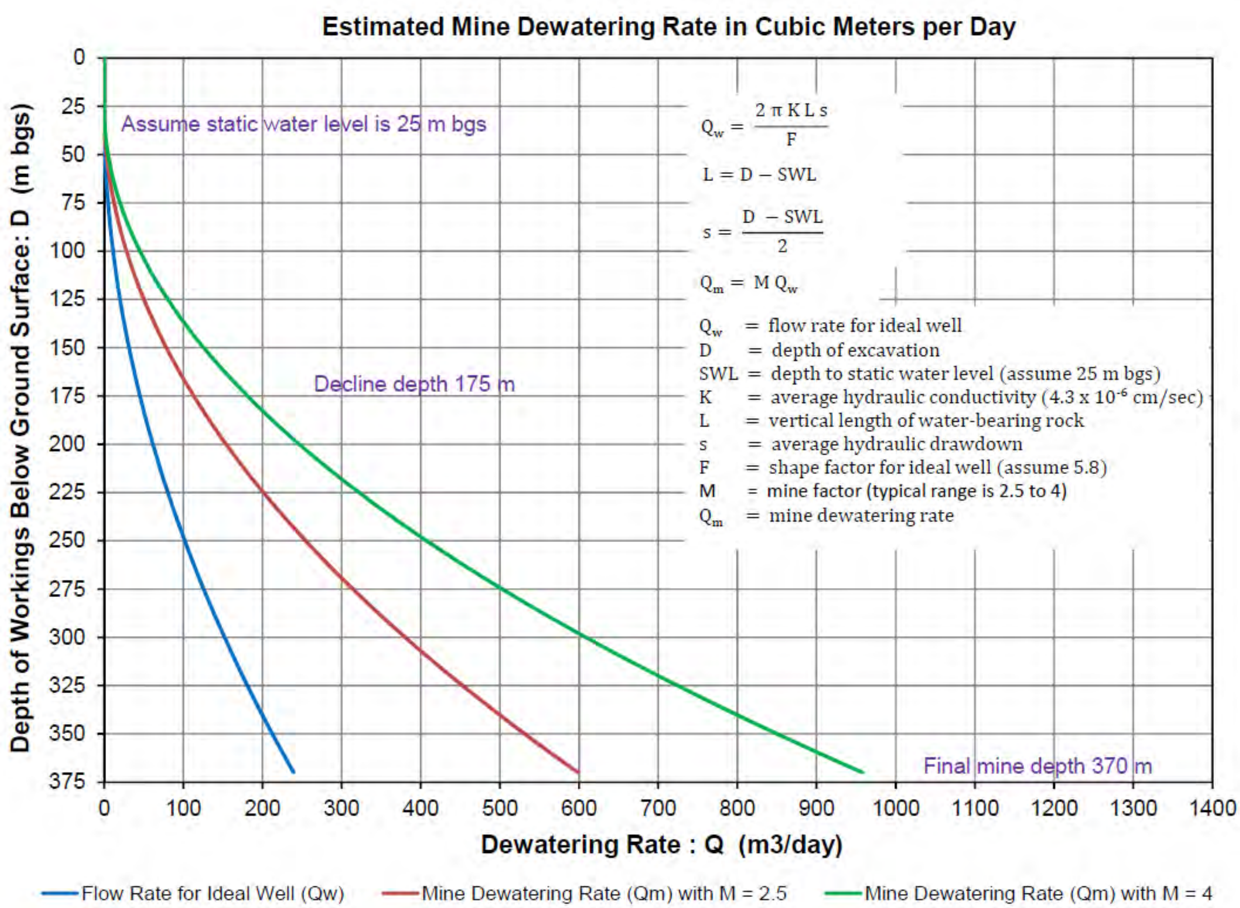


Figure 3-6: Mine Water Inflow versus Mine Depth

4 GEOTECHNICAL ASSESSMENT

4.1 GEOTECHNICAL AND GROUND SUPPORT METHODS

The following describes the ground support classes and ground support requirements for development of the Bermingham deposit.

4.2 GROUND CLASSES

Based on the interpreted geotechnical conditions at Bermingham, the following ground classes have been defined and presented in Table 4-1 and will be applied at Bermingham. These are based on the lithology determined from the face of the advancing heading. These ground control classes will form the basis of the ground control management for development of the Bermingham deposit and additional classes added or modified as required.

Table 4-1: Ground Classes

Area	Ground Class	Typical Conditions
Development Headings	**DG-1**	Quartzite with less than 20% interbeds of schist (graphitic, chloritic). RQD* 70 – 90%, and intact rock strength ("IRS") 100 – 150MPa.
	DG-2	Quartzite with 20 – 80% interbeds of schist (graphitic, chloritic). RQD 60 – 80%, and IRS 40 – 90MPa.
	DG-3	Fault/shear zones comprising predominantly graphitic schist. RQD <50% and IRS 15 – 40MPa.

** "RQD" Rock Quality Designation*

4.2.1 Development Support Requirements

In general, the infrastructure and development is considered to be open for the long-term situation, and support has been designed accordingly. The infrastructure has been designed to avoid areas with potential poor ground conditions; in some situations, this is unavoidable and support will be increased to provide long term stability. Table 4-2 outlines the recommended ground support for waste development headings (decline).

Table 4-2: Support Classes for Development Headings

Area	Ground Class	Support Class	Support Requirements
Waste Development Headings1	DG-1	DS-1 2	1.8m friction anchors on 1.2x1.2m diamond spacing across back and shoulders; #6 welded wire mesh and/or straps across back and shoulders; Additional spot bolting down ribs as required
		DS-1A 3	1.8m friction anchors on 1.2x1.2m diamond spacing across back and shoulders; 2.4m resin grouted rebar on 1.2x2.4m spacing across back; #6 welded wire mesh and/or straps across back and shoulders; Additional spot bolting down ribs as required
	DG-2	DS-3	2.4m coated swellex on 1.2x1.2m diamond spacing down to 1.4m above floor; #6 welded wire mesh down to 1.2m above sill; Additional spot bolting as required; Mesh straps as required
	DG-3	DS-4	25mm flash-coat shotcrete in back and ribs; 2.4m coated swellex on 1.0x1.0m diamond spacing down to 1.2m above floor; #6 welded wire mesh down to 1.2m above sill; Mesh straps as required; 50-75mm additional shotcrete in back and ribs; If required: spiling at 30cm centres with 4.5m grouted bar spiles

1. Galvanized friction anchors and galvanized welded wire mesh should be used in long life openings and corrosive environments. For main declines in DS-1 and DS-1A the use of resin grouted rebar is recommended.
2. DS-1 support should only be used for waste headings considered to be open for the short term situation.
3. See additional caveats for the use of DS-1A support

5 ORE PROCESSING AND TAILING STORAGE MANAGEMENT

5.1 ORE PROCESSING

Ore from Bermingham will be processed in the already authorized Keno District Mill. A summary of the Keno District Mill is provided for continuity and ease of reference during review of the Project Proposal.

Figure 5-1 shows the general features of the Keno District Mill.

Figure 5-1: Keno District Mill

The Keno District Mill utilizes conventional differential flotation processes common throughout the mining industry. The process recovers valuable mineral sulfides through mechanical and chemical processes. The process flowsheet includes the following main components (Figure 5-2):

- Primary and secondary crushing circuits with a belt conveyor to transport the crushed ore to the covered fine ore stockpile;
- Fine ore reclaim system feeding crushed ore from the covered fine ore stockpile;
- Primary ball milling in a closed circuit with a high frequency screen to produce a grinding product of 80% passing 174 µm;
- The ground high frequency screen underflow feeding to lead rougher scavenger flotation circuit to recover lead and silver minerals; the lead rougher flotation concentrate being upgraded in three stages of cleaner flotation;

- The zinc rougher flotation concentrate being upgraded in three stages of cleaner thickening and pressure filtration of the lead and zinc concentrates
- Thickening and pressure filtration of tailings, disposed either as underground backfill or at surface on the DSTF.

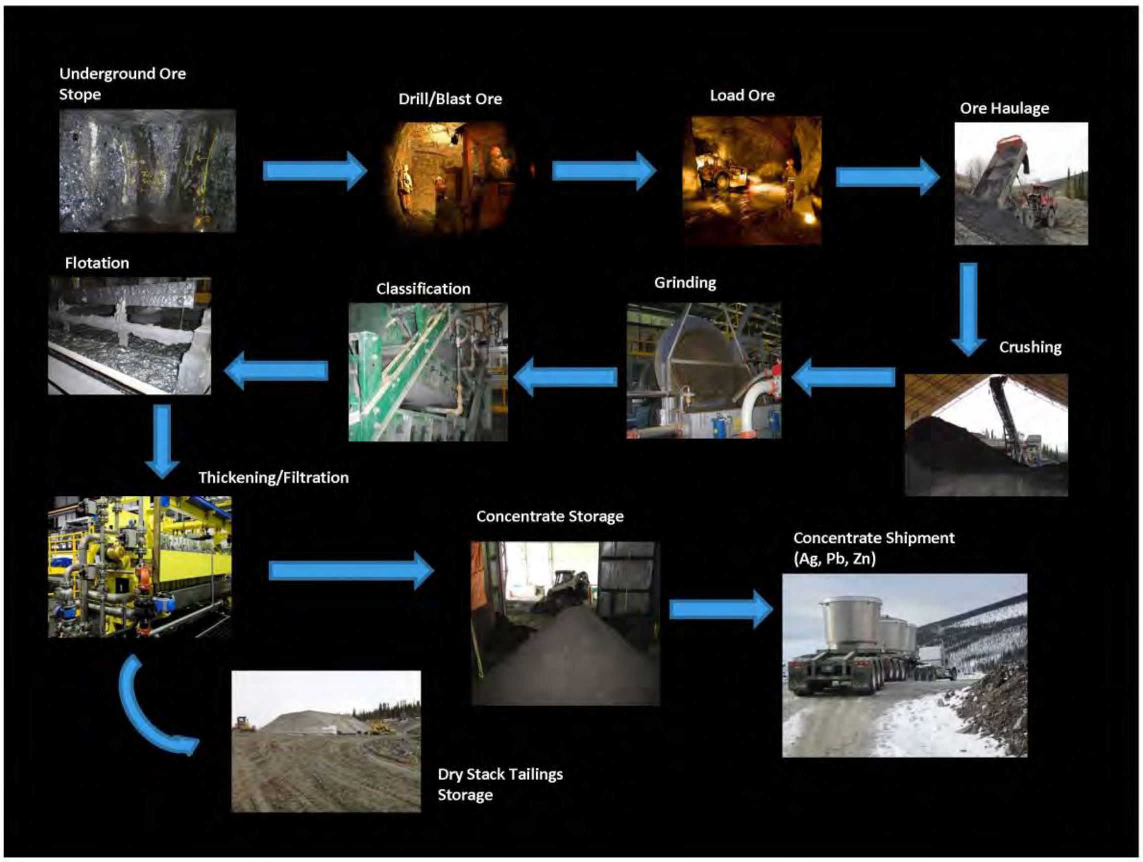


Figure 5-2: Simplified Process Flowsheet

5.2 TAILINGS MANAGEMENT

The Bermingham project will continue to utilize dry stack tailings technology for management and long-term storage of tailings produced from the processing of Bermingham ore. Depending on various operating and economic conditions, Bermingham will either be processed through the Keno District Mill as a standalone feed, or in combination with other permitted mines including Flame and Moth, Bellekeno, Lucky Queen and Onek. Dry stack tailings technology has been successfully applied for management of Bellekeno tailings for nearly 3 years.

Dry-stacked tailings deposition has become a proven technology in recent years due to development of tailings dewatering technology and is a preferred method for tailings disposal in cold weather environments. Dry-stack tailings management and storage technology, although more expensive to construct and operate than conventional tailings disposal techniques, produces an engineered structure with superior geochemical and geotechnical stability.

Dry stack tailings management at the Keno District Mill involves the dewatering or filtering of tailings after the valuable minerals have been removed. Plate and frame filter presses inside the mill building remove the water from the tailings and produce a dry tailings product (<10% moisture). The filtered tailings from the filter press drop onto a conveyor belt and are transported outside the building onto a concrete slab for short-term storage. On a periodic basis (daily/weekly) the filtered tailings are loaded into a haul truck and transported to the DSTF. The tailings are deposited onto the DSTF in thin lifts (~300 mm) and compacted with a 10-t vibratory compactor. The chief advantages of progressive-construct and progressive-reclaim dry stack technology include:

- A smaller overall footprint of tailings deposit facility compared to conventional impoundments;
- Minimizes open area of tailings;
- Minimizes environmental disturbances (less clearing before immediate use, therefore less erosion/runoff);
- More stable structure, enhances long-term closure stability;
- Reduces water usage and makeup requirements from filtering;
- For cold climates, dry stacking prevents pipe freezes and frosting problems common with conventional impoundments; and,
- Enhances closure measure performance.

As the DSTF advances, progressive reclamation is undertaken through recountoring slopes to final angles and constructing a soil/revegetation cover. The cover system reduces pore water seepage through the tailings and promotes revegetation. An August 2017 photo of the DSTF demonstrating progressive reclamation is shown in Figure 5-3.

Figure 5-3: DSTF Progressive Reclamation – August 2017

5.3 DSTF EXPANSION

The current DSTF (Phase I and II) is permitted for a capacity of 912,000 tonnes (Phase I =322,000 tonnes, Phase II = 590,000 tonnes). At the end of October 2013, the DSTF Phase I has approximately 178,000 tonnes placed with a remaining volume of 144,000 tonnes. Bermingham ore will be processed in the current LOM plan before Phase 1 is complete and therefore Bermingham tailings will deposited in both Phase I and II of the DSTF, with the majority of Bermingham tailings going to Phase II. An estimated 163,000 tonnes of tailings generated from Bermingham will deposited into the DSTF.

The combination of future ore streams is a function of numerous operating and economic parameters. The expansion will be contiguous, and to the southeast of the current DSTF.

The current as built of Phase I along with the design of Phase I and II is shown in Figure 5-4.

Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on October 2017

Datum: NAD 83; Projection: UTM Zone 8N

1:3,000 *(when printed on 11 x17 inch paper)*

0 25 50 100 150 Meters

- Adit
- Existing Building
- Land Disposition
- Mill Pond
- DSTF Phase II Expansion
- DSTF 322k Tonnes Design
- Current DSTF
- Watershed Boundaries

AKHM

AEG

KENO HILL SILVER DISTRICT MINING OPERATIONS
BERMINGHAM

FIGURE 5-4

SITE PLAN SHOWING DSTF PHASE AS BUILT AND PHASE I, II DESIGN

OCTOBER 2017

5.4 DSTF PERFORMANCE

Geotechnical and geochemical performance of the DSTF since inception (December 2010) demonstrates that actual field performance meets or exceeds original design considerations. The following general performance indicators are presented as support for the assessment of the expanded DSTF:

- The moisture content of the filtered and stacked tailings is lower than expected resulting in lower makeup water requirements and no discharge of mill water;
- The metals content of the pore water (i.e. Zn) is orders of magnitude lower than initially estimated (~2 mg/l vs. 20 mg/l);
- Humidity cell test results for actual Bellekeno tailings deposited in the DSTF demonstrate there is no concern for acid or metals generation;
- Progressive reclamation plans have been met with successful recontouring and revegetation of the majority (+90%) of the DSTF completed;
- No measurable pore water has been measured or observed in the DSTF monitoring well installed within the DSTF;
- Compaction results have met design specifications;
- No surface subsidence has been observed; and
- Ground temperature and slope indicator readings indicate no thawing of underlying permafrost or movement has occurred to date.

5.5 METALLURGICAL TESTING

SGS Canada was commissioned by Alexco to undertake a precious and base metal recovery study on samples originating from the Bermingham deposit during surface drilling programs completed in 2016. The purpose of this testing was to determine the recovery of silver, lead and zinc in the flotation circuits in the existing mill flowsheet, and to evaluate the environmental parameters of the residual tailings. Representative samples from drill core intervals were used to produce a composite sample of Bermingham for metallurgical testing.

The results of the metallurgical testwork indicate that Bermingham ore samples respond well to the current metallurgical flowsheet operating at the mill. Milling of Bermingham either as standalone mill feed or concurrently with ore from other deposits (Lucky Queen, Onek, Flame and Moth, and/or Bellekeno) will result in good metal recovery. The metallurgical results demonstrate that the general metallurgical parameters are in line with historic performance and further optimization will improve the metallurgical response of Bermingham ore. Locked cycle tests (i.e. tests that mimic the overall process flowsheet) were completed on Bermingham and are considered an accurate estimate of real plant conditions and performance.

Table 5-1 to Table 5-6 summarizes the results of the metallurgical tests completed on Bermingham.

5.5.1 Master Composite

Crushed samples in 11 rice bags containing 97 individual samples were delivered to the SGS Burnaby facility on July 19, 2016. The samples were weighed and inventoried. A portion was split from each individual sample to make a master composite.

A total of 46.8 kg of master composite was prepared. The composite was crushed to -10 mesh, well-blended, split into 1 kg charges, and stored in a freezer for flotation testwork. Table 5-1 details the head assay for the master composite.

Table 5-1: Bermingham Master Composite Head Assays

Analyte	Scheme	Unit	Master Comp
Pb	GO_XRF77B	%	6.09
Zn	GO_XRF77B	%	1.77
Ag	GO_FAG313	g/t	3308
Fe	GO_XRF77B	%	7.08
S	GC_CSA06V	%	4.03
Al	GE_ICP90A	%	2.01
As	GE_ICP90A	%	0.083
Ba	GE_ICP90A	%	0.033
Be	GE_ICP90A	%	<0.0005
Ca	GE_ICP90A	%	0.6
Cd	GE_ICP90A	%	0.025
Co	GE_ICP90A	%	<0.001
Cr	GE_ICP90A	%	0.026
Cu	GE_ICP90A	%	0.077
Fe	GE_ICP90A	%	7.25
K	GE_ICP90A	%	0.7
La	GE_ICP90A	%	0.001
Li	GE_ICP90A	%	<0.001
Mg	GE_ICP90A	%	0.36
Mn	GE_ICP90A	%	3.76
Mo	GE_ICP90A	%	<0.001
Ni	GE_ICP90A	%	0.009
P	GE_ICP90A	%	0.05
Pb	GE_ICP90A	%	6.22
Sb	GE_ICP90A	%	0.194
Sc	GE_ICP90A	%	<0.0005
Si	GE_ICP90A	%	26.1
Sn	GE_ICP90A	%	<0.005
Sr	GE_ICP90A	%	0.003
Ti	GE_ICP90A	%	0.16
V	GE_ICP90A	%	0.005
W	GE_ICP90A	%	<0.005
Y	GE_ICP90A	%	0.001
Zn	GE_ICP90A	%	1.8
Al_2O_3	GE_ICP90A	%	3.8
CaO	GE_ICP90A	%	0.8
Cr_2O_3	GE_ICP90A	%	0.037
Fe_2O_3	GE_ICP90A	%	10.4
K2O	GE_ICP90A	%	0.8
MgO	GE_ICP90A	%	0.6
MnO	GE_ICP90A	%	4.86
P_2O_5	GE_ICP90A	%	0.12
SiO_2	GE_ICP90A	%	55.8
TiO2	GE_ICP90A	%	0.27
V_2O_5	GE_ICP90A	%	0.009
SUM	GE_ICP90A	%	77.5
LOI	G_PHY01K	%	10.1

5.6 FLOTATION

5.6.1 Standard Flotation Test Procedure

Standard flotation test procedures involve grinding a 1 kg test charge at 65% solids, in a laboratory rod mill to a target grind size. After grinding, the density of the pulp was adjusted to 33% solids in a Denver D1 flotation cell. The collectors were then added, conditioned, and finally the frother added. Air was introduced into the pulp and concentrates were collected over specified time periods, in stages. No regrind was performed before cleaning which was conducted in a 250 g cell using the same procedures. All products were filtered, dried, weighed, and assayed. Initial grind calibrations were performed followed by rougher kinetic, batch cleaner and locked cycle tests. Three rougher tests, eight cleaner tests and two locked cycle tests were completed. The summary conditions and results are presented in Table 5-2.

Table 5-2: Summary of Rougher Conditions

Test	Primary Grind				Lead Rougher				Zinc Rougher			
No.	K_{80}, µm	Lime, g/t	ZnCN	$ZnSO_4$	Stage	3418A, g/t	SIPX, g/t	pH	Stage	$CuSO_4$, g/t	SIPX, g/t	pH
F1 (Rougher)	148	200	500		3	40	4	7.6	3	400	35	10.6
F2 (Rougher)	267	200	500		2	25		7.5	3	200	35	10.5-10.6
F3 (Rougher)	174	300		300	2	25		7.9-8.2	3	200	35	10.6
F4 (Cleaner)	147	300		300	2	25		8-8.4	-	-	-	-
F5 (Cleaner)	125	300		300	2	25		8-8.1	3	200	35	11-11.1
F6 (Cleaner)	117	300		300	2	22		7.9-8	3	100	25	11-11.1
F7 (celaner)	149	300		300	2	22		7.9-8.1	3	50	25	11
F8 (Cleaner)	148	300		300	2	25		8-8.1	3	80	35	9.6
F9 (Cleaner)	148	300		750	2	25		7	2	100	30	9.5
F10 (cleaner)	147	300		750	2	35		6.9-7	2	125	35	9.6
LCT1	152	300		750	2	25-30		7	2	100	30	9.6
LCT2	150	300		750	2	35		7	2	125	32	9.6

Table 5-3: Summary of Cleaner Conditions

Test	Lead Cleaner				Zinc Cleaner		
No.	Stage	$ZnSO_4$, g/t	3418A, g/t	pH	Stage	SIPX, g/t	pH
F1	-	-	-	-	-	-	-
F2	-	-	-	-	-	-	-
F3	-	-	-	-	-	-	-
F4	3	30	8.5	7.3-7.5	-	-	-
F5	3	50		7-7.1	2		11.6
F6	3	50		7-7.1	2		11.5-11.6
F7	3	150		6.9	2		11.5
F8	3	50		7.1-7.2	2		10-10.2
F9	3	200		6.8-6.9	2		11.5
F10	3	300		6.7-6.9	2		11.6
LCT1	3	200		6.8-6.9	2		11.6
LCT2	3	200		6.8-6.9	2		11.8-11.9

Table 5-4: Summary of Lead Flotation Results

Test	Pb Rougher Grade and Mass, g/t, %						Pb Rougher Recovery, %				
No.	Mass	Ag	Pb	Zn	Fe	S	Ag	Pb	Zn	Fe	S
F1	14.9	22645	41.1	4.5	5.2	11.1	98.1	98.6	36.4	10.8	41.0
F2	13.1	25129	47.9	2.9	4.4	11.2	91.0	94.6	20.8	7.9	35.0
F3	13.5	25534	43.8	3.1	4.7	10.9	96.8	97.2	22.7	8.8	36.9
F4	13.4	24094	43.6	2.8	4.9	10.9	96.3	96.8	20.8	9.0	36.3
F5	13.4	23848	45.4	2.9	4.8	11.1	96.7	97.7	21.3	8.8	37.1
F6	15.1	22463	40.5	3.0	4.8	10.2	98.0	97.7	23.7	10.4	37.6
F7	15.6	21347	37.9	4.1	4.9	10.4	98.4	97.8	35.4	10.9	41.2
F8	14.9	22543	42.5	4.0	4.9	11.4	98.3	98.2	34.1	10.5	41.6
F9	10.7	30233	50.1	3.4	3.8	12.0	96.2	84.7	20.0	5.7	31.8
F10	12.4	26855	49.0	3.9	4.2	12.2	98.1	97.1	27.0	7.3	38.0
LCT1	-	-	-	-	-	-	-	-	-	-	-
LCT2	-	-	-	-	-	-	-	-	-	-	-

Test	Pb Cleaner Grade and Mass, g/t, %						Pb Cleaner Recovery, %				
No.	Mass	Ag	Pb	Zn	Fe	S	Ag	Pb	Zn	Fe	S
F1	-	-	-	-	-	-	-	-	-	-	-
F2	-	-	-	-	-	-	-	-	-	-	-
F3	-	-	-	-	-	-	-	-	-	-	-
F4	8.7	36295	64.8	2.7	3.4	14.3	94.2	93.3	13.2	4.0	30.8
F5	8.5	36567	68.2	2.3	2.7	14.3	94.0	93.1	10.7	3.2	30.4
F6	8.8	37617	66.4	2.9	2.9	14.2	95.7	93.3	13.4	3.6	30.6
F7	9.6	34066	58.3	5.1	3.4	14.4	96.5	92.5	27.0	4.7	35.1
F8	9.8	33542	61.5	4.7	3.6	15.1	96.7	93.9	26.5	5.1	36.5
F9	7.9	40317	66.0	3.1	2.6	14.4	94.4	82.1	13.5	2.8	28.1
F10	9.0	36344	64.6	3.9	3.1	14.8	96.5	93.0	19.4	3.8	33.4
LCT1	9.2	35972	58.4	3.9	3.1	13.2	95.9	86.7	19.4	4.1	30.7
LCT2	11.0	31597	56.7	4.1	3.6	12.8	97.5	95.3	24.0	5.5	34.5

Table 5-5: Summary of Zinc Flotation Results

Test	Zn Rougher Grade and Mass, g/t, %						Zn Rougher Recovery, %				
No.	Mass	Ag	Pb	Zn	Fe	S	Ag	Pb	Zn	Fe	S
F1	9.8	393	0.38	11.7	18.2	22.0	1.1	0.6	62.4	24.9	53.4
F2	8.4	1415	1.12	16.3	11.3	14.8	3.3	1.4	75.3	13.0	29.6
F3	10.9	495	0.67	12.4	17.3	21.9	1.5	1.2	74.0	26.1	59.3
F4	-	-	-	-	-	-	-	-	-	-	-
F5	10.8	476	0.58	12.9	18.0	22.1	1.6	1.0	77.1	26.7	59.6
F6	11.7	337	0.50	11.9	15.4	20.5	1.1	0.9	73.6	25.8	59.0
F7	9.0	365	0.51	11.0	18.3	23.4	1.0	0.8	55.0	23.4	53.4
F8	10.5	331	0.54	10.7	17.1	21.1	1.0	0.9	64.2	26.1	54.8
F9	7.2	1069	9.73	17.5	12.9	20.5	2.3	11.0	69.5	12.9	36.3
F10	6.8	501	0.70	17.9	17.0	23.7	1.0	0.7	67.2	15.8	39.9
LCT1	-	-	-	-	-	-	-	-	-	-	-
LCT2	-	-	-	-	-	-	-	-	-	-	-

Test	Zn Cleaner Grade and Mass, g/t, %						Zn Cleaner Recovery, %				
No.	Mass	Ag	Pb	Zn	Fe	S	Ag	Pb	Zn	Fe	S
F1	-	-	-	-	-	-	-	-	-	-	-
F2	-	-	-	-	-	-	-	-	-	-	-
F3	-	-	-	-	-	-	-	-	-	-	-
F4	-	-	-	-	-	-	-	-	-	-	-
F5	5.78	629	0.52	23.7	25.6	38.8	1.1	0.5	76.1	20.4	56.4
F6	5.59	470	0.51	24.8	23.4	40.7	0.8	0.5	72.9	18.7	55.8
F7	4.95	486	0.49	19.8	26.8	40.1	0.7	0.4	54.5	18.8	50.2
F8	5.42	503	0.51	20.5	26.4	39.0	0.8	0.4	63.3	20.8	52.1
F9	2.24	1187	1.34	52.9	7.6	32.4	0.8	0.5	65.5	2.4	17.9
F10	2.72	872	0.56	43.0	14.7	34.3	0.7	0.2	65.1	5.5	23.3
LCT1	2.28	1324	2.97	48.3	10.0	33.8	0.9	1.1	60.0	3.2	19.6
LCT2	2.28	1283	2.36	52.8	7.1	32.2	0.8	0.8	63.6	2.2	17.9

5.6.2 Locked Cycle Flotation Testing

Locked cycle flotation testing is often conducted to simulate the plant continuous operation and to estimate the metallurgy (grade and recovery) for final design purposes. In this case, the locked cycle tests mimicked the current Keno District Mill process flowsheet. Open circuit batch cleaner test inevitably produces middling streams containing economic levels of metals such as in the 3rd cleaner and 2nd cleaner tailing; locked cycle testing recycles this material. Two 6-cycle locked cycle tests were completed on the master composite. The test conditions and results are summarized in with the flowsheet shown in Table 5-6.

Table 5-6: Locked Cycle Test Conditions

Stage	Flotation Conditions	LCT-1	LCT-2
Primary Grind	Size, µm (K_{80})	152	150
	Lime, g/t	300	300
	pH	9.5	9.5
Pb Roughing	Stage	2	2
	ZnSO4, g/t	750	750
	3418A, g/t	30	35
	pH	7	7
	Float Time (min.)	5	5
Pb Cleaning	Stage	3	3
	ZnSO4, g/t	200	200
	3418A, g/t	0	0
	pH	6.9	6.9
	Float Time (min.)	9.5	9.5
Zn Roughing	Stage	2	2
	$CuSO_4$	100	125
	SIPX	30	30
	pH	9.6	9.6
	Float Time (min.)	4	4
Zn Cleaning	Stage	2	2
	SIPX	0	0
	pH	***11.6***	***11.9***
	Float Time (min.)	4	4

Table 5-7: Locked Cycle Test Results

Grade		LCT1	LCT2
Feed (calc.)	Ag, g/t	3416	3545
	Pb, %	6.19	6.56
	Zn, %	1.83	1.89
	Fe, %	7.10	7.23
	S, %	3.94	4.10
Pb Cln Conc	Ag, g/t	35972	31597
	Pb, %	58.4	56.70
	Zn, %	3.87	4.11
	Fe, %	3.14	3.62
	S, %	13.2	12.8
Zn Cln Conc	Ag, g/t	1324	1283
	Pb, %	2.97	2.36
	Zn, %	***48.3***	***52.8***
	Fe, %	10.0	7.13
	S, %	33.8	32.2

Distribution		LCT1	LCT2
Pb Cln Conc	Ag, %	95.9	97.5
	Pb, %	***86.7***	***95.3***
	Zn, %	19.4	24.0
	Fe, %	4.07	5.52
	S, %	30.7	34.5
Zn Cln Conc	Ag, %	0.88	0.82
	Pb, %	1.09	0.82
	Zn, %	60.0	63.6
	Fe, %	3.22	2.24
	S, %	19.6	17.9

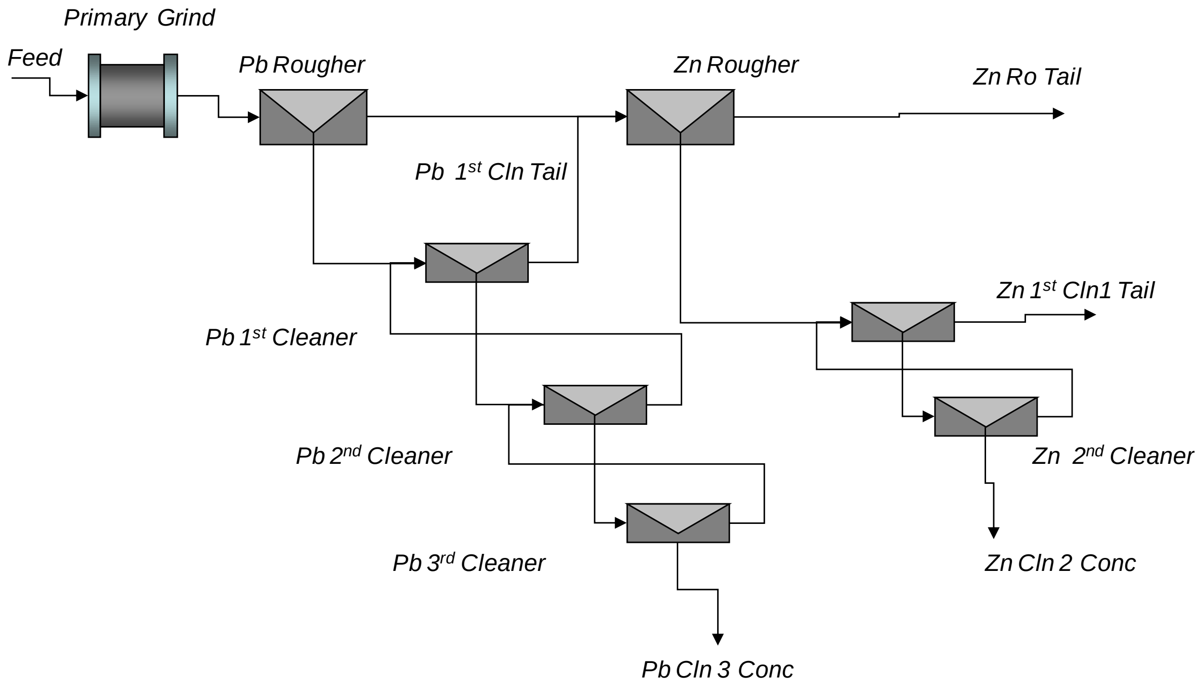


Figure 5-5: Locked Cycle Test Flowsheet

5.6.2.1 LCT1 Test Results Summary

The test was based on the F9 conditions. The lead concentrate assayed 35,972 g/t Ag, 58.4% Pb and 3.9% Zn at recoveries of 95.9% silver, 86.7% lead and 19.4% zinc, and the zinc concentrate assayed 48.3% Zn, 2.97% Pb and 1,324 g/t Ag at recoveries of 60% zinc, 1.1% lead and 0.9% silver. For the batch test, the lead and zinc cleaner recoveries were 82.1% and 65% respectively. The lead recovery was higher but the zinc recovery was lower when compared to the batch test. The lower zinc recovery was due to more zinc loss to the zinc rougher tailing.

5.6.2.2 LCT2 Test Results Summary

The test was performed with modified conditions: higher 3418A addition to improve lead recovery, higher CuSO4 addition and higher zinc cleaner pH to improve zinc grade and recovery. The lead concentrate assayed 31,597 g/t Ag, 56.7% Pb and 4.1% Zn at recoveries of 97.5% silver, 95.3% lead and 24% zinc, and the zinc concentrate assayed 52.8% Zn, 2.36% Pb and 1,283 g/t Ag at recoveries of 63.3% zinc, 0.8% lead and 0.8% silver. Both lead and zinc flotation (grade and recovery) improved, especially lead recovery.

5.6.3 Product Characterization

The cleaner concentrates from LCT2 were submitted for chemical assays and Inductively Coupled Plasma (ICP) Scan. The results are summarized in Table 5-8.

The lead concentrate assayed 1.82% Sb and the other penalty elements such as arsenic and cadmium were low, 0.29% As and 0.69% Cd in the zinc cleaner concentrate.

