KENO HILL SILVER DISTRICT MINE OPERATIONS

ADAPTIVE MANAGEMENT PLAN

May 2022

Prepared by:

ALEXCO KENO HILL MINING CORP.

DOCUMENT REVISIONS

DATE	SECTION	SUMMARY OF CHANGES
July 2007		ERDC District-wide AMP issued
April 2011		Initial AKHM AMP based on district-wide AMP issued Principal activities Bellekeno Mine and Mill added Existing plans under QML-009 and WL QZ09-092 added Links to existing monitoring and management plans added
	AMIs #1, #4, #5	Events previously described in the district-wide AMP revised (AMP1 now AMI#1, AMP6 now AMI #5, AMPs 7 and 8 now AMI #4) to be specific to the Bellekeno Mine and the District Mill
	AMIs #2, #6, #7, #10 to #13	Events added
	AMI #7, AMI #8	Erosion and transport of sediment into Christal Creek from Mill discharge pending design
	AMI #14	Water quality impacts to Keno City water wells added
September 2012	AMI #1, #2, #4, #13	Onek and Lucky Queen incorporated
	AMI #15	Erosion and permafrost degradation at Onek and Lucky Queen added
	AMI #16	Operation of Lucky Queen WTP added
	References	Section added
January 2014	AMI#1	Triggers used to initiate action for parameters without EQSs added
	AMI #2	N-AML waste rock kinetic tests added
	AMI #7, AMI #8	Erosion and transport of sediment into Christal Creek from Mill discharge provided
October 2016	AMI #1, #2, #4, #8, #9, #12, #13, #14	Flame & Moth incorporated
	AMI #1, AMI #12	Significant thresholds EQS and WQOs for Christal Creek and Lightning Creek added Triggers used to initiate actions added for specific indicators
	AMI #2	Seepage from DSTF and tailings kinetic tests added
	AMI #6	Water level in DSTF monitoring wells added
	AMI #17	Dust generation added
March 2018	AMI #1	Triggers used to initiate action for Flame & Moth discharge quantity added
	AMI #2	Sulphate and alkalinity added as indicator parameters
	AMI #6	Water level in DSTF monitoring wells moved to AMI #13
	AMI #8	Trigger used to initiate actions added
	AMI #12	KV-50 station added Trends compared to preceding 3 years added 95th percentile and UCLM based on 12-month moving average added Radium WQOs added
	AMI #13	Groundwater triggers for action revised Trigger used to initiate action for water in DSTF moved from AMI #6 DSTF expansion area incorporated
	AMI #18	Attenuation of effluent discharge into Christal Creek added
October 2020	AMI #1	Update to mass load models
	AMI #2	Review of waste rock geochemical testing data, particularly kinetic testing, added as part of the monitoring requirements and specific thresholds.

	AMI #12	Integration of WQOs at KV-111 between May and September added Arsenic WQO for KV-21 updated Text describing a workshop with representatives of the three levels of government to develop a mechanism to update the WQO at KV-21 once treatment of the historical No Cash 500 adit has been implemented. A candidate approach to updating the KV-21 WQO is also presented.
	AMI #12, AMI #13	Ammonia, zinc, cadmium, selenium and uranium added to the parameters being used to establish thresholds and monitor trends for changes in water quality.
October 2021	AMI #1	The requirement to update the Christal Creek, Lightning Creek, and No Cash Creek mass load models annually has been added
	AMI #12, AMI #13	Updated AMP triggers added based on evaluation of a longer data set (see Appendix A)
	Appendix A	Appendix A, Assessment of Water Quality Triggers added.
May 2022	Entire document	This version of the Adaptive Management Plan (AMP) has been prepared by Alexco Keno Hill Mining Corp (AKHM) pursuant to Section 6.0 and Schedule C Part 2 of QML-0009, as updated December 9, 2021. In 2021, an independent contractor was retained to conduct an audit of the 2018 and 2020 AMPs in accordance with the requirements of QML-0009 Section 12.0. The audit identified opportunities for improvement and recommended modifications and updates to the 2020 AMP (Morrison, 2021).
	Document Revisions	Section added to record the entire version history for the AKHM AMP. Key revisions made to specific AMI tracked.
	List of acronyms and abbreviations	Section added
	References	Section added

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LIST OF ACRONYMS AND ABBREVIATIONS

ABA	Acid Base Accounting
AKHM	Alexco Keno Hill Mining Corp.
Alexco	Alexco Resource Corp.
AMI	Adaptive Management Initiative
AMP	Adaptive Management Plan
CCASP	Christal Creek Natural Attenuation Study Plan
CCME	Canadian Council of Ministers of the Environment
DSTF	Dry Stack Tailings Facility
EQS	Effluent Quality Standard
ERDC	Elsa Reclamation and Development Company
FNNND	First Nation of Na-Cho Nyak Dun
ICP	Inductively Coupled Plasma
KHSD	Keno Hill Silver District
MDMER	Metal and Diamond Mine Effluent Regulations
N-AML	Non-Acid Metal Leaching
NCCASP	No Cash Creek Natural Attenuation Study Plan
OMS	Operational Monitoring and Surveillance Manual
P-AML	Potentially-Acid Metal Leaching
PM	Particulate Matter
PM_{10}	Aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Aerodynamic diameter of less than 2.5 µm
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
WL	Water Licence
WQO	Water Quality Objectives
WRSA	Waste Rock Storage Area
WTP	Water Treatment Plant
YCSR	Yukon Contaminated Sites Regulation
YESAA	Yukon Environmental and Socio-economic Assessment Act
YESAB	Yukon Environmental and Socio-economic Assessment Board
YG	Yukon Government
YWB	Yukon Water Board

1 INTRODUCTION

1.1 OVERVIEW

Alexco Keno Hill Mining Corp. (AKHM), a wholly-owned subsidiary of Alexco Resource Corp. (Alexco), owns and operates the Keno Hill Silver District (KHSD) Mine Operations in the central Yukon. The site is 354 km north of Whitehorse, in the vicinity of Keno City (Figure 1-1). The KHSD Mine Operations comprise a series of small underground silver/lead/zinc mines with a centralized mill as presented in Table 1-1 and Figure 1-2.

Table 1-1: Keno Hill Silver District Mine Operations Overview

Location	0.5 to 4 km from Keno City, 45 km northeast of Mayo, 354 km north of Whitehorse, YT
Land Position	Alexco Resource Corp. and its wholly-owned subsidiaries ERDC and AKHM own 1,563 claims and leases covering an area of approximately 24,262 ha within the Keno Hill Silver District including the Bellekeno, Flame & Moth, New Bermingham, Onek and Lucky Queen, deposits Two Fee Simple lots within KHSD total 59 ha (Lot 960 and Lot 956)
Mines/Ore Deposits	Bellekeno (Production 2010 – 2013, suspended 2013 – 2020, production 2020, temporary closure 2020) Flame & Moth (Development 2018, suspended 2018 – 2020, development and production 2020 - present) Bermingham (Advanced exploration 2017 – 2018, development and production 2020 - present) Lucky Queen, Onek 990 (Advanced exploration 2013, not active)
Mining Method	Year round underground narrow vein cut and fill / longhole stope mining with cemented rock fill and unconsolidated rock fill
Current Total Project Life [1]	8 years construction/development/operations/progressive reclamation 2 year final decommissioning and reclamation 10 years closure monitoring and maintenance
Production Rate	400 tonnes/day (Bellekeno, Flame & Moth, Bermingham)
Schedule	Ore mining and milling operations 365 days/year
Mill Recovery Process	Conventional flotation process producing separate lead/silver concentrate and zinc concentrate shipped off site for smelting District Mill location at historic Flame & Moth pit area (Constructed 2010) Tailings placed in Dry Stack Tailings Facility or underground as backfill (Established 2010)
Work Force	~ 200 employees and contractors during active mine operations
Airstrip	Village of Mayo, YT
Camp Facilities	Flat Creek camp facilities include a trailer camp, kitchen facility, welcoming center and dry Four refurbished houses and a bunkhouse located nearby in the townsite of Elsa
Power	Hydro grid power Yukon Energy, diesel power backup
Water Supply and Use	Water use and discharge within 3 drainages, Lightning Creek, Christal Creek and No Cash Creek. Conventional lime precipitation water treatment at Bellekeno 625, Flame & Moth, and New Bermingham. Ammonia treatment via breakpoint chlorination at Flame & Moth and Bermingham. Process water is recycled to the plant for milling.
First Nations	First Nation of Na-Cho Nyak Dun (FNNND)
Notes	1. Mine operating plans are continuously reviewed and optimized depending on a variety of factors including metals prices, exchange rates, underlying operating costs (fixed and variable), ore grades, etc. As these and other factors change, both positively and negatively, ore production profiles from each of the mines will change. Depending on the various parameters, mines may come in and out of the Life of Mine plan as factors change.