Table 5-8: Concentrate ICP Assays

Analyte	Unit	LCT-2-5 Pb Cln3	LCT-2-5 Zn Cln2
Pb	%	55.8	2.05
Zn	%	4.24	54.0
Fe	%	3.73	6.49
S	%	12.3	31.6
Ag	g/t	31202	1233
Al	g/t	5080	5050
As	g/t	1243	2970
Ba	g/t	146	172
Be	g/t	<0.8	<0.8
Bi	g/t	<400	<400
Ca	g/t	1300	1100
Cd	g/t	650	6950
Co	g/t	<200	<200
Cr	g/t	<40	<40
Cu	g/t	6920	860
K	g/t	1900	4200
Li	g/t	<800	<800
Mg	g/t	970	560
Mn	g/t	9220	4630
Mo	g/t	<300	<300
Ni	g/t	<300	<300
Sb	g/t	18200	1300
Se	g/t	<2000	<2000
Sn	g/t	<800	<800
Sr	g/t	<10	<10
Ti	g/t	967	463
Tl	g/t	<2000	<2000
V	g/t	<80	<80
Y	g/t	20	14

5.7 TAILINGS CHARACTERIZATION

Following metallurgical testing of Bermingham, standard ABA analysis was completed on the remaining tailings samples, similar to the approach for Bellekeno, Lucky Queen, Flame and Moth and Onek samples in the previous assessments. Most importantly, Alexco has nearly 3 years of actual field results and ongoing humidity cell results from Bellekeno on which to compare Bermingham tailings to real world performance.

One tailings sample (Berm LCT2) was obtained from locked cycle metallurgical testing of Bermingham ore and subjected to static testing by Maxxam Analytics. The tailings sample (5.5 kg) from the locked cycle testing was homogenized without any further crushing prior to shake flask extraction analysis. A subsample of the tailings was crushed further to 85% passing 200 mesh (75 µm) for acid base accounting, elemental, and X-ray diffraction analyses.

Acid base accounting (ABA) testing included:

- Siderite-corrected neutralization potential (NP) (Skousen et al., 1997);
- Total Sulphur by Leco;
- Sulphate-sulphur by HCl extraction;
- Total inorganic carbon; and
- Paste pH.

The siderite-corrected NP method was used since:

- Ferrous carbonate including siderite was anticipated to represent a significant portion of the carbonate mineralogy in a number of samples based on ABA data collected on waste rock samples elsewhere in the KHSD; and
- The siderite-corrected NP method has been used in the majority of ABA characterization work on waste rock from proposed production units elsewhere in the KHSD, which facilitates the comparison of the Bermingham ABA data with the wider KHSD dataset.

Total sulphur was measured by Leco, sulphate was determined with HCl leach and sulphide sulphur calculated as the difference between total sulphur and sulphate sulphur. Total inorganic carbon was measured with the direct HCl method. The acid generation potential (AP) of the sample was calculated from the sulphide sulphur content of the sample, the carbonate-NP was calculated from the inorganic carbon concentration, and the neutralization potential ratio (NPR) was calculated as NP/AP. Further details regarding these calculations can be found in Price (2009).

Aqua regia digestion followed by ICP-MS and ICP-AES analysis was used to determine the metals content of the tailings sample and the mineralogy of the sample was determined by Rietveld X-ray diffraction (XRD) (latter work performed at the Department of Earth, Ocean & Atmospheric Sciences, University of British Columbia). A standard 24-hour shake flask extraction (SFE) test was also performed using a 3:1 liquid to solid ratio using deionized water as the extracting liquid according to the procedure documented in Price (2009).

5.7.1 Acid Base Accounting

The purpose of ABA is to quantify the content and ratio of potentially acid producing and potentially acid consuming minerals in each sample. This is an indication of the acid generation potential of geologic materials.

The ABA characteristics of the Bermingham tailings sample (Berm LCT2) are displayed in Table 5-9 alongside the ABA analysis of the Onek F7+F8 tailings, Lucky Queen F9+F10 tailings, Flame & Moth F4+F5 composite tailings and the average of monthly ABA analyses of composite tailings samples produced from Bellekeno ore between January 2011 and July 2013 (ACG, 2015). All five tailings exhibited a slightly alkaline paste pH (7.8 to 8.2) and high carbonate neutralization potential (204 to 389 kg $CaCO_3$/t). The carbonate-NP of the Berm LCT2 sample (204 kg $CaCO_3$/t) was significantly higher than the siderite-corrected NP (56.3 kg $CaCO_3$/t), which indicates that ferrous carbonates such as siderite ($FeCO_3$) comprise a substantial portion of the carbonate mineralogy in the Bermingham tailings. The Flame & Moth and Bellekeno tailings also returned much lower siderite-corrected NP measurements than carbonate-NP, also reflecting the presence of a significant ferrous carbonate component in these samples.

The hydrogen peroxide used in the siderite-corrected NP method oxidizes the Fe(II) liberated from siderite dissolution, which then hydrolyzes rapidly at pH>7 to precipitate poorly ordered iron (oxyhydr)oxides. This process produces an equal amount of acid as that neutralized from the carbonate portion of the siderite, hence ferrous carbonates do not contribute to acid neutralization under pH neutral oxidizing conditions. It should be noted that the siderite associated with ore in the KHSD is typically manganiferous (Cathro, 2006), resulting in manganoan siderite in tailings material (SRK, 2009). The siderite-corrected NP method will also oxidize Mn(II); however, Mn(II) oxidation and subsequent precipitation (which is acid generating and balances the acid neutralization from the carbonate component) under oxidizing weathering conditions is typically much slower than that of Fe(II). Therefore, the siderite-corrected NP may underestimate the amount of NP available for acid neutralization since it assumes that all the manganese released during carbonate dissolution will oxidize and precipitate *in situ*, which may not be the case.

The Bellekeno tailings contained the highest total sulphur content (2.3 wt.%), followed by the Berm LCT2 tailings (1.39 wt.%). The other three site tailings samples had much lower sulphur concentrations (0.16 to 0.45 wt.%; Table 5-9). Sulphide-sulphur comprised the bulk of total sulphur in Berm LCT2, similar to the other KHSD tailings.

The NPR of the Berm LCT2 tailings sample (1.3) is lower than the other five tailings, of which the remainder ranged from 1.9 (Bellekeno) to 8.4 (Onek). Despite having a lower sulphide-sulphur content (and hence lower AP) than the Bellekeno tailings, the siderite-corrected NP of the Berm LCT2 was much lower than both the other two samples, resulting in the lowest NPR of all five samples. An NPR>2 typically indicates that acid generation is not expected whereas an NPR of between 1 and 2 indicates that the potential to generate acid is uncertain (Price, 2009). Given that the NP available for acid neutralization may be underestimated due to the oxidation of Mn(II) during the siderite-corrected NP method as discussed above, the NPR calculated for the Bermingham sample may be viewed as a lower bound, and may be considerably higher. This is supported by detailed mineralogical examination of historic tailings deposited in the KHSD in which material identified as potentially acid generating (i.e., NPR<2) by conventional ABA analysis was likely not potentially acid generating (i.e., NPR>2) when its manganese carbonate content was included in the NPR calculation (SRK, 2009).

Regardless, blending and/or co-disposal of the Bermingham tailings with tailings from other production units that contain much higher NP (e.g., Bellekeno, Flame and Moth) will offset any acid generating potential of the Bermingham tailings material such that net acid generation from tailings deposited in the DSTF is not anticipated. The Bermingham tailings fraction in the LOM DSTF represents only approximately 20% of the total tailings deposited.

Table 5-9: ABA characteristics of Bermingham, Onek, Lucky Queen, Flame & Moth and Bellekeno tailings

Sample	Paste pH	Total Sulphur	Sulphate-Sulphur	Sulphide-Sulphur	CO_2	CO_3-NP	NP	AP	NPR
	Unity	%	%	%	%	kg $CaCO_3$/t			Unity
Berm LCT2	8.15	1.39	0.01	1.38	8.96	204	56.3	43.1	1.3
Onek F7 + F8 average	7.8	0.16	0.04	0.12	n/a	n/a	31.4	3.8	8.4
Lucky Queen F9 + F10 average	7.85	0.19	0.04	0.15	n/a	n/a	19.1	4.5	4.2
Flame & Moth F4+F5 Composite Tailings	8	0.45	0.02	0.43	17.1	389	100	14.1	7.1
Bellekeno Tailings, Jan 11-July 13 Monthly Avg.	8.1	2.3	0.02	2.21	12	273	132	71.7	1.9

n/a denotes not available

5.7.2 ICP Metals

The tendency for an element to leach from its host rock is dependent on a number of factors including its mineral host, oxidation state and presence of complexing ligands. Although the bulk concentration of an element does not offer a direct measure of how mobile an element may be during weathering, it can provide a preliminary indication of constituents that should be monitored in subsequent leach and kinetic tests.

The ICP metals composition of the Bermingham tailings sample (Berm LCT2) is shown in Table 5-10, alongside that of the Flame & Moth F4+F5 composite tailings, Onek F7+F8 tailings, Lucky Queen F9+F10 tailings, and the average of monthly ICP analyses of composite tailings samples produced from Bellekeno ore between July 2012 and August 2013 (when Bellekeno mining and milling operations occurred). Concentrations of antimony, arsenic, bismuth, cadmium, lead, manganese, selenium, silver, and zinc typically exceeded 10x their respective crustal abundance (CRC, 2005). The Bellekeno tailings generally had the highest concentration of these elements, with arsenic, antimony, cadmium, lead and zinc concentrations present at three- to seven-fold higher levels than those in the Berm LCT2. The Berm LCT2 and Bellekeno tailings contained comparable concentrations of selenium and silver (0.5 to 0.8 ppm and 50 to 56 ppm, respectively; Table 5-10). The Berm LCT2 tailings contained similar arsenic content to the Onek and Flame and Moth tailings, but were an order of magnitude higher than the arsenic concentration in the Lucky Queen tailings. The cadmium and zinc concentration in the Berm LCT2 tailings was higher than that of both the Lucky Queen (*ca.* 4- to 6-fold higher) and Flame and Moth (*ca.* 2- to 3-fold higher) tailings, but approximately 3- to 4-fold lower than the Onek tailings (Table 5-10). Finally, the lead content of the Berm LCT2 tailings was approximately 3- to 6-fold higher than the Onek, Lucky Queen, and Flame and Moth tailings (Table 5-10).

Table 5-10: Elemental composition of Bermingham, Onek, Lucky Queen, Flame & Moth and Bellekeno composite tailings

Element	Unit	Berm LCT2	Onek F7 + F8 average	Lucky Queen F9 + F10 average	Flame & Moth F4+F5 Composite	Bellekeno Tailings Monthly Composite Jul 12 - Aug 13	Crustal Abundance
Aluminum (Al)	%	0.16	0.36	0.74	0.2	0.2	8.23
Antimony (Sb)	ppm	44.6	<5	9	41	120.6	0.2
Arsenic (As)	ppm	401	375	17.5	699	2147	1.8
Barium (Ba)	ppm	30	24	125	11.5	16.4	425
Bismuth (Bi)	ppm	0.04	<2	<2	6.59	2.1	0.0085
Cadmium (Cd)	ppm	23.4	72.8	3.95	7.19	165.8	0.15
Calcium (Ca)	%	0.73	0.47	0.38	0.59	1.52	4.15
Chromium (Cr)	ppm	115	174	265.5	185.5	5.5	102
Cobalt (Co)	ppm	4.3	2	3	2.7	9.9	25
Copper (Cu)	ppm	57.5	377	254	565	242.4	60
Iron (Fe)	%	7.07	18.6	6.4	16.3	10.1	5.63
Lead (Pb)	ppm	2330	413	555	789	6359	14
Magnesium (Mg)	%	0.36	0.47	0.34	0.31	0.31	2.33
Manganese (Mn)	%	4.43	5.19	2.47	4.28	3.22	0.095
Mercury (Hg)	ppm	0.13	n/a	n/a	0.055	0.19	0.085
Molybdenum (Mo)	ppm	2.02	<1	2	3.74	1.16	1.2
Nickel (Ni)	ppm	49.1	44	51	86.6	19.5	84
Phosphorus (P)	%	0.032	0.014	0.013	0.01	0.02	0.105
Potassium (K)	%	0.08	0.08	0.275	0.03	0.04	2.09
Selenium (Se)	ppm	0.8	n/a	n/a	0.1	0.52	0.05
Silver (Ag)	ppm	56.4	6.4	16.4	12.35	50.1	0.075
Sodium (Na)	%	<0.01	0.02	0.025	0.006	0.014	2.36
Strontium (Sr)	ppm	15	11	15	4.81	24	370
Thallium (Tl)	ppm	1.9	17.5	11	0.652	0.129	9.6
Tin (Sn)	ppm	2	n/a	n/a	32.9	17.6	2.3
Titanium (Ti)	%	<0.005	<0.01	0.02	0.001	0.002	0.56
Uranium (U)	ppm	0.38	n/a	n/a	0.406	1.052	2.7
Vanadium (V)	ppm	5	5.5	12.5	9.4	5.18	120
Zinc (Zn)	ppm	2080	8784	557	1265	12623	70

Highlighted cells indicate concentrations greater than 10x crustal abundance; n/a denotes not available

5.7.3 Shake Flask Leachable Metals

SFE provides a measure of the soluble metals in the sample that may be mobilized in the short term upon flushing. SFE data for the Bermingham tailings sample, the Flame & Moth tailings composite and the average Bellekeno tailings composite are shown in Table 5-11. Leachable metal(loid) concentrations were consistently lower from the Berm LCT2 sample than from the Bellekeno tailings and the Flame & Moth tailings (with exception of aluminum, lead and thallium which were marginally higher than the Flame & Moth tailings sample only). Metal(loid)s with elevated bulk ICP concentrations in Berm LCT2 relative to either of the other tailings samples, generally did not correspond to similarly relatively elevated SFE leachable concentrations. For example, although the ICP selenium in the Berm LCT2 sample was greater than the ICP selenium in the other two samples, leachable selenium was one and two orders of magnitude lower than the Flame & Moth and Bellekeno tailings leachable selenium, respectively. Of particular interest, SFE leachable cadmium and zinc concentrations – primary constituents of concern in surface waters of the KHSD (Minnow, 2015) – were both significantly lower from the Berm LCT2 sample than from the Flame & Moth and Bellekeno samples.

Table 5-11: SFE leachable metals from Bermingham, Flame & Moth and Bellekeno tailings composites

Leachable Metals	Unit	Berm LCT2	Flame & Moth F4+F5 Composite	Bellekeno Tailings Monthly Composite July 12 - Aug 13
Aluminum (Al)-Leachable	mg/L	0.0214	0.0109	0.0282
Antimony (Sb)-Leachable	mg/L	0.0111	0.0217	0.0387
Arsenic (As)-Leachable	mg/L	0.000331	0.0061	0.0072
Barium (Ba)-Leachable	mg/L	0.0134	0.0253	0.0234
Beryllium (Be)-Leachable	mg/L	<0.000010	<0.00050	<0.00050
Bismuth (Bi)-Leachable	mg/L	<0.0000050	<0.00050	<0.00050
Boron (B)-Leachable	mg/L	<0.050	0.071	0.0942
Cadmium (Cd)-Leachable	mg/L	0.000309	0.0024	0.00318
Calcium (Ca)-Leachable	mg/L	12.4	105	138
Chromium (Cr)-Leachable	mg/L	<0.00010	<0.00050	<0.00050
Cobalt (Co)-Leachable	mg/L	0.000099	0.0004	0.00031
Copper (Cu)-Leachable	mg/L	0.000334	0.0271	0.0096
Iron (Fe)-Leachable	mg/L	<0.0010	<0.030	<0.030
Lead (Pb)-Leachable	mg/L	0.0188	0.0144	0.0593
Lithium (Li)-Leachable	mg/L	0.00294	0.0071	0.0339
Magnesium (Mg)-Leachable	mg/L	0.988	6.9	6.01
Manganese (Mn)-Leachable	mg/L	0.445	1.95	0.797
Mercury (Hg)-Leachable	mg/L	<0.000050	0.0001	<0.000050
Molybdenum (Mo)-Leachable	mg/L	0.000928	0.0024	0.0108
Nickel (Ni)-Leachable	mg/L	0.000368	0.0012	0.0009
Phosphorus (P)-Leachable	mg/L	0.0414	<0.30	<0.30
Potassium (K)-Leachable	mg/L	1.7	2.04	10.6
Selenium (Se)-Leachable	mg/L	0.000041	0.0009	0.00106

Leachable Metals	Unit	Berm LCT2	Flame & Moth F4+F5 Composite	Bellekeno Tailings Monthly Composite July 12 - Aug 13
Silicon (Si)-Leachable	mg/L	0.45	1.55	3.4
Silver (Ag)-Leachable	mg/L	0.00003	0.0009	0.0018
Sodium (Na)-Leachable	mg/L	0.596	2.36	24.1
Strontium (Sr)-Leachable	mg/L	0.0172	0.38	0.515
Thallium (Tl)-Leachable	mg/L	0.000177	0.0001	0.0002
Tin (Sn)-Leachable	mg/L	<0.00020	<0.00050	<0.00050
Titanium (Ti)-Leachable	mg/L	<0.00050	0.01	0.012
Uranium (U)-Leachable	mg/L	<0.0000020	0	0.00162
Vanadium (V)-Leachable	mg/L	<0.00020	<0.0010	<0.0010
Zinc (Zn)-Leachable	mg/L	0.0172	0.156	0.051

5.7.4 Mineralogy

The purpose of XRD is to quantitatively determine the crystalline mineralogy of samples and, in particular, identify the minerals that may influence the metal leaching and acid rock drainage (ARD/ML) properties of the rock material. Carbonate minerals (primarily calcite and dolomite) are typically the principal contributors to neutralization potential (NP) whereas sulphide minerals (primarily ferrous sulphide minerals) are usually the major sources of acid potential (AP).

XRD analysis of the Bermingham tailings indicated that it was dominated by quartz (SiO_2, 59 wt.%) and calcian siderite ($FeCO_3$; 28 wt.%), similar to the Flame & Moth and Bellekeno tailings (Table 5-12). Pyrite (FeS_2) was present at a similar concentration in the Bermingham tailings (2.2 wt.%) as in the Bellekeno tailings (2.3 wt.%) whereas the main base metal sulphides sphalerite [(Zn,Fe)S] and galena (PbS) were less abundant in the Berm LCT2 sample (0.3 wt.% of both sphalerite and galena) than in the Bellekeno tailings (2.4 wt.% sphalerite; 0.6 wt.% galena). Of the three samples, pyrite, sphalerite and galena concentrations were lowest in the Flame & Moth composite. No calcite ($CaCO_3$) was detected in the Berm LCT2 sample, which differed from the 1.2 and 3.2 wt.% calcite content in the Flame & Moth and Bellekeno tailings, respectively. Conversely, ankerite, a calcium, iron, magnesium, manganese carbonate mineral ($Ca(Fe,Mg,Mn)(CO_3)_2$) was identified in the Berm LCT2 (1 wt.%) and Bellekeno tailings (0.4 wt.%), but was not detected in the Flame & Moth composite.

The XRD data corroborate the ABA and ICP metals results, showing that in the Berm LCT2 sample, the lower siderite-corrected NP is likely due to the deficiency of calcite content relative to the other two samples. The low AP of the Flame & Moth sample is reflected in its low pyrite content (0.7 wt.%). Although both the Bermingham and Bellekeno tailings samples share similar pyrite concentrations (2.2 and 2.3 wt.%, respectively), the higher AP for the Bellekeno sample reflects its higher sphalerite (2.4 wt.%) and galena (0.6 wt.%) content compared to that of the Bermingham sample (0.3 wt.% each for sphalerite and galena).

Table 5-12: Mineralogy of Bermingham, Flame & Moth and Bellekeno composite tailings as determined by XRD

Mineral	Berm LCT2	Flame & Moth F4 + F5 Composite	Bellekeno Tailings Monthly Composite July 12 - Aug 13
Quartz	59.3	45.2	52.6
Siderite	-	45.3	29.8
Siderite, calcian	27.8	-	-
Muscovite	8.2	2.5	6.6
Pyrite	2.2	0.7	2.3
Ankerite	1	-	0.4
Kaolinite	0.9	-	-
Sphalerite	0.3	-	2.4
Galena	0.3	-	0.6
Calcite	-	1.2	3.2
Plagioclase	-	-	0.8
Gahnite	-	-	0.2
Chalcopyrite	-	-	0.1
Clinochlore	-	1.3	0.4
Rutile	-	-	0.3
Wurtzite	-	-	0.2
K-Feldspar	-	-	0.3
Dravite	-	3.2	-
Cassiterite	-	0.5	-
Total	100	100	100

Dash indicates mineral was not detected in XRD analysis

5.7.5 Discussion

The final tailings deposited in the DSTF or underground as cemented tailings backfill at Bermingham will either be standalone Bermingham tailings or a combination of ores originating from the mines currently permitted in the Keno Hill District. Given the performance of the Bellekeno tailings (as presented in the QZ09-092 Annual Reports) the ABA testwork completed on the bulk tailings stored on the DSTF are not a concern from an acid generating potential perspective. Comparison of static geochemical testing of the Bermingham tailings sample (Berm LCT2) with Onek, Lucky Queen, Flame & Moth, and Bellekeno tailings indicates that the tailings share similar geochemistry, with the Bermingham tailings showing more favourable metal leaching characteristics in the form of lower leachable metal(loid) concentrations (particularly cadmium and zinc) than Flame & Moth and Bellekeno tailings. While ABA work indicated that the Bermingham tailings had a relatively higher potential for acid generation, the calculated NPR may be considered a low bound considering that:

1. A portion of the manganese carbonate material will likely contribute to net acid neutralization given the slow oxidation kinetics of Mn(II) at circumneutral pH, even under oxidizing conditions. This

suggests that the siderite-corrected NP is likely an underestimate of the NP available for acid neutralization; and

2. XRD analysis identified sphalerite (0.3 wt.%), galena (0.3 wt.%), and pyrite (2.2 wt.%) in the Bermingham tailings sample. Under circumneutral weathering conditions, the oxidation of galena and sphalerite is not an acid generating process. Both these minerals constitute approximately 20% of the XRD-measured sulphide mineralogy, indicating that the AP (based on sulphide content) is likely overestimated.

In any event, blending and/or co-disposal of the Bermingham tailings with higher NPR tailings from the Onek, Lucky Queen, Flame & Moth and Bellekeno in the DSTF would significantly increase the bulk NP of the tailings and net acid generation is considered unlikely. Additional static and kinetic geochemical testing will be initiated with blended tailings from Bermingham and Flame and Moth when suitable tailings material is available from future metallurgical work or tailings produced from the District Mill.

6 WASTE ROCK CHARACTERIZATION AND MANAGEMENT

The geology and mineralization at Bermingham share a number of similarities with other assessed and permitted deposits within the district such as Bermingham, Bellekeno, Onek, and Lucky Queen and Flame and Moth. Common features between these deposits include occurrence within the same major lithologic unit, similarity in general age and mineralization. As such, the geochemical characteristics of the rocks are similar.

Geochemical characterization using the results of a suite of static (acid base accounting (ABA), shake flask extraction (SFE) testing and trace element assay by ICP) testing using exploration drill core was undertaken to assess the applicability of the current AKHM Waste Rock Management Plan to the management of waste rock at Bermingham. The geochemical characterization study for Bermingham is attached as Appendix D.

6.1 GEOENVIRONMENTAL CHARACTERIZATION OF BERMINGHAM WASTE ROCK

The geoenvironmental rock characterization for the Bermingham deposit focused on the cover hole drilled for the advanced exploration decline. It was found in the geochemical characterization study for Bermingham, (Appendix D) that this planned development which will be permanently excavated to surface contained generally low contained and leachable metals, and had predominantly favorable (i.e., non-potential acid generating) ABA characteristics. This work will be refined as additional geological information and samples are collected as part of the advanced exploration program.

Material from Bermingham not within 5 m of the mineralized vein which is to be permanently excavated will be subjected to the standard waste rock management criteria. The Waste Rock Management Plan has been updated to reflect these changes and will be protective when applied to the Bermingham deposit. The updated Waste Rock Management Plan (Revision 6) is included as Appendix E.

6.2 HISTORY AND PERFORMANCE OF THE WASTE ROCK MANAGEMENT PLAN

The Waste Rock Management Plan (WRMP) was established in 2008 for the management of excavated waste rock during advanced underground exploration and development activities prior to mine licensing and production at the Bellekeno Mine. These activities were licenced and carried out under Mining Land Use approval LQ00240 and Type B Water Use Licence (WUL) QZ07-078. The WRMP was determined to be effective and adopted for the Bellekeno Mine operations and production, which was licenced under QML-0009 and WUL QZ09-092 and commenced at the end of 2010. QZ09-092 was amended on May 15, 2013 as (application QZ12-053) to include water use and waste deposition associated with the Lucky Queen and Onek Mines. A further Water Licence amendment for the Flame and Moth mine is undergoing review by the Yukon Water Board, with the amendment expected in Q4 of 2017.

No N-AML waste rock dumps have been created since the Bellekeno mine was licenced in 2010. N-AML waste rock has been either placed underground or used for construction/upgrade/maintenance of the Bellekeno Haul Road/Lightning Creek Bypass Road. N-AML waste associated with initial development at Lucky Queen and Onek has been used for road construction material. Seeps from the road building materials have not been identified; therefore, N-AML waste rock seepage quality data do not exist.

Clause 69 of QZ09-092 Amendment 1 pertains to inspections and monitoring waste rock dumps:

> *69. Monthly, between May and October of each year, the Licensee shall inspect all Waste Rock locations including all pre-existing Bellekeno Waste Rock dumps described in the Application, and any new dumps or Waste Rock locations created after the effective date of this licence.*

Additionally, the KHSD Mining Operations Adaptive Management Plan (AMP) (AKHM,2013) stipulates measures to be taken in the case of identified waste rock seepage. The AMP will be further developed during the Water Use Licence amendment process to incorporate Bermingham.

Feedback and demonstration of the effectiveness of the WRMP is provided primarily through periodic review of routine geochemical testing of excavated materials as a check of the field screening criteria. Longer term geochemical stability and water quality prediction information is provided through the Mine Wall Testing Plan, Hydrogeology Study Plan, Groundwater Monitoring Plan and Monitoring and Surveillance Plan, which also form parts of the major mine licences (QML-0009 and QZ09-092). The results and synthesis of annual WRMP activity are summarized and presented each year as part of the annual reports which are requirements of the major mine licences.

Results of geochemical confirmation testing will be compiled and interpreted as part of the annual reporting requirements of the Quartz Mining Licence and Type A Water Use Licences (due annually by March 31), which will help refine the effectiveness and accuracy of the waste rock determination. It should be noted that very little waste rock excavated (P-AML and N-AML) was brought to surface during 2013. The reason for this was the mining cycle at Bellekeno required that all of the new development rock be used for backfill.

Part of the purpose of the annual report and review is to identify and suggest improvements and streamlining of the WRMP within the annual reports. The WRMP has been effective overall in the identification, segregation, operational management and geochemical verification of excavated materials at the Bellekeno, Onek, and Lucky Queen mines. The robust feedback mechanisms featured within the WRMP and in the other related plans will help ensure the efficacy of waste rock management activities at Bermingham, and other mines within the district.

The annual reports which contain complete WRMP summaries are available online at Yukon Government (YG) Energy Mines and Resources website:

http://www.emr.gov.yk.ca/mining/bellekeno.html

The annual reports for Water Use Licences QZ07-078 and QZ09-092 which also contain WRMP summaries are available in hard copy at the Yukon Water Board's office and online at the Waterline website.

6.3 ROCK MANAGEMENT CATEGORIES

The rock at the Bermingham deposits can be categorized as follows: Non-Acid Metal Leaching waste rock (N-AML), potentially-acid metal leaching (P-AML) waste rock, mineralized rock, and ore. Waste rock and ore excavated from the Bermingham mine will be categorized and managed according to the existing Waste Rock Management Plan:

- Non-Acid Metal Leaching Waste Rock (N-AML): Rock of non-economic grade with no significant potential for the generation of net acidity or metal leaching. Rock field-classified as N-AML will be used for general construction purposes as required or backfilled underground.
- Potentially-Acid Metal Leaching (P-AML) Waste Rock and Mineralized Waste Rock of no Economic Interest: Rocks field-classified as P-AML that is brought to surface will be temporarily stored in designated lined P-AML waste rock storage facilities prior to be backfilled underground. In addition to P-AML wall rocks, some material especially along the margins of zoned veins contain mostly gangue minerals such as siderite, pyrite and quartz, but do not contain economic amounts of silver (Ag), zinc (Zn), or lead (Pb) minerals and therefore are of no economic interest. Due to their increased likelihood for acidic or metal leaching, all such mineralized non-economic rock is considered to be P-AML and will be stored in the temporary P-AML Waste Rock Storage Facility (WRSF) until used as rock backfill.
- Mineralized Rock and Ore: Ore and vein material which contains significant Ag, Zn or Pb minerals may be temporarily stockpiled at the surface at the mine site before being transported to the mill. Confirmatory assay will determine whether this rock is milled, or is sent to the temporary P-AML WRSF or hauled back underground to be incorporated in the cemented rock backfill material.

The ultimate fate and use of these rock types are summarized in Table 6-1.

Table 6-1: Summary of Management Protocols for Rock Types

Rock Management Category	Management Procedures
N-AML Waste Rock	Use for general construction purposes Used as underground rock backfill as required
P-AML Waste Rock	Stored in temporary P-AML WRSFs Used as underground rock backfill
Mineralized Rock and Ore	Milled for mineral recovery if deemed of economic grade If deemed uneconomic grade: Stored in temporary P-AML WRSFs Used as underground rock backfill

6.4 ESTIMATED ROCK QUANTITIES

A total of 165,000 t (137,000 t with 20% contingency) of waste rock are anticipated to be brought to surface at Bermingham over its currently known mine life. Waste rock volumes and tonnages for the Bermingham deposit, including a breakdown by the major lithologic units and the relative proportion of N-AML and P-AML waste are shown in Table 6-2.

Table 6-2: Bermingham Rock Excavation Estimate

Bermingham	Greenstone (GNST)	Quartzite (QZT), Calcareous Quartzite (CQZT), Thin Bedded Quartzite (TQZT)	Graphitic Schist/Interbedded Carbonaceous Quartzite and Schist (GSCH/ICQS)	Total
Tonnes	13,669	95,682	27,338	136,689
% of Total Excavation	10%	70%	20%	100%
% N-AML	100%	87%	93%	
% P-AML	0%	13%	7%	

6.4.1 Estimation Methodology

The estimated tonnages by lithology presented in Table 6-2 were derived by superimposing the planned underground workings with the 3D geologic model created with Mintec's MineSite® software, which was constructed using data obtained and interpreted by Alexco geologists from all available exploration diamond drill core from the Bermingham area (drilled between 2010-2017). Estimations of N-AML and P-AML are based on ARD/ML characterization of the Bermingham cover hole, and is described in the geochemical characterization report for Bermingham, which is included as Appendix D.

6.5 WASTE ROCK MANAGEMENT

A summary of waste rock management for Bermingham over the life of mine for each deposit is shown in Table 6-3. The waste rock materials balance for the project (Table 3-4) indicates that the major permanent excavation to surface will be placed on surface between 2018 and 2023 for a total permanent excavation tonnage of up to 137,000 tonnes (165,000 tonnes with 20% contingency). A temporary P-AML storage facility will be located on the historic Bermingham waste rock dump (shown on Figure 1-3) which was already previously assessed. The P-AML facility may be expanded if more than the currently approved temporary facility capacity is exceeded. The PAML rock will be used preferentially as backfill, and the P-AML rock may come to surface temporarily to be stored within the temporary facility prior to being used underground as backfill.

Table 6-3: Bermingham Waste Rock Management

Lithology	Total estimated tonnage	Tonnage P-AML	Tonnage N-AML	P-AML Rock Management	N-AML Rock Management
Quartzite	95,682	12,439	83,243	Underground backfill utilizing temporary storage on surface or permanent storage on surface in approved EBA generic design	construction/ upgrade material; road upgrade and maintenance and general construction, underground backfill, N-AML WRDA
Graphitic Schist	27,338	1,914	25,424		
Greenstone	13,669	0	13,669		
Project Proposal Total	136,689	14,352	122,337		

Appendix E presents the revised Waste Rock Management Plan which includes provisions and updates for management of Bermingham waste rock and upgrades to Calumet Road.

Evaluation of the Bermingham geoenvironmental dataset indicated that the Flame and Moth geochemical screening criteria were adequate for segregating P-AML and N-AML waste rock for storage and disposal (Appendix D). Therefore, rock to be used and incorporated around the Bermingham portal and N-AML waste rock disposal area will use the geochemical screening criteria for identification of P-AML rock for the Flame and Moth rock distal to (≥ 5 m or the presence of vein associated stringers, whichever is further) the mineralized vein fault deposit is as follows:

a) or S via ICP ≥ 1.5%;

b) or Pb ≥ 5000 ppm; and

cd) or Zn ≥ 5000 ppm.

However, all rock to be used for construction purposes outside the Bermingham portal and N-AML waste rock disposal area will be subject to the more stringent Bellekeno screening criteria as follows:

a) Ca% ≤ 0.75% and S via ICP ≥ 0.25 %;

b) or S via ICP ≥ 1.5%;

c) or Pb ≥ 5000 ppm; and

d) or Zn ≥ 5000 ppm.

The above criteria will be used for screening historic waste rock to be used for widening Calumet Road, as required.

Upon P-AML or N-AML determination as per the WRMP, directions will be given to the surface crew for hauling and disposal of the waste rock as described in the previous sections. These management protocols will mitigate potential effects associated with improper waste rock disposal, such as soil and surface/groundwater contamination. During operations, all waste rock will be immediately classified and moved to the appropriate disposal area or storage facility depending on type, thereby negating the need for a temporary waste rock classification area.

The temporary P-AML WRSF facilities will be located at the top of the historic Bermingham waste rock dump as previously assessed by YESAB. Water management structures (e.g. ditching) will be installed around the facility to ensure runoff and leachate are appropriately managed. Temporary storage of P-AML waste rock will be within temporary P-AML PAD adjacent to portal constructed with a cemented base fill for up to 30 days and either sent to the PAML facility for longer term storage or placed back underground as backfill. The previously assessed facility was designed for 1,000 m^3 and a second facility may be built if additional PAML is encountered at a greater rate than the backfill rate using EBA's Construction Specifications require that an engineer approve the site. Design criteria/specifications for additional P-AML Waste Rock Storage Facilities are provided in the approved Typical Waste Containment Facility Design – Construction Specifications (included in Appendix E). EBA's Construction Specifications account for physical stability of the facility. The facilities are lined and seepage is collected and treated as required during operations. At closure, all P-AML material in the temporary facility will be backfilled underground and the P-AML will be decommissioned.

7 ASSOCIATED MINE SERVICES AND INFRASTRUCTURE

7.1 POWER

Power for the KHSD is supplied by Yukon Energy Corporation (YEC). The Mayo hydro facility was recently upgraded with a new penstock and turbine plant providing additional capacity (Mayo B). Currently the power for the KHSD is supplied by a 69 kV overhead line from Mayo and is then stepped down at the Onek transformer to 6.9 kV for further distribution to the Bellekeno mine. A new 69 kV spur line was constructed in 2010 to supply power to the Keno District Mill. A 69 kV – 600 V transformer is located at the mill to supply power and will be used to supply electrical power for the Bermingham project.

Peak power demand for the Bermingham mine under full production development project are estimated at 700 kW (~6,000 MWh/yr).

The power requirements for the Bermingham mine will be primarily for the Jumbo, support equipment (fans, compressed air, pumps) and surface facilities. Initial development and production may commence on diesel generated power from a generator located at the Bermingham laydown area. Electrical power distribution will be extended from the YEC 69 kV overhead line located approximately 600 m from the Bermingham portal. A step down transformer substation (69 kV – 4,160 V) will be constructed for power distribution to the portal MCC. Surface teck cable will be run from the mill MCC to the Bermingham portal area where additional transformers and switch gear will be located and then distributed either underground or to surface facilities.

7.2 COMMUNICATIONS

The KHSD is not within the Yukon grid for cell phone communication therefore a dedicated on site radio communication system has been installed for the KHSD and radio communication is available across the district. The system in place functions for the Bermingham project. A leaky feeder system will be installed at Bermingham which allows surface radio communication to extend to underground operations.

7.3 COMPRESSED AIR

The Bermingham mine will be supplied with compressed air via a 400 cfm electric compressor. A 6-inch Victaulic airline will provide air from the air compressor to the advancing decline face.

7.4 VENTILATION

The planned ventilation flow for Bermingham is 130,000 cfm based on a ventilation model. Heated fresh air will be delivered centrally to the mine from the portal and exhausted through a 3-metre diameter bored raise equipped with a manway.

Fresh air will be distributed by lateral development and ventilation raises to the lower extremities of the Bermingham mining zones. Fresh air will be distributed upwards through the zones by a combination of ventilation raises and spiral ramps. Exhaust will be removed from the upper extremities of the Bermingham mining zones through the ramp systems that connect them to the main ramp.

7.5 SUPPORT FACILITIES

Most of the mobile equipment maintenance will be performed in a planned surface shop, to be constructed near the Bermingham portal. The mine area is relatively small and it will not be difficult to bring underground equipment to the surface shop. An additional small maintenance shop will be set up underground to handle small repairs and routine servicing.

The maintenance department will have a fuel/lube truck, a mechanic's service truck, a tractor, and access to a scissor lift and a boom truck.

In addition to the mobile equipment, the mine maintenance department will be responsible for the stationary equipment consisting of air compressors, main ventilation fans, propane air heaters, underground electrical distribution system, and main dewatering pumps.

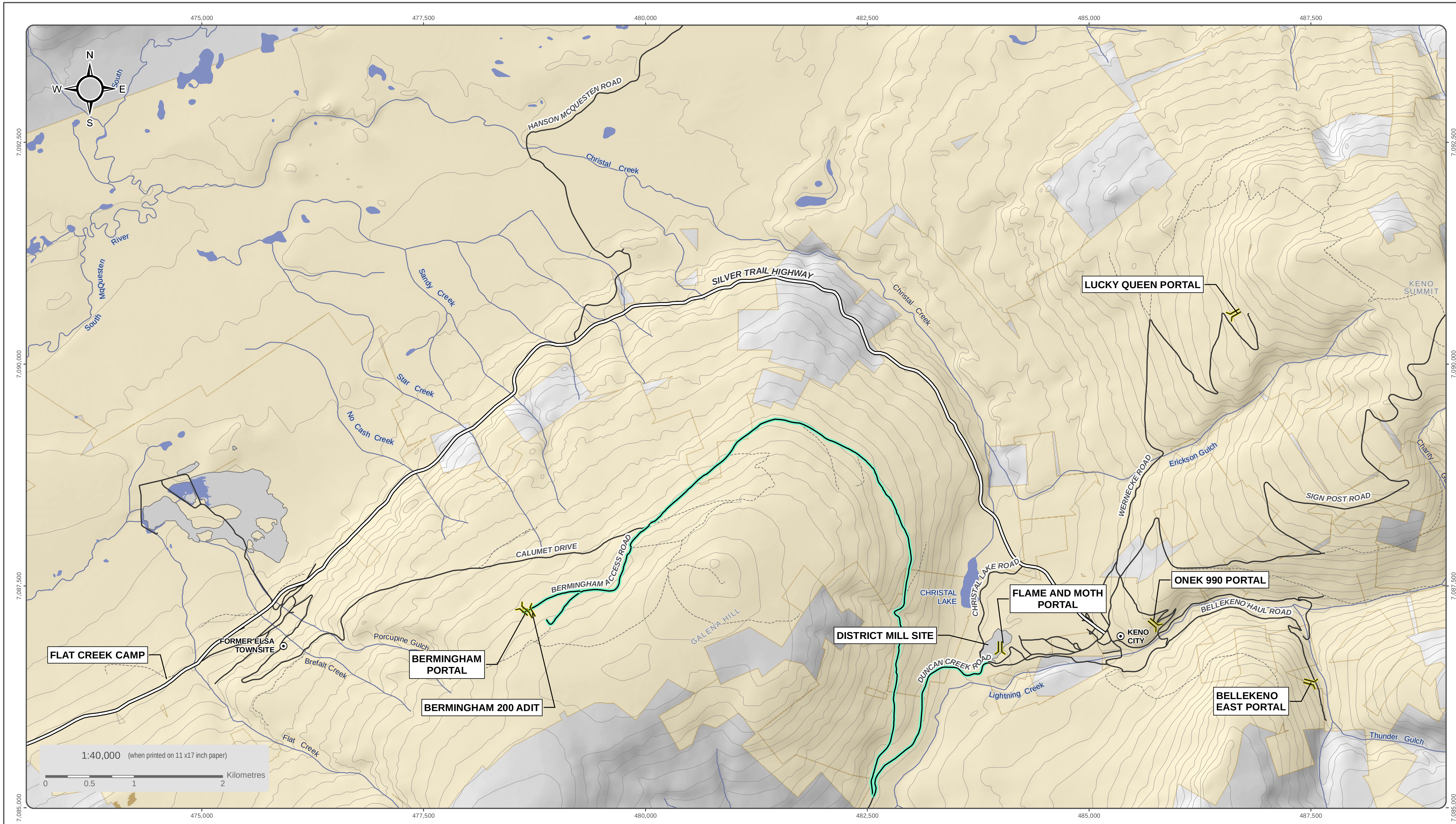
There will be several laydowns on the portal bench for ground support materials. The majority of the mining gear will be stored at the shop and office location as shown in Figure 1-3.

7.6 SITE ACCESS AND TRANSPORT

Mine traffic associated with the Bermingham mine will use the Bermingham access road, Calumet Road and a short section of the Duncan Creek road (~3 km) between the Mill and the Bermingham Mine, as shown in Figure 7-1. The roads will be upgraded to Workers Compensation Board (WCB) standards using cut and fill techniques. N-AML waste rock from both the Bermingham mine and historic Galkeno or Sime mines may be used as fill is required. The waste rock used for road construction will be subject to the Bellekeno waste rock screening criteria listed in Appendix E.

The Duncan Creek Road section will be upgraded to meet WCB standards and will be widened with a berm using local cut materials. The upgrading and the maintenance of the road will be done under a working within a Highway Right of Way permit and managed per the Road Management Plan under the QML as this section overlaps with Alexco claims. The road will be upgraded using cut and fill techniques from hillside gravel sources. Appropriate signage and traffic control will be incorporated during the upgrading of the Duncan Creek Road section and signage will be erected notifying users of haul trucks on this section during operations. Alexco met with Yukon Government Department of Highways on November 6, 2017 to discuss the upgrading for the section of the Duncan Creek Road.

A decrease in traffic along the Bellekeno Bypass Road is expected during Bermingham operations as Bellekeno mine operations are expected to cease during the active operations period at Bermingham. There will be no additional traffic through Keno City for the Bermingham Mine. During mine production, all heavy and light truck traffic will be routed along the Christal Lake Road (Figure 7-1). Table 7-1 presents estimated traffic volumes associated with mining activities at Bermingham.



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Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on October 2017

Datum: NAD 83; Map Projection: UTM Zone 8N

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- Place of Interest
- Adit
- Valley Tailings
- Alexco/ERDC Quartz Claims
- Waterbody
- Proposed Road Upgrades
- Silver Trail Highway
- Other Road
- Limited-Use Road
- Watercourse

AKHM

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ALEXCO KENO HILL MINING CORP.
BERMINGHAM

FIGURE 7-1

BERMINGHAM ROAD UPGRADES

OCTOBER 2017

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(Last edited by: amatlashevska;25/10/2017/10:12 AM)

Table 7-1: Estimated Daily Traffic Count – Operations Phase Bermingham

		Shift Change	Day Shift	Shift Change	Night Shift
Vehicle Type – One way traffic count	Travel Direction	6 am – 8 am	7 am – 7 pm	4 pm- 6 pm	7 am – 7 pm
Light Trucks (< 1 ton) and Autos	Elsa to Mine/Mill	4	12	4	6
Buses	Elsa to Mine/Mill	2		2	
Heavy Trucks (>5 tonne) bulk materials	Elsa to Mine/Mill		3		
Ore Trucks (>20 tonne) hauling ore	Mine to Crusher		8		
Ore Trucks (>20 tonne) hauling tailings or empty	Crusher to Mine		8		
Total round trips per day		**6**	**31**	**6**	**6**

Notes:

1) Warehouse receiving and shopping normally confined to hours between 8 am and 4 pm. This will minimize heavy traffic during shift changes. Normally no heavy truck deliveries on night shift.
2) Bulk materials include fuel, reagents, materials, supplies and concentrate haulage.
3) Above values are considered typical of daily traffic anticipated during operations. Variations up to 50% are possible on any given day.
4) Based on 408 t/d production rate which results in highest ore haulage traffic count.

7.6.1 Road Development and Traffic Management Measures

The Traffic Management Plan, developed and approved under QML-0009, has been updated to incorporate Bermingham mine traffic (Appendix F).

Potential socio-economic effects associated with project traffic are addressed in Section 110.

7.7 WORKER HEALTH & SAFETY

Operations at the KHSD fall under the jurisdiction of the Occupational Health & Safety Act and Regulations administered by the Yukon Workers' Compensation Health & Safety Board (YWCHSB). Alexco has in place a Health & Safety Policy (Appendix A) and both will continue to be adhered to during the course of operations at Bermingham.

All personnel and Contractors will meet the standards outlined in the Occupational Health and Safety Legislation, Mine Safety Rules, and Regulations of the Worker's Compensation Board.

The Emergency Response Plan is included in Appendix G.

Alexco has an established program for achieving and maintaining a healthy and safe workplace. In the KHSD there are currently emergency first aid responders providing 24-hour service. There are multiple first aid rooms and an ambulance on the site as well.

Alexco policy requires that all employees (including contractors' employees) have pre-employment medical examinations including a drug and alcohol test. All employees will be fully equipped with the proper personal protective equipment standard for working underground, taking into consideration hazards caused by noise level, air born particulates and confined work space.

All new employees will have a site wide and safety orientation and another orientation of the underground work site prior to commencing work. Regular safety meetings with supervisors, safety officer and employees are mandated. Any changes in procedures, equipment, or hazards require immediate notification to employees.

Underground contractors, Alexco personnel and others will have to comply with the Yukon Occupational Health and Safety (OH&S) regulations in addition to Alexco and contractors in-house standards.

A Safety Coordinator/Officer specific for the underground operation will ensure all workers are orientated to all aspects of the work site including hazard identification, protective equipment requirements and that medical and health requirements are followed according to legislation. That position is also charged with ensuring continued training and skill development for all personnel.

7.8 WASTE MANAGEMENT

Project waste will be managed according to a revised Waste Management Plan in place under the QML-0009 (Appendix H).

7.9 FUEL AND HAZARDOUS MATERIALS MANAGEMENT

Fuel and petroleum products required for Bermingham development will be managed appropriately. A 28,000 L Envirotank will be used for fuel containment at Bermingham. Alexco's existing and approved Spill Contingency plan and Hazardous Materials Management Plan have been updated for the Bermingham Mine and are presented in Appendices I and J, respectively.

7.9.1 Explosives

Explosives will be used to develop the decline and ongoing waste development and ore production. Explosives will be trucked to the site and stored in an approved magazine in accordance with YWCHSB (mine regulations) and onsite manufacturing will not be required. Explosives use, transport, handling, storage and disposal is governed by the Yukon Occupational Health and Safety Act Blasting Regulations and Occupational Health & Safety Regulations, and the Transport of Dangerous Goods Act and Regulations. Figure 1-2 shows the location for the explosive magazine. The explosive magazines will be located at appropriate distances away from the portals and other buildings as dictated by regulations. Explosives and detonators will be conveyed to the working headings on as need basis transported via approved day boxes. Excess explosives will be returned to the magazine at the end of the shift. A log book will be maintained in the magazine as required by regulations.

Blasting reagent consumption is expected to be comprised of approximately two thirds ANFO (ammonium nitrate and fuel oil), and one third explosives in stick form. Estimated consumption for ANFO and stick product is 1.15 kg/t (2.3 lb/ton). Both products contain nitrogen compounds (0.33 kg N per kg ANFO and similar composition for stick product); the stick product is a less soluble formulation and is typically used under wetter conditions.

Detonators will be non-electric and tied in with detonator cord.

7.10 GENERAL GROUND PROTECTION MEASURES

During development, certain activities could affect ground stability. In general, ground disturbance will be minimized and only minimal new footprint development will be required. Geotechnical engineers will inspect sites proposed for N-AML and P-AML storage and construction and other major surface facilities prior to development. Appropriate water management infrastructure (e.g. diversions, berms) will be established to ensure site runoff is managed and erosion/ground instability is avoided.

While the broad region in which the KHSD is located is generally characterized by discontinuous permafrost, Alexco has not encountered significant permafrost during development anywhere in the District. As much of the surface development is proposed for existing disturbed areas, the likelihood to encounter permafrost at surface is relatively low. If significant surface permafrost is encountered during the construction and operation of the Bermingham it will be inspected by a geotechnical engineer who will advise Alexco on any construction modifications required to proceed with activities.

Permafrost may be encountered underground. Alexco will engage geotechnical engineering consultants to inspect areas where permafrost is encountered that could pose significant geotechnical issues. The geotechnical engineers will advise Alexco as to any modifications to design or operations to ensure mitigation of slumps or failures relating to the presence of permafrost.

8 WATER

8.1 METEOROLOGY

8.1.1 Weather Stations

An automated meteorological station (Calumet Weather Station) was installed on Galena Hill above Hector adit at 1,380 masl in June 2007. The station measures air temperature, relative humidity, barometric pressure, rainfall, wind speed and direction, solar radiation, and soil temperature. Average temperatures and total rainfall for Calumet Weather Station are presented Table 8-1.

A second weather station for closure planning purposes was installed at the Valley Tailings Facility (VTF) in 2012 at an elevation of 718 masl. Monthly averages from installation to December 2016 inclusively were calculated from instantaneous 10-minute or 15-minute values recorded by the datalogger for the following parameters: temperature, daily maximum temperature, daily minimum temperature, relative humidity, wind speed, gust speed, barometric pressure and solar radiation. Monthly extreme maximum temperature, extreme minimum temperature, maximum and minimum relative humidity, maximum gust speed and total rainfall are also shown in Table 8-2 below. Note that the barometric pressure has not been corrected for elevation and therefore represents the absolute pressure.

A meteorological station located above the Alexco District Mill near Keno City was installed in spring 2011 and became operational June 2011 at an elevation of 936 masl. Monthly averages were calculated from hourly values recorded by the datalogger (averaged values from a 10 seconds sampling interval) for the following parameters: temperature, daily maximum temperature, daily minimum temperature, relative humidity, wind speed, maximum wind speed and solar radiation. Monthly extreme maximum temperature, extreme minimum temperature, maximum wind speed, total rainfall and total evapotranspiration are also shown in Table 8-3 below. The information for the three stations is presented in Appendix K.

Snow Surveys

Alexco conducted manual snow surveys from 2011 to 2017 at ten monitoring stations with the addition of one station in 2016 and two stations in 2017 in order to adequately represent the varying snow conditions as a function of aspect, elevation, etc. Snow water equivalent (SWE) results are presented in Table 8-4 below and the station locations are shown of Figure 8-1. Figure 8-2 presents the average SWE across all stations.

Table 8-1: Calumet Weather Station Temperature and Rainfall 2007-2016

	Average Temperature (°C)										Total Rainfall (mm)									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
January	-	-17.18	-18.84	-14.08	-16.78[3]	-18.71[4]	-16.90	[6]	-13.22	*-8.34*[12]	-	-	-	-	-	-	-	[6]	0.0	*0.0*[12]
February	-	-16.99	-16.95	-9.09	-15.88[3]	-9.94[4]	-10.81	-15.69	-13.42	-9.32	-	-	-	-	1.8[3]	[9]	-	-	0.2	0.3
March	-	-11.04	-16.39	-9.21	-12.92[3]	-12.92[4]	-14.45	-11.95	-10.69	-5.84	-	-	-	-	0.5[3]	[9]	0.6	-	2.8	2.8
April	-	-4.93	-4.75	-2.01	-3.77[3]	-1.88[4]	-12.32	-4.39	-3.33	-0.43	-	1	-	1.3[3]	2.8[3]	[9]	0.2	6.2	8.6	7.8
May	-	3.31	3.66	5.35	4.41[3]	1.61[4]	n/a	4.17	7.85	5.55	-	25.4	21.8	32.3[3]	15.5[3]	[9]	n/a	17.2	4.0	23.0
June	*11.25*[1]	8.70	9.58	8.68	8.82[3]	7.76[4]	11.59	*7.31*[11]	8.42	10.07	*55.2*[1]	44.6	*11.8*[7]	56.7[3]	121.8[3]	[9]	45.2	*69.8* [11]	45.2	43.0
July	11.80	8.17	12.45	10.50	3.80[3]	7.84[4]	11.11	[11]	9.67	10.60	108.8	108.4	*22.8*[8]	137.7[3]	135.9[3]	*27.8*[10]	39.2	[11]	135.5	[13]
August	9.63	5.54	7.47	9.61	[2]	8.33[5]	10.58	7.95	6.71	9.25	54.8	110.2	89.4	140.0[3]	[9]	45.0	35.6	112.0	97.0	[13]
September	1.12	2.27	3.58	2.40	[2]	3.39	3.33	1.86	*2.17*[12]	2.95	57.6	61.4	50.4	78.0[3]	[9]	17.4	64.6	43.8	*46.4*[12]	[13]
October	-6.53	-7.20	-4.73	-4.86	[2]	-8.16	-2.52	-5.02	[12]	-6.23	-	12.6	-	16.0[3]	[9]	1.6	14.6	15.2	[12]	*0.0*[13]
November	-9.41	-10.17	-11.94	-11.19	-17.39[4]	-18.44	-15.50	-9.87	[12]	-8.87	-	-	-	-	-	0.2	0.0	0.2	[12]	0.0
December	-16.19	-18.34	-11.16	-17.72	-11.78[4]	-18.83	*-14.55*[6]	-10.43	[12]	-15.27	-	-	-	-	-	0.0	*0.0*[6]	0.0	[12]	0.0

Notes:

Values in grey italics indicate a partial month

[1] *Station commissioned June 15, 2007*
[2] *Temperature probe malfunction – no proxy data available*
[3] *Calculated from MAYO A data*
[4] *Sensor occasionally offline but most data complete*
[5] *Sensor replaced August 7*
[6] *The station was down from December 12, 2013 to January 31, 2014.*
[7] *Rainfall gauge malfunction on June 11; total rainfall provided for June 1-11.*
[8] *Rainfall gauge back online; total rainfall provided for July 7-31.*
[9] *Tipping bucket malfunction – no proxy data available.*
[10] *Tipping bucket repaired July 4th; total rainfall provided for July 4-31.*
[11] *Station was down between June 26 and July 31, 2014.*
[12] *Data missing from September 17, 2015 to January 5, 2016.*
[13] *Rainfall data missing from June 23, 2016 to October 23, 2016.*

Table 8-2: Monthly Statistics for Meteorological Parameters Collected at the Valley Tailings Meteorological Station

Month	Extreme Minimum Temp.(°C)	Average Minimum Temp. (°C)	Average Temp. (°C)	Average Maximum Temp. (°C)	Extreme Maximum Temp. (°C)	Average Relative Humidity (%)	Maximum Relative Humidity (%)	Minimum Relative Humidity (%)	Total Rain (mm)[2]	Average Wind Speed (m/s)[3]	Average Maximum Wind Speed (m/s)[3]	Extreme Maximum Wind Speed (m/s)[3]	Average Barometric Pressure (mbar)	Average Solar Radiation (W/m²)	Soil Average Water Content (%)[4]
Oct-2012[1]	-23.84	-20.12	-15.71	-9.71	-4.05	81.92	89.16	70.76	n/a	0.51	1.39	7.81	939.06	34.14	n/a
Nov-2012	-40.71	-27.24	-23.77	-20.42	-8.07	82.04	90.97	69.24	n/a	0.59	1.66	7.81	932.15	7.72	n/a
Dec-2012	-44.20	-29.97	-26.29	-22.98	-3.99	82.75	97.20	71.67	n/a	0.52	1.75	6.04	926.06	1.48	n/a
Jan-2013	-45.56	-25.98	-21.58	-17.72	0.74	84.73	94.43	72.60	n/a	0.94	2.10	14.61	929.62	4.78	n/a
Feb-2013	-24.88	-16.72	-12.96	-8.80	2.40	90.08	96.67	81.42	n/a	0.90	2.09	10.83	919.93	23.70	n/a
Mar-2013	-33.45	-21.40	-13.93	-5.74	5.57	68.05	92.35	53.08	n/a	0.84	2.00	13.85	931.80	93.31	n/a
Apr-2013	-25.05	-14.66	-7.17	-0.87	8.37	53.23	81.57	39.58	n/a	2.01	4.10	16.62	930.07	171.18	n/a
May-2013	-8.36	0.10	6.08	11.66	23.35	62.90	95.00	40.13	4.80	1.42	3.26	11.84	928.76	186.87	12.3
Jun-2013	1.64	8.20	15.63	22.00	32.82	58.66	84.24	42.04	46.20	1.50	3.45	22.66	930.76	215.51	8.0
Jul-2013	1.59	8.95	15.68	21.90	29.32	60.65	87.50	38.38	25.40	1.39	3.22	16.12	931.69	194.18	6.9
Aug-2013	-1.90	6.94	13.85	20.49	29.49	68.65	95.18	44.98	43.00	0.93	2.45	13.60	926.92	144.34	9.6
Sep-2013	-2.45	2.00	6.39	10.85	18.06	80.70	98.19	60.89	64.80	1.19	2.83	17.38	921.41	71.21	14.4
Oct-2013	-11.22	-5.32	-1.54	2.56	9.11	91.89	99.04	68.02	49.40	0.61	1.86	11.58	927.19	32.16	12.2
Nov-2013	-42.69	-22.40	-18.25	-14.23	-0.59	88.31	99.71	75.50	0.00	0.55	1.71	11.58	931.23	8.07	n/a
Dec-2013	-40.38	-30.71	-27.25	-23.50	-2.48	83.73	95.83	72.42	0.00	0.49	1.72	9.07	936.80	1.69	n/a
Jan-2014	-37.92	-18.28	-14.50	-10.52	1.67	93.54	99.99	81.10	0.00	0.17	1.96	6.30	926.22	2.73	n/a
Feb-2014	-39.42	-27.88	-22.85	-14.48	-3.33	84.27	91.09	77.57	0.00	0.34	1.43	8.31	933.74	27.52	n/a
Mar-2014	-30.55	-20.48	-12.32	-3.50	5.85	63.32	80.35	46.47	7.00	0.75	2.17	9.57	928.51	103.16	n/a
Apr-2014	-20.69	-6.99	-0.45	6.19	11.52	59.76	87.11	43.10	5.00	1.34	3.20	13.09	923.72	152.86	n/a
May-2014	-3.24	1.34	8.66	14.54	21.94	53.49	74.94	35.74	11.40	1.39	3.41	13.35	931.01	201.57	17.3
Jun-2014	-0.85	6.35	12.79	18.09	28.17	56.74	87.94	38.68	56.80	1.39	3.45	15.61	926.57	206.09	14.0
Jul-2014[5]	6.86	9.96	16.01	21.50	24.85	64.71	82.34	48.07	32.20	1.30	3.24	13.35	930.01	193.02	14.0
Aug-2014[5]	Station Down – No data														
Sep-2014[5]	Station Down – No data														
Oct-2014[5]	-17.47	-12.34	-7.87	-4.47	-1.47	93.68	95.52	90.51	0.00	0.69	1.93	7.05	923.44	16.88	n/a
Nov-2014	-35.71	-18.96	-15.69	-12.75	-2.25	89.63	99.47	80.36	0.00	0.75	2.09	8.06	932.50	8.54	n/a
Dec-2014	-29.59	-18.70	-15.22	-12.12	-1.73	92.55	98.58	85.41	0.00	0.59	1.93	10.32	924.68	1.53	n/a
Jan-2015	-41.27	-22.34	-19.15	-15.78	-0.14	90.13	99.54	78.03	0.00	0.32	1.68	9.07	932.43	2.93	n/a
Feb-2015	-41.50	-21.41	-17.51	-12.68	3.85	89.56	99.96	78.51	13.60	0.46	1.80	12.34	935.86	22.75	n/a
Mar-2015	-31.12	-16.89	-10.20	-3.39	6.84	75.01	91.08	58.48	3.20	1.00	2.33	13.35	927.14	84.81	n/a
Apr-2015	-11.15	-4.79	1.23	7.51	12.53	64.06	88.56	50.40	13.80	1.45	3.36	12.84	921.78	153.92	n/a
May-2015	-6.99	3.25	11.76	18.45	27.55	48.65	67.29	33.82	6.00	1.43	3.41	17.12	932.37	235.70	21.4
Jun-2015	1.24	5.77	12.99	19.00	25.82	59.92	81.85	34.81	27.20	1.48	3.49	16.62	929.55	213.66	13.1

Month	Extreme Minimum Temp.(°C)	Average Minimum Temp. (°C)	Average Temp. (°C)	Average Maximum Temp. (°C)	Extreme Maximum Temp. (°C)	Average Relative Humidity (%)	Maximum Relative Humidity (%)	Minimum Relative Humidity (%)	Total Rain (mm)[2]	Average Wind Speed (m/s)[3]	Average Maximum Wind Speed (m/s)[3]	Extreme Maximum Wind Speed (m/s)[3]	Average Barometric Pressure (mbar)	Average Solar Radiation (W/m^2)	Soil Average Water Content (%)[4]
Jul-2015	4.14	7.64	13.90	19.65	27.16	69.15	93.72	43.99	82.60	1.05	2.63	10.83	927.71	180.54	17.2
Aug-2015	-2.57	4.53	10.52	15.76	25.84	76.20	95.53	54.67	69.20	*1.01*	*2.48*	*10.83*	927.00	138.77	20.2
Sep-2015	-8.10	-0.86	3.67	8.66	16.03	81.30	93.24	61.31	42.60	*1.29*	*2.97*	*21.40*	923.36	80.01	20.7
Oct-2015	-12.79	-4.25	-1.37	1.63	7.70	91.95	99.99	65.89	14.00	*0.75*	*2.01*	*8.56*	924.77	33.28	8.6
Nov-2015	-36.15	-18.71	-14.44	-10.89	2.64	92.87	99.34	82.48	0.00	*0.40*	*1.71*	*7.05*	921.85	6.59	n/a
Dec-2015	-33.38	-18.58	-15.58	-12.85	3.01	92.73	97.50	83.71	0.00	*0.46*	*2.12*	*11.84*	919.23	1.26	n/a
Jan-2016	-26.91	-16.61	-13.08	-10.02	4.17	91.42	98.22	78.66	0.00	*0.69*	*2.08*	*17.38*	922.28	4.92	n/a
Feb-2016	-34.26	-17.54	-12.62	-7.02	2.96	89.23	97.60	79.77	2.00	*0.49*	*1.71*	*9.82*	924.51	26.62	n/a
Mar-2016	-15.91	-9.95	-4.83	0.67	13.83	76.08	94.59	62.59	4.80	*1.34*	*2.86*	*9.82*	922.88	80.42	n/a
Apr-2016	-10.97	-2.76	2.77	8.43	15.25	65.43	92.00	46.16	3.20	*1.53*	*3.40*	*14.10*	925.77	151.79	6.8
May-2016	-2.10	2.56	9.64	15.44	23.88	56.10	83.81	36.95	16.40	*1.66*	*3.66*	*15.11*	931.02	205.21	25.5
Jun-2016	3.01	7.16	14.43	20.48	27.53	55.89	88.06	36.60	40.40	1.63	3.64	15.11	927.96	233.69	21.6
Jul-2016	0.63	9.33	14.84	20.11	26.92	73.54	93.34	54.86	67.20	1.08	2.67	11.84	929.36	173.57	23.9
Aug-2016	-1.47	7.05	12.77	18.13	24.80	73.62	94.25	58.18	45.80	1.15	2.75	15.11	932.57	146.43	23.6
Sep-2016	-6.14	0.03	5.67	11.48	18.11	73.70	94.96	34.79	39.40	*0.96*	*2.56*	*14.86*	927.36	98.46	23.4
Oct-2016	-22.37	-11.82	-7.27	-1.85	5.00	84.13	97.87	63.33	0.60	*0.57*	*1.77*	*9.32*	929.65	47.00	5.2
Nov-2016	-32.83	-17.19	-13.41	-9.77	5.62	90.97	99.91	74.28	6.80	*0.49*	*1.84*	*10.83*	919.86	6.43	1.0
Dec-2016	-39.74	-25.23	-21.84	-18.83	-3.42	87.07	96.70	76.06	0.00	*0.43*	*1.68*	*6.55*	931.27	1.78	0.2

Notes: Values in grey italics indicate a partial month
[1] Station was commissioned on October 19 so October 2012 has 12 days of complete data
[2] May2013 has 14 days of compete rain data
[3] October 2012 has 2 days of complete and 11 days of partial wind data
November 2012 has 5 days of complete and 24 days of partial wind data
December 2012 has 2 days of complete and 16 days of partial wind data and
January 2013 has 5 days of complete and 16 days of partial wind data
February 2013 has 2 days of complete and 26 days of partial wind data
March 2013 has 4 days of complete and 27 days of partial wind data
April 2013 has 14 days of complete and 16 days of partial wind data
May 2013 has 15 days of complete and 16 days of partial wind data
June 2013 has 29 days of complete and 1 day of partial wind data
August 2013 has 29 days of complete and 2 days of partial wind data
September 2013 has 15 days of complete and 15 days of partial wind data
October 2013 has 6 days of complete and 25 days of partial wind data
November 2013 has 1 day of complete and 28 days of partial wind data
December 2013 has 2 days of complete and 23 days of partial wind data
January 2014 has 0 days of complete and 12 days of partial wind data
February 2014 has 0 days of complete and 13 days of partial wind data
March 2014 has 1 days of complete and 30 days of partial wind data
April 2014 has 10 days of complete and 20 days of partial wind data
May 2014 has 21 days of complete and 10 days of partial wind data
December 2014 has 3 days of complete and 12 days of partial wind data
January 2015 has 0 days of complete and 14 days of partial wind data
February 2015 has 1 day of complete and 17 days of partial wind data
March 2015 has 5 days of complete and 26 days of partial wind data
April 2015 has 12 days of complete and 18 days of partial wind data
May 2015 has 27 days of complete and 4 days of partial wind data
August 2015 has 29 days of complete and 2 days of partial wind data
September 2015 has 14 days of complete and 16 days of partial wind data
October 2015 has 12 days of complete and 19 days of partial wind data
November 2015 has 1 day of complete and 23 days of partial wind data
December 2015 has 0 day of complete and 9 days of partial wind data
January 2016 has 4 days of complete and 19 days of partial wind data
February 2016 has 2 days of complete and 17 days of partial wind data
March 2016 has 8 days of complete and 23 days of partial wind data
April 2016 has 22 days of complete and 4 days of partial wind data
May 2016 has 30 days of complete and 1 day of partial wind data
September 2016 has 22 days of complete and 8 days of partial wind data
October 2016 has 4 days of complete and 27 days of partial wind data
November 2016 has 3 days of complete and 11 days of partial wind data
December 2016 has 0 day of complete and 18 days of partial wind data
[4] Negative values reported from Oct 2012 to April 2013, from Nov 2013 to Apr 2014, from Oct 2014 to Apr 2015 and from Nov 2015 to March 2016 were invalidated – soil assumed to be frozen
[5] Station was down between July 16 and October 26, 2014

Table 8-3: Monthly statistics for meteorological parameters collected at District Mill Station