The KHSD has a long mining history and is a brownfields site. AKHM develops the mineral resources of the KHSD and undertakes receiving environmental monitoring and treatment of mine discharge waters. Alexco's wholly owned subsidiary Elsa Reclamation & Development Company Ltd. (ERDC) undertakes care and maintenance, environmental monitoring and water treatment of historic adit drainages, district-wide closure planning and studies for the historic environmental liabilities. ERDC will commence reclamation of the historic liabilities upon approval of the Yukon Water Board and receipt of permits.

Table 1-2: Keno Hill Silver District Mine Operations Timeline

2006 - 2008:	Alexco acquires KHSD and begins aggressive surface exploration programs, focus on expansion of Bellekeno resource
2009:	Underground development and construction at Bellekeno begins
2010:	Comprehensive Cooperation and Benefits Agreement signed with FNNND AKHM constructs the mill and surface facilities, and establishes the DSTF
2011:	Production at Bellekeno Mine and Keno District Mill Surface exploration at Flame & Moth begins
2012:	Development and rehabilitation of Lucky Queen adit Development of new Onek 990 decline
2013:	Temporary suspension of Bellekeno Mine operations and milling AKHM monitors KHSD Mine Operations sites during care and maintenance
2014 – 2020:	Permitting and development of Flame & Moth and New Bermingham mines Continued surface exploration, advanced underground exploration decline at Bermingham deposit Decline development at Flame & Moth and New Bermingham mines Care and maintenance and water treatment
2021:	Ore production from Bellekeno and New Bermingham Camp, surface facilities, and mill upgrades Mine development at Flame & Moth and Bermingham Temporary suspension of Bellekeno Mine operations. Continued surface exploration and water treatment
2022	Ore production and development at New Bermingham and Flame & Moth mines Continued surface exploration and water treatment

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2021 ANNUAL REPORT QUARTZ MINING LICENSE
QML-0009

FIGURE 1-1
PROJECT LOCATION

MARCH 2022

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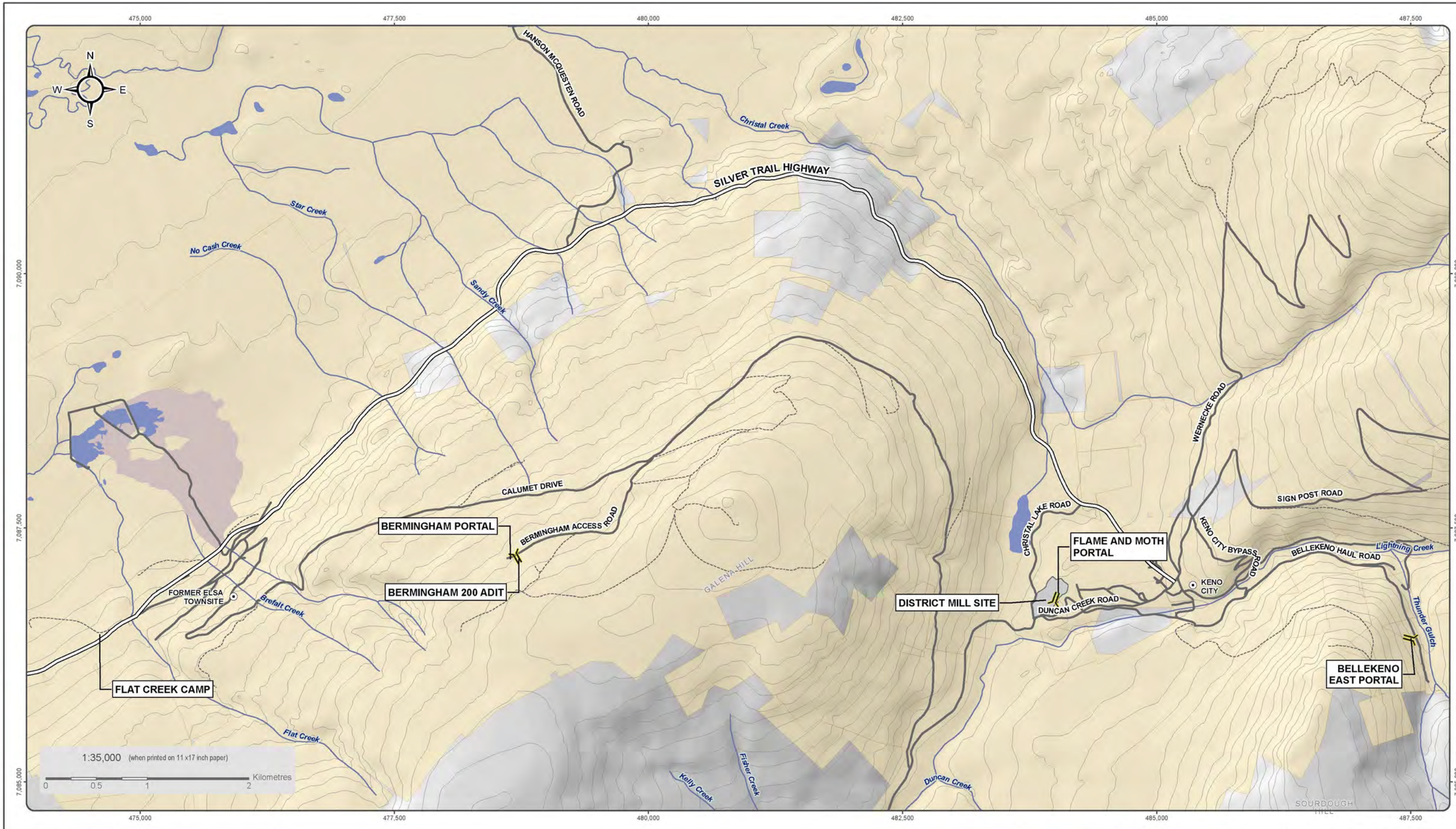

- Place of Interest
- Adit
- Alexco/ERDC Quartz Claims
- Tailings Area
- Waterbody
- Watercourse
- Silver Trail Highway
- Road
- Limited-Use Road

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FIGURE 1-2
KENO HILL SILVER DISTRICT
MINING OPERATIONS OVERVIEW

MAY 2022

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1.2 PROJECT ACTIVITIES

The principal activities involved with development and production of the underground mines and the operation of the conventional flotation mill include:

- Mining ore and waste rock from Bellekeno, Flame & Moth, and New Bermingham mines;
- Placement of potentially acid metal leaching (P-AML) rock within engineered waste rock storage facilities;
- Placement of non-acid metal leaching (N-AML) rock in waste rock disposal areas;
- Crushing, grinding, flotation, thickening, filtration, and production of a lead-silver concentrate, zinc concentrate, and tailings streams at the District Mill;
- Placement of tailings in the engineered Dry Stack Tailings Facility (DSTF);
- Placement of tailings and waste rock as backfill within the former underground vein areas; and
- Use of water for camp purposes and quartz mining undertakings.

Ancillary activities include:

- Treatment of water from Bellekeno, Flame & Moth, New Bermingham mines, and the District Mill;
- Construction of earthworks and erosion control protection measures;
- Maintenance and operation of site infrastructure, including access roads;
- Site security and maintenance of site facilities and structures for public health and safety;
- Operation and maintenance of a camp for up to 200 people; consisting of bunkhouse accommodations, mine dry, cooking facilities, water and sewage facilities, heating, and recreational facilities;
- Operation and maintenance of hazardous material storage areas and fuel containment facilities;
- Deposit of waste as lime treatment sludge;
- Non-hazardous solid waste disposal; and
- Environmental monitoring, inspections, and sampling programs; including monitoring and inspection of physical structures, air quality, noise, waste rock, surface water, groundwater and treated mine water prior to discharge.

1.3 REGULATORY CONTEXT

The Bellekeno, Flame & Moth, and New Bermingham mines have all permits and authorizations in place for mine production. The existing approvals and assessments for exploration, mining activities, and for ERDC care and maintenance activities are summarized in Table 1-3.

Table 1-3: Relevant Assessment and Regulatory Approvals

Purpose	YESAA Approval	QUARTZ MINING ACT APPROVAL	Water Use Licence
Alexco Keno Hill Mining Corp. Permits			
Bellekeno Advanced Exploration	Project #2008-0039 Decision Document	Class 4 Mining Land Use Approval (LQ00476, expires 2028)	Type B Water Use Licence QZ07-078/Amendment 1 QZ10-060, licence cancelled in 2015. Replaced by amended type A Water Licence in 2015[2]
Bermingham Advanced Exploration	Project#2017-0086 Decision Document	Class 4 Mining Land Use Approval (LQ00476, expires 2028)	Schedule 3 Notice of Water Use/Deposit of a Waste without a Licence
Bellekeno Mine Production	Project #2009-0030 Decision Document	Quartz Mining Licence (QML-0009, Amendment 2, expires 2037)[1]	Type A Water Use Licence QZ18-044, expires 2037[2]
Onek 990 and Lucky Queen Mine Production	Project#2011-0315 Decision Document	Quartz Mining Licence (QML-0009, Amendment 2, expires 2037)[1]	Use of water and the deposit of waste into water is not authorized
Flame & Moth Mine Production	Project #2013-0161 Decision Document	Quartz Mining Licence (QML-0009, Amendment 2, expires 2037)[1]	Type A Water Use Licence QZ18-044, expires 2037[2]
Bermingham Mine Production	Project#2017-0176 Decision Document	Quartz Mining Licence (QML-0009, Amendment 2, expires 2037)[1]	Type A Water Use Licence QZ18-044 issued, Expires 2037[2]
Elsa Reclamation and Development Company Ltd. Permits			
Care and Maintenance	Project #2006-0293 and 2012-0141	N/A	Type B Water Use Licence QZ17-076 expires 2022[2]
Reclamation Plan	Project #2011-0187 Decision Document (land treatment facility) Project #2012-0077 Decision Document (building demolition) Project #2018-0169 Decision Document (Reclamation Plan implementation)	N/A	Submitted application QZ21-012 to Water Board following issuance of YESAB Decision Document for Project #2018-0169

Notes
1. https://emr-ftp.gov.yk.ca/emrweb/COMM/major-mines/keno-hill/mml-keno-qml-0009-nov2019.pdf
2. http://www.yukonwaterboard.ca/waterline/

1.4 LINKAGES TO OTHER OPERATIONAL MANAGEMENT PROGRAMS

AKHM has developed operational management plans to guide activities and monitoring associated with expected operating conditions at the Bellekeno, Flame & Moth, and New Bermingham mines, and the District Mill. Table 1-4 lists the plans that have been created or updated as part of Water Licence QZ18-044 and the Quartz Mining License QML-009 and describe the management and response actions for expected conditions.

The AMP is designed to provide a framework for the review of the monitoring data and proactive identification of conditions that may lead to adverse effects. If the results indicate that there are no negative environmental impacts, then the management and response actions would continue as usual. Adaptive management will be implemented to respond to negative trends observed through the operational management programs.

Table 1-4: Operational Management Plans Under the Existing Mine Licenses

QML-009 PLANS	WL QZ18-044 PLANS
• Emergency Response Plan	• Attenuation Study Plans
• Construction Site Plan	• Bioreactor Design and Operation Plan
• Dry Stack Tailings Facility Construction and Operation Plan[3]	• Detailed Water Balance Report
• Dust Abatement and Monitoring Plan	• Environmental Monitoring, Surveillance and Reporting Plan[1]
• Explosives Management Plan	• Groundwater Monitoring Plan[2]
• Hazardous Materials Management Plan	• Hydrogeology Monitoring Plan
• Heritage Resources Protection Plan	• Mass Load Models
• Mill Development and Operation Plans	• Physical Inspections and Reporting Plan[1,2]
• Mine Development and Operation Plan	• Receiving Environment Study
• Noise Monitoring and Management Plan	• Reclamation and Closure Plan[1]
• Road Construction Plan	• Sludge Management Plan
• Spill Contingency Plan	• Tailings Characterization Plan[1]
• Traffic Management Plan	• Waste Rock Management Plan[1]
• Waste Management Plan	• Water Management Plan
• Wildlife Protection Plan	• Water Treatment Systems Operating Manuals

Note: 1. Plan required under both the QML and WL
2. Included as an appendix to the Environmental Monitoring, Surveillance and Reporting Plan
3. Included as an appendix to the Physical Inspections and Reporting Plan

AKHM recognizes that the activities associated with the Bellekeno, Flame & Moth, and New Bermingham mines and the District Mill are being performed in a historic mining district which includes waters and physical workings at the KHSD that could potentially become an environmental risk or hazard that do not yet require immediate attention. The discharge of treated water, and placement of waste rock, tailings and water treatment sludge is being performed in watersheds that are impacted by historic mining operations. As the reclamation and closure of historic liabilities is implemented by ERDC in the KHSD, it is expected that changes in the environmental status of the AKHM's KHSD Mine Operations will be observed.

In addition, results of the monitoring programs undertaken by ERDC also inform the environmental performance of the KHSD Mine Operations.

2 ADAPTIVE MANAGEMENT PLAN APPROACH

2.1 GOALS AND OBJECTIVES

An adaptive management plan (AMP) is a management tool designed to guide responses to unforeseen or contingency events respecting, for example, water quality and quantity and physical conditions of site workings and infrastructure. The adaptive management approach will provide for assessment of mitigation measures and their effectiveness and guide the orderly implementation of responses. Since it is difficult to predict the specific environmental conditions that may arise and which require a response from management, the AMP does not necessarily provide specific detailed descriptions of responses to every situation. The AMP provides procedures that can be implemented to ensure appropriate action is taken before adverse effects are realized.

The AMP, and a Management Response Plan (MRP) developed as a result, provide possible management responses that range in level of intervention or mitigation.

2.2 UPDATED ADAPTIVE MANAGEMENT APPROACH

The AMP is laid out using a common element approach to consistently implement the AMP protocols for each Adaptive Management Initiative (AMI). An Adaptive Management Initiative (AMI) is a specific condition, or event, that is anticipated to require monitoring, assessment, and management as part of the AMP. The AMP follows the Yukon Government Guidelines for developing adaptive management plans in Yukon, water-related components of quartz mining projects (Yukon Government, 2021). For each AMI a methodical approach is provided:

1) Description of the event and possible environmental consequences - Addresses issues or information that trigger the AMP;
2) Location of possible event occurrence – Identifies specific working site locations if applicable to event;
3) Monitoring requirements – Identifies the parameters to be monitored, frequency and means for monitoring each parameter;
4) Specific indicators and thresholds - Defines the conditions when management actions should be taken. There may be a series of indicators and staged thresholds for an individual event; and
5) Approach to responses – Description of the approach to staged responses including notification, evaluation, response planning, action and timelines.