Month-Year (MMM-YY)	Extreme Maximum Temperature (°C)	Average Maximum Temperature (°C)	Average Temperature (°C)	Average Minimum Temperature (°C)	Extreme Minimum Temperature (°C)	Average Relative Humidity (%)	Total Precip (mm)	Average Wind Speed (m/s) [1]	Extreme Maximum Wind Speed (m/s)[1]	Average Solar Radiation (W/m^2)	Total Evapo-transpiration (mm)[8]
Jun -11[2]	24.72	18.59	11.96	6.30	-2.56	n/a	n/a	1.35	9.14	n/a	n/a
Jul-11	25.67	18.50	12.91	8.00	5.09	n/a	n/a	1.15	8.02	n/a	n/a
Aug-11	22.32	15.58	9.78	5.37	1.93	n/a	n/a	1.18	9.15	n/a	n/a
Sep-11	17.97	11.29	6.07	1.85	-2.47	n/a	n/a	1.43	11.36	n/a	n/a
Oct-11	7.20	0.20	-2.74	-5.41	-9.84	n/a	*2.60*[3]	0.94	13.12	n/a	n/a
Nov-11	-4.23	-16.79	-19.54	-22.47	-34.99	n/a	0.00	0.58	12.05	n/a	n/a
Jan-12	-0.96	-19.10	-23.13	-26.79	-37.32	n/a	0.00	*0.59*	*9.51*	n/a	n/a
Feb-12	2.77	-6.77	-10.00	-13.07	-26.78	n/a	0.10 [4]	*1.38*	*15.62*	n/a	n/a
Mar-12	5.33	-7.69	-13.37	-18.00	-27.80	n/a	0.00	*0.97*	*9.24*	n/a	n/a
Apr-12	9.69	6.13	0.96	-3.87	-15.92	n/a	0.60 [4]	1.37	10.27	n/a	n/a
May-12	17.78	10.73	6.31	1.91	-3.47	*51.81* [5]	18.30	1.78	10.60	n/a	n/a
Jun-12	27.62	18.41	13.46	8.29	4.42	56.35	21.70	1.44	10.26	n/a	n/a
Jul-12	25.14	18.07	12.75	7.73	1.64	69.26	85.80	1.36	12.99	n/a	n/a
Aug-12	21.72	16.31	11.25	6.56	-0.89	67.79	47.00	1.62	9.41	n/a	n/a
Sep-12	20.24	10.33	5.90	2.08	-5.22	69.51	36.40	1.84	14.27	n/a	n/a
Oct-12	7.60	-3.95	-7.35	-10.32	-20.62	79.54	7.60	1.13	10.37	n/a	n/a
Nov-12	-8.98	-19.55	-21.90	-24.32	-33.36	81.43	0.00	0.94	9.36	n/a	n/a
Dec-12	-3.36	-21.30	-23.44	-25.58	-36.32	81.34	0.00	*0.26*	*5.93*	*1.01* [6]	*0.05* [7]
Jan-13	-1.59	-17.06	-20.01	-23.08	-41.48	82.92	0.00	*0.76*	*14.48*	1.06	0.81
Feb-13	1.54	-9.10	-12.52	-15.46	-23.74	88.36	0.30 [4]	*0.85*	*12.25*	10.26	1.27
Mar-13	3.26	-7.52	-13.16	-17.99	-29.96	64.08	3.90	1.59	12.47	95.82	6.33
Apr-13	6.07	-2.76	-7.94	-13.69	-25.07	54.50	8.20	2.44	12.93	190.02	14.48
May-13	23.31	10.20	5.27	0.23	-9.46	61.83	39.60	1.77	11.76	215.44	21.70
Jun-13	30.51	19.97	14.27	8.30	1.84	58.72	57.30	1.82	12.87	234.69	29.79
Jul-13	24.93	19.40	14.01	8.60	2.25	62.67	46.90	1.75	16.14	211.00	27.10
Aug-13	27.34	18.54	12.98	8.01	-0.38	66.30	51.90	1.49	11.05	156.25	21.38
Sep-13	16.11	9.69	5.81	2.26	-3.74	77.52	59.70	1.54	10.99	79.69	10.88
Oct-13	8.25	1.61	-1.32	-4.21	-10.10	86.75	44.60	1.11	11.62	35.75	4.26
Nov-13	0.18	-13.41	-16.68	-20.08	-37.96	84.26	10.60	*1.02*	*10.96*	4.93	*1.08*
Dec-13	-1.73	-21.23	-23.91	-26.70	-35.29	78.77	4.90	*0.75*	*9.47*	0.57	*0.62*
Jan-14	3.74	-9.33	-12.16	-15.10	-32.22	89.44	24.9	*0.72*	*10.03*	2.42	*0.641*
Feb-14	-1.93	-15.25	-19.40	-23.02	-33.55	75.20	2.9	0.87	10.85	31.34	1.988
Mar-14	4.57	-5.31	-11.29	-16.16	-26.79	54.77	0.7	1.57	11.98	115.54	9.174
Apr-14	10.93	4.09	-0.96	-5.78	-17.33	57.54	5.1	1.64	12.05	171.28	15.77
May-14	21.30	12.70	7.64	2.03	-3.03	52.18	12.8	2.09	19.21	217.91	29.81
Jun-14	24.93	16.21	11.39	5.95	-0.13	56.14	40.4	1.78	10.43	217.90	28.58

Month-Year (MMM-YY)	Extreme Maximum Temperature (°C)	Average Maximum Temperature (°C)	Average Temperature (°C)	Average Minimum Temperature (°C)	Extreme Minimum Temperature (°C)	Average Relative Humidity (%)	Total Precip (mm)	Average Wind Speed (m/s)[1]	Extreme Maximum Wind Speed (m/s)[1]	Average Solar Radiation (W/m²)	Total Evapo-transpiration (mm)[8]
Jul-14	23.44	18.49	13.68	8.73	-0.04	65.01	31.0	1.63	13.38	187.31	23.84
Aug-14	22.09	15.57	10.87	6.93	0.06	74.59	67.7	1.44	11.85	139.84	15.72
Sep-14	17.70	8.76	4.28	0.49	-6.74	70.54	36.4	1.37	11.32	93.38	11.56
Oct-14	7.47	-0.91	-3.79	-6.33	-15.42	88.21	15.7	1.24	12.80	24.83	3.39
Nov-14	-2.21	-12.15	-14.34	-16.59	-30.16	88.64	1.40	*0.59*	*6.27*	3.12	*0.60*
Dec-14	-0.09	-11.05	-13.67	-16.31	-26.66	89.06	1.40 [9]	*0.51*	*8.87*	0.33	*0.40*
Jan-15	-0.34	-13.74	-16.50	-19.13	-34.86	85.85	1.9	*0.49*	*5.488*	1.30	*0.431*
Feb-15	2.87	-12.95	-15.93	-18.78	-39.39	84.95	12.7	0.75	10.36	9.06	0.859
Mar-15	5.54	-4.76	-9.83	-14.37	-28.70	70.52	4.1	1.45	12.6	86.48	6.292
Apr-15	10.90	5.36	0.56	-3.89	-10.48	61.71	4.2	1.75	12.37	163.45	16.03
May-15	26.51	16.95	10.96	4.60	-7.00	45.35	1.4	1.89	10.64	246.80	34.67
Jun-15	23.18	16.65	11.37	5.81	0.52	61.05	26.3	1.85	12.62	219.18	26.46
Jul-15	25.43	17.54	12.54	7.72	4.73	68.63	72.4	1.48	12.62	190.74	19.98
Aug-15	24.63	14.03	9.35	5.08	-3.09	75.14	54.9	*1.47*	*9.86*	146.76	*13.87*
Sep-15	13.57	7.07	2.77	-0.72	-7.72	79.33	32.6	1.71	15.64	83.01	10.12
Oct-15	7.32	0.88	-1.78	-4.16	-13.22	89.14	19.4	*1.08*	*10.07*	32.52	*2.92*
Nov-15	0.83	-11.17	-13.75	-17.16	-31.38	89.09	22.8	*0.71*	*12.15*	4.03	*0.60*
Dec-15	0.18	-12.38	-14.60	-16.93	-31.06	89.01	4.0	*4.59*	*14.24*	0.63	*0.13*
Jan-16	1.17	-8.96	-11.14	-13.58	-21.91	88.06	24.9	*0.83*	*15.35*	1.67	*1.45*
Feb-16	2.04	-7.63	-10.94	-14.27	-26.68	82.96	2.3	0.86	9.55	22.80	2.32
Mar-16	12.35	-0.55	-4.96	-8.72	-16.96	73.13	7.1	1.26	8.11	82.81	7.12
Apr-16	13.50	7.12	2.28	-2.23	-12.45	63.20	3.8	1.64	10.66	159.95	15.86
May-16	22.80	13.61	8.44	3.04	-1.59	54.73	14.7	1.89	11.89	210.96	25.97
Jun-16	25.98	18.36	12.88	7.17	2.27	56.52	40.0	1.76	13.37	234.99	29.78
Jul-16	23.73	17.71	13.37	9.07	1.71	73.05	63.4	1.46	12.54	173.59	17.36
Aug-16	24.42	16.67	11.92	7.82	1.22	70.86	42.2	1.50	10.69	152.32	17.72
Sep-16	17.42	10.00	5.01	0.90	-6.18	71.05	28.9	1.50	10.81	100.94	14.02
Oct-16	2.43	-3.20	-7.07	-9.99	-17.15	79.60	11.4	1.12	8.29	50.66	4.15
Nov-16	4.05	-8.20	-10.89	-13.45	-25.46	86.45	7.6	*0.80*	*9.57*	5.70	*1.99*
Dec-16	-4.20	-17.39	-19.62	-21.89	-32.16	83.76	1.3	*0.62*	*8.45*	0.56	*0.51*

Notes: Values in grey italics indicate a partial month

[1]January 2012 has 25 days of complete wind data
February 2012 has 28 days of complete wind data
March 2012 has 30 days of complete wind data
December 2012 has 15 days of complete wind data
January 2013 has 21 days of complete wind data
February 2013 has 26 days of complete wind data
November 2013 has 24 days of complete wind data
December 2013 has 20 days of complete wind data
January 2014 has 9 days of complete wind data
November 2014 has 23 days of complete wind data
December 2014 has 6 days of complete wind data
January 2015 has 24 days of complete wind data
August 2015 has 28 days of complete wind data
October 2015 has 29 days of complete wind data
November 2015 has 9 days of complete wind data
December 2015 has 0 days of complete wind data
January 2016 has 16 days of complete wind data
November 2016 has 23 days of complete wind data
December 2016 has 22 days of complete wind data

[2] June 2011 has 29 days of complete data (station commissioned on June 2)

[3] 16 days of complete rain data

[4] Rainfall recorded at temperatures below zero may be due to snowmelt

[5] 25 days of complete RH data

[6] 18 days of complete solar radiation data

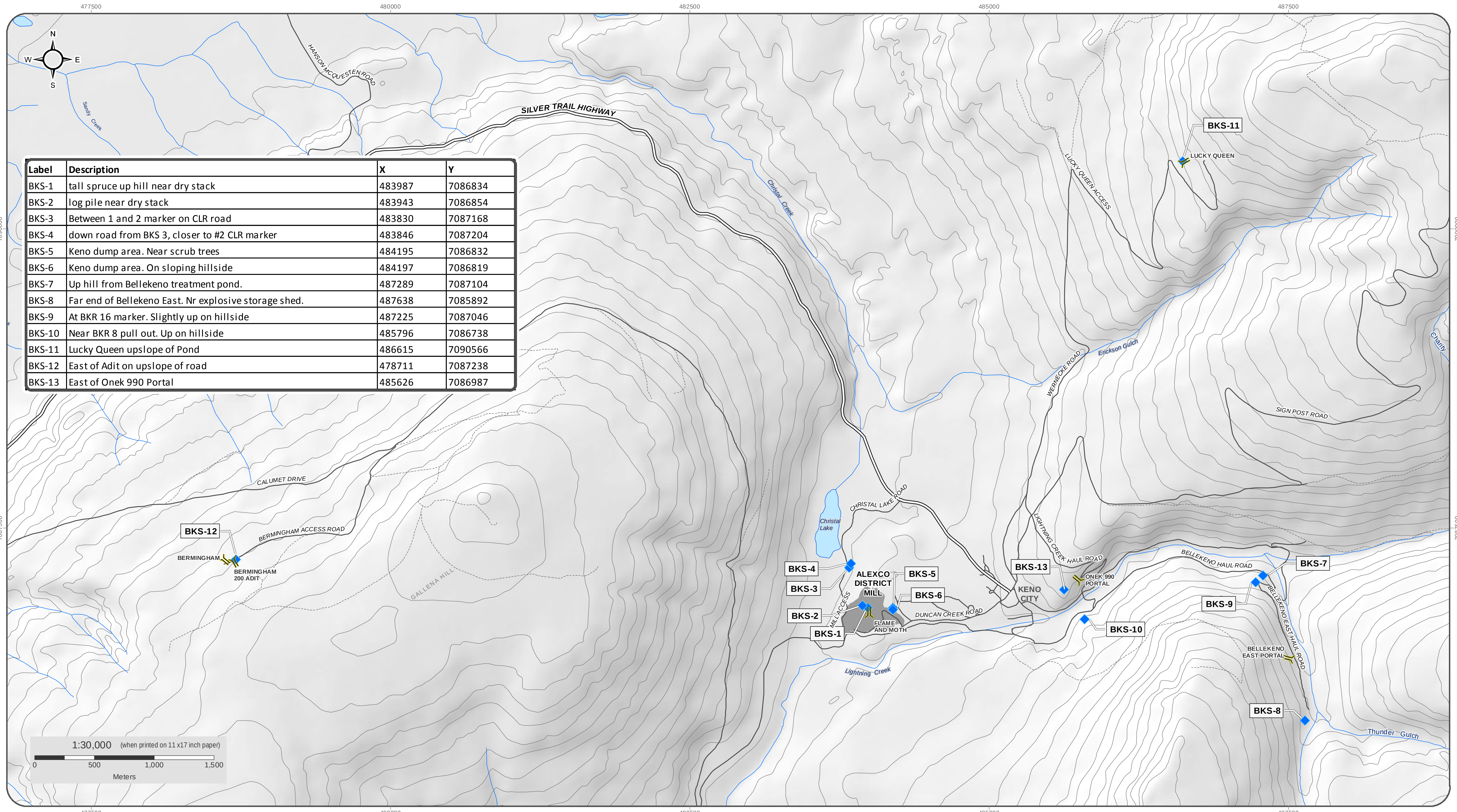
[7] 7 days of complete evapotranspiration data

[8] Evapotranspiration is invalid where wind is invalid

[9]Total precipitation likely underestimated due to partial freezing in snowfall conversion adaptor

Table 8-4: Snow Survey SWE Results (cm)

Station	Description	Jan 2011	Feb 2011	Mar 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013	Jan 2014	Feb 2014	Mar 2014	Apr 2014	Feb 2015	Mar 2015	Apr 2015	Feb 2016	Mar 2016	April 2016
BKS-1	tall spruce up hill near dry stack	7.6	7.6	5.1	6.0	16.1	18.7	8.7	7.3	11.3	13.0	15.0	12.3	14.0	12.3	9.7	8.0	9.3	8.7	4.0	8.7	7.7
BKS-2	log pile near dry stack	7.6	7.6	7.6	12.2	13.6	9.3	20.8	9.3	10.7	11.7	13.8	10.3	10.7	10.0	7.7	9.0	10.3	9.0	8.0	11.0	10.3
BKS-3	Between 1 and 2 marker on CLR road	7.6	10.2	7.6	9.6	12.5	4.4	7.7	7.3	10.0	14.3	14.7	13.0	12.3	11.0	9.7	9.3	7.0	10.7	8.0	9.3	10.7
BKS-4	down road from BKS 3, closer to #2 CLR marker	7.6	7.6	7.6	8.5	17.6	12.3	8.8	9.3	11.7	18.3	14.3	12.7	12.0	11.7	7.3	3.7	8.7	7.3	10.0	8.7	12.3
BKS-5.0	Keno dump area. Near scrub trees	5.1	7.6	5.1	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BKS-5.1	Keno dump area. Near scrub trees	-	-	-	-	11.3	12.2	9.6	6.7	9.7	13.3	13.0	11.0	12.0	10.7	8.7	8.3	10.7	12.0	10.0	8.7	10.7
BKS-6	Keno dump area. On sloping hillside	2.5	2.5	0	11.2	12.6	14.8	19.8	6.7	9.2	12.0	11.3	10.7	10.3	8.7	8.3	7.3	8.7	9.0	8.0	8.0	8.3
BKS-7	Uphill from Bellekeno treatment pond	7.6	10.2	7.6	12.5	13.6	4.8	8.5	6.7	11.0	10.3	13.7	13.3	13.0	13.0	10.0	9.0	12.7	14.0	7.3	7.0	11.3
BKS-8	Far end of Bellekeno East. Nr explosive storage shed	7.6	7.6	5.1	9.9	13.8	17.6	19.5	8.0	10.0	18.5	19.7	9.3	12.7	12.7	10.7	6.7	17.0	12.3	7.3	9.3	-
BKS-9	At BKR 16 marker. Slightly up on hillside	7.6	10.2	10.2	12.4	13.3	17.1	0.00	7.3	10.0	15.0	14.0	12.3	11.7	11.3	9.0	7.7	10.7	8.3	7.3	7.0	0.0
BKS-10	Near BKR 8 pull out. Up on hillside	10.1	7.6	5.1	13.3	16.5	27.7	10.7	9.3	10.0	12.3	14.3	14.0	15.7	14.3	7.0	10.0	10.0	12.0	10.7	6.0	11.7
BKS-11	Lucky Queen, upslope of the pond	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.3	20.7	15.0
BKS-12	East of Bermingham 200 adit, Upslope of road	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.3
Mean	-	7.1	7.9	6.1	10.9	14.1	13.9	11.4	7.8	10.4	13.9	14.4	11.9	12.4	11.6	8.8	7.9	10.5	10.3	8.1	8.4	9.8



Label	Description	X	Y
BKS-1	tall spruce up hill near dry stack	483987	7086834
BKS-2	log pile near dry stack	483943	7086854
BKS-3	Between 1 and 2 marker on CLR road	483830	7087168
BKS-4	down road from BKS 3, closer to #2 CLR marker	483846	7087204
BKS-5	Keno dump area. Near scrub trees	484195	7086832
BKS-6	Keno dump area. On sloping hillside	484197	7086819
BKS-7	Up hill from Bellekeno treatment pond.	487289	7087104
BKS-8	Far end of Bellekeno East. Nr explosive storage shed.	487638	7085892
BKS-9	At BKR 16 marker. Slightly up on hillside	487225	7087046
BKS-10	Near BKR 8 pull out. Up on hillside	485796	7086738
BKS-11	Lucky Queen upslope of Pond	486615	7090566
BKS-12	East of Adit on upslope of road	478711	7087238
BKS-13	East of Onek 990 Portal	485626	7086987

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Quartz claim boundaries current as of February 24th, 2011. Ownership data current as of December 20th, 2010.
Data source: http://geomaticsyukon.ca.

Datum: NAD 83; Map Projection: UTM Zone 8N

- Snow Monitoring Station
- Adit
- District Mill
- Silver Trail Highway
- Other Road
- Limited-Use Road
- Contours (100 ft)
- Watercourse
- Waterbody

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FIGURE 8-1

SNOW SURVEY STATIONS LOCATION

NOVEMBER 2017

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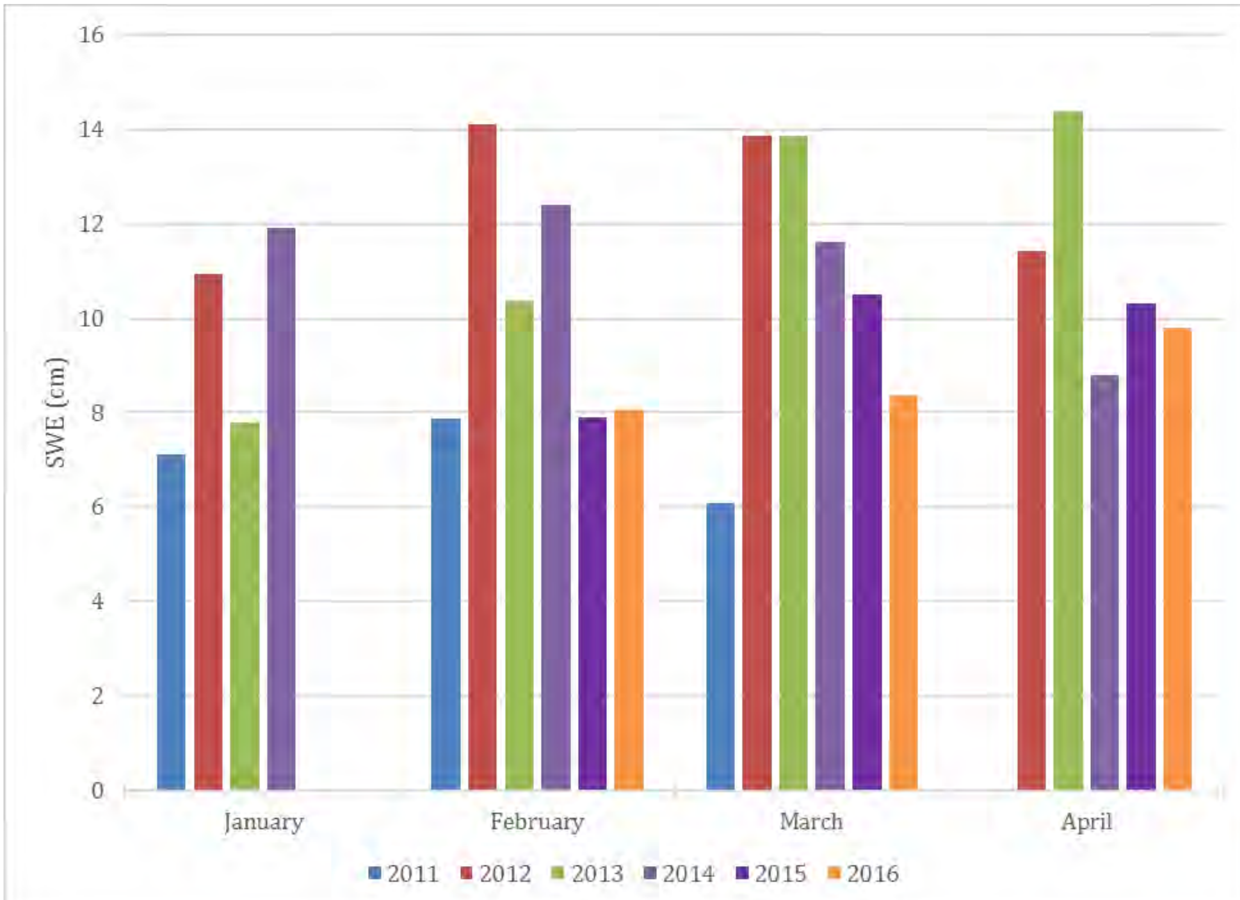


Figure 8-2: Average Snow Water Equivalent across all Snow Survey Stations

8.1.2 Mean Annual Precipitation

Mean annual precipitation (MAP) within a mountainous region typically increases with increasing elevation. The significant relief over which the Keno Hill area spans is well represented by two historical weather stations with Elsa at 814 masl and the Keno Hill weather station at 1472 masl. In 1996, Clearwater Consultants Ltd. used data from these two stations as well as from Environment Canada's station located at Mayo airport (504 masl) to derive a relationship between MAP and elevation. Assuming a linear relationship, a line was fitted to the data of these stations (see Figure 8-3) (Access, 1996). The slope of this line indicates that MAP increases by an average of 27 mm for every 100 m of ascent, a value not too dissimilar from that observed in other regions of the Yukon interior.

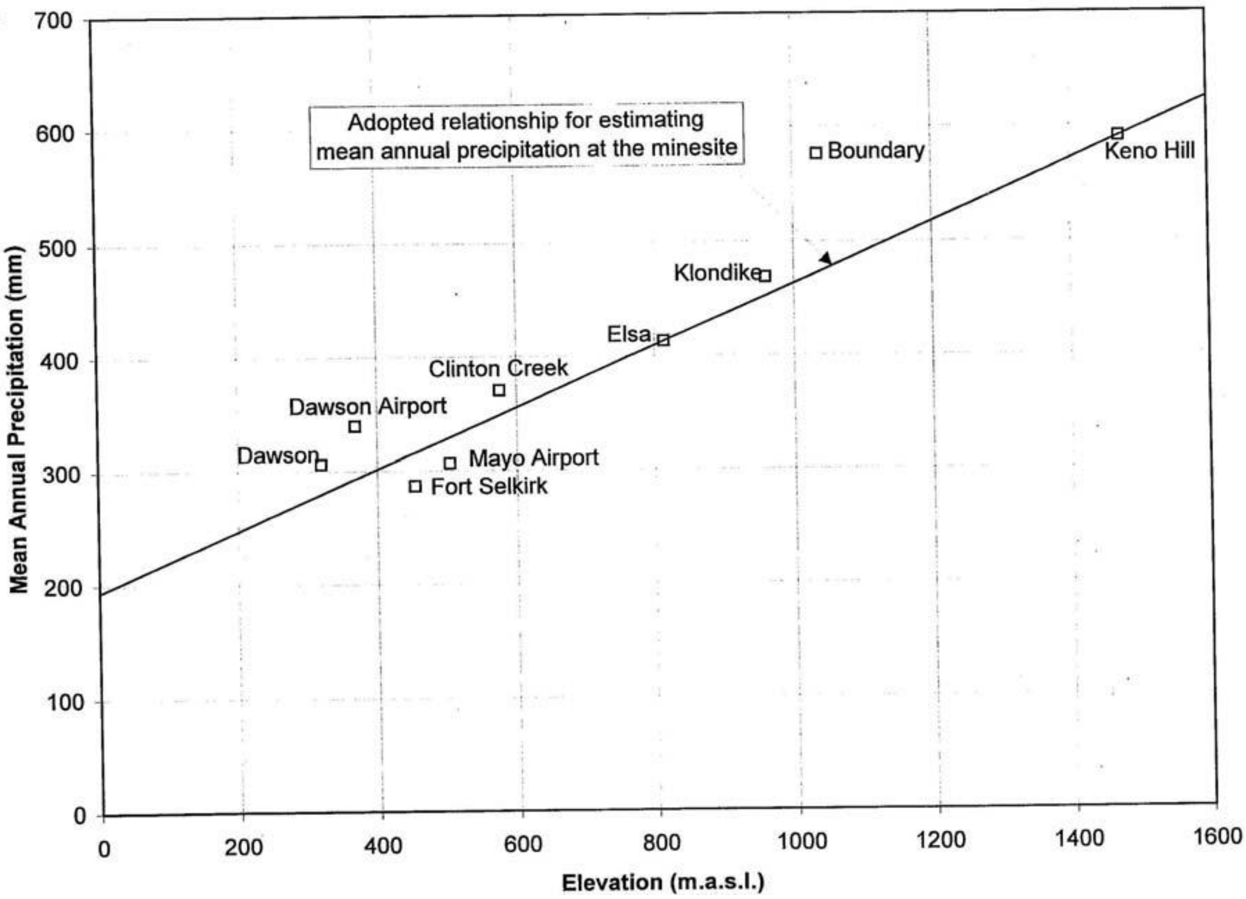


Figure 8-3: Mean Annual Precipitation as a Function of Elevation

As with MAP, the seasonal distribution is influenced by elevation. To demonstrate this influence, the seasonal distributions for Mayo Airport, Elsa, and Keno Hill have been plotted on Figure 8-4, as part of the same assessment conducted by Clearwater Consultants in 1996. The proportion of total precipitation which falls as rain decreases as elevation increases (60% of total precipitation at Mayo Airport, 53% at Elsa, and 41% at Keno Hill). Again, a simple linear relationship can be derived and the slope indicates that the proportion of total precipitation that falls as rain decreases by about 2% for every 100 m ascent.

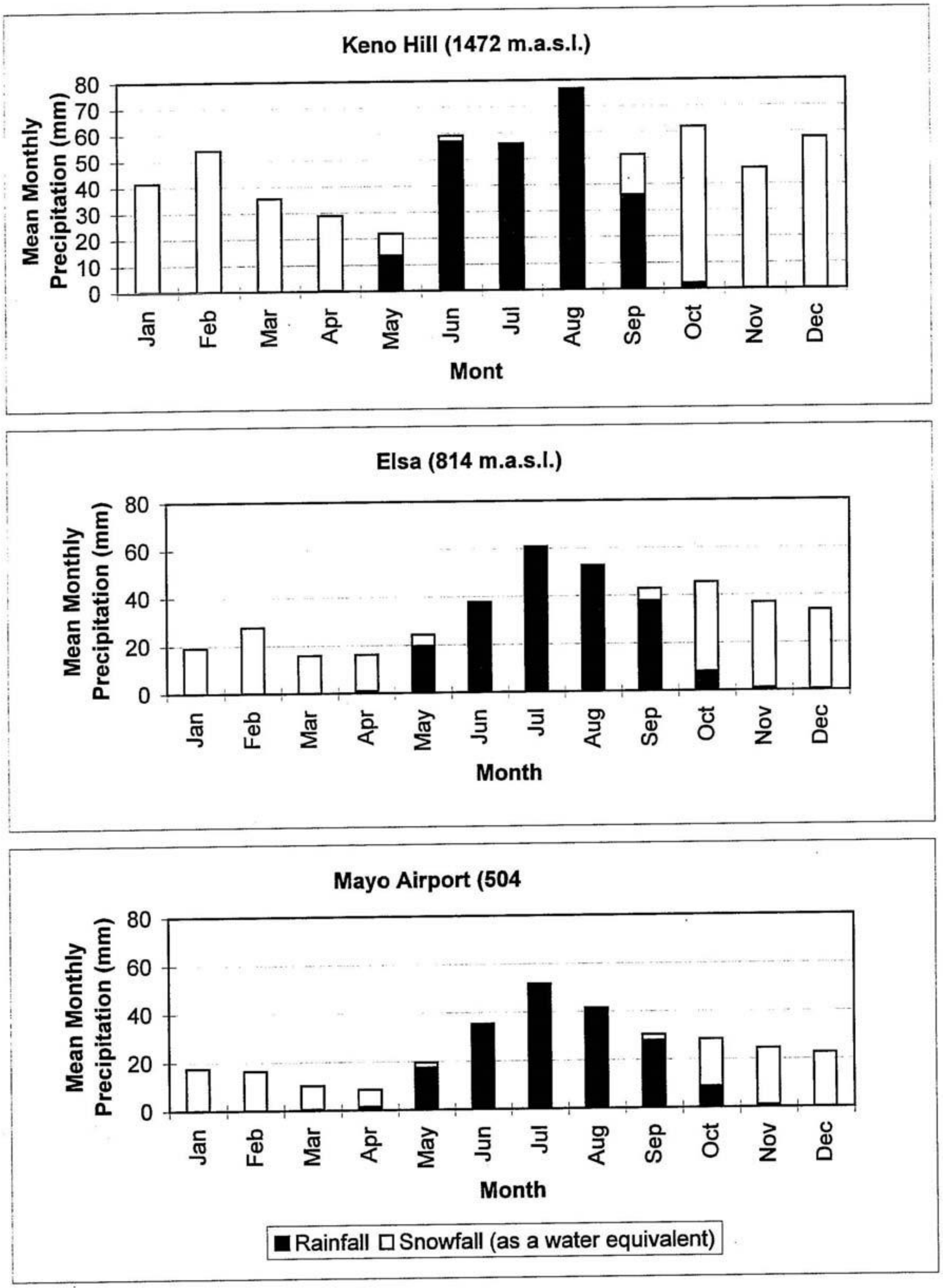


Figure 8-4: Mean Monthly Precipitation

Recent precipitation data from Mayo A, Calumet, District Mill and the Valley Tailings weather stations were used to verify the empirical relationships presented above. Validated precipitation data at Mayo A are available until the end of 2016, with the exception of the year 2013, which is missing, therefore, the common periods with Calumet station (2007-2016), with the District Mill station (2012-2016) and the Valley Tailings (2014-2016) were used for this comparison. Mayo A reports both rain and total precipitation, while Galena Hill and the Valley Tailings weather stations record rainfall only. The District Mill weather station recorded rainfall only in 2012 and 2013 and total precipitation in 2014 and 2015. Table 8-5 presents the proportion of total precipitation that fell as rain for the 2007-2016 period at Mayo A.

Table 8-5: Annual Precipitation at Mayo A, 2007-2015

	Total Rain (mm)	Total Snow (cm)	Total Precipitation (mm)	% rain
2007	217.2	188.4	345.8	62.8
2008	309.3	157.8	429.3	72.0
2009	186.9	181.6	304.3	61.4
2010	198.1	129.8	293.7	67.4
2011	329.5	164.9	452.9	72.8
2012	171.7	158.4	276.1	62.2
2013	n/a			
2014	259.4	69.4	376.3	68.9
2015	133.9	123.5	393.4	34.0
2016	245.5	124.2	316	77.7
AVG	**227.9**	**144.2**	**354.2**	**64.4**

For this 9-year period, the average proportion of total precipitation that fell as rain was 64.4%, which is slightly higher than the original estimate of 60%. Since the value of 60% was estimated using data collected between 1974 and 1982, it is possible that the proportion of total precipitation falling as rain has increased with the warming temperature trend. Figure 8-5 shows the temperature trend at Mayo A since 1925; maximum, minimum and mean temperatures recorded over the 1925 to 2010 time period all show an increasing trend.

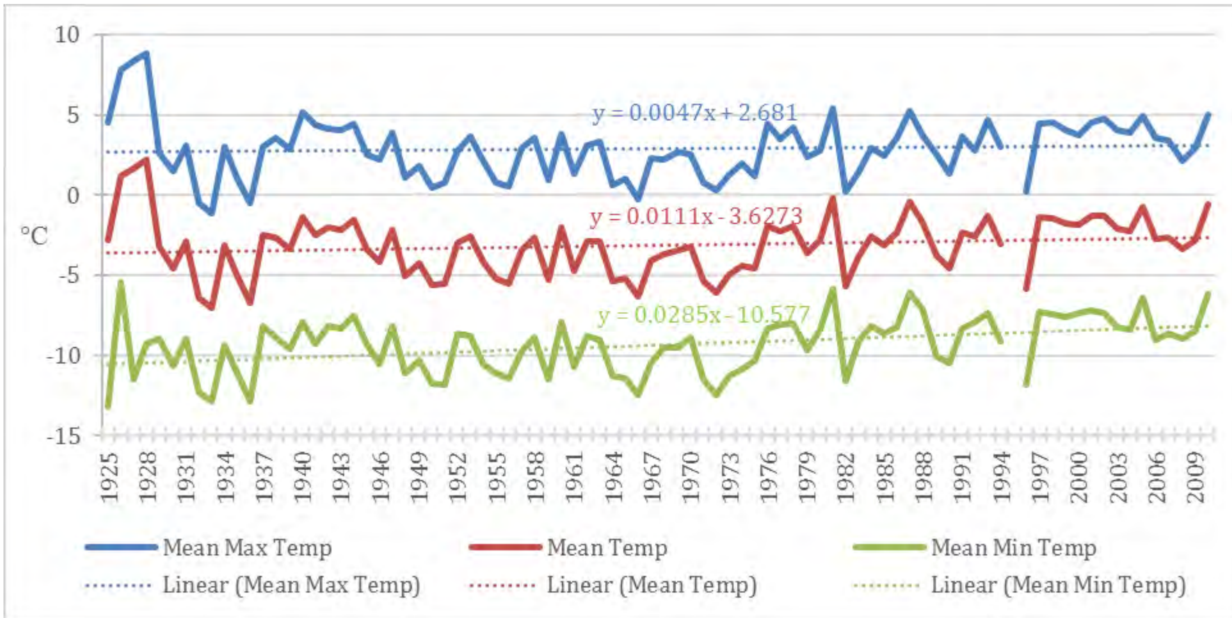


Figure 8-5: Mayo A Annual Temperatures, 1925-2010

Assuming the empirical linear relationship where the proportion of total precipitation that falls as rain decreases by about 2% for every 100 m ascent, it is expected that 45.2% of total precipitation falls as rain at Calumet, 54.1% at the District Mill and 58.4% at the Valley Tailings station. Since total precipitation was not measured at Galena Hill, Valley Tailings nor at the District Mill in 2012, this assumption was used to verify the linear relationship between MAP and elevation developed by Clearwater. Based on Mayo A annual total precipitation from 2007 to 2016 (Table 8-5), predicted total rainfall is compared to total rainfall measured at Galena Hill and the District Mill (Table 8-6). Note that Galena Hill observed rainfall data for 2016 are largely incomplete (see Table 8-1 for details) and that year was therefore not included in the comparison below.

Table 8-6: Predicted Versus Measured Total Rain (mm)

Year	Predicted Annual Total Precipitation (mm)	Predicted Total Rain (mm)	Measured Total Rain (mm)	Actual – Predicted (mm)	Difference (%)
Calumet (1380 masl)					
2007	582.3	263.1	*276.4*	13.3	4.8
2008	665.8	300.8	363.6	62.8	17.3
2009	540.8	244.3	*196.4*	-48.0	-24.4
2010	530.2	239.6	462.2	222.7	48.2
2011	689.4	311.5	*305.5*	-6.0	-2.0
2012	512.6	231.6	*137.0*	-94.6	-69.0
2013	n/a				
2014	612.8	276.9	264.4	-12.5	-4.7
2015	629.9	284.6	*339.7*	55.1	16.2

Year	Predicted Annual Total Precipitation (mm)	Predicted Total Rain (mm)	Measured Total Rain (mm)	Actual – Predicted (mm)	Difference (%)
AVG	**595.5**	**269.0**	**293.1**	**24.1**	**-1.7**
District Mill (936 masl)					
2012	419.5	226.8	217.5	-9.3	-4.3
2013	n/a				
2014	519.7	n/a	292.6**	-227.1	-77.6
2015	536.8	n/a	296.9**	-239.9	-80.8
2016	459.4	n/a	277.7**	-181.7	-65.4
AVG	**483.8**	**226.8**	**271.2**	**-164.5**	**-57.0**
Valley Tailings (718 masl)					
2014	460.8	269.2	*112.4*	-156.8	-139.5
2015	477.9	279.2	272.2	-7.0	-2.6
2016	400.5	234.0	226.6	-7.4	-3.3
AVG	**446.4**	**260.8**	**203.7**	**-57.1**	**-48.4**

**Values in grey italics indicate a partial total*
*** Measured total precipitation, corrected for winter undercatch and wind deflection*

Note that some years have incomplete rain data at Calumet (refer to Table 8-1 for specific details) and Valley Tailings, and this could explain the negative difference between actual and predicted rainfall in 2009 and 2012 at Calumet and 2014 at the Valley Tailings. In other cases however, the difference is positive even though the Calumet data set in incomplete (e.g. 2015). For the three years where the Calumet dataset is complete, the difference between actual and predicted total rainfall is positive for 2008 and 2010, and negative for 2014. The average difference between actual and predicted for those three years is positive (20.2%), implying that the linear relationship between MAP and elevation developed by Clearwater might underestimate total precipitation increase with elevation. A confounding factor is the assumed relationship between the proportion of total precipitation that falls as rain and elevation, which may also need to be refined. At the Valley Tailings station, the 2015 and 2016 dataset are complete and actual versus predicted rainfall are relatively similar (-2.6% and -3.3% difference respectively).

In the case of the District Mill, there is good agreement between predicted and measured total rain for the year 2012. In 2014, 2015 and 2016 however, comparison is made for total precipitation since a snowfall conversion adaptor was installed in 2013. In that case, the measured amount is considerably less than the predicted amount, indicating probable under catch of the snowfall conversion adaptor. Literature reports a cumulative winter catch efficiency of 0.66 for a Campbell Scientific TE525 tipping bucket gauge with a CS705 snow fall adaptor and alter screen (MacDonald and Pomeroy, 2007). Total precipitation data (2014-2016) from October through April were therefore corrected using this factor. Also, because the use of an alter screen for wind deflection has a documented improvement of 10 to 16% in snow collection efficiency and 6% to 10% for all types of precipitation (Belfort Instrument, 2013), average correction factors of 8% and 13% for summer and winter months respectively were applied to precipitation data collected prior to the installation of the alter screen in June 2015. Corrected total precipitation data are still below the values predicted from the MAP-elevation relationship, suggesting that the snowfall undercatch might be greater at this site than the average value reported in the literature, or that there is uncertainty in the MAP-elevation relationship. Refinement of the MAP-elevation relationship derived by Clearwater will be possible as more years of data become available at Galena Hill and at the District Mill, and as total precipitation data become available at the District Mill weather station.

8.2 SURFACE WATER HYDROLOGY AND WATER QUALITY

The Bermingham Portal and associated infrastructure is in the No Cash Creek Catchment. The No Cash Creek is situated on the northwest slope of Galena Hill and flows down the hillside towards the wetlands northeast of Flat Creek. There is no direct connection between No Cash Creek and either Flat Creek or the South McQuesten River as No Cash Creek ends in a bog. From the headwaters on Galena Hill to dispersion in the bog, the distance is roughly 2.3 km. There is one routine sampling station on No Cash Creek, located just above the Silver Trail Highway (KV-21). Located within the No Cash Creek catchment are the Bermingham 200 adit (KV-18), Ruby 400 (KV-19) and No Cash 500 (KV-20) adit discharges. The monitoring stations currently monitored for the KHSD and Project area are shown on Figure 5-3 and Figure 8-7, respectively.

A field program was carried out during 2010 and 2011 on No Cash Creek and the No Cash bog to assess the natural attenuation processes occurring which currently aid in treatment of water in the No Cash Creek catchment. A number of additional sites were monitored within the No Cash Creek catchment to carry out this study. Interralogic Inc. (ITL) presented preliminary results for this program in 2010 (ITL, 2010), an updated report exhibiting the state of knowledge for attenuation in No Cash Bog in 2012 (ITL, 2012), and a finalized summary report in 2013 (ITL, 2013).

ITL observed that natural attenuation processes operate along the reach of No Cash Creek where cadmium and zinc concentrations decrease by 98% or more by the terminal pond of No Cash Bog. The majority of the metal load removal (>90%) occurs on the hillside before No Cash Creek reaches the flatter bog area where oxidative processes act to precipitate iron and manganese oxyhydroxides which scavenge cadmium and zinc from solution via co-precipitation and adsorption (ITL, 2013).

Further detailed mineralogical studies using electron microscopic and synchrotron-based X-ray analyses by Gault et al. (2013) have indicated that zinc is primarily associated with iron (oxyhydr)oxides, calcite ($CaCO_3$), and organic material in samples from the No Cash Bog reach of No Cash Creek and only a small proportion of zinc was identified as sphalerite ((Zn,Fe)S) in No Cash Bog sediment samples (Gault et al., 2013; ITL, 2013). Thus, zinc removal is primarily via sorption and co-precipitation processes and precipitation as sulphides is relatively minor. While the exact nature of cadmium sequestration could not be identified, a strong correlation between observed cadmium and zinc suggests cadmium is sequestered by similar processes (Gault et al., 2013).

8.2.1 No Cash Creek

No Cash Creek flows just northeast of the former townsite of Elsa and has a catchment area of ~1.4 km^2 at the Silver Trail Highway (KV-21). The median elevation is ~1,212 masl and includes the No Cash 500 adit (KV-20), which is free draining. In June of 2015, AEG Whitehorse personnel installed a V-notch weir to garner reliable continuous data, which the hydrographs for 2015 and 2016 are presented in Appendix L. Table 8-7 shows the discrete measurements gathered to date at KV-21 and the mean monthly discharge for 2015 and 2016 based on the continuous record.

Table 8-7: Discrete Discharge measurements at KV-21, No Cash Creek at the Silver Trail Highway (m^3/s)

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2007							0.015					
2008								0.007				
2009							0.003			0.006		
2010					0.010	0.008	0.007			0.008		
2011					0.020		0.005	0.011				
2012		0.002					0.012					
2013									0.016	0.017	0.004	
2014					0.058	0.005	0.005	0.011	0.026	0.013	0.007	
2015	0.003			0.002	0.244	0.011			0.035	0.017	0.002	0.010
2016	0.005	0.004	0.006	0.003	0.049	0.016	0.022	0.045	0.025	0.010	0.006	0.006
Mean	0.004	0.003	0.006	0.002	0.076	0.010	0.010	0.019	0.026	0.012	0.005	0.008
95% Confidence limit	0.002	0.002	N/A	0.001	0.084	0.005	0.005	0.018	0.008	0.004	0.002	0.004

Table 8-8: Mean Monthly Discharge at KV-21, No Cash Creek at the Silver Trail Highway (m^3/s)

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2015						0.010	0.017	0.020	0.027	0.016	0.004	0.008
2016	0.005	0.004	0.005	0.01	0.044	0.017	0.019	0.019	0.019			
Mean	0.005	0.004	0.005	0.010	0.044	0.014	0.018	0.020	0.023	0.016	0.004	0.008

The discrete measurements collected in 2016 for KV-18, KV-19, KV-20 and KV-21 are presented below in Table 8-9.

Table 8-9: 2016 Discrete Discharge Measurements for No Cash Creek Catchment Stations

Station ID	Description	Sample Date	Discharge (L/s)
KV-18	Bermingham 200 Adit	05/01/2016	2
		03/02/2016	2.4
		05/03/2016	1.3
		07/04/2016	1.1
		05/05/2016	1.3
		15/06/2016	2.8
		14/07/2016	2.9
		08/08/2016	9.9
		24/09/2016	3.8
		20/10/2016	2.7
		11/11/2016	1.8
		03/12/2016	6.9

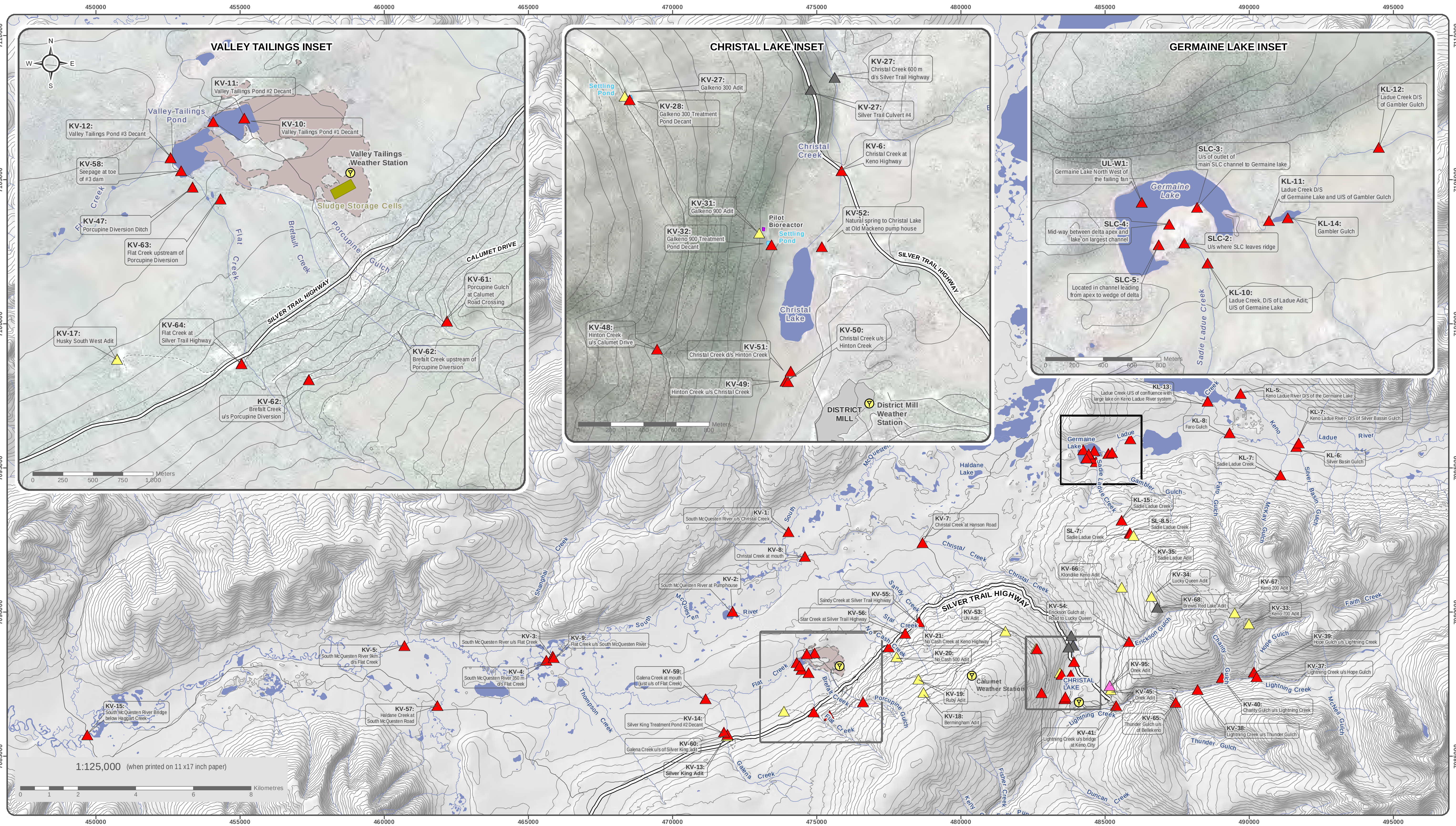
Station ID	Description	Sample Date	Discharge (L/s)
KV-19	Ruby 400 Adit	05/01/2016	4
		03/02/2016	2.8
		05/03/2016	2.7
		07/04/2016	2.1
		05/05/2016	2.8
		15/06/2016	1.3
		15/07/2016	2.3
		08/08/2016	2.8
		24/09/2016	3.1
		20/10/2016	2.9
		11/11/2016	2.9
		01/12/2016	9.2
KV-20	No Cash 500 Adit	09/01/2016	10.3
		03/02/2016	4.9
		05/03/2016	4.1
		07/04/2016	3
		05/05/2016	4.4
		14/06/2016	10
		17/07/2016	10.7
		05/08/2016	13.5
		23/09/2016	11.5
		23/10/2016	8.8
		11/11/2016	5.5
KV-21	No Cash Creek u/s Silver Trail Highway	09/01/2016	5.4
		01/02/2016	3.6
		06/03/2016	5.8
		05/04/2016	2.7
		04/05/2016	48.9
		16/06/2016	16.2
		15/07/2016	21.6
		06/08/2016	45.2
		23/09/2016	25.1
		23/10/2016	10.2
		10/11/2016	5.8
		01/12/2016	6.2

Surface water quality monitoring has been ongoing in the No Cash Creek catchment with regular monitoring occurring at the Bermingham 200 adit (KV-18), Ruby 400 (KV-19), No Cash 500 (KV-20) and No Cash Creek at Silver Trail Highway (Appendix M) (Figure 8-7). Four samples were collected from No Cash Creek (KV-21) in 2016 and summary statistics for total zinc and cadmium are presented in Table 8-10. The water quality in No

Cash Creek at KV-21 (Appendix M) is dominated by the water quality discharge from the No Cash 500 adit and the natural attenuation processes occurring in this section of the Creek. The Bermingham 200 adit discharge is not a significant loading source in the No Cash Creek Catchment.

Table 8-10: Summary Statistics for No Cash Creek (KV-21) at Silver Trail Highway

Zinc, total	**2016**	**2007 - 2016**
Average	2.37	1.80
Count	4	61
Minimum	0.903	0.365
Maximum	3.64	8.39
Geometric Mean	2.08	1.46
Count <DL	0	0
Standard Deviation	1.24	1.36
1st Quartile	1.60	0.92
Median	2.47	1.22
3rd Quartile	3.24	2.06
Count > Guideline	4	61
% > Guideline	100	100
Cadmium, total	**2016**	**2007 - 2016**
Average	0.0219	0.0162
Count	4	61
Minimum	0.0084	0.0016
Maximum	0.0332	0.1070
Geometric Mean	0.0187	0.0117
Count <DL	0	0
Standard Deviation	0.01296	0.0161
1st Quartile	0.0120	0.0067
Median	0.0230	0.0108
3rd Quartile	0.0329	0.0194
Count > Guideline	4	59
% > Guideline	100	97



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Datum: NAD 83; Map Projection: UTM Zone 8N

- Adit Water Quality Station, Active
- Surface Water Quality Station, Active
- Surface Water Quality Station, Pending
- Water Quality Station, Decomissioned
- Weather Station
- Sludge Storage
- Valley Tailings
- District Mill
- Silver Trail Highway
- Other Road
- Limited-Use Road

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FIGURE 8-6

SURFACE WATER QUALITY STATION LOCATIONS

NOVEMBER 2017

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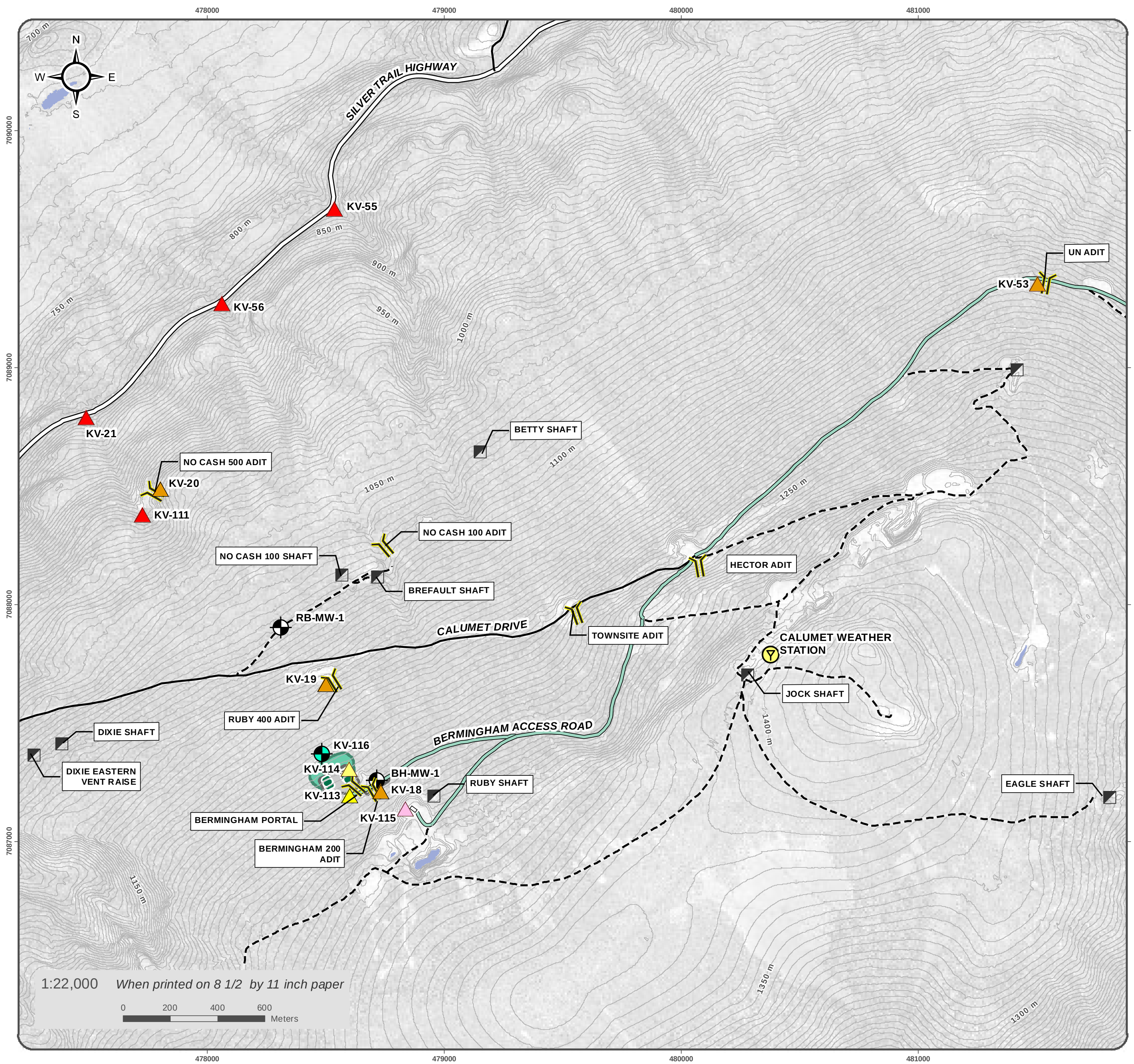
FIGURE 8-7

WATER QUALITY MONITORING LOCATIONS WITHIN PROJECT AREA

NOVEMBER 2017



Adit/Portal
Shaft
Weather Station
Surface Water Quality Station, Existing
Surface Water Quality Station, Proposed
Adit Water Quality Station, Existing
Adit Water Quality Station, Proposed
Groundwater Quality Monitoring, Existing
Groundwater Quality Monitoring, Proposed
Proposed Mine Infrastructure Footprint
Permitted Mine Infrastructure Footprint
Proposed Road Upgrades
Silver Trail Highway
Road
Limited-Use Road
Contour (5m interval)

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Datum: NAD 83; Map Projection: UTM Zone 8N

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8.2.2 Bermingham 200 adit

The Bermingham 200 adit is located on the northwest side of Galena Hill, approximately 1.5 km up the switchback located at the Hector adit. The Bermingham 200 adit is connected with the historic Bermingham open pit and drains water that enters it, but not the Bermingham SW open pit. As seen in Figure 8-8, zinc concentrations peak during July typically around 3 to 4 mg/L, however the peaks in 2015 and 2016 have been less than 3 mg/L. Minimum concentrations are observed to occur during baseflow prior to spring freshet in the 0.5 mg/L to 1.5 mg/L range. The peak zinc concentrations in 2016 at Bermingham 200 adit discharge is 2.76 mg/L in October, which is the lowest peak for this data record. Cadmium concentrations show a similar trend as zinc, with a peak concentration in 2016 of 0.110 mg/L in September.

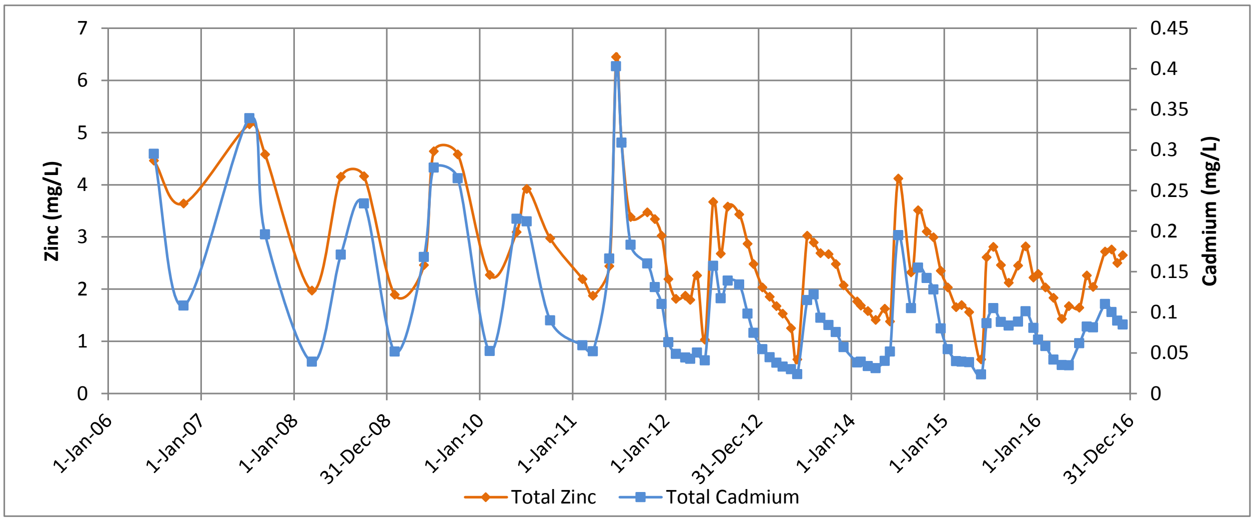


Figure 8-8: Zinc and Cadmium Concentrations at Bermingham 200 Adit, 2006-2016

The Bermingham 200 Adit discharge has a median flow of 2.1 L/s while the 2016 median was a little higher at 2.55 L/s. The Bermingham 200 Adit discharge from 2006-2016 is presented in Table 8-9 and Figure 8-9. The Bermingham 200 adit discharge since 2014 has been greater than the proposed 70 m^3/day (0.81 L/s) of water use.

Sulphate concentrations in the discharge from Ruby 400 and Bermingham 500 adits are considerably lower than No Cash 500 adit, averaging about 40 mg/L and 120 mg/L, respectively, compared to an average of 450 mg/L from the No Cash adit. The seasonal behaviour is also distinct, with sulphate concentrations at Ruby and Bermingham relatively constant throughout the year, in contrast with concentrations at No Cash adit that vary seasonally from about 300 mg/L in the summer to about 600 mg/L in the winter. The seasonal variation at the station slightly downstream from the adit (KV-21) was more pronounced with concentrations varying seasonally from about 100 mg/L in the spring to about 600 mg/L in the winter. The high concentrations in the winter do not appear to be due to groundwater loading for the following reasons:

- Groundwater concentrations are much lower than the adit discharge (130 to 230 mg/L); and
- Winter concentrations at KV-21 are comparable to adit discharge.

Dissolved zinc concentrations at KV-21 on No Cash Creek were significantly lower than those in the No Cash 500 adit discharge, located approximately 500 m upstream. This is due to natural attenuation processes that serve to lower the zinc and cadmium concentration along the reach of No Cash Creek such that greater than 99% load reduction is observed in the lower reach of No Cash Creek (ITL, 2013 and references therein).

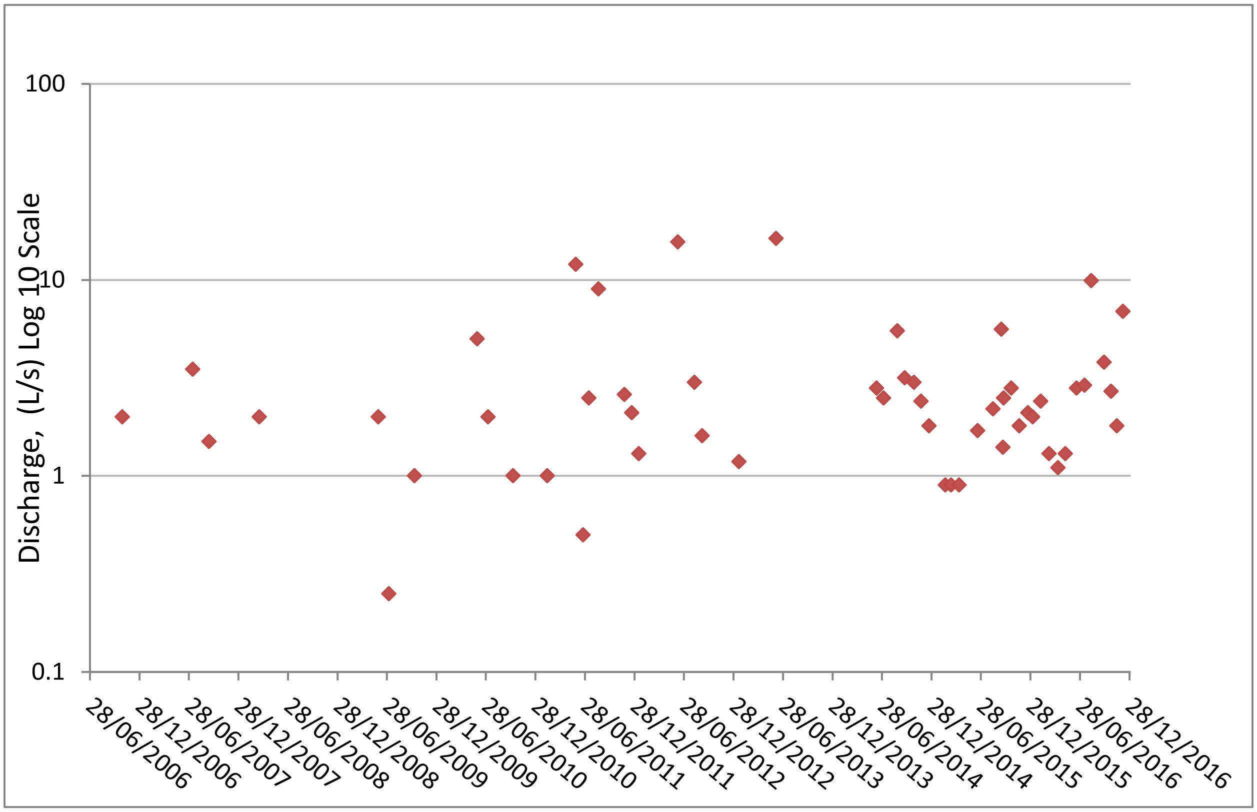


Figure 8-9: Bermingham 200 Adit (KV-18) Discharge (L/s), 2006-2016

8.3 GROUNDWATER QUALITY

Groundwater around the Bermingham project has been studied and understood over the last several years as part of previous assessments and licensing of the Elsa Reclamation and Development Company (ERDC) Care and Maintenance activities (QZ12-057). Groundwater Flow Direction is to the northwest following the contours of Galena Hill (Figure 8-13).

The bedrock geology for the Ruby mine area includes quartzite and graphitic schist. The mine is on the upper slopes of Galena Hill and therefore the overburden is till like material. Monitoring Well RB-MW-1 (Figure 8-7 and Figure 8-13), drilled downslope from Ruby 400 adit intersected sand and gravel with some silt and silt and sand with some gravel (till-like). Graphitic schist was encountered at a depth of 12.2 m. The RB-MW-1 well screen was installed at the base of the overburden and top of rock. The water level in the well ranged from

2.5 mbgs to 7.0 mbgs within the overburden. The groundwater flowpath at Ruby is primarily in the upper bedrock.

Bermingham Mine is located up gradient from the Ruby Mine and is drained by the Bermingham 200 adit, which is located at an elevation of 1,255 masl. The Bermingham 200 adit is near the plateau area of Galena Hill, which limits the available gradient towards the mine opening and there is some recharge from the overlying pit. The bedrock geology for Bermingham area includes quartzite and graphitic schist. The mine is on the upper slopes of Galena Hill and therefore the overburden is till-like material. Monitoring Well BH-MW-1, drilled downslope from Bermingham 200 adit intersected 2.8 m waste rock with gravel over quartzite and Graphitic schist. The well screen was installed in bedrock from 17.8 mbgs to 21.3 mbgs. The water level in well BH-MW-1 ranged from 14.1 mbgs to 15.8 mbgs within the bedrock. The groundwater aquifer at Bermingham is primarily in the upper bedrock.

The groundwater quality monitored in the Bermingham (BH-MW-1) and Ruby (RB-MW-1) monitoring wells in the No Cash Creek Catchment show the local groundwater quality has not been impacted by historic mining activities. The groundwater monitoring data for these wells is presented in Appendix M. The summary statistics for dissolved zinc and cadmium are presented in Table 8-11 and Table 8-12., respectively. The dissolved cadmium, zinc and geodetic groundwater levels are presented in Figure 8-10, Figure 8-11 and Figure 8-12, respectively.