3 ADAPTIVE MANAGEMENT INITIATIVES

AMIs have been developed for the KHSD Mining Operations to address the following risks:

1) Increase in contaminant load from mine water discharge or the water treatment plant effluent causes adverse effects to aquatic resources in the receiving environment;
2) Acidic or metal leachate occurs because of seepage or runoff though N-AML waste rock or the DSTF;
3) Seepage from or lack of storage capacity in the sludge storage areas results in a risk to aquatic resources;
4) Physical instability of waste rock disposal areas or underground workings endangers the health and safety of site employees or visitors, or leads to an increase in contaminant loading to the receiving environment.
5) Public access to the site creates an unacceptable safety risk to mine employees, contractors, and the public;
6) Modelling has underestimated the foundation pore pressures leading to slope failure and exposure of tailings in the long term;
7) Large precipitation event erodes through the surface cover, exposes the tailings resulting in transport of tailings into the natural environment;
8) Erosion develops because of water being discharged from a WTP or the District Mill ponds;
9) Transport of sediment from the District Mill or WTP discharge areas causes an adverse effect to the receiving environment;
10) Large differential settlement in the long-term leads to tailings exposure on the surface from compromised cover;
11) Large differential settlement of a water conveyance or water retaining structure leads to an uncontrolled release of contact water to the environment or effluent to the environment.
12) Surface water quality objectives exceeded in the receiving environment occurring irrespective of compliance with effluent discharge standards;
13) Flux of geochemical load from the mines, waste rock disposal areas, or DSTF via groundwater pathways causes surface water quality objectives to be in exceeded downgradient;
14) Fugitive dust generated exhibits potential effects on the community of Keno City; and
15) Natural attenuation of several metals in Christal Creek or No Cash Creek is reduced or stopped, which results in a risk to aquatic resources resident in the creeks.

3.1 AMI #1 – CHANGE IN DISCHARGE WATER QUALITY OR QUANTITY

3.1.1 Description

Water quality and quantity is currently monitored from the Bellekeno, Flame & Moth and New Bermingham mine workings, their associated water treatment plant (WTP) and the District Mill for potential effects to the receiving environment. The nearest waterbodies to these sites are described below and shown on Figure 3-1.

- The Bellekeno Mine is near the confluence of Thunder Gulch with Lightning Creek. Bellekeno 625 WTP discharge reports to ground, flowing via a diffuse surface pathway into Lightning Creek, downstream of Thunder Gulch;
- The District Mill pond is located south of Christal Lake, and immediately north of Lightning Creek. When required, the pond discharges to ground in the Christal Creek catchment;
- The Flame & Moth Mine is located adjacent to the District Mill along Lightning Creek. The Flame & Moth WTP can discharge to Christal Creek or Lightning Creek. Discharge into Christal Creek reports to ground, while discharge into Lightning Creek is into surface water; and
- The New Bermingham WTP discharges to ground in the upper No Cash Creek catchment.

Monitoring of mine and WTP effluent discharge water quality and quantity is required under WL QZ14-044 to ensure that effluent discharge limits are not exceeded.

3.1.2 Risk Narrative

Increase in contaminant load from mine water discharge or the water treatment plant effluent causes adverse effects to aquatic resources in the receiving environment.

3.1.3 Monitoring Requirements and Evaluation of Results

When the treatment ponds are discharging, daily water quality samples are taken at the mine sites and analyzed on-site for zinc, ammonia, turbidity, total suspended solids (TSS), temperature, conductivity, and pH as well visual observations of the settling ponds are made, and equipment operating status verified. Evaluation of the inspection and sample results is conducted by the WTP operators in consultation with the Mill Manager and Mill Superintendent. The results allow the WTP operators to change plant settings (e.g., lime addition rates and pond clean-out activities) in order to maintain effluent quality standard (EQS) prior to discharging to the environment. Results of on-site testing and measurements are recorded in a daily tracking spreadsheet which incorporates predefined set point triggers that flag conditions where changes to plant settings are required.

Weekly water quality samples of effluent discharge and untreated mine water are submitted to an external laboratory for analysis of inductively coupled plasma (ICP) metals analysis (total and dissolved), Ammonia-N, Nitrite-N, Nitrate-N, phosphorous, sulphate, dissolved organic carbon (DOC), hardness, alkalinity, TSS, pH and conductivity. Tests to determine acute lethality of effluent discharge on rainbow trout, 96-h LC_{50} (median lethal concentration) at 100% concentration, are conducted monthly. The frequency of sublethal toxicity testing and Radium 266 on the effluent discharge is in accordance with federal *Metal and Diamond Mine Effluent Regulations* (MDMER).

The external laboratory results are evaluated, and quality checks made by a qualified professional (QP) upon receipt of weekly results. All data for water sample stations required in the WL QZ18-044 are stored in an EQWin database that allows water quality and quantity to be tracked at each site such that conditions can be identified at any point in the season. In this way parameters can be tracked, and fluctuations from the normal levels where management is required to respond can be monitored. Set point triggers are in place within the database so that response parameters are flagged for notification and action. Results of the evaluation are reported to AKHM immediately. The effluent discharge station ID and the description used in WL QZ18-044 are provided in Table 3-1

Table 3-1: Effluent Discharge Station Description and Identifier

SITE	SITE DESCRIPTION
KV-42	Bellekeno 625 Adit
KV-43	Bellekeno 625 Settling Pond Decant
KV-82	District Mill Pond
KV-83	District Mill Treatment Plant Discharge
KV-105	Flame and Moth Portal
KV-104L	Flame and Moth Settling Pond Decant discharge to Lightning Creek
KV-104C	Flame and Moth Settling Pond Decant discharge to Christal Creek
KV-110	New Bermingham Portal
KV-114	New Bermingham Pond Decant

The Flame & Moth WTP can discharge to Christal Creek or Lightning Creek. The EQS for each watershed is defined by the discharge rate, as listed in Table 3-5 and Table 3-6. Mine development and operations require continual dewatering through the Flame & Moth portal. The effluent discharge rate from the mine is limited to 3,024 m^3/day, or the equivalent of continuous discharge at 35 L/s.

During operation, the Bellekeno Mine requires continual dewatering through the Bellekeno 625 Adit. The maximum effluent discharge rate from Bellekeno WTP is 864 m^3/day, or the equivalent of continuous discharge at 10 L/s. The EQS for discharge from the Bellekeno WTP are included in Table 3-3.

The EQS for discharge from the New Bermingham WTP are included in Table 3-7. The maximum effluent discharge rate from New Bermingham WTP is 13.9 L/s (1,200 m^3/day).

Discharge flow rates from the underground workings at each mine are monitored continuously via a totalizer flow meter. The data from the flowmeter and totalizer is downloaded daily and analyzed monthly. The average daily totalized flow for each month will be compared with the trailing 24 months of water flow to establish trends and to determine significant deviation from the trends.

Effluent discharge from the District Mill Pond (referred to as the District Mill Treatment Plant in WL QZ18-044) is limited to 864 m^3/day and is not to exceed a rate of 10 L/s, nor 0.8% of the corresponding total monthly volume of flow passing monitoring station KV-6 on Christal Creek. The EQS for discharge from the District Mill pond, should it occur, is included in Table 3-4.

Water balances for each mine and the District Mill are refined as water use, effluent discharge and meteorology information is collected during operations. This information is used to review and refine assumptions utilized in the water balances that are reported as part of the annual report. In addition, the measured flow and water

quality data from the mine workings and WTPs is used to update the Lightning Creek, Christal Creek, and No Cash Creek mass load models and validate the model predictions.

Monthly and annual reports on water quality monitoring results are submitted under WL QZ18-044. An annual report is also submitted under QML-0009 and with Environment Canada as required under the MDMER. All monthly and annual reports are provided to FNNND.

3.1.4 Indicators, Action Levels, Management Responses

3.1.4.1 Significant Change in Water Quality

The specific water quality indicators being monitored and assessed in the untreated mine water and WTP effluent discharge to assess whether a trigger has been activated include metals analysis (total and dissolved), ammonia, nitrite, nitrate, phosphorous, sulphate, dissolved organic carbon, hardness, alkalinity, TSS, pH and conductivity.

Action level triggers have been developed based on the EQS parameters for the Bellekeno WTP (KV-43, Table 3-3), the District Mill pond (KV-83, Table 3-4), the Flame & Moth WTP (KV-104C, Table 3-5 and KV-104L, Table 3-6) and the New Bermingham WTP (KV-114, Table 3-7). An increasing trend whereby the water quality objectives (WQO) in the receiving environment maybe be exceeded is used to assess parameters without effluent discharge standards (i.e., nitrate, nitrite, selenium, uranium, sulphate).

Specific thresholds for the Bellekeno 625 adit, Flame & Moth portal and New Bermingham portal discharges applied to determine if mine water source quality had been significantly altered are trends in zinc, cadmium, ammonia, turbidity, TSS, pH and conductivity. Monthly averages of pH, conductivity, ammonia, cadmium and zinc are considered good surrogate parameters to identify water quality changes that may affect water treatment. Due to the nature of mining activities high concentration of suspended solids and metals found in the suspended solids are periodically expected as sumps are cleaned out or during dewatering changes; consequently, metals concentrations will not be a primary trigger.

The management response strategy for AMI #1 is to assess, characterize and define a potential problem at the low action level. At the moderate action level, a QP will be engaged to assist in identifying the root cause, assess the effectiveness of the existing water treatment and to support AKHM in the design of mitigation measures. At the high action level, the MRP will be implemented with on-going monitoring and reporting.

Responses to changes in water quality from treatment plants and changes in adits will be different to account for the level of control over the results of water quality, where treatment plants are actively managed, while a mine's water quality is dependent on the native groundwater associated with veins, host rock, recharge, and other factors not directly under the control of the mine operator. A screening level water quality study may implemented using field pH and conductivity equipment to identify mine areas that may be contributing to the change in mine water quality.

Depending on the results of the evaluations, the MRP may considered the following measures:

- Reduce WTP discharge rates until corrective actions are implemented;
- Storage of water in underground sumps or the mill sediment pond to the extent practical to limit discharge until root causes have been identified and a solution implemented;

- If a root cause can be identified, plans will be implemented to manage the water quality, which may include modification of the water treatment plant design or operating approach.

3.1.4.2 Significant Change in Water Quantity

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated is observed ingress flow into the underground working and measure mine water discharge rates.

Short term temporary spikes in water quantity are to be expected as new mine areas with water transmissive features such as faults or fractures are encountered. However, if encountered, experience has shown that the amount of water associated with these initial drainage episodes is not significant, and in a short timeframe the water drains from the fault or fracture and the net contribution compared to the ongoing flow is minimal.

The trigger is a sustained increase of flow rate. Thresholds for determining significantly by a statistical test or if 90% of the maximum discharge rate permitted under the water licence is observed as listed in Table 3-8.

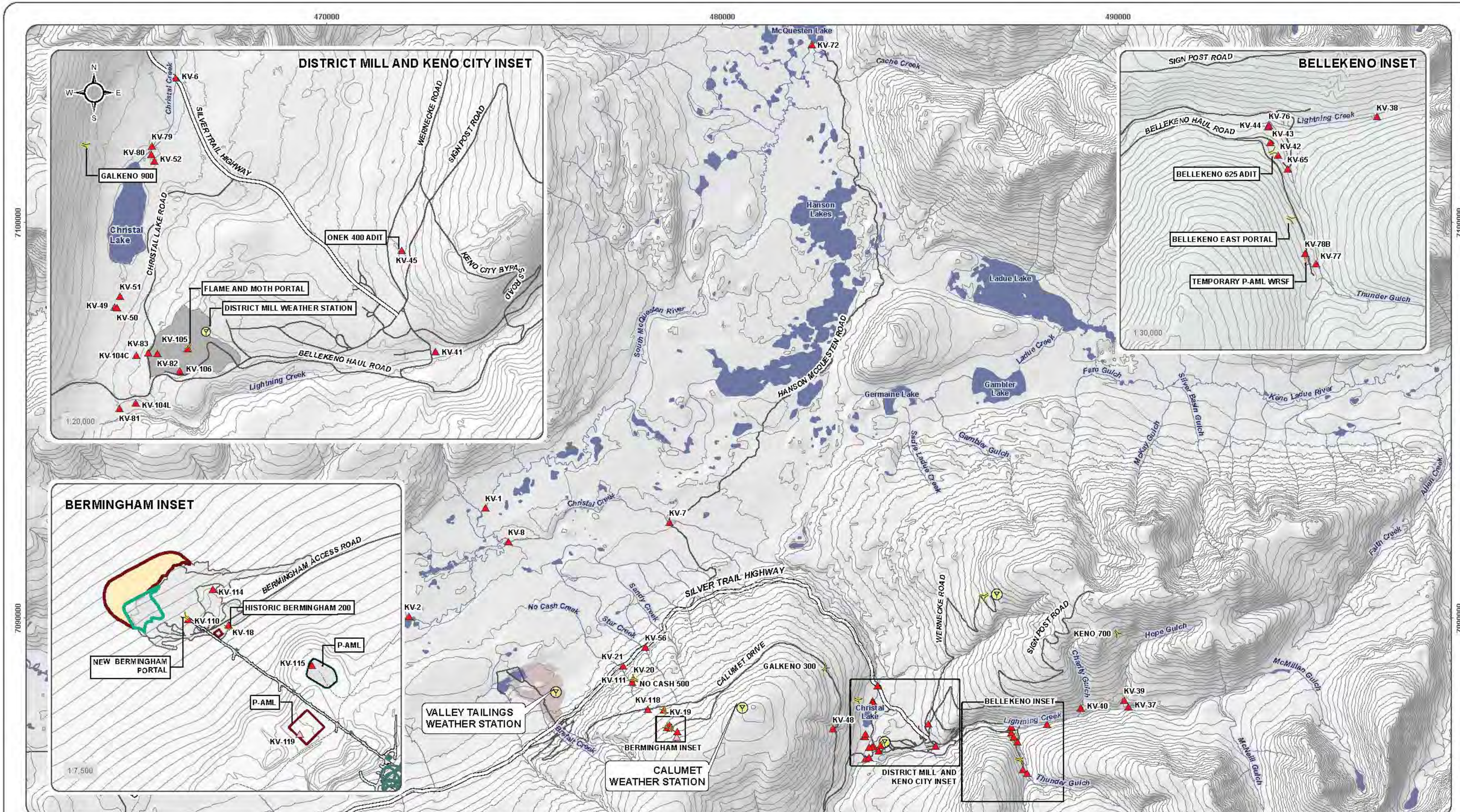
A screening level water quantity study may be implemented using portable flow meter equipment such as portable flumes or a standard time to fill the bucket test to identify mine areas that may be contributing to the change in water quantity

Depending on the results of the evaluations, the MRP may consider the following measures:

- Modify of the water treatment plant's design;
- Change the mine operating approach such as increasing water recycle usage;
- Establish surface water diversions around the mine portals or vent raises.

3.1.5 AMI #1 Reporting

Review and data quality checks are completed following each monitoring event. Set point triggers are in place in the site tracking spreadsheet and EQWin database so that response parameters are flagged for notification and action. Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-2 and Table 3-8 and management's response and next steps to be taken included in monthly reports.