Table 8-11: No Cash Catchment Groundwater Wells Dissolved Cadmium Summary Statistics, 2013-2016

	BH-MW-1	RB-MW-1
Average (mg/L)	0.00017	0.00009
Count	15	14
Minimum (mg/L)	0.0000382	0.0000106
Maximum(mg/L)	0.000517	0.000728
Geometric Mean (mg/L)	0.00013	0.00004
Count <DL	0	0
Standard Dev. (mg/L)	0.0001236	0.0001829
1st Quartile (mg/L)	0.00008	0.00002
Median (mg/L)	0.00014	0.00003
3rd Quartile (mg/L)	0.00022	0.00007
# Over Guideline	3	1
% Over Guideline	20%	7%

Table 8-12: No Cash Catchment Groundwater Wells Dissolved Zinc Summary Statistics, 2013-2016

	BH-MW-1	RB-MW-1
Average (mg/L)	0.0179	0.00895
Count	15	14
Minimum (mg/L)	0.0084	0.0025
Maximum (mg/L)	0.0258	0.0488
Geometric Mean (mg/L)	0.01697	0.00609
Count <DL	0	0
Standard Dev. (mg/L)	0.005364	0.0115
1st Quartile (mg/L)	0.014	0.00355
Median (mg/L)	0.0167	0.00495
3rd Quartile (mg/L)	0.0234	0.00975
# Over Guideline	0	1
% Over Guideline	0%	7%

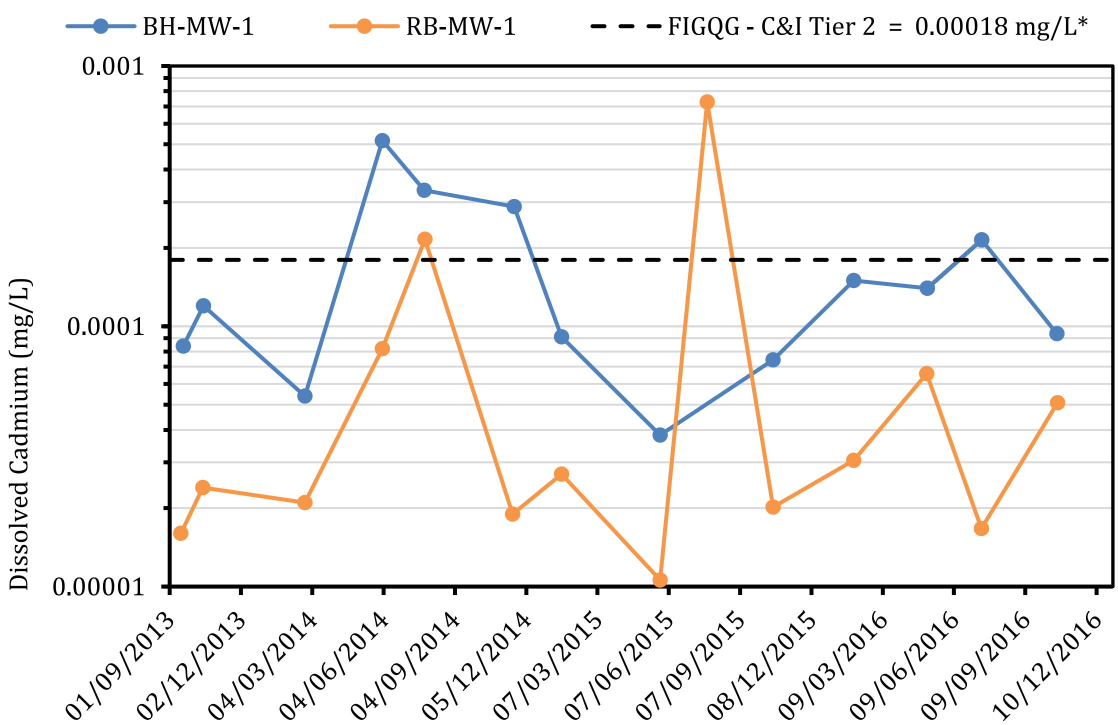


Figure 8-10: Dissolved Cadmium (mg/L) in No Cash Creek Catchment Wells

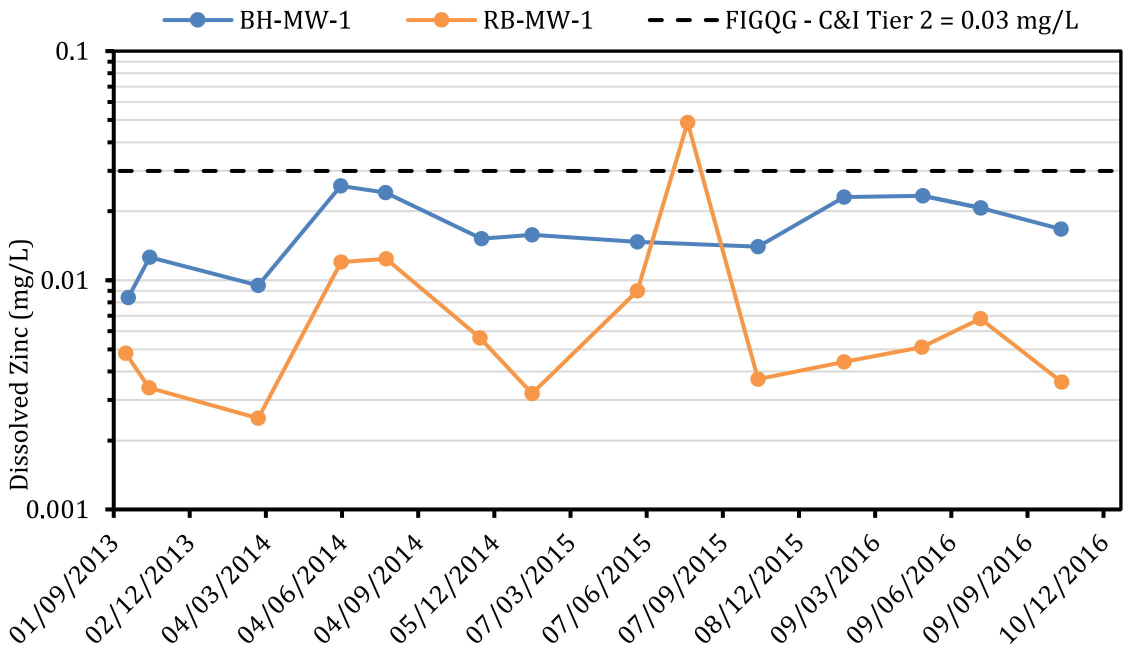


Figure 8-11: Dissolved Zinc (mg/L) in No Cash Creek Catchment Wells

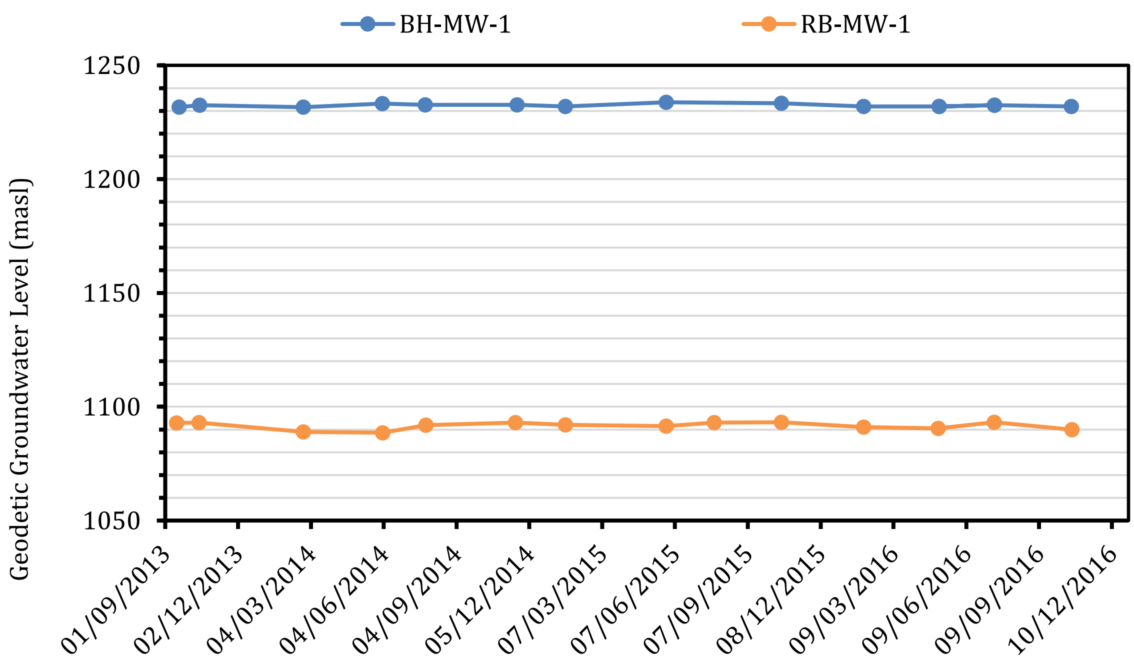
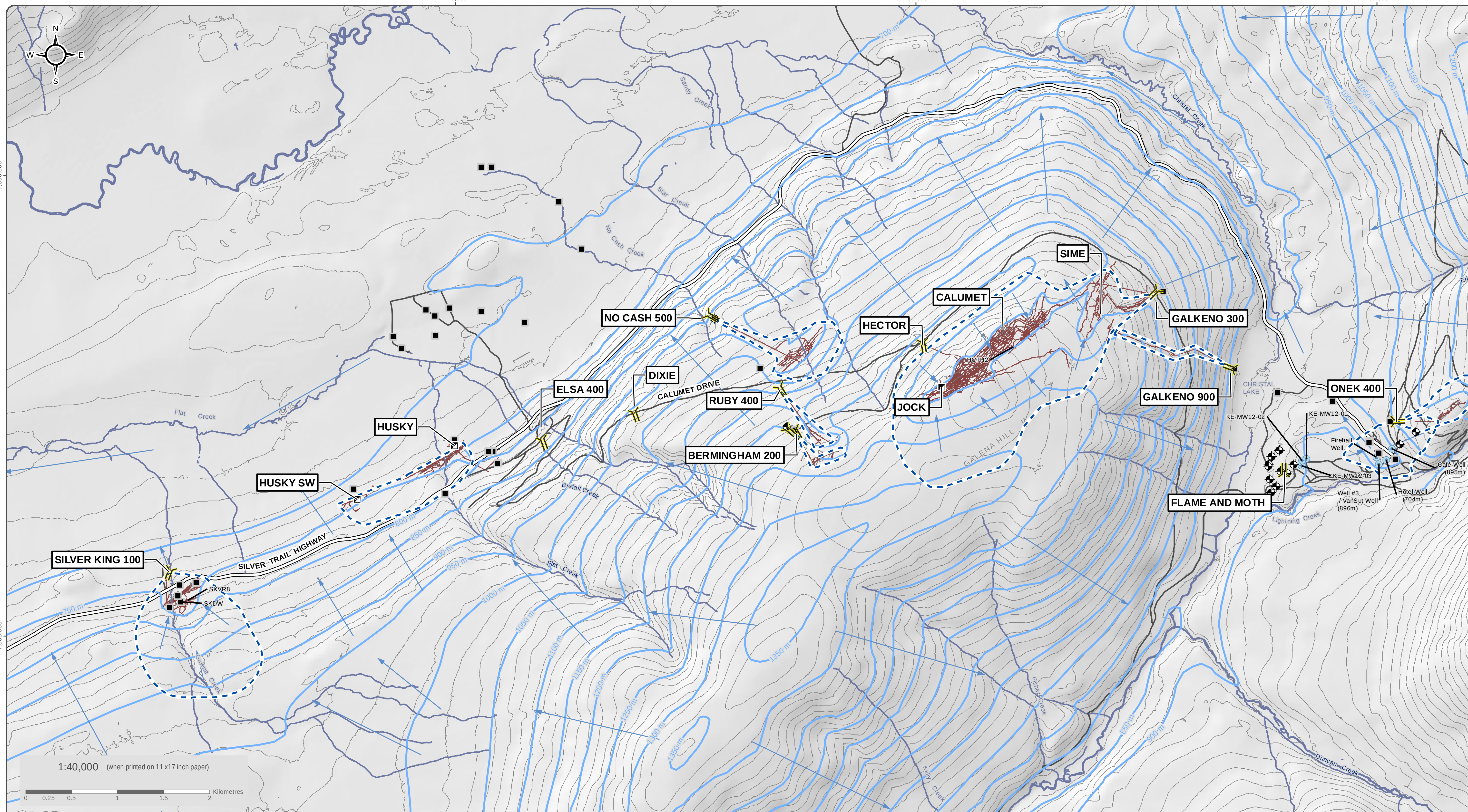


Figure 8-12: Groundwater Level (masl) in No Cash Creek Catchment Wells



475,000 480,000 485,000

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Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on November 2017

Datum: NAD 83; Map Projection: UTM Zone 8N

- Alexco Monitoring Well
- ERDC Monitoring Well
- Mine Pool Well
- Private Drilled Well
- Public Drilled Well
- Adit
- Shaft
- Underground Mine Workings
- Groundwater Flow Direction
- Groundwater Contour (50m Intervals)
- Groundwater Catchment
- Waterbody
- Watercourses
- Silver Trail Highway
- Secondary Road
- Contours

* Only showing mine sites referenced in document

* * Depth to water table displayed in MASL when used for contour interpretation

ERDC

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FIGURE 8-13

GALENA HILL CONCEPTUAL GROUND WATER TABLE

NOVEMBER 2017

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8.4 WATER MANAGEMENT

8.4.1 Water Management

The proposed Bermingham underground development and production will require up to 141.1 m^3/day, which includes a contingency of 25%. Daily water usage during ongoing underground mine development and operation is estimated at 112.1 m^3/day when mining at an estimated maximum rate of 400 tpd. This water will be used to support activities including percussion drilling, dust suppression, equipment cooling and minor use for sanitation. The site infrastructure and water management structures for Bermingham are shown on Figure 8-14.

To the greatest degree possible, reused process water from the underground workings will be the primary source of water for Bermingham mine. This water will be supplemented by water sourced from groundwater encountered in the underground workings and any additional water initially will be sourced from a groundwater well. Water will be pumped out of the workings into the proposed water treatment plant which includes a settlement pond. There it will be treated via the proposed water treatment plant to meet the proposed standards. Water will then be discharged to a receiving pond prior to being discharged to ground. The overall Bermingham Mine water management schematic is presented in Figure 8-14.

Variations in water quality in the reused water from the underground workings may necessitate using treated water from the proposed water treatment plant in addition to the reuse of water from underground. For example, poor settling of suspended solids in the underground sumps may limit the use of this water with equipment due to potential damage of mechanical systems. Makeup water could then be sourced from groundwater well or the proposed water treatment plant in this situation.

In terms of protocols and decision-making, the Mine Manager is the primary person responsible for determining if certain scenarios would require alternative water sources. In conjunction with Alexco Environmental Group support professionals, the decision would then be made to withdraw water from a groundwater well or use water from the proposed water treatment plant.

A diversion ditch has been excavated up gradient of the Bermingham portal (Figure 8-14) and will be extended as the project advances. The purpose of this ditch is to divert surface water runoff from above the portal from reaching the portal pad and associated infrastructure, including the proposed pond. The surface water to be managed is intended to be minimal at the portal site (1237 masl) and is designed to accommodate the 24 hour maximum rain event of 38.9 mm which was calculated for an elevation of 1250 masl.

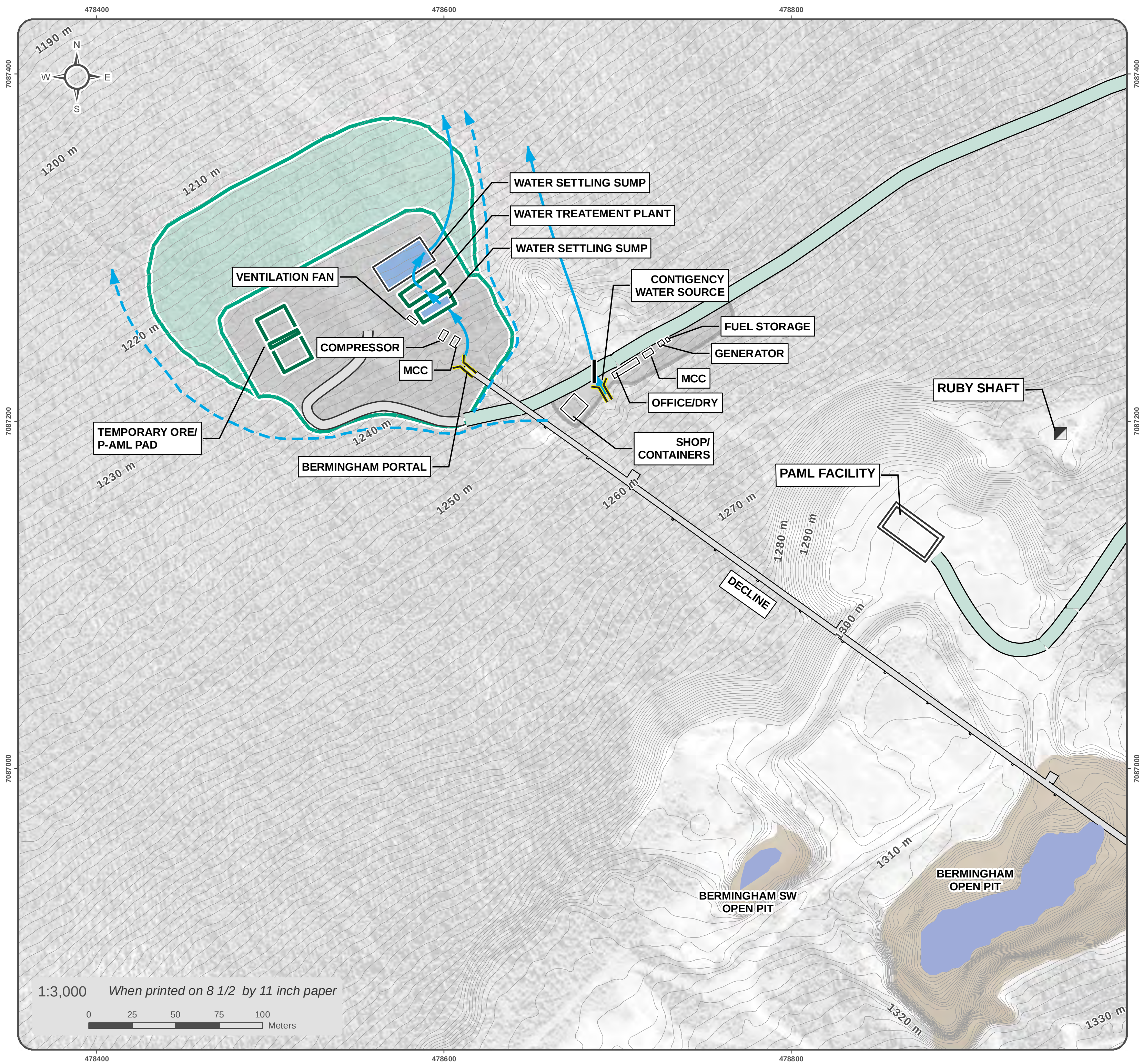

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FIGURE 8-14

BERMINGHAM WATER MANAGEMENT

NOVEMBER 2017

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Datum: NAD 83; Map Projection: UTM Zone 8N

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8.4.2 Bermingham Mine Water Balance

A monthly water balance was developed for the Bermingham Mine to calculate the maximum potential discharge rate from the proposed mining activities at 370 m below ground surface. The water balances for the Bermingham mine at 200 and 400tpd including groundwater inflows, mine water supply sources, water storage sources such as ore (5%), waste rock (5%) and tailings backfill are presented in Table 8-13. A schematic showing the water conveyance is presented in Figure 8-14. The water management plan for the KHSD Mining Operations has been updated to include Bermingham, which is included as Appendix N. It should be noted that the full flow rate of 1200 m^3/day has been considered in the water treatment process and water quality model.

Table 8-13: Bermingham Mine Water Balance at 370m below ground surface, 200 tpd and 400tpd

200 tpd	Inputs (m^3/day)	Outputs (m^3/day)					Output (L/s)
Month	Groundwater	Water in Ore	Water In Waste Rock	Water to Septic	Tailings Paste Backfill	Adit discharge	Adit discharge
Jan	1200	10	5.3	1.4	40	1143.3	13.2
Feb	1200	10	5.3	1.4	40	1143.3	13.2
Mar	1200	10	5.3	1.4	40	1143.3	13.2
Apr	1200	10	5.3	1.4	40	1143.3	13.2
May	1200	10	5.3	1.4	40	1143.3	13.2
Jun	1200	10	5.3	1.4	40	1143.3	13.2
Jul	1200	10	5.3	1.4	40	1143.3	13.2
Aug	1200	10	5.3	1.4	40	1143.3	13.2
Sep	1200	10	5.3	1.4	40	1143.3	13.2
Oct	1200	10	5.3	1.4	40	1143.3	13.2
Nov	1200	10	5.3	1.4	40	1143.3	13.2
Dec	1200	10	5.3	1.4	40	1143.3	13.2
400 tpd	**Inputs (m^3/day)**	**Outputs (m^3/day)**					**Output (L/s)**
Month	**Groundwater**	**Water in Ore**	**Water In Waste Rock**	**Water to Septic**	**Tailings Paste Backfill**	**Adit discharge**	**Adit discharge**
Jan	1200	20	10.7	1.4	80	1087.9	12.6
Feb	1200	20	10.7	1.4	80	1087.9	12.6
Mar	1200	20	10.7	1.4	80	1087.9	12.6
Apr	1200	20	10.7	1.4	80	1087.9	12.6
May	1200	20	10.7	1.4	80	1087.9	12.6
Jun	1200	20	10.7	1.4	80	1087.9	12.6
Jul	1200	20	10.7	1.4	80	1087.9	12.6
Aug	1200	20	10.7	1.4	80	1087.9	12.6
Sep	1200	20	10.7	1.4	80	1087.9	12.6
Oct	1200	20	10.7	1.4	80	1087.9	12.6
Nov	1200	20	10.7	1.4	80	1087.9	12.6
Dec	1200	20	10.7	1.4	80	1087.9	12.6

8.4.3 Water Treatment Plant

Alexco is proposing to construct a water treatment plant to treat water from the Bermingham mine. Alexco is currently proposing to discharge the water consistent with the Metal Mining Effluent regulations which is consistent with previous Licenced Effluent Quality Standards (EQS) for Bellekeno, Onek and Lucky Queen. Within this section, Alexco provides a breakdown of the proposed water treatment process to ensure the discharged water from the Bermingham site meets the proposed effluent quality standards (Table 8-12).

Alexco has been treating water successfully for the past ten years in the KHSD as part of care and maintenance of the Silver King, Galkeno 300 and Galkeno 900 sites and mining operations at the Bellekeno mine. The four sites mentioned above each provide unique water treatment challenges which has provided Alexco with the experience to design water treatment plants for a wide range of contaminants and flow rates in the District. The design of the water treatment plant for the Bermingham mine has been designed based on the experience gained through the operations of the above water treatment facilities.

The Bermingham mine will require continual dewatering, with discharge flows dependent on mine depth. It is estimated that flow rates may reach a maximum of 13.9 litres per second (lps) with incoming water quality generally compliant except for some metals and potentially with elevated levels of ammonia and total suspended solids from underground mining activities. The new treatment facility would be located adjacent to the Bermingham portal, and the processes used in the treatment plant will be comprised of the following general processes:

a) Metals removal as needed with the addition of air, pH adjustment, a polymer, and settling in a clarifier/thickener;

b) Particle removal via a hydrocyclone, clarifier/thickener, and settling pond;

c) Ammonia removal via optional ion exchange (IX) system for final polishing.

Elements of the Proposed System

Figure 8-15 shows the layout of the proposed Bermingham Water Treatment Plant (WTP). All of the systems and technology proposed for the Bermingham WTP are proven technologies operating at Keno Hill or elsewhere in the industry. The system operates as follows:

- Water is collected underground and pumped to surface where it passes through one, or several, hydrocyclone(s). At the hydrocyclone, water enters tangentially and spins at the cylindrical entrance. The spinning action causes heavier particles to be thrown toward the wall of the chamber and drift downward, thereby removing total suspended solids. Water, which is less dense than the solids, continues spinning and moves vertically up and out of the unit.

- Water then flows into a rapid mix tank where it is mechanically agitated and reagents are added to adjust the pH. By raising the pH, a small portion of the ammonia is transformed into a dissolved gas, and some treatment of ammonia occurs in the rapid mix tank and subsequent settling. A polymer is added to densify the sludge and in the future, additional reagents such as coagulant aids may be added into the reactor to remove other metals if determined necessary during plant commissioning.

- Water flows from the rapid mix tank into the clarifier settling body where heavier particles accumulate at the bottom of the cone as sludge. This sludge is pulled from the clarifier by a sludge blow-down system and sent to a thickener.

- Sludge and heavier particles from both the clarifier and hydrocyclone enter an optional thickener which increases the percent solids of this combined slurry before sending the sludge to either textile dewatering bags or sludge settling pond for final disposal in the Bermingham SW pit. At closure the sludge in the pit will be covered with waste rock and till material. The Sludge Management Plan under Water Licence QZ12-053 is presented in Appendix O.

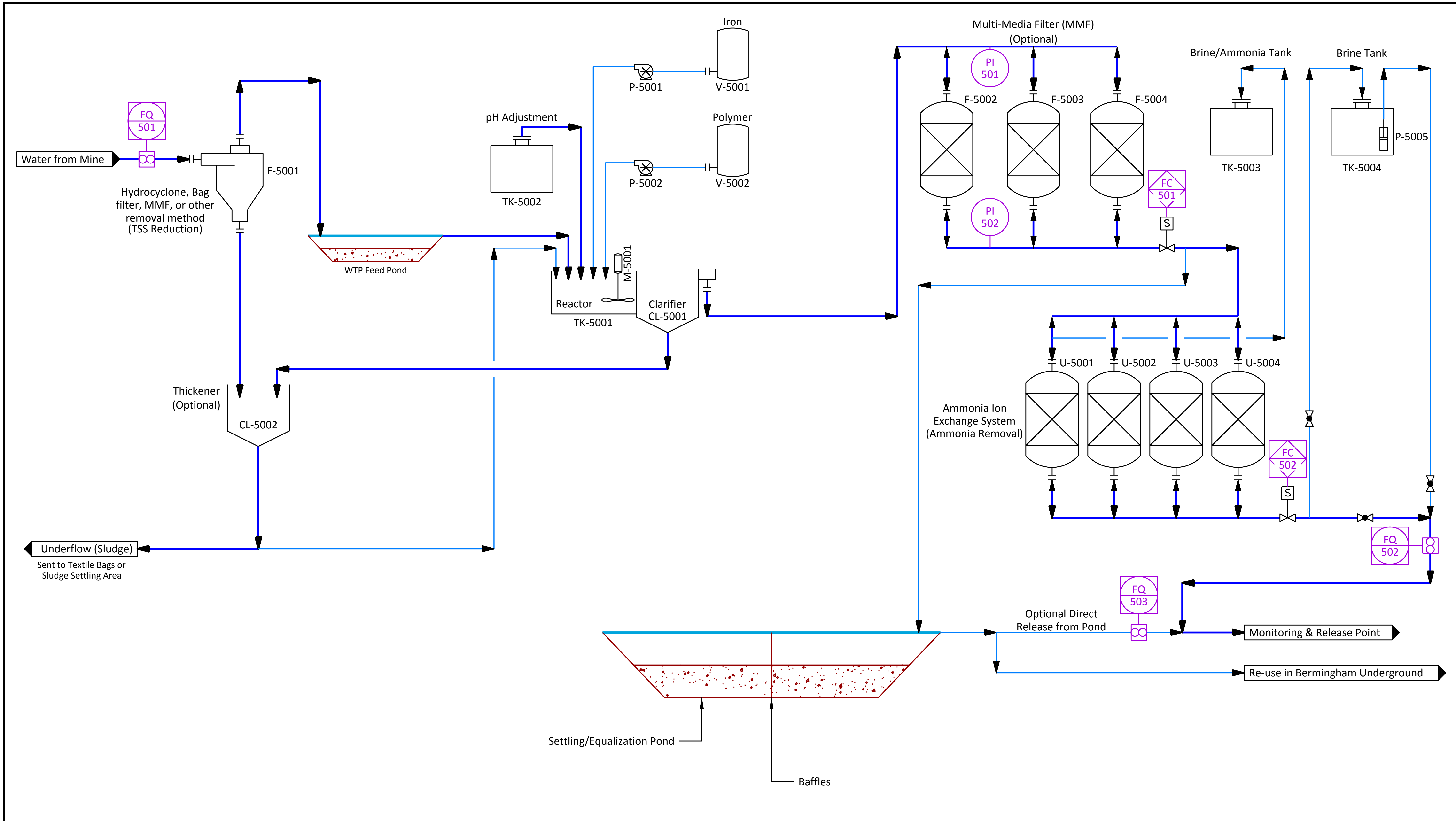
- Water from the clarifier travels vertically up and out of the settling body where it enters the aeration and treatment portion of a lined pond.

- Once water enters the settling and equalization area, residence time will allow for final particle removal and polishing of the treated water.

- Water can then be decanted from the pond for discharge or reused within the Bermingham underground activities, or pumped to an optional ion exchange ammonia removal system for final treatment.

- If additional ammonia removal is necessary, water will be transferred via a submersible pump to an ion exchange system. Resins within the ion exchange tanks sorb ammonia until they reach a maximum threshold at which time each tank must be regenerated with a salt water (brine) solution. This solution is pumped into one tank at a time, while the remaining tanks continue to remove ammonia prior to discharge. The brine/ammonia solution is collected and pumped to the brine/ammonia tank where it is disposed. The solution from the tank is then used underground as part of cement backfill or placed in the Bermingham SW pit along with the sludge.

- Finally, the effluent from the ion exchange passes through a flow meter with a totalizer that tracks the total amount of discharged water that has passed through the system before it passes the Monitoring and Release Point (lined pond) where it passes to the environment.



DATE	ISSUE/REVISION	REV No.	DRW.	APP.
2017-09-26	Draft for review	A	KAB	--

ALEXCO ENVIRONMENTAL GROUP

Bermingham WTP
Bermingham Water Treatment Plant
Drawing No.: ALEX-16-NMP-03-D-5602

Process and Instrumentation Diagram

Figure 8-15

REVISION A	2017-09-26	PROJECT No.: ALEX-16-NMP-03
DRAWN BY: KB	DESIGNED BY: EL	REVIEWED BY: BT

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8.5 NO CASH CREEK MASS LOADING MODEL RESULTS SUMMARY

This section presents the results from the modelling for the No Cash Creek watershed. It is currently estimated that the reclamation of the historic mines in the Keno District will have been assessed, permitted and funded in late 2019 or early 2020. It is assumed the Keno District Closure construction begins in 2020, but the No Cash 500 mine pool treatment isn't commissioned and in operation until October 1, 2020. Load reduction from the No Cash 500 mine has not been modelled for conservatism at this time.

The load model calculates metal loadings in No Cash Creek (at KV-21) for three phases of the project: 1) advanced exploration (9 months); 2) operations (5 years); and 3) reclamation and post-closure (10 years). The load model calculates loads and associated concentrations in No Cash Creek for the following constituents of potential concern (COPC): silver, arsenic, cadmium, copper, nickel, lead, zinc, sulphate and ammonia.

8.5.1 Loading Sources

The baseline loading sources for the No Cash Creek mass load model include untreated Bermingham adit discharge during advanced exploration, discharge from the Bermingham WTP during operations, contact water from the N-AML waste rock storage dump and Bermingham adit discharge in closure treated as required via mine pool treatment. A schematic of the proposed loading sources is presented in Figure 8-16.

Proposed Load Source: Bermingham Adit Discharge

The portal location for the Bermingham Mine will be developed below the water table and thus discharge is anticipated from the adit throughout all phases of the project. The discharge for the advanced exploration was assumed to be 205 m^3/day (2.37 L/s) during the 9-month period based on the maximum predicted rate (AEG, 2017a). The Bermingham mine dewatering rate was predicted to be a maximum of 1,000 m^3/day (Appendix C) and for purpose of assessment and licensing a maximum discharge of 1,200 m^3/day has been modelled. During mining the adit discharge has been assumed to increase linearly from 205 m^3/day (2.37 L/s) up to 1,200 m^3/day (13.9 L/s) linearly to its maximum at the end of mining operations. The portal discharge when the mine is flooded to the elevation of the portal at closure is estimated to be 216 m^3/day or 2.5 L/s (Appendix C). The water quality of the adit discharge is anticipated to change throughout the life of the mine as the decline is developed into more mineralized rock that likely will leach higher concentrations of COPCs. The water quality sources throughout the mine life vary such that:

- During advanced exploration the loading was based on the median water quality observed in the discharge from the Bermingham decline and its cover hole (total concentrations, July to September 2017; Table 8-14);

- During operations there was no loading from the adit as discharge will be conveyed to the water treatment plant (WTP to be captured in that loading term;

- During reclamation and post-closure the loading was based on the monthly median water quality observed from the nearby flowing Bermingham 200 adit (KV-18) (total concentrations, 2011 to 2017; Table 8-15).

Table 8-14: Median Water Quality of Modelled Parameters in Bermingham Decline and cover hole (KV-110) from July to September 2017

Parameter	mg/L	Parameter	mg/L
Silver	0.00032	Lead	0.021
Arsenic	0.0024	Sulphate	60
Cadmium	0.0018	Ammonia	0.14
Copper	0.0028	Hardness	163
Nickel	0.0080	Zinc	0.10

Table 8-15: Monthly Median Water Quality of Modelled Parameters of Bermingham 200 Adit (KV-18) from 2011 to 2017

	Silver	Arsenic	Cadmium	Copper	Nickel	Lead	Zinc	Sulphate	Ammonia	Hardness
	mg/L									
January	0.00010	0.068	0.06	0.0010	0.0025	0.0026	2.0	41	0.008	168
February	0.00010	0.071	0.05	0.0010	0.0021	0.0026	1.8	42	0.008	166
March	0.00003	0.073	0.04	0.0050	0.0016	0.0018	1.8	42	0.005	169
April	0.00019	0.078	0.04	0.0050	0.0020	0.0013	1.5	41	0.005	165
May	0.00032	0.066	0.03	0.0076	0.0023	0.0016	1.6	37	0.005	158
June	0.00040	0.028	0.06	0.0066	0.0029	0.0067	1.6	39	0.008	102
July	0.00024	0.053	0.12	0.0036	0.0029	0.0056	3.0	46	0.022	145
August	0.00025	0.039	0.11	0.0044	0.0030	0.0067	2.5	44	0.015	126
September	0.00030	0.047	0.11	0.0027	0.0031	0.0057	2.7	45	0.007	147
October	0.00016	0.048	0.12	0.0026	0.0032	0.0061	2.9	47	0.005	142
November	0.00018	0.060	0.10	0.0018	0.0028	0.0050	2.8	47	0.007	159
December	0.00015	0.067	0.08	0.0021	0.0030	0.0065	2.4	43	0.005	161

Proposed Load Source: Bermingham Water Treatment Plant Discharge

Alexco proposes to discharge treated mine water from the Bermingham mine via a proposed WTP to meet the metal mining effluent regulations. As the model is completed in monthly time steps, the model has incorporated conservative discharge concentrations to be proposed as effluent quality standards presented in Table 8-14. The project expects to discharge on a regular basis given its experience treating water in the district at four water treatment plants (Galkeno 300, Galkeno 900, Silver King and Bellekeno 625). The WTP will be online during the operations phase of the project, discharging initially at 2.37 L/s at the beginning of operations and ramping up to 13.9 L/s at the end of operations as more mine water requires treatment. The Bermingham discharge concentrations used in the model represent conservative loading rates given the experience at the Bellekeno Mine, yet discharge up to the Effluent Quality Standards are anticipated to be infrequent during the mine life, therefore the concentrations used in the model are appropriate to determine potential environmental effects.

Table 8-16: Bermingham Proposed WTP Effluent Quality Standards and Discharge Water Quality

WTP Discharge Water Quality	EQS (mg/L)
Silver	0.01
Arsenic	0.1
Cadmium	0.01
Copper	0.1
Nickel	0.5
Lead	0.2
Zinc	0.5
Ammonia	15

Proposed Load Source: Bermingham N-AML Waste Rock

Up to 165,000 tonnes of N-AML waste rock (137,000 tonnes plus 20% contingency) from the development of the Bermingham decline and mine will be stored in a N-AML waste rock storage facility. The approximate waste rock placement schedule is presented in Table 8-17. It is assumed that the annual tonnage is accumulated in equal tonnages each month of the year.

The load rates for Bermingham N-AML waste rock (165,000 tonnes) placed in N-AML waste rock disposal area and used as construction are calculated with placement starting October 1st of 2018 and ending December 31st, 2022. The waste rock from Bermingham will only be deposited in the No Cash Creek catchment for the purpose of road building, No P-AML rock will be left on surface at closure.

The metal loading rates for the Bermingham N-AML waste rock were based on the Flame and Moth N-AML loading rates (Table 8-18), which used the highest loading rate predicted for each element based on steady state humidity cell or median field barrel release rates for conservativism. The Bermingham waste rock comparison to Flame and Moth is presented in Bermingham Geochemical Characterization report (Appendix D).