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

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1:90,000 (when printed on 11 x17 inch paper)

0 1 2 3 4 5 Kilometers

- Active Surface Water Quality Station
- Pending/Proposed Water Quality Station
- Weather Station
- Adit
- As Built Mine Feature
- Valley Tailings
- Silver Trail Highway
- Other Road
- Watercourse
- Waterbody

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FIGURE 3-1
SURFACE WATER QUALITY STATION LOCATIONS

MAY 2022

Table 3-2: AMI #1 Water Quality Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Bellekeno Water Treatment Facilities (KV-43), District Mill pond discharge (KV-83), Flame & Moth settling pond decant (KV-104), Bermingham settling pond decant (KV-114) WTP effluent water: On-site results • pH • TSS • Total Zinc • Ammonia External laboratory: • TSS • Arsenic • Cadmium • Zinc • Ammonia-N Bellekeno adit (KV-42), Flame & Moth adit (KV-105), Bermingham adit (KV-110) Field pH and conductivity, turbidity, ammonia, TSS External laboratory zinc, cadmium, ammonia Trend analysis of nitrate, nitrite, selenium, uranium, and suphate in effluent Monthly averages of pH, conductivity, ammonia, cadmium and zinc from underground	**Low** Bellekeno and Mill pond effluent discharge: For three consecutive days on-site laboratory: • TSS > 20 mg/L ; or • pH < 7.0; or • total zinc > 0.40 mg/L and pH < 7.0; or • ammonia > 4.0 mg/L and pH > 9.0. pH < 7.0 for three consecutive days and weekly confirmatory result returns total arsenic > 0.075 mg/L or total cadmium > 0.0075 mg/L Flame & Moth and Bermingham effluent discharge: For three consecutive days: • pH < 7.0; or • TSS or zinc or ammonia trending towards exceedance of EQS	**Notification** • AKHM site management within 48 hours of receiving results **Evaluation** • Confirm results • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation • A review of recent mining practices and a study of specific rock lithologies in the area of recent mining activity to assess if the change is associated with specific rock types or if a mining practice could be associated with the change **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes
	Moderate WTP Effluent • Weekly sample exceeds EQS • For three consecutive weekly sampling events effluent discharge exceed 80% of the EQS • An increasing trend whereby the water quality objectives in the receiving environment maybe be exceeded. Adit discharge field pH more than 1 pH standard unit lower than historical average A trend would be established comparing the prior month average to the historic average. Adit discharge increasing trend towards historical maximum for ammonia, conductivity, cadmium, and zinc in comparison to the previous 24 months of data	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Report on WaterLine, to EMR and YG Inspector within 24 hours of receipt of results • Include in WL QZ18-044 monthly report **Evaluation** • Initiate review of associated catchment background and receiving environment monitoring data • Visual inspect the effluent discharge flow path to Christal Creek or No Cash Creek for evidence of significant channel formation that may be limiting interaction with soil and vegetation substrate, potentially limiting natural attenuation • Assess any water quality changes in effluent discharge (KV-83, KV-104C or KV-114) that may be limiting effectiveness of natural attenuation • Identify potential mitigative actions • Specific metals trends will be evaluated if a pH, conductivity, ammonia, zinc or cadmium trend has been triggered in mine discharge water **Management Response** • Engage a QP • Initiate implementation of recommendations of the QP upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to manage water quality
	High WTP Effluent weekly sample exceeds EQS three weeks in a row Exceedance of WQOs in receiving environment of parameters without effluent discharge standards (i.e., nitrate, nitrite, selenium, uranium, sulphate)	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within I week of confirmation of receiving environment water quality results **Evaluation** • Gather additional data to finalize the mitigation design **Management Response** • Obtain permits if necessary and implement mitigation measures as outlined in the MRP • Actions are to continue until WQOs and EQSs are no longer exceeded

Table 3-3: Bellekeno 625 Adit Effluent Quality Standards and Thresholds

PARAMETER	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-43 (mg/L)	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS
pH	6.5 to 9.5 pH Units	<7.0 pH Units
Total suspended solids	25	
Ammonia Nitrogen (as N)	5	>4.0 mg/L and pH >9.0 units
Arsenic (Total)	0.1	>0.075 mg/L and pH <7.0 units
Cadmium (Total)	0.01	>0.0075 mg/L and pH <7.0 units
Copper (Total)	0.1	
Lead (Total)	0.2	
Nickel (Total)	0.5	
Radium 226	0.37 Bq/L	
Silver (Total)	0.01	
Zinc (Total)	0.5	>4.0 mg/L and pH >9.0 units
96-hour Rainbow Trout LC50 at 100% concentration	Non-toxic	

Table 3-4: District Mill Effluent Quality Standards and Thresholds

PARAMETER	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-83 (mg/L)	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS
pH	6.5 to 9.5 pH Units	<7.0 pH Units
Total suspended solids	25	
Ammonia Nitrogen (as N)	5	>4.0 mg/L and pH >9.0 units
Arsenic (Total)	0.1	>0.075 mg/L and pH <7.0 units
Cadmium (Total)	0.01	>0.0075 mg/L and pH <7.0 units
Copper (Total)	0.1	
Lead (Total)	0.2	
Nickel (Total)	0.5	
Radium 226	0.37 Bq/L	
Silver (Total)	0.02	
Zinc (Total)	0.5	>4.0 mg/L and pH >9.0 units
96-hour Rainbow Trout LC50 at 100% concentration	Non-toxic	

Table 3-5: Flame & Moth Discharge to Christal Creek Effluent Quality Standards and Thresholds

PARAMETER	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-104C mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-104C mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-104C mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-104C mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS
Discharge rate	Up to 10 L/s		Up to 20 L/s		Up to 30 L/s		Up to 35 L/s	
Arsenic (Total)	0.043	0.034	0.021	0.017	0.017	0.014	0.012	0.001
Cadmium (Total)	0.01	0.008	0.01	0.008	0.0094	0.0075	0.0086	0.0069
Copper (Total)	0.042		0.026		0.021		0.019	
Lead (Total)	0.131	0.105	0.081	0.065	0.064	0.051	0.056	0045
Nickel (Total)	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4
Silver (Total)	0.00089		0.00064		0.00053		0.00049	
Radium 266	0.37 Bq/L		0.37 Bq/L		0.37 Bq/L		0.37 Bq/L	
Zinc (Total)	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4
pH	6.5-9.5		6.5-9.5		6.5-9.5		6.5-9.5	
Total suspended solids	15		15		15		15	
Ammonia Nitrogen as N	6.5	5.2	3.7	3.0	2.7	2.2	2.4	1.9
96-hour Rainbow Trout LC50 at 100% concentration	Non-toxic		Non-toxic		Non-toxic		Non-toxic	

Table 3-6: Flame & Moth Discharge to Lightning Creek Effluent Quality Standards and Thresholds

PARAMETER	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-105L mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-105L mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-105L mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-105L mg/L	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS
Discharge rate	Up to 10 L/s		Up to 20 L/s		Up to 30 L/s		Up to 35 L/s	
Arsenic (Dissolved)	0.034	0.027	0.020	0.016	0.015	0.012	0.013	0.010
Cadmium (Dissolved)	0.0012	0.00096	0.0007	0.00056	0.00052	0.000416	0.00048	0.000384
Copper (Dissolved)	0.042	0.034	0.023	0.018	0.016	0.013	0.015	0.012
Lead (Dissolved)	0.035	0.028	0.019	0.015	0.014	0.011	0.012	0.001
Nickel (Dissolved)	0.42	0.34	0.42	0.34	0.43	0.34	0.40	0.32
Radium 266	0.37 Bq/L		0.37 Bq/L		0.37 Bq/L		0.37 Bq/L	
Silver (Dissolved)	0.0029	0.0023	0.0016	0.0013	0.0011	0.0009	0.0010	0.0008
Zinc (Dissolved)	0.23	0.18	0.13	0.10	0.09	0.07	0.08	0.06
pH	6.5-9.5		6.5-9.5		6.5-9.5		6.5-9.5	
Total suspended solids	15		15		15		15	
Ammonia Nitrogen as N	10	8	10	8	9.0	7.2	8.1	6.48
96-hour Rainbow Trout LC50 at 100% concentration	Non-toxic		Non-toxic		Non-toxic		Non-toxic	

Table 3-7: New Bermingham Effluent Quality Standards and Thresholds

PARAMETER	MAXIMUM CONCENTRATION IN A GRAB SAMPLE KV-114 (mg/L)	AMI THRESHOLD FOR 3 CONSECUTIVE DAYS
pH	6.5 to 9.5 pH Units	
Total suspended solids	25	
Ammonia Nitrogen (as N)	5	4
Arsenic (Dissolved)	0.061	0.049
Cadmium (Dissolved)	0.01	0.008
Copper (Dissolved)	0.024	
Lead (Dissolved)	0.048	0.038
Nickel (Total)	0.37	0.30
Radium 226	0.37 Bq/L	
Silver (Dissolved)	0.00062	
Zinc (Dissolved)	0.5	0.4
96-hour Rainbow Trout LC50 at 100% concentration	Non-toxic	

Table 3-8: AMI #1 Water Quantity Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Discharge flow rates from: • Bellekeno 625 adit (KV-43) • Flame & Moth portal (KV-105) • New Bermingham portal (KV-110)	**Low** Water discharge from the Flame & Moth adit (KV-105) increases from 0-10L/s to greater than 20 L/s in a period of less than two weeks. Average daily water discharge at the Bermingham adit (KV-110), calculated each month, shows an increasing trend which is extrapolated to exceed the daily discharge rate of 1,200 m^3/day within six months.	**Notification** • AKHM site management within 24 hours of confirming rates **Evaluation** • Confirm rates • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome
	Moderate Bellekeno Mine adit discharge within 10% of the licenced maximum discharge rate (864 m^3/day) for seven consecutive days Flame & Moth Mine portal discharge flow within 10% of the licenced maximum discharge rate (3,024 m^3/day) for seven consecutive days New Bermingham Mine portal discharge flow within 10% of the licenced maximum discharge rate (1,200 m^3/day) for seven consecutive days	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in monthly WL report **Evaluation** • Investigation into limiting mine inflows • Identify potential mitigative actions **Management Response** • Engage a QP • Initiate implementation of recommendations of the QP upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to mange the change in water quantity
	High Mine workings discharge exceeds maximum discharge rate	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • Report on WaterLine, to EMR and YG Inspector within 24 hours of confirmation of rates **Evaluation** • Gather additional data to finalize the mitigation design **Management Response** • Obtain permits if necessary and implement mitigation measures as outlined in the MRP • Actions are to continue until maximum discharge rate is no longer exceeded

3.2 AMI #2 – N-AML WASTE ROCK SEEPAGE OR TAILINGS EXHIBIT ACID OR METAL LEACHATE

3.2.1 Description

Water draining from waste rock or tailings can contain elevated concentrations of metals and other elements at any pH. To develop appropriate waste rock and tailings management procedures an accurate prediction of future drainage chemistry is needed (Price, 2009).

Acid rock drainage and metal leaching characterization of waste rock produced from prospective production areas in the KHSD was initiated by AKHM in 2006. This dataset includes static (e.g., acid base accounting (ABA), elemental metals by ICP, shake flask leach test) and kinetic (e.g., humidity cells and field barrels) of material from Bellekeno, Onek, Lucky Queen, Flame & Moth, Silver King, and Bermingham. Static and kinetic testing of the tailings generated and placed in the DSTF commenced in 2010.

The Waste Rock Management Plan provides procedures to be followed in order to segregate and dispose of N-AML or store P-AML waste rock and thereby minimize potential impacts of waste rock brought to surface on land and water resources. It also provides guidance on the classification of waste rock as P-AML or N-AML during mining and procedures to confirm the field screening with geochemical testing.

The Tailings Characterization Plan provides procedures to confirm the physical, chemical, and mineralogical properties of the tailings deposited at the DSTF through static tests. Provisions for conducting long-term humidity cell tests and saturated column tests of the co-mingled tailings generated through the processing of ore from the Bellekeno, Flame & Moth and New Bermingham mines are also defined.

Routine monitoring of the DSTF and waste rock disposal areas, including areas where waste rock was used in construction, is conducted to assess the effectiveness of the management measures, confirm predictions and to obtain the appropriate information to assist in mine closure planning.

Prior to the development and operation of the Flame & Moth Mine and the New Bermingham Mine all N-AML waste rock produced by AKHM was used for construction purposes as follows:

- N-AML waste rock from the Bellekeno Mine was used to construct the Bellekeno Haul Road, Keno City Bypass Road and the mine laydown area.
- N-AML waste rock from Flame & Moth was used to expand the District Mill yard, establish the laydown area for the new warehouse, to construct the P-AML waste rock storage area, and the realignment of the Bellekeno Haul Road through the DSTF Phase 2 expansion area.
- N-AML waste rock from the New Bermingham Mine has been used to construct the adjacent mine laydown area and for upgrades and maintenance of the haulage road from the mine to the Duncan Creek Road.

In 2021, N-AML waste rock disposal areas were established at the Flame & Moth and New Bermingham mines. Waste rock from both of these disposal areas is to be recovered and used as backfill underground. In addition, N-AML waste rock the Flame & Moth Mine can continue to be used for construction, however N-AML rock from New Bermingham must meet criteria described in the Waste Rock Management Plan to be considered for use in construction.

3.2.2 Risk Narrative

Acidic or metal leachate occurs because of seepage or runoff though N-AML waste rock or the DSTF.

3.2.3 Monitoring Requirements and Evaluation of Results

The geochemical characterization of waste rock and tailings produced during operations provide a verification of the properties of the N-AML waste rock and tailings. The sampling frequency and geochemical testing methods are dependant on volume of waste rock produced and its N-AML or P-AML designation as described in the Waste Rock Management Plan.

Kinetic testing of humidity cells are conducted in a laboratory environment over a minimum 40-week period with weekly to bi-weekly testing, depending on parameters.

Static test results are reviewed upon receipt by AKHM's Geology Department and uploaded into a database for comparison with the field screening classification. Both the static and kinetic test results are reviewed by a QP upon receipt of the results and an interpretation report to confirm the predicted future drainage chemistry from N-AML waste rock or tailings is prepared annually.

Any waste rock drainage or seeps observed between May and October is monitored for estimated flow volume and basic field parameters of pH and conductivity. Evidence of sulphide oxidation such as snow melt areas or the presence of sulphide oxidations products are also be noted. This monitoring occurs in conjunction with the monthly regional surface and groundwater monitoring program which is carried out by competent, trained field operators.

Monthly field measurements of flow, pH, temperature, conductivity, and on-site zinc analysis are taken between May and October at a seep below the Bellekeno 625 Adit (KV-44) and samples submitted for dissolved ICP metals, Ammonia-N, Nitrite-N, Nitrate-N, phosphorous, sulphate, dissolved organic carbon (DOC), hardness, alkalinity, TSS, pH, conductivity and LC_{50} on a quarterly seasonal basis.

The toe of the New Bermingham water rock disposal area and those sections of the Keno City Bypass Road constructed of waste rock are monitored to detect seeps during the seasonal monthly monitoring program. Should seeps be detected, monitoring stations will be established. These stations will be monitored monthly between May and October for flow, pH, temperature, conductivity, and zinc. Runoff accumulating with the DSTF diversion ditch following freshet is also monitored and sampled.

External laboratory water quality monitoring results are uploaded weekly into the EQWin database and the results are evaluated and quality checks undertaken by a QP. Monthly reports on water quality monitoring and an annual interpretation report prepared by a QP are submitted under WL QZ18-044. All monthly and annual reports are provided to FNNND.

Documentation of waste rock management activities including field screening, segregation, handling, management and ongoing geochemical monitoring and analyses are compiled and included in the annual reports submitted under QML-0009 and WL QZ18-044.

Monitoring of DSTF runoff and N-AML waste rock seeps is used to evaluate if water quality is trending to acid or metal leaching conditions and to assess the adequacy of the waste rock screening criteria and management procedures.

Adaptive management will be implemented to respond to negative trends or ineffective screening, or waste rock management procedures being detected through the monitoring and testing programs.

3.2.4 Indicators, Action Levels, Management Response

The specific indicators that are monitored to assess whether a trigger may have been activated include field measurements of pH, conductivity; along with external laboratory results for alkalinity, sulphate, zinc, cadmium, and hardness.

Water quality results of samples collected from waste rock seeps, runoff accumulating within the DSTF diversion ditch (following freshet) or the field bins and geochemical test results of the waste rock can trigger the need for adaptive management.