Table 8-17: N-AML Waste Rock Placement Schedule

Start Date	End Date	Waste Rock	Cumulative Waste Rock Stored
		tonnes	
Dec-17	Oct-18	25,000	25,000
Oct-18	Oct-19	25,000	50,000
Oct-19	Oct-20	50,000	100,000
Oct-20	Oct-21	50,000	150,000
Oct-21	Oct-22	15,000	165,000

Table 8-18: Bermingham N-AML Waste Rock Loading Rates

Parameter	Annual loading rate (kg/kg/yr)	Source	Monthly loading rate (mg/kg/month)
Silver	5.94E-11	Humidity cell	4.95E-06
Arsenic	2.15E-08	Humidity cell	1.79E-03
Cadmium	1.29E-09	FMB3-median	1.08E-04
Copper	2.97E-09	Humidity cell	2.48E-04

Parameter	Annual loading rate (kg/kg/yr)	Source	Monthly loading rate (mg/kg/month)
Nickel	1.08E-08	FMB4-median	9.00E-04
Lead	1.04E-09	FMB2-median	8.67E-05
Zinc	6.56E-08	FMB3-median	5.47E-03
Sulphate	2.81E-04	Humidity cell	2.34E+01

Additional Model Considerations

The No Cash Creek mass load model considered natural attenuation that would occur along the flowpath between the Bermingham site and KV-21 and reduce COPC loading to No Cash Creek. Natural attenuation process between KV-20 (No Cash 500 adit) and KV-21 have been well-documented and it was conservatively assumed that 50% of COPC loads (excluding sulphate) would be attenuated between the site and KV-21 (Appendix P).

As potentially elevated concentrations of COPCs are anticipated in the Bermingham adit discharge upon closure based on the water quality observed in the historic Bermingham 200 adit – particularly for cadmium and zinc (see Table 8-15) – in situ treatment of the Bermingham mine pool was considered. This treatment approach has been successfully implemented in the flooded underground workings of the Silver King mine to treat COPCs expected to be found in the Bermingham adit discharge (AEG, 2017b). The conservative percent reduction of COPCs resulting from in situ Bermingham mine pool treatment are presented in

Table 8-19: Percent Reduction of COPCs Resulting from in situ Bermingham Mine Pool Treatment

COPC	In Situ Treatment Reduction (% Removal)
Silver	0
Arsenic	0
Cadmium	0.75
Copper	0
Nickel	0.5
Lead	0.5
Zinc	0.75
Sulphate	0
Ammonia	0.5

NO CASH CREEK MASS LOADING MODEL SCHEMATIC

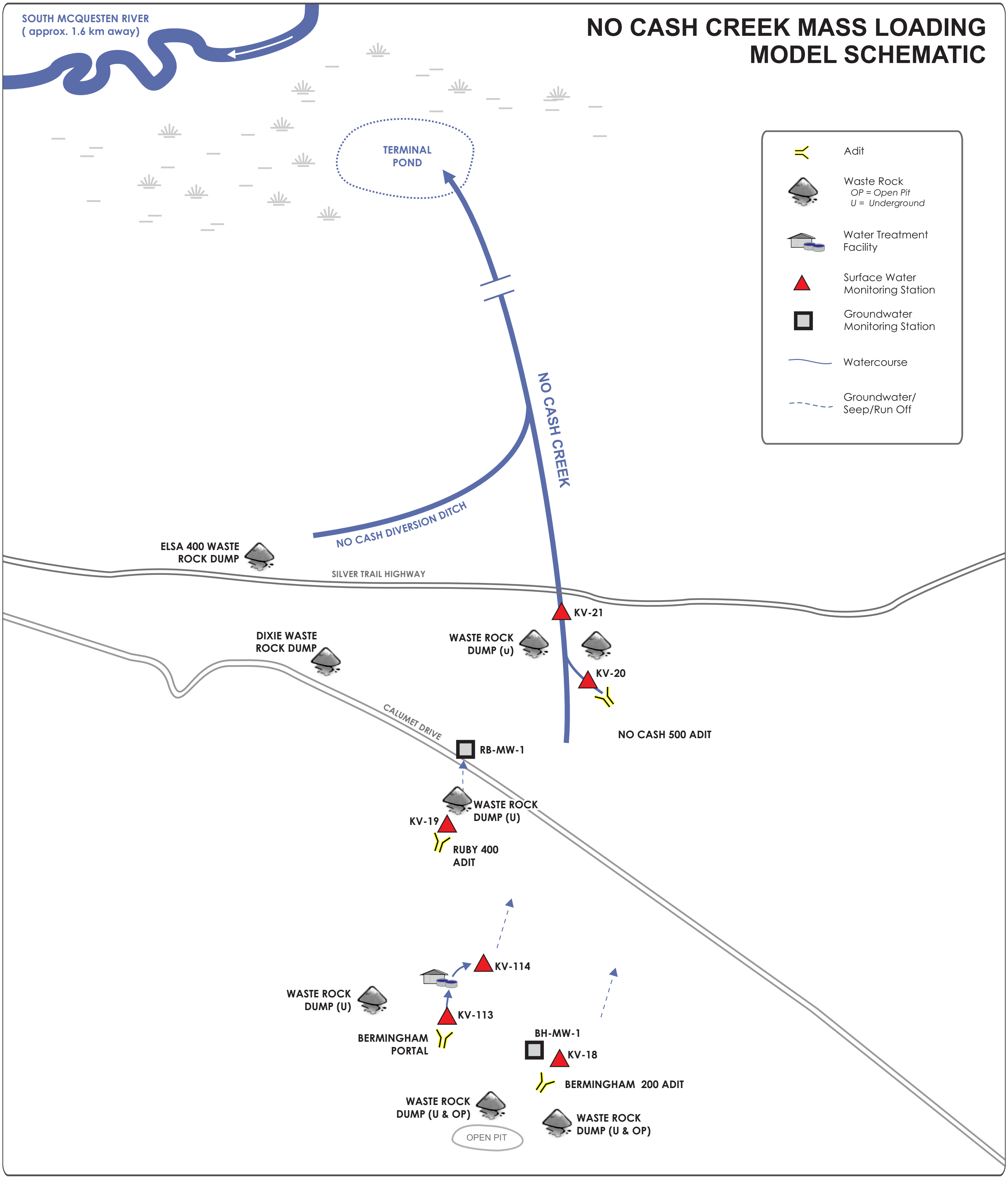

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FIGURE 8-16
NO CASH CREEK MASS LOADING MODEL SCHEMATIC

SEPTEMBER 2017

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8.5.2 Results

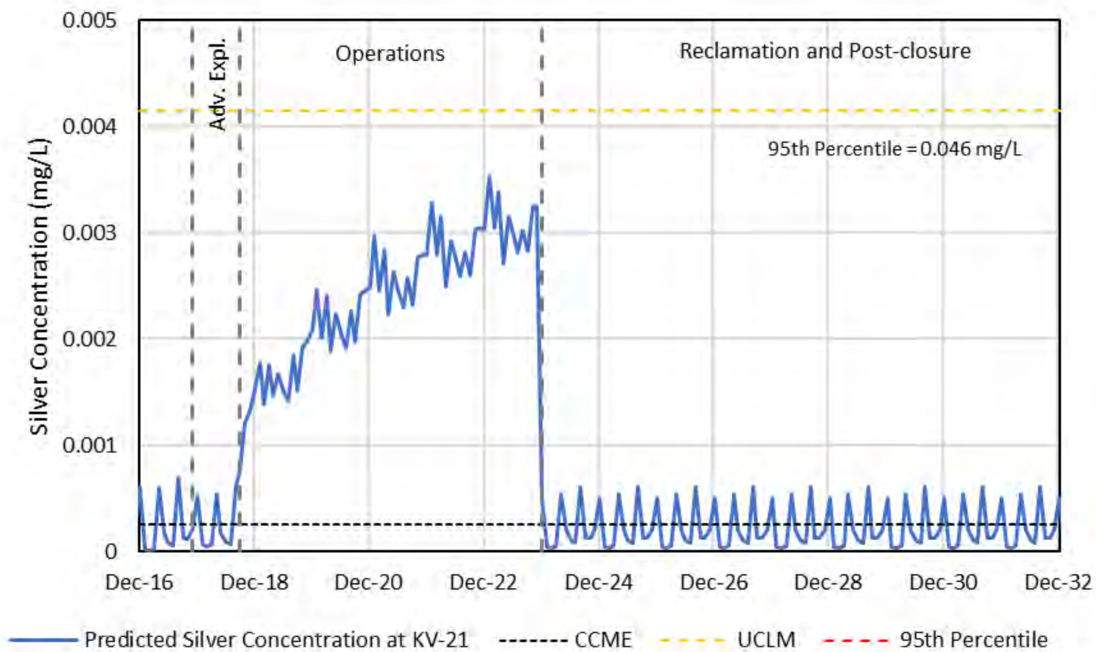
The mass load model for No Cash Creek was run for the addition of the Bermingham Mine and the resulting monthly concentrations for constituents of potential interest at KV-21 are presented in Figure 8-17 through Figure 8-21. Station KV-21 is located on No Cash Creek upstream of the Silver Trail highway and is located ~500 m downstream from No Cash 500 mine discharge. No Cash Creek does not have a direct connection to the South McQuesten River. Water quality objectives (WQO) for No Cash Creek at KV-21 have been developed using the surface water quality guidelines for protection of aquatic life prepared by the Canadian Council of Ministers of the Environment (CCME) (CCME, 2017) or the British Columbia Minister of the Environment (BCMOE) (BCMoE, 2016), or the CCME background concentration procedure (BCP) (CCME, 2003). The WQO developed using the background concentration procedure used the 2011 to July 2017 data set for KV-21. As there are no fish in No Cash Creek and no direct connection to the South McQuesten River these WQO have been used for comparison purposes only. The WQOs plotted in Figure 8-17 through Figure 8-21 which are hardness-dependent were calculated with hardness computed by the model. The WQOs will be reviewed and updated for the closure plan of the other No Cash Creek catchment mines following the finalisation of the Existing State of Mine Reclamation Plan by Elsa Reclamation and Development Company Ltd.

Table 8-20: Water Quality Objectives for No Cash Creek (KV-21) (Greyed value selected as WQO for comparison)

KV-21	95th percentile (mg/L)	UCLM (mg/L)	CCME (mg/L)	BCMoE (mg/L)	WQO	Guideline Used
Total Arsenic	0.022	0.010	0.005	0.005	BCP	95th and UCLM
Total Cadmium	0.045	0.018	0.00037[a]	0.00046[a]	BCP	95th and UCLM
Total Copper	0.063	0.0094	0.004[a]	0.01[a]	BCP	95th and UCLM
Total Lead	0.20	0.11	0.007[a]	0.02[a]	BCP	95th and UCLM
Total Nickel	0.031	0.011	0.15[a]	-	CCME	0.15
Total Silver	0.046	0.0041	0.00025	0.0015	BCP	95th and UCLM
Total Zinc	4.39	1.98	0.03	0.19[a]	BCP	95th and UCLM
Sulphate	549	374	-	429[a]	BCMOE	429
Ammonia	-	-	1.27[b]	1.18[b]	CCME	pH and Temp dependent

[a] Based on lower quartile hardness of 385 mg/L observed at No Cash Creek
[b] Based on pH 8 and temperature of 5°C

The model results for the Bermingham mine show an increase in metal concentrations in the receiving environment, but No Cash Creek is not a fish bearing stream nor does it have a direct connection to the South McQuesten River. The largest loading source, Bermingham Mine discharge, is only of short duration and will diminish at the end of the mine life. It has been documented that significant natural attenuation occurs between No Cash Creek at KV-21 and the terminal pond in No Cash Bog. Therefore, no significant adverse effects to water quality are expected from the Bermingham Mine.



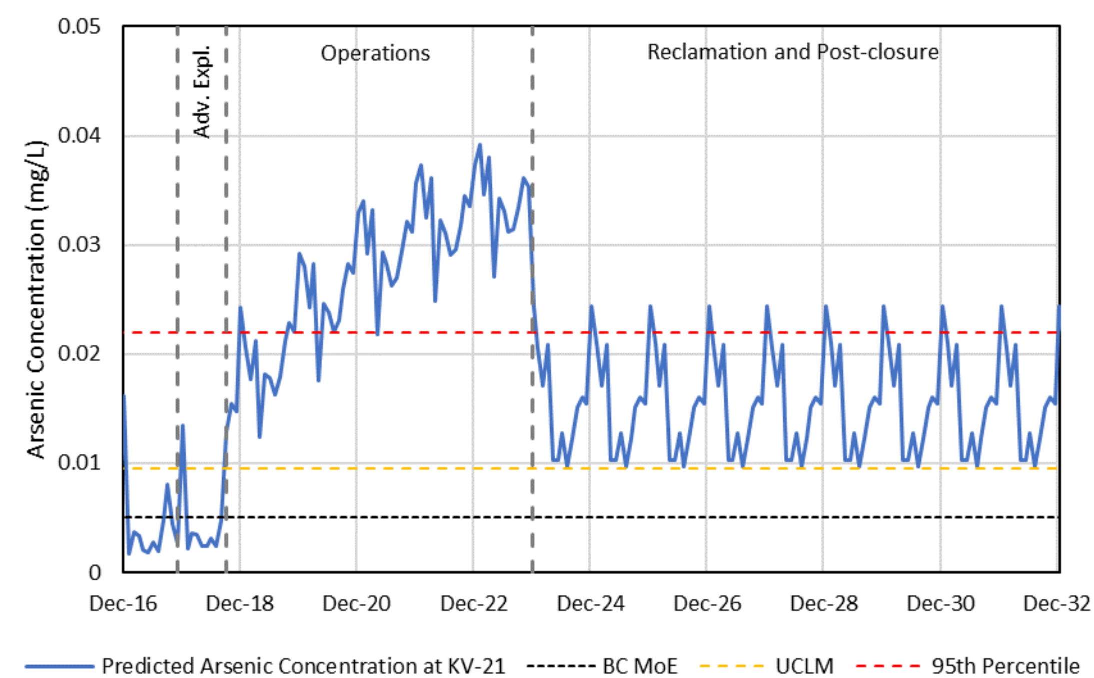


Figure 8-17: Predicted Silver and Arsenic Concentrations in No Cash Creek at KV-21.

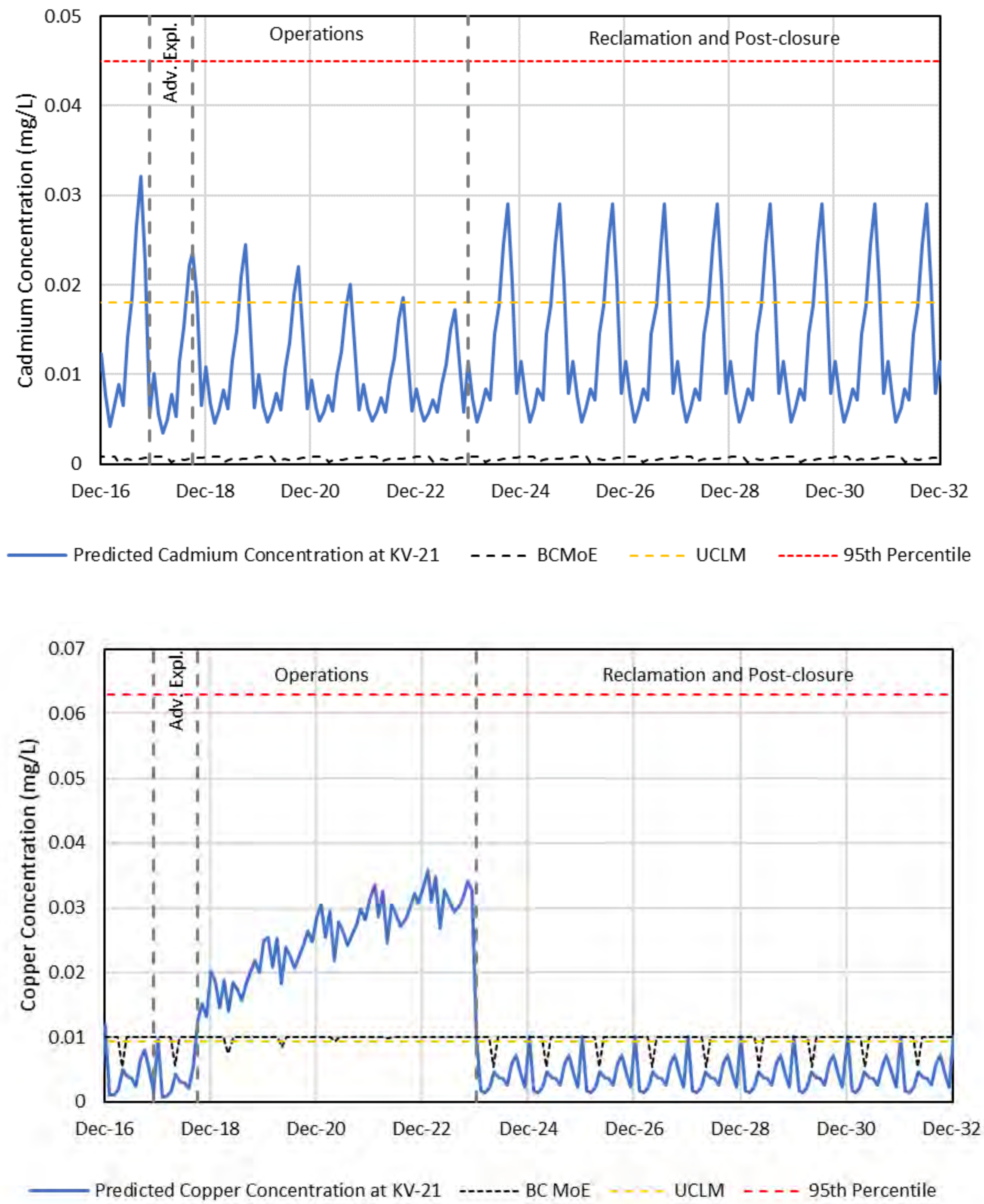


Figure 8-18: Predicted Cadmium and Copper Concentrations in No Cash Creek at KV-21.

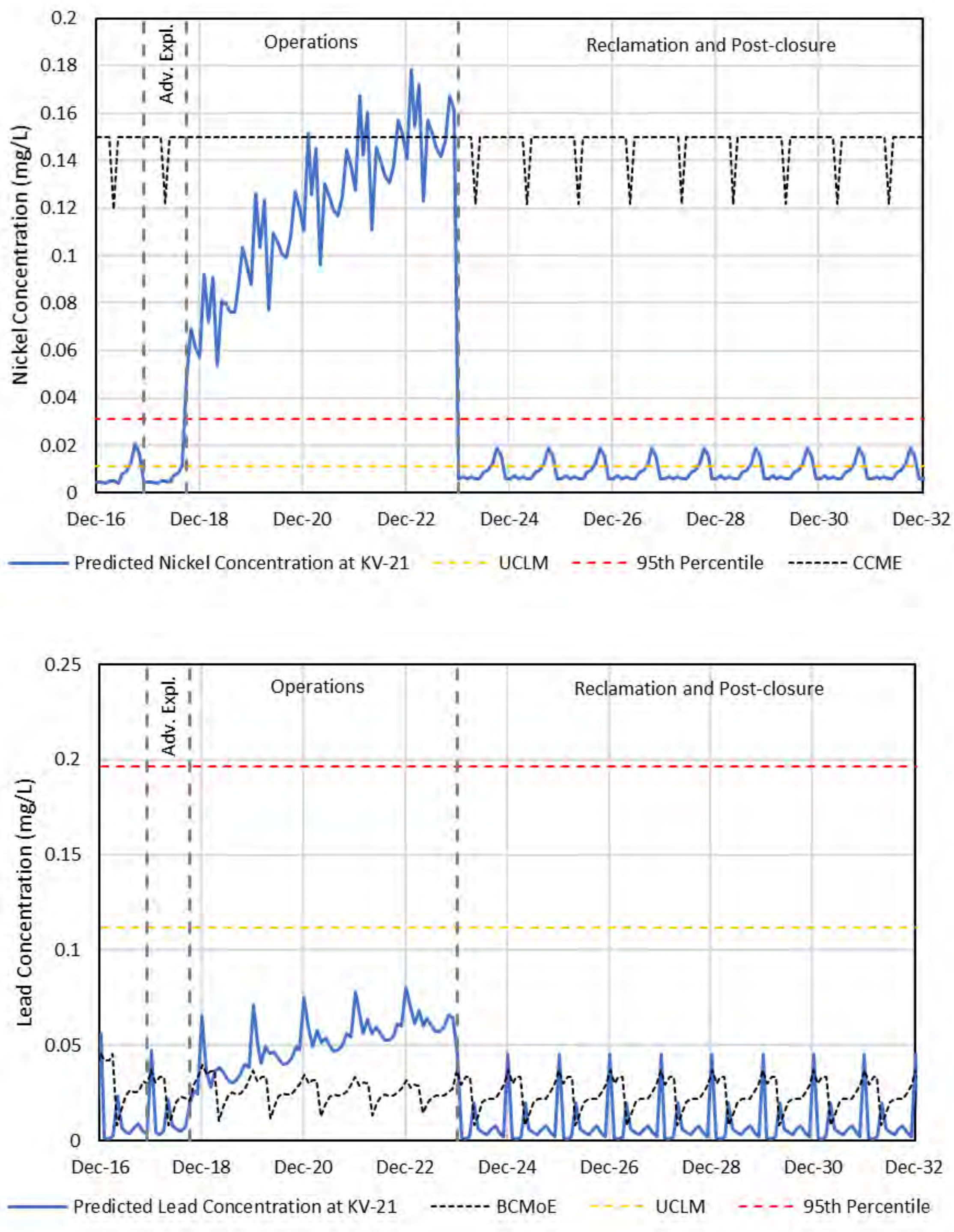
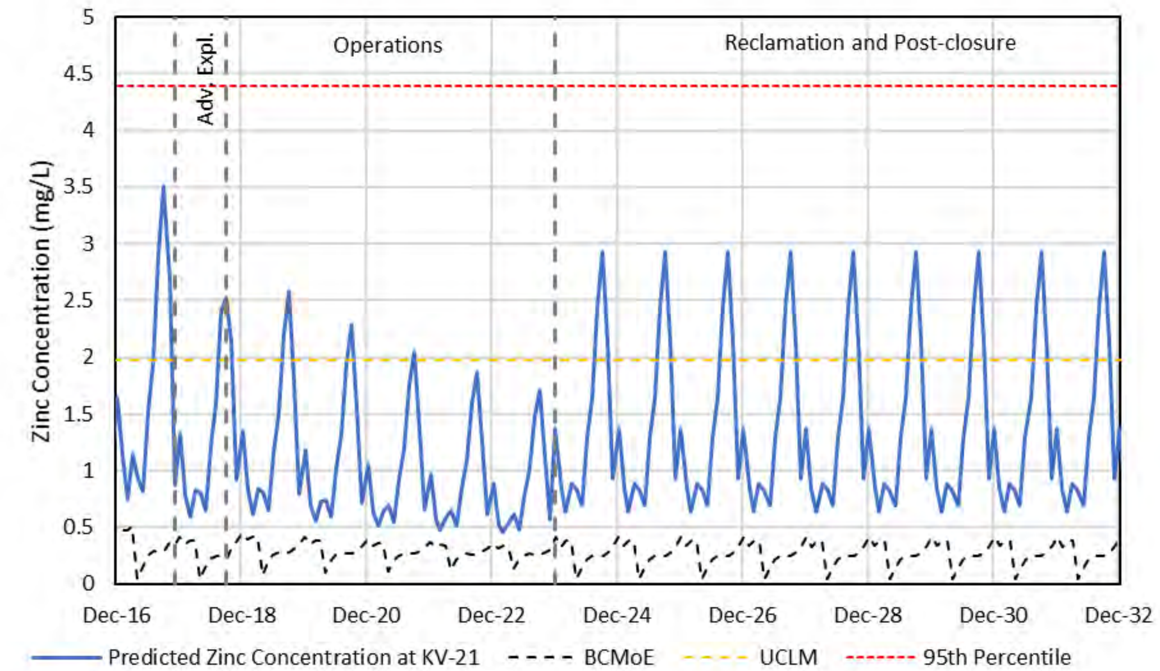


Figure 8-19: Predicted Nickel and Lead Concentrations in No Cash Creek at KV-21.



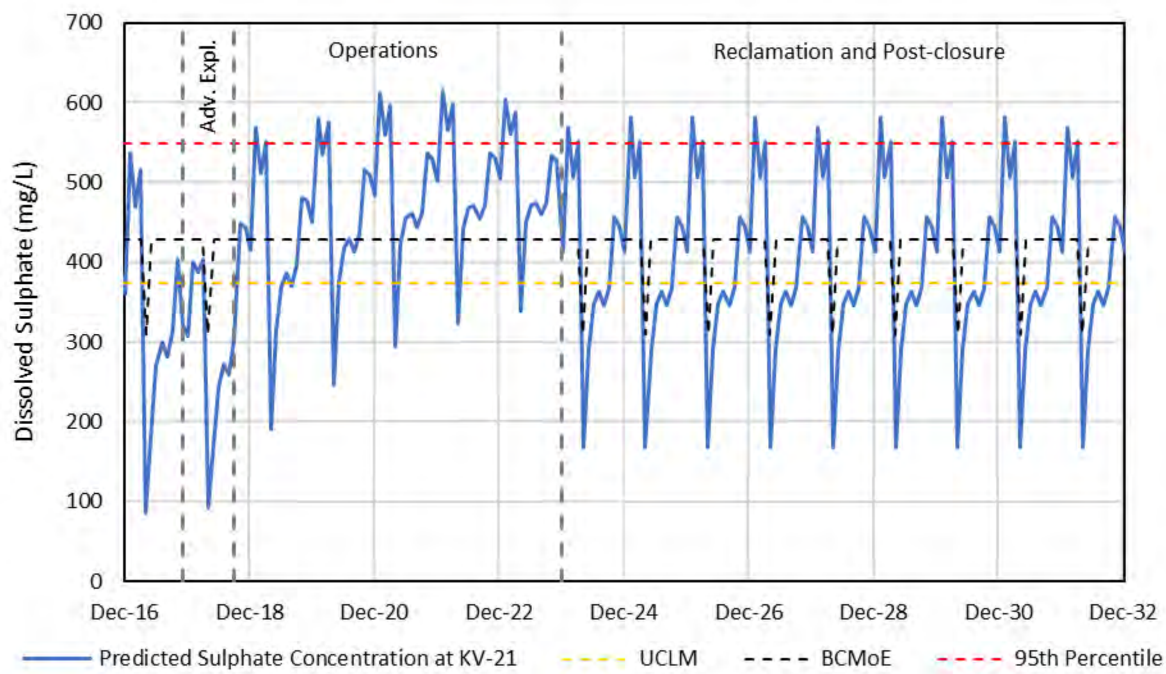


Figure 8-20: Predicted Zinc and Sulphate Concentrations in No Cash Creek at KV-21.

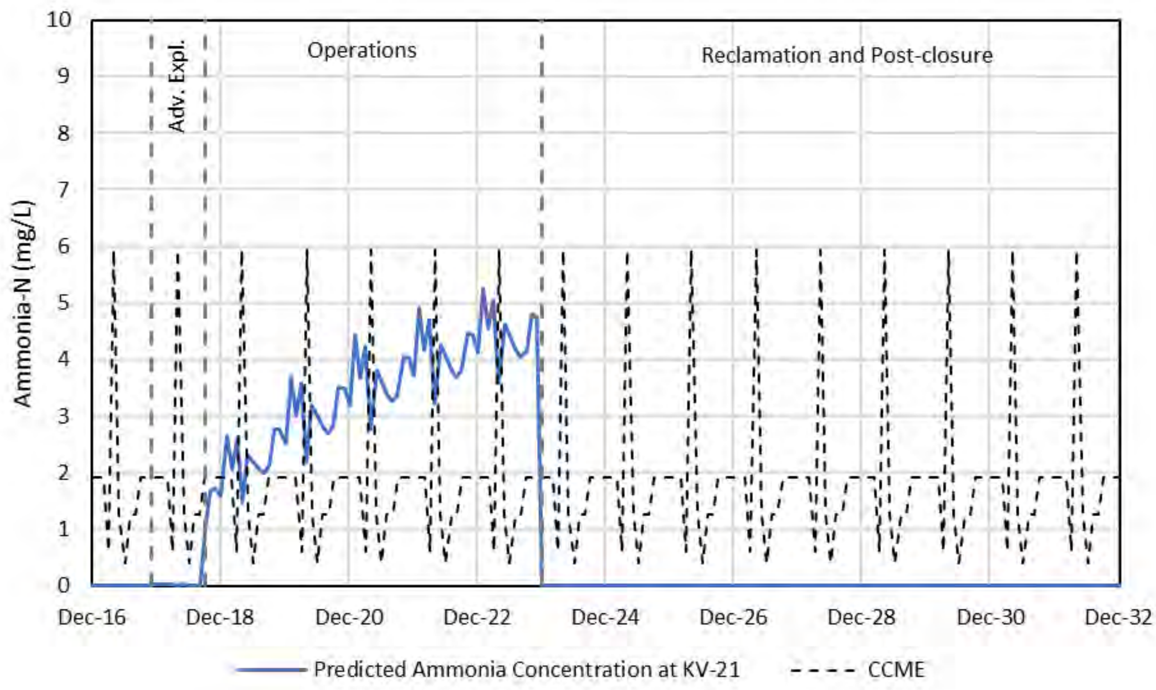


Figure 8-21: Predicted Ammonia Concentrations in No Cash Creek at KV-21.

8.5.3 Monitoring

An extensive water quality surveillance network is in place at the site through Water Licenses QZ12-053 and QZ12-057, and monitoring will continue during development of the Bermingham deposit to update site data and provide further information for closure planning. Additional monitoring locations and frequency have been identified in Table 8-21 and Figure 8-7 to reflect the proposed mining activities. As part of ongoing closure planning, the water balance and mass loading calculations will be continually re-visited and updated. Monitoring of Star Creek has been included given its proximal location to No Cash Creek and the potential for groundwater flow path in that direction. Data from Star Creek will be incorporated into the Adaptive Management Plan. Additionally, metals in vegetation will be monitored along discharge flow path to understand potential metal uptake.

Table 8-21: Proposed Additional Monitoring Locations

Proposed Station	Description	Frequency
KV-56	Star Creek at Silver Trail Highway	Monthly
KV-111	No Cash Creek upstream of No Cash 500 discharge	Monthly
KV-113	Bermingham Portal	Weekly when discharging
KV-114	Bermingham Decant Pond	Weekly when discharging
KV-115	Bermingham P-AML facility	Monthly from May to October

KV-116	Groundwater well downgradient of N-AML WRDA	Monthly for first twelve months then Quarterly

8.5.4 Adaptive Management

The Adaptive Management Plan for the KHSD Mining Operations has been developed and will be updated to include the Bermingham deposit as part of the Water Licence application. The Adaptive Management Plan will be updated and submitted to the Water Board, which will specifically include events for changes in water quality or quantity in No Cash Creek, mine adit water quality changes, post-closure mine pool treatment performance and Star Creek water quality changes, in addition to issues such as sludge and waste rock management providing assurance that no significant impacts to the receiving environment will occur. The AMP will be updated to include the results of the No Cash Creek Load Model to evaluate potentially triggered thresholds.

8.6 PROPOSED COMPLIANCE POINT AND EFFLUENT QUALITY STANDARDS FOR BERMINGHAM MINE DISCHARGE

Alexco is proposing to discharge water from the Bermingham Mine at a new discharge location (KV-114) which will meet the Metal Mining Effluent Regulations (MMER) as summarized in Table 8-22.

Table 8-22: Proposed EQS for Bermingham Mine

Parameter	Maximum Concentration Grab Sample for KV-114
pH	6.5 – 9.5
Suspended Solids	30 mg/L
Arsenic (Total)	0.1 mg/L
Cadmium (Total)	0.01 mg/L
Copper (Total)	0.1 mg/L
Lead (Total)	0.2 mg/L
Nickel (Total)	0.5 mg/L
Silver (Total)	0.01 mg/L
Zinc (Total)	0.5 mg/L
Ammonia	15 mg/L
96-hour Rainbow trout	Non-Toxic, LC_{50} (100%)

8.7 CHARACTERIZATION AND MANAGEMENT OF POTENTIAL EFFECTS ON WATER

Significant adverse effects on surface water or groundwater quality/quantity from development and production of the Bermingham deposit are not anticipated as No Cash Creek is not a fish bearing stream nor does it have a direct connection to the South McQuesten River.

Water that is dewatered from the proposed development will be pumped to surface and directed to the proposed water treatment plant as outlined in Section 8.4.3. The collected water will be monitored regularly through production. As an adaptive management response, if deteriorating discharge quality is detected, an investigation will be undertaken to ascertain the source of the deterioration and appropriate mitigations will be developed.

The proposed mining methods will mitigate potential effects on water quality by limiting the interaction between water and the underground workings (e.g., mining "off the vein" through host country rock; shotcreting; and cement paste backfill).

The EQS being proposed for ammonia is 15 mg/L. If ammonia is elevated during operations from use of explosives, ammonia will be treated using the appropriate technology to achieve the proposed EQS. Proven ammonia removal technologies (e.g. Ion exchange) has been implemented at Bellekeno 625 and may be directly applicable to Bermingham if required.

The Bermingham Geochemical characterization presented in Appendix D shows that the N-AML rock to be used as construction materials is non-acid generating or metal leaching through both shake flask extraction. Based on the results for these rock samples presented in the geochemical characterization and the modelling results presented in Appendix P, it is unlikely that the project will result in metal loadings that will deteriorate baseline water quality conditions in the long term. Based on the results for the rock samples from the cover hole and using the WRMP, it is unlikely that the project will result in metal loadings that will deteriorate baseline water quality conditions in the long term as P-AML will be placed in the P-AML facility. Further, the historic Bermingham waste rock is approximately 1,500,000 tonnes, it is one of the largest in the KHSD and is not a significant source of metal leaching and does not produce acid rock drainage. This material was excavated from the historic Bermingham mine which is ~500 m from the proposed decline. The Project is only proposing to excavate 165,000 tonnes of waste rock to surface, which represents 11% of the current Bermingham waste rock on surface.

Additionally, the proposed mining methods will mitigate potential effects on water quality over the long term by limiting the interaction between water and the underground workings (e.g., mining "off the vein" through host country rock; shotcreting; and cement paste backfill).

The Groundwater Monitoring Plan will be updated for the Water Licence amendment application which will also include an adaptive management plan. Operational experience and ongoing hydrogeological monitoring will inform closure plan development.

The discharge from the Bermingham water treatment plant must pass a distance over 1,000 m to reach the nearest water body, No Cash Creek. Attenuation processes have been well documented in No Cash Creek to remove metals from water sources, removing metals concentrations greater than 90%. The eventual downstream receptor, No Cash Creek (KV-21), will continue to be monitored by the current water licence and an additional station has been added above the No Cash 500 adit. Further attenuation has been documented downstream of KV-21 prior to the terminal pond in No Cash Bog.

Additionally, groundwater will continue to be monitored in the Bermingham and Ruby wells (BH-MW-01 and RB-MW-01, respectively). Further, No Cash Creek is not fish bearing and does not have a surface connection with the South McQuesten River.

At closure, it is predicted that the Bermingham portal would discharge up to 2.5 L/s and as part of the closure plan the mine pool will be treated as required. Mine pool treatment has been successfully implemented at the Silver King mine in the district and is the approved closure measure for Bellekeno and Flame and Moth. Additional mine pool treatment designs will be included as part of the water licence submission.

9 KENO HILL SILVER DISTRICT STAKEHOLDERS

Alexco and its subsidiaries have been operating in the KHSD since 2006 and have actively engaged the FNNND and stakeholders, including Keno City and Mayo residents, other land and resource users in the area, and federal and territorial regulators and government agencies, throughout this period. In general, FNNND and stakeholders raise concerns about potential impacts on the following components:

- Quality and quantity of watercourses and waterbodies;
- Aquatic resources;
- First Nation traditional pursuits and subsistence harvesting;
- Community health and well-being; and
- Various land and resource uses, including tourism and recreation.

9.1 FIRST NATION OF NA-CHO NYAK DUN

Alexco has a signed Comprehensive Cooperation and Benefits Agreement (the "Agreement") that formally describes the nature of the relationship between it and the FNNND. The Agreement, signed on June 8th, 2010 recognizes both Alexco's mineral rights as well as FNNND's aboriginal rights, and sets out rights, obligations and opportunities for both parties.

Individual chapters in the Agreement include human resources (employment and training), contracting, a formal drug and alcohol policy, business contracting and business partnering opportunities, environmental issues and financial resourcing for the Agreement including legacy funding contributions. Implementation of the Agreement is formalized through regular Quarterly Implementation Meetings, wherein senior representatives of the parties meet to review all aspects of the two parties' interaction over the past calendar quarter, a forecast of upcoming opportunities such as contracts and employment, as well as upcoming regulatory events such as the amendments described in this document. All new job vacancies are posted on the FNNND website to ensure opportunities are not missed.

Since environmental matters occupy prime importance with FNNND, the Agreement includes detailed discussion about respecting and protecting the environment; including enhanced opportunities for FNNND to be involved in environmental management of all operations, from mining through to closure and reclamation. The Agreement describes the process to be followed with respect to consultation around new or amended permits and licences. This process, called the Cooperative Engagement Process, mandates Alexco to engage FNNND earlier in the mine permitting process than they would otherwise be involved, giving them unique opportunity to provide input that may influence the intended course of action on any of the many aspects of project design. This process has been followed, and will continue through the permitting process for the Bermingham project.

Alexco routinely engages in consultation on a variety of issues and matters associated with activities in the KHSD. These ongoing consultations collectively inform Alexco on the issues and concerns from stakeholders. Alexco has gained knowledge on the reoccurring concerns raised over the past several years and considers this knowledge and experience an important part of consultation for the Bermingham project.

10 SOCIO-ECONOMIC EFFECTS ASSESSMENT AND MANAGEMENT

The socio-economic effects assessment considers potential effects of the Project on the following valued components:

- Community Health & Well-being;
- Land and Resource Use;
- Local Economic and Human Resources; and
- Heritage Resources.

10.1 COMMUNITY HEALTH & WELL-BEING

Addressing potential effects on community health and well-being is of key importance given the proximity of the proposed project to Keno City. Implications for health and well-being are considered in terms of noise and dust generation, as well as mine traffic considerations. The Bermingham portal is located approximately 6.8 km from Keno City, which is the furthest mine development project from Keno City proposed by Alexco to date (Onek, 0.4 km; Flame and Moth, 1.3 km; Bellekeno, 2.2 km; and Lucky Queen, 3.8 km). Alexco met with Keno City residents and YESAB representatives in Keno City on October 25, 2017 to discuss the proposed Project.

10.1.1 Noise

During previous environmental assessments for the Bellekeno, Lucky Queen, Onek and Flame and Moth projects, Keno City residents raised concerns about noise from construction and mining activities. In 2012, YESAB, (YG) and AKHM jointly commissioned an independent Noise Impact Assessment (NIA) (Patching, 2012) to assess the potential noise impacts associated with the Lucky Queen and Onek mining operations, including noise at the portals, traffic, and operation of the mill and DSTF. The NIA included five monitoring locations within Keno City. The Lucky Queen portal is located approximately 3.8 km from Keno City and the Onek portal is located 400 m from the community. The NIA concluded that significant noise impacts on the community were not anticipated. The Noise Monitoring and Management Plan has been included as Appendix Q.

10.1.1.1 Effects Characterization

The scope of this assessment consists noise generated at the Bermingham mine, which includes portal fan and compressor, blasting, underground haul truck traffic to and from surface, heavy and light vehicles to and from the mill via Calumet Road. Given the results of the previous NIA that demonstrated that there would be no anticipated noise effects on Keno City from activities that are significantly closer than proposed, it is concluded that there will be no significant adverse effects from noise. Further support to this conclusion is that over the past three years, three surface exploration drills have operated at the Bermingham area and there has been no concern regarding noise from Keno City residents.

10.1.1.2 Mitigation and Management

Alexco has developed a Noise Monitoring and Management Plan that meets the requirements of the QML, including addressing relevant noise-related mitigations from the YESAA Decision Document for the Flame and Moth, Lucky Queen and Onek Mine Production project. The revised plan is included as Appendix Q.

The Noise Management Plan is expected to effectively mitigate and manage potential noise impacts associated with the project. Alexco proposes the following additional measures to address potential effects associated with noise generation:

- Noise silencer or enclosure will be part of the ventilation fan for Bermingham portal.

Alexco proposes the following additional mitigations to address noise associated with mine traffic to and from the Bermingham mine:

- The use of existing bypass roads around Keno City will continue to be used;
- Avoid the use of engine breaks; and
- Bermingham Mine traffic management protocols have been incorporated in the revised draft Traffic Management Plan (Appendix F).

In addition to noise mitigation measures and the creation of a Noise Disturbance Notification Form and Noise Disturbance Register to track noise disturbance claims, AKHM committed to monitor noise levels within the community at various locations to assess the actual versus predicted noise levels and to determine if the noise abatement measures are effective. Monitoring results up to the end of 2016 are presented in Appendix R "2016 Noise Monitoring Data Summary, Keno, YT", and monitoring will be ongoing throughout the Project.

10.1.2 Dust

Through the assessment processes for the previous KHSD mining projects, and during operations, Keno City residents have raised concerns about dust generation. Dust emissions around the Keno District Mill and DSTF are currently monitored under the approved Monitoring and Surveillance Plan under QML-0009. Dust monitoring around the Keno District Mill was initiated during the Bellekeno Mine project to meet the requirements of the YESAA Decision Document (YESAB Project 2009-0030) and QML-0009. In accordance with terms and conditions 36 and 37 of the Decision Document for the assessment of the Onek and Lucky Queen Deposit Production Project (YESAB Project 2011-0315), total suspended particulates (TSP) monitoring was initiated in August 2012 at two sites around the Keno District Mill and DSTF. A third sampler, located in Keno City, was commissioned in December 2014, and additional sampling for coarse and fine fractions of particulate matter (PM_{10} and $PM_{2.5}$ respectively) was instigated in August 2015, in accordance with the revised Dust Abatement and Monitoring Plan required in the Decision Document for the assessment of the Flame & Moth Development and Production Program (YESAB file Number 2013-0161). Figure 10-1 shows the air quality monitoring locations.

10.1.2.1 Effects Characterization

Activities at Bermingham that may generate dust beyond current activities that have not already been assessed include: fugitive dust emissions from the ~12 km long Bermingham haul road between the portal and the crusher. No other activities will be conducted at Bermingham that would add new fugitive dust sources; operation of the mill, crusher and surface support will not change from currently assessed and permitted activities. Operation of the expanded DSTF will not occur simultaneously with operation of the current DSTF and therefore is not a new source of dust. Final reclamation of the current DSTF will be complete when the expanded DSTF becomes operational.

Air dispersion modelling was carried out using CALPUFF, a recognized and approved air dispersion model by the United States (US) Environmental Protection Agency (EPA) and the British Columbia Ministry of Environment (BCMOE). Surface meteorological data were taken from the District Mill Campbell Scientific Weather Station for the year 2013. Data from the Calumet HOBO or the Valley Tailings HOBO weather stations were also used to complete the local data record. Meteorological parameters not observed at site were obtained from Environment and Climate Change Canada (EC) Mayo A meteorological station, located about 63 km away from the project area. Upper air data were obtained from the Whitehorse airport upper air station.

The modelled scenario assumes the concurrent operation of Flame and Moth and Bermingham mines and include design mitigations (e.g. enclosures) and basic operational mitigations (e.g. road watering/dust suppressant application and progressive reclamation). Emission sources include fugitive dust from the dry stack tailings facility, mineral processing and unpaved roads. Emission rates were obtained from the US EPA AP-42: *Compilation of Air Emission Factors* (1995).

Ambient concentrations were predicted at six discrete receptors in Keno City and results are also provided graphically as ambient concentration contours.

No exceedances of the Yukon Ambient Air Quality Standards (YAAQS) were predicted at any of the receptors. Higher ambient concentrations could occur in close proximity to the sources. Modelling results presented for 24-hour averaging periods represent the maximum predicted value over the one-year period modelled (for each Project phase), while the annual value which represents the single annual result for the modelling period. Therefore, ambient concentrations are predicted to be below the values reported the rest of the year. Overall, conservative assumptions were made to produce reasonable worst case scenarios and confidence is high that the model is not under-predicting ambient concentrations. Air dispersion model details are presented in Appendix S "Bermingham Development and Production Program Air Dispersion Model".

Ambient air quality monitoring at site supports the modelling results with the following findings:

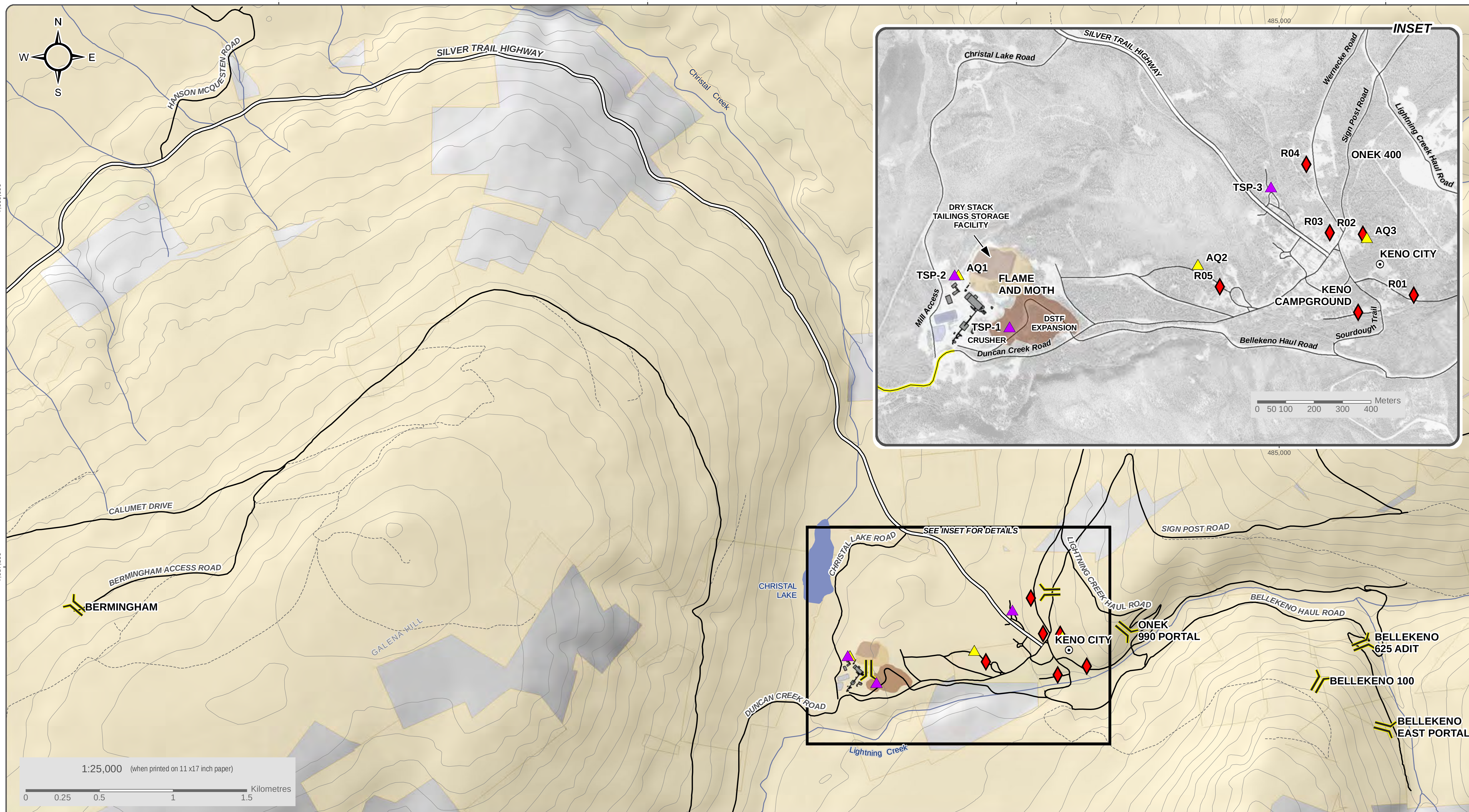
- All TSP samples collected to date near the District Mill, DSTF and Keno City are on average at least an order of magnitude below the Yukon air quality standard for TSP;
- PM_{10} and $PM_{2.5}$ samples collected at the same three locations are all well below their respective YAAQS. Most results were in fact found to be below the lab detection limit;

Detailed results of the air quality monitoring program are provided in the 2016 "Air Quality Data Summary, Keno, YT" (Appendix T).

Given the demonstrated low dust generation from current operations, the incremental contribution from the Bermingham project (via haul truck traffic from the portal to crusher) is not expected to exceed the Yukon Ambient Air Quality Standards for TSP, PM_{10} or $PM_{2.5}$. Alexco will continue to monitor dust around the District Mill, DSTF and in Keno City. Alexco will also continue to implement the following measures to control dust from the project:

- Progressive reclamation, such as placement of cover and revegetation, measures will be implemented on the existing and DSTF phase II.
- The crusher will be enclosed inside a ventilated building.
- Chemical dust suppressant (calcium chloride or similar) will be applied to the roads in addition to the road watering that will be carried between chemical dust suppressant applications.

If Keno residents raise concerns about dust from Bermingham, Alexco will work with the stakeholders to identify additional mitigation options. Alexco's Dust Abatement and Monitoring Plan is presented in Appendix U.



National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on October 2017

Datum: NAD 83; Map Projection: UTM Zone 8N

- Air Quality Monitoring Station
- Former Air Quality Monitoring Station
- Noise Monitoring Station
- Alexco/ERDC Quartz Claims
- Mill Pond
- DSTF Phase II Expansion
- DSTF 322k Tonnes Design
- Current DSTF
- Existing Building
- Waterbody
- Watercourse
- Silver Trail Highway
- Other Road
- Limited-Use Road

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FIGURE 10-1

KENO CITY AIR QUALITY MONITORING LOCATIONS

OCTOBER 2017

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10.2 LAND AND RESOURCE USE

The regional land use within the KHSD has evolved from a long history of occupation and development. Significant development activity and local population fluctuations have historically occurred in the area. The general area is utilized for several purposes by a variety of users. Regional land use has been influenced by the following activities:

- the area has been utilized by First Nations for thousands of years;
- a variety of anthropogenic activities have occurred throughout the region including both hard rock and placer mining, forestry, hunting and gathering, transportation, recreation and residential;
- the project footprint lies within Registered Trapline Concession (RTC) #82;
- the sites lie within outfitting Concession #7;
- numerous historic mining related structures exist in the general area and are of interest to local community groups and government; and
- the area is known and used for recreational pursuits and has potential for tourism development.

This section addresses: recreation and tourism; First Nations subsistence harvesting and traditional use; sport and commercial hunting, fishing and trapping; and mineral exploration and development.

In general, potential effects on land and resource use resulting from the project are not anticipated to be significant. This outcome has been determined as Bermingham is situated within the area of existing disturbance, minimal footprint expansion is proposed, and Bermingham activity is consistent with activity already occurring within the proposed footprint.

10.2.1 Recreation and Tourism

Recreation and tourism are important in the Keno area and concerns have been raised by stakeholders about potential impacts on these values from mining activities in the KHSD. The Bermingham Mine is not anticipated to adversely impact recreation and tourism in Keno. The mine site is located in a currently disturbed area hidden from Keno City and Silver Trail Highway by topography and vegetation. The project involves limited footprint expansion and no increase in mine traffic.

The Bermingham mine site is not anticipated to significantly affect the visual aesthetics of the area because the site is not visible from Keno City or the Silver Trail Highway. The visual disturbance of mine traffic to and from the Bermingham site is expected to be minimal, because the traffic will be routed along the privately controlled Christal Lake road, which is not visible from Keno City.

Noise disturbance is addressed in Section 10.1.1. Impacts on tourism associated with noise disturbance from the Bermingham mine site are not anticipated.

Consistent with the trend in most small Yukon communities, tourism in the region has decreased over the past five years, as indicated by decreasing visitor numbers to the Mayo and Keno Visitor Information Centres (Derome & Associates, 2013). Fluctuations in visitor numbers in Keno City are consistent with the same trends in other communities within the Yukon.

Risks to public health and safety could result from access to the active mine sites and interactions with mine traffic along public roads. Signage is already in place at the Christal Lake road prohibiting the public from entering the mine site and warning of the dangers.

10.2.2 First Nations Subsistence Harvesting

The proposed project is not anticipated to impact traditional harvesting pursuits. While First Nations subsistence harvest in the general region, the project area is not known to be of particular importance for this purpose, most likely because of the high level of activity on the property. There is no settlement land in the vicinity of the project area.

10.2.3 Sport/Commercial Hunting, Fishing and Trapping

Very limited sport/commercial hunting or trapping is conducted in the KHSD, likely because of the high level of historic and present mineral development activity and general use of the area.

The project sites lie within RTC#82, which is currently unassigned (though FNNND have expressed interest in the trapline), and near RTC#83, assigned to Christine Hager. Alexco is aware of some trapping on Galena Hill, but otherwise trapping in the district is limited. The project is not anticipated to affect trapping. Alexco personnel will continue to be instructed not to disturb trapping equipment or activities.

The Bermingham Mine lies within hunting outfitting concession #7, operated by Rogue River Outfitters. Hunting on the Bermingham site is not allowed due to employee safety concerns and its close proximity to current operations and impacts on outfitting activities are not anticipated.

10.2.4 Mineral Development

Alexco owns the majority of quartz claims in the KHSD, and all the quartz claims within the Bermingham mine. Alexco has interacted with other mineral exploration and development users for several years and is of the opinion that continued communication will address any issues concerning claim holders.

10.3 LOCAL ECONOMY AND HUMAN RESOURCES

The economy of Keno City is based on tourism and mining. Consistent with the trend in most small Yukon communities, tourism in the region has decreased over the past five years, indicated by decreasing visitor numbers to the Mayo and Keno Visitor Information Centres (Derome & Associates, 2013). In addition to the Keno City Mining Museum, which provides excellent historical perspective on the KHSD, a population of butterflies also exists in the region and attracts interested individuals. The Signpost Viewpoint on Keno Hill Summit also attracts numerous tourists throughout the summer months.

Tourism in the Mayo area is an important industry. Accommodations, food services, recreation services (i.e. guiding and outfitting) and retail cater to tourists and provide employment for local residents. Tourist attractions in the area are linked with the history of mining around Mayo and Keno City. Camping and hiking, hunting and fishing, and other outdoor pursuits comprise the activities undertaken by tourists in the area.

The economy of Mayo is linked to the provision of services to the people of Mayo and the surrounding areas. One third of the jobs in the community are related to government services, including First Nation and territorial administration. Placer mining and mineral exploration and development also provide an economic base for the community. Construction also provides considerable employment to Mayo residents.

The Mayo Official Community Plan outlines local economic conditions and describes community priorities: “Mayo's economy is presently based on its role as a regional administrative and service centre, mineral exploration and placer mining and tourism. In addition, traditional activities play a large role in the community's economic life. Diversification and stabilization of the regional economy remains a community priority” (2006, p. 11). The Mayo Official Community Plan recognizes opportunities for local economic diversification in terms of supporting mineral exploration and development, expanding the local service sector, maximizing the use of the local labour force and reducing dependence on outsiders to fill local employment opportunities.

In cooperation with industry (developers/companies), the FNNND Development Corporation is establishing a number of training, work, and apprenticeship programs in the community. The First Nation works toward participation in land and resource development in their traditional territory and employs many FNNND citizens.

10.3.1 Economic and Employment Opportunities

Alexco's operations in the KHSD have provided numerous economic and employment opportunities to local and regional people and businesses. Alexco has a corporate commitment to hire as many Yukoners as possible and is very active in mine training initiatives necessary to increase the number of positions available to qualified Yukon residents. During active mine operations, Alexco employs approximately 70 Yukoners including approximately 15 Mayo residents and over 20 FNNND and other First Nations citizens. Alexco has entered into joint venture partnerships through the FNNND Development Corporation and has retained local contractors to provide a variety of services. The Comprehensive Cooperation and Benefits Agreement between FNNND and Alexco guides the creation of business development and employment opportunities for the First Nation.

Development and production at Bermingham is expected to require over 125 positions, including mine and mill operations and site services. To the extent possible, Alexco will source these positions locally or regionally. Under the Comprehensive Benefits and Cooperation Agreement between FNNND, Alexco notifies FNNND about new job postings as part of the company's internal posting procedure.

10.4 HERITAGE RESOURCES

The KHSD has rich historical significance and is characterized by numerous historic and heritage resources, largely related to past mineral development. As part of the KHSD Closure Plan, ERDC is developing a district-wide heritage plan in consultation with stakeholders, including YG Heritage Resources, FNNND, the Silver Trail Tourism Association, the Binet House Museum, the Village of Mayo, Keno City Mining Museum, Keno City and Indigenous and Northern Affairs Canada (INAC).

Adverse effects on heritage resources are not anticipated. Heritage Resources in the KHSD in general are known and in many cases, documented. The extent of new footprint associated with the project is limited and no heritage resources are known to exist in that area. In order to mitigate potential significant effects of the project on heritage resources, Alexco proposes to implement the existing Heritage Resources Protection Plan developed under QML-0009 (Appendix U). The Plan outlines specific response and notification protocols and mine site personnel training to protect heritage resources.

11 DECOMMISSION, RECLAMATION AND CLOSURE

Alexco has in place an approved (June 2015) Reclamation and Closure Plan (RCP) that addresses the currently permitted operations at Bellekeno, Flame and Moth, Lucky Queen and Onek including the mine(s) and Keno District Mill facilities. The Reclamation and Closure Plan - Keno District Mining Operations is structured to be amended and updated as new mines are developed and permitted. Financial security for implementation of the RCP is fully posted with YG and the plan is scheduled to be updated every two years. Alexco currently has in place $6.3M in security through a Letter of Credit to implement the approved RCP.

The Keno District Mining Operations RCP will be updated as part of the QML and WUL processes to reflect the addition of the Bermingham deposit and will be refined through the outcomes of the assessment process and ongoing engagement with FNNND, regulatory agencies and stakeholders. The only new mine components of the Bermingham project that are not already included in the currently approved RCP are the Bermingham mine portal and surface facilities (pond, office trailers, fuel storage, etc.). The closure objectives that guide the selection and refinement of reclamation and closure measures in the approved RCP will be used to update the RCP and the additional mine components associated with Bermingham.

11.1 CLOSURE OBJECTIVES

Closure objectives established in the Keno District Mining Operations RCP will be incorporated into the closure of the Bermingham mine. To ensure that the overall closure philosophy can be achieved, the following primary closure objectives were emphasized during the development of the RCP and will be continued for the update of the RCP to include Bermingham.

Protect Public and Worker Health and Safety, and Protect and Restore the Environment by:

- incorporating progressive reclamation where possible;
- providing slope stabilization and erosion control on linear and non-linear disturbances;
- ensuring long-term chemical stability of the waste rock disposal areas and components constructed from waste rock to minimize effects to downstream aquatic resources;
- ensuring the long-term physical stability of key structures such as portals, waste rock storage facilities, and access roads;
- conducting post closure monitoring of the site and adaptive management to assess effectiveness of closure measures for the long term;
- Ensure Land Use Commensurate with Surrounding Lands;
- Ensure Meaningful Participation of the FNNND;
- Ensure Cost Effectiveness; and
- Realize a Walk-away Closure Scenario.

These closure principles and objectives work to ensure both physical stability and chemical stability of the site in the long term and are reflective of the guidelines derived from the YG's Reclamation and Closure Policy. The effectiveness of closure measures implemented at the Keno District Mining Operations will be the subject of review by regulatory agencies and under the Yukon Quartz Mining Act; the company would be able to apply for a certificate of closure from the YG once there is agreement with their effectiveness.

Closure objectives can be considered in terms of the following key areas:

- (geo)chemical stability;
- water quality;
- physical stability; and,
- land use, aesthetics and public health and safety.

At closure the facilities for which physical stability must be addressed will be the portals, waste rock storage areas, any access roads not decommissioned, mill pad, and dry stack tailings facility.

11.2 MINE CLOSURE MEASURES

There are only minor amendments and adjustments necessary to the RCP to incorporate development activities at Bermingham. The same closure measures associated with the Bellekeno mine will be transferred and used for closure of similar facilities at Bermingham.

11.2.1 Closure Objectives

The objective for decommissioning the Bermingham infrastructure is to ensure: (1) physical stability (2) chemical stability of any mine discharge (3) that there are no threats to public health and safety, and (4) that the mine area is reclaimed such that it is aesthetically acceptable.

11.2.2 Closure Measures

Closure of the Bermingham mine will include restricting access and identifying and removing hazards and hazardous materials. Concern regarding physical stability of infrastructure at closure will be mitigated for the most part through disassembly and removal from the site, and by eliminating underground access. Additional chemical stability objectives will be associated with any soil contamination by fuel, chemicals or other wastes in the areas around the portal and treatment system. The Bermingham portal is expected to produce long term discharge therefore mine pool treatment is proposed.

At closure, underground equipment will be removed from the underground mine through the portal. The portal entrances will be blocked by inserting rock fill to protect human health and safety and prevent wildlife access. This method, in use at other northern Canadian mines, allows for movement of water and air through the opening, as well as allowing for any movement of rock walls, to prevent failure as would occur with a concrete plug for example.

Reclamation of the portal site will include removal of the surface facilities and other buildings (e.g. explosives and cap magazine). Fuel tanks will be cleaned and removed along with liners for reuse or landfilling. Any additional debris will also be removed for reuse or proper disposal. All solid waste will be disposed of in accordance with the Yukon Environmental Act Solid Waste Regulations. Alexco has a permitted commercial solid waste facility located in Elsa. All waste petroleum products and any other special waste, as defined in the Special Waste Regulations will be disposed of in accordance with the Regulations. Any soil contamination will be documented through a final site contamination assessment. Contaminated soil will be removed and/or remediated in an approved manner. A land treatment facility will be constructed near the Elsa Valley Tailings Facility for remediation of such soils for district closure, and can be used for remediation of any hydrocarbon contamination at the Bermingham mine. The portal site would then be recontoured and scarified to facilitate revegetation and establish drainage. Signage will be installed to indicate the portal presence.

11.3 WASTE ROCK CLOSURE MEASURES

Waste rock extracted from the Bermingham mine will be characterized according to industry standards laid out in the Waste Rock Management Plan (Appendix E). Waste rock is identified as being one of the following types: (a) potentially acid-generating (P-AML) (b) non-acid-generating (N-AML). Waste rock is separated according to its acid-generation potential and stored in a manner protective of the environment.

11.3.1 Closure Objectives

During operations and at closure, the physical and chemical objectives for the waste rock storage facilities and disposal areas are erosion control, geotechnical stability and geochemical stability.

11.3.2 Closure Measures

P-AML waste rock from Bermingham mine development and production activities will be used as priority material for underground backfill and it is not expected that any P-AML produced from Bermingham will remain on surface longterm.

Rock that is not potentially acidic or metals-leaching (N-AML), will be deposited in a waste rock disposal area (WRDA) as described in Section 6-5 or used for construction purposes including roads, laydown areas and the DSTF toe berm.

Permanent P-AML WRSF

There is no longterm WRSF envisioned for P-AML waste produced from Bermingham as all P-AML will be used as backfill.

Non-AML WRDA

In order to further increase stability and improve aesthetics, Alexco will recontour the structures constructed with N-AML by pulling the crests back with an excavator followed by scarification and revegetation of the flat surfaces. The final overall (crest to crest) slope of the WRDA will be 3H:1V.

11.4 ROAD CLOSURE MEASURES

All roads will be upgraded from existing roads will be subject to standard road decommissioning and reclamation measures at closure. These roads will be resloped and scarified, culverts removed and seeded in areas where erosion control is necessary.

11.4.1 Closure Objectives

The primary consideration for the physical stability of roads at closure will be slope stability where culverts have been removed and intermittent drainage channels have been established through the road alignments which could lead to localized erosion.

11.4.2 Closure Measures

Standard road decommissioning and reclamation measures at closure include culvert removal, resloping banks and removal of the safety berm to reflect the natural topography as well as provide stability, and surface scarification to encourage natural revegetation). Regrading/contouring the roads will ensure that runoff sheds off the road surface. Localized seeding will take place where erosion control is necessary.

12 PROJECT ALTERNATIVES

There are several project alternatives that were considered in developing this Project Proposal. Each of these are further described and rational for the final alternative selection is discussed.

Development and Production at other deposits

Advancing an alternative deposit other than Bermingham (i.e. Silver King, Husky) to production at this time was a consideration. There are not sufficient resources at any other deposit in the district that would supersede the Bermingham deposit in terms of tonnage, grade, value, location and level of risk.

Alternative haul route to mill

Alternative haul routes for trucking Bermingham ore were considered. The primary alternative considered was via Calumet road to the Silver Trail Highway and via the Christal Lake Road to the mill. This route would have significant more interaction with Keno residents and tourist as the majority of the route is via public road, whereas the proposed route is the majority on an Alexco controlled road.

13 REFERENCES

Access Consulting Group. (2015) *Summary of Geochemical Characterization of Flame & Moth Tailings.* August 6, 2015.

Alexco Keno Hill Mining Corp. (AKHM) (2012) *Keno Hill Silver District Operations Lucky Queen and Onek Deposit Production.* Project Proposal Submission to YESAB, April 2012.

Access Mining Consultants Ltd. 1996. United Keno Hill Mines Limited – Site Characterization, Report No. UKH/96/01.

Alexco Environmental Group Inc. (AEG) (2017a). Advanced Underground Exploration of the Bermingham Deposit – Groundwater Dewatering Estimate for the Proposed Decline [Memorandum]. March 21, 2017.

Alexco Environmental Group Inc. (AEG) (2017b). Silver King in situ treatment pilot test update, Keno Hill, YT. Report prepared for Elsa Reclamation and Development Company Ltd., March 2017.

Alexco Keno Hill Mining Corp. 2013. Keno Hill Silver District Mining Operations Adaptive Management Plan.

Belfort Instrument. 2013. Reducing Precipitation Gauge Inconsistencies Using Modern Wind Deflection Methodologies.

British Columbia Ministry of Environment (BCMoE) (2016). British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Summary Report. Water Protection & Sustainability Branch, Ministry of Environment, March 2016.

Cathro, R.J. (2006) Great Mining Camps of Canada 1. The History and Geology of the Keno Hill Silver Camp, Yukon Territory. Geoscience Canada, 33, 103-134.

Canadian Council of Ministers of the Environment (CCME) (2017). Canadian Water Quality Guidelines for the Protection of Aquatic Life. Accessed at http://st-ts.ccme.ca/' September 2017.

Canadian Council of Ministers of the Environment (CCME) (2003). Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedure for Deriving Numerical Water Quality Objectives.

Cathro, R.J., 2006. The History and Geology of the Keno Hill Silver Camp, Yukon Territory, Geoscience Canada, v. 33, No. 3, p. 103 – 134.

CRC (2005) *Handbook of Chemistry and Physics, 85th Edition.* CRC Press. Boca Raton, Florida.

Derome & Associates. October 2013. Influence of Changing Travel Patterns and Modes of Transportation on Visitor Numbers in Dawson City, Mayo and Keno, Yukon. Derome & Associates Development + Management Inc.

Gault, A.G., Jamieson, H.E. and Sherriff, B.L. (2013) Mechanisms of Zn and Cd sequestration in No Cash Creek, Yukon, Canada. Report prepared for Access Consulting Group, Whitehorse, YT, August 12th, 2013

Interralogic Inc. (ITL). 2010. *2010/2011 South McQuesten Water Quality Investigation*. Technical Memorandum prepared for Access Consulting Group.

Interralogic Inc. (ITL). 2012. *Dispersed Tailings and Drainage Studies – United Keno Hill Mines Yukon Territory, Canada*. Prepared for Access Consulting Group.

Interralogic Inc. (ITL). 2013. N*atural Attenuation Evaluation Summary Report, United Keno Hill Mines, Elsa, YT, November 2013*. Draft Report prepared for Elsa Reclamation and Development Company Ltd.

Lortie, G, February 2009. Current State of Wildlife in the Keno Hill Silver District.

MacDonald, Jimmy P. and John W. Pomeroy. 2007. Gauge Undercatch of Two Snowfall Gauges in a Prairie Environment. 64th Eastern Snow Conference. St. John's, Newfoundland, Canada, 2007.

Minnow Environmental Inc. (2015) *Draft Memorandum: Proposed Water Quality Goals for United Keno Hill Complex Watersheds*. February 23, 2015.

Patching and Associates Acoustical Engineering Ltd. 2012. Noise Impact assessment, Keno Hill Silver District Operations, Yukon Territory, Rev 1

Price, W.A. (2009) *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials*. MEND Report 1.20.1. CANMET – Mining and Mineral Science Laboratories, Smithers, BC.

Skousen, J., Renton, J., Brown, H., Evans, P., Leavitt, B., Brady, K., Cohen, L. and Ziemkiewicz (1997) Neutralization Potential of Overburden Samples Containing Siderite. Journal of Environmental Quality, 26, 673-681.

SRK Consulting (2009) 2007/08 Geochemical Studies, Keno Hill Silver District, YT. Report prepared for Elsa Reclamation and Development Company Ltd., February 2009.

APPENDICES - UNDER A SEPARATE COVER