As per the general approach to the adaptive management plan, a staged response to the development of P-AML conditions or ineffective management of P-AML waste rock will be implemented if the threshold is triggered. The initial response can include further inspection and testing to access and define the potential for acid rock drainage and metal leaching. At the moderate action level, conceptual designs are prepared and mitigation measures intended to stabilize conditions and minimize further deterioration implemented. At the high action level permits are obtained, the preferred mitigative action taken to improve environmental conditions implemented, conditions monitored, and the effectiveness of the response evaluated.

Depending on the results of the evaluations, the MRP may consider the following measures:

- Diversion of seepage or runoff by ditching, berming, or pumping water;
- Relocation of newly classified P-AML waste rock to a P-AML waste rock storage facility or underground; or
- Installation of a cover and a water diversion system.

3.2.5 AMI #2 Reporting

Review and data quality checks is completed following each monitoring event and includes a review of the relevant monitored data from the Environmental Monitoring, Surveillance and Reporting Plan, Appendix A Groundwater Monitoring Plan, the Waste Rock Management Plan, and the Tailings Characterization Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-9 and management's response and next steps to be taken included in monthly reports.

Table 3-9: AMI #2 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Seepage from waste rock disposal areas or from works constructed or upgraded with N-AML material that originated from the Bellekeno. Flame & Moth or New Bermingham mine Seepage from the DSTF Field bins and humidity cells results from N-AML waste rock and tailings ABA, ICP metals analysis and shake flask leach test of N-AML waste rock and tailings Field measurements of: • pH • conductivity External laboratory analysis of: • zinc • cadmium • sulphate • alkalinity	**Low** New seeps are identified from N-AML waste rock or works constructed or upgraded with N-AML waste rock Observation of oxidized iron staining in seeps from N-AML waste rock A comparison the geochemical test results with field screening classification indicates that P-AML waste rock may have been misclassified and handled as N-AML waste rock	**Notification** • AKHM site management within 1 week of confirmation of results **Evaluation** • Sample the seep, conduct field tests, submit sample for analysis and confirm results • Document the occurrence of the seep with photographs and estimate flow rate • Assess potential mine related waste rock sources and external environmental interactions at the seep location • Determine the volume of waste rock that may have been misclassified and its current location on site **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the seep indicates that it is not in contact with waste rock generated by AKHM; document the outcome • If the waste rock misclassified as N-AML is not currently on surface or is stored in a P-AML facility; document the outcome
	Moderate Seep sample result trend exhibits: • a decline in pH between measurements or pH <7.0 or • conductivity, zinc, cadmium or sulphate showing a significant increasing trend or • decreasing trend in alkalinity or • indicators approaching effluent quality standards Kinetic testing of N-AML waste rock or tailings exhibit: • a decline in pH between measurements or pH <6.0 or • conductivity, zinc, cadmium, or sulphate or showing a significant increasing trend or • alkalinity shows a significant decreasing trend	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in monthly WL report **Evaluation** • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation • Continue to monitor seep locations weekly until flow has stopped for two consecutive weeks or as recommended by the QP • Initiate an assessment of downstream or downgradient locations for potential impacts • QP to evaluate the potential risk to the environment based on the volume of P-AML waste rock misclassified and its current location • Identify potential mitigative actions **Management Response** • Engage a QP • Initiate implementation of recommendations of the QP upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration
	High QP determines a high action level trigger reached	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 1 week of confirming results • Where required, submit mitigation plan to the water board, EMR and YG inspector for review and approval **Evaluation** • Gather additional data to finalize the mitigation design • Determine if tailings characterization or waste rock management plan requires modification • Determine is modifications to the DSTF reclamation plan are required **Management Response** • Engage the DSTF Engineer of Record if appropriate • Where appropriate, accelerate progressive reclamation of the DSTF • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Continue to monitor the area following the implementation of mitigation measures until conditions stabilize or as recommended by the QP

3.3 AMI #3 – SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED

3.3.1 Description

Lime solution is added to the underground mine collected waters and a zinc hydroxide precipitate (sludge) is formed in the Bellekeno, Flame & Moth, and New Bermingham WTPs.

At the Bellekeno WTP, the sludge settles in the bottom of two lined ponds. The sludge from the settling ponds is removed using a vacuum truck. Up until 2021, sludge from the Bellekeno WTP was stored in a dedicated cell at the Valley Tailings area, the Valley Tailings Bellekeno Sludge Storage Area (VTBSSA). The sludge storage area is not lined to allow water to exfiltrate. Since 2021, sludge removed from the Bellekeno settling ponds has been disposed of underground in the Bellekeno Mine.

A lamella clarifier is the primary liquid/solids separation equipment for removal of the metal hydroxides formed at the Flame & Moth and New Bermingham WTP's. The lamella clarifier is an inclined-plate clarifier. The inlet stream is stilled upon entry into the clarifier. Solid particles begin to settle on the plates and accumulate in collection hoppers at the bottom of the clarifier unit. The sludge is drawn off at the bottom of these hoppers and the clarified liquid exits the unit at the top by a weir.

Underflow from the clarifier is gravity fed to a series of geotextile filter bags which dewater the sludge. A valve manifold allows the de-sludge solution to be directed to the next sludge bag in the series when the active bag is filled. Sludge in the no longer active bag becomes solid overtime and is then loaded by a skid steer or front loader for removal in a truck.

At the Bermingham WTP, the dewatered sludge is hauled on average once a month to the historic Bermingham SW open pit for final disposal. The pit is located approximately 500 m upgradient of the New Bermingham mine. The dewatered sludge recovered from the Flame & Moth WTP is either deposited in the mill tailings thickener where it is mixed with filtered and dry stacked tailings, or disposed in the DSTF directly, or co-mingled with rock in the P-AML waste rock storage facility or transferred to a sludge dewatering area prior to disposal underground in the Flame & Moth Mine. Sludge management practices for the Flame & Moth sludge are currently being evaluated.

Sludge that accumulates in the WTP settling ponds and the District Mill Pond are removed using a vacuum truck or dredge and disposed of in the same manner as the WTP sludge.

Additional details on site sludge management are available in the Sludge Management Plan, Operations and Maintenance Manual for the Flame & Moth Mine (AKHM, 2018), and Bermingham Water Treatment Facility Operations Manual (AKHM, 2021a). The following section pertain to the potential for the effectiveness of the VTBSSA or the Bermingham SW Open Pit to become compromised. The locations of the sludge storage areas are shown on Figure 3-2 and Figure 3-3.

Any sludge deposited in the DSTF will be evaluated by DSTF monitoring programs and sludge stored in P-AML waste rock storage areas will be evaluated by waste rock management programs.

3.3.2 Risk Narrative

Seepage from or lack of storage capacity in the sludge storage areas results in a risk to aquatic resources.

3.3.3 Monitoring Requirements and Evaluation of Results

Any seeps below the Bermingham SW pit or VTBSSA observed between May and October will be monitored for estimated flow volume, field pH and conductivity. This monitoring occurs in conjunction with the monthly regional surface and groundwater monitoring program which is carried out by competent, trained field operators. Seepage will be documented, and if flow is sufficient water samples collected and submitted for analysis of ICP metals analysis (total and dissolved), sulphate, hardness, alkalinity, TSS, pH and conductivity.

External laboratory water quality monitoring results are evaluated upon receipt by AKHM's Environment Department. In addition, a QP completes quality checks and uploads water quality monitoring results weekly into the EQWin database. Monthly and annual reports on water quality monitoring results are reviewed and interpreted by AKHM and submitted under WL QZ18-044.

Visual inspection of freeboard in Bermingham SW and VTBSSA are conducted to ensure sufficient capacity remains prior to the deposition of additional sludge. A quarterly physical inspection report is submitted as part of the associated monthly report under WL QZ19-044 and the annual QML-009 report.

3.3.4 Indicators, Action Levels, Management Response

The specific water quality indicators to be monitored in seeps from sludge storage areas to provide the necessary information to assess whether a trigger has been activated include pH, alkalinity, sulphate, zinc, and cadmium to determine if it is resulting from sludge deposition.

Visual observation of the freeboard in the Bermingham SW Pit and the VTBSSA will indicate whether a sludge storage capacity trigger has been activated.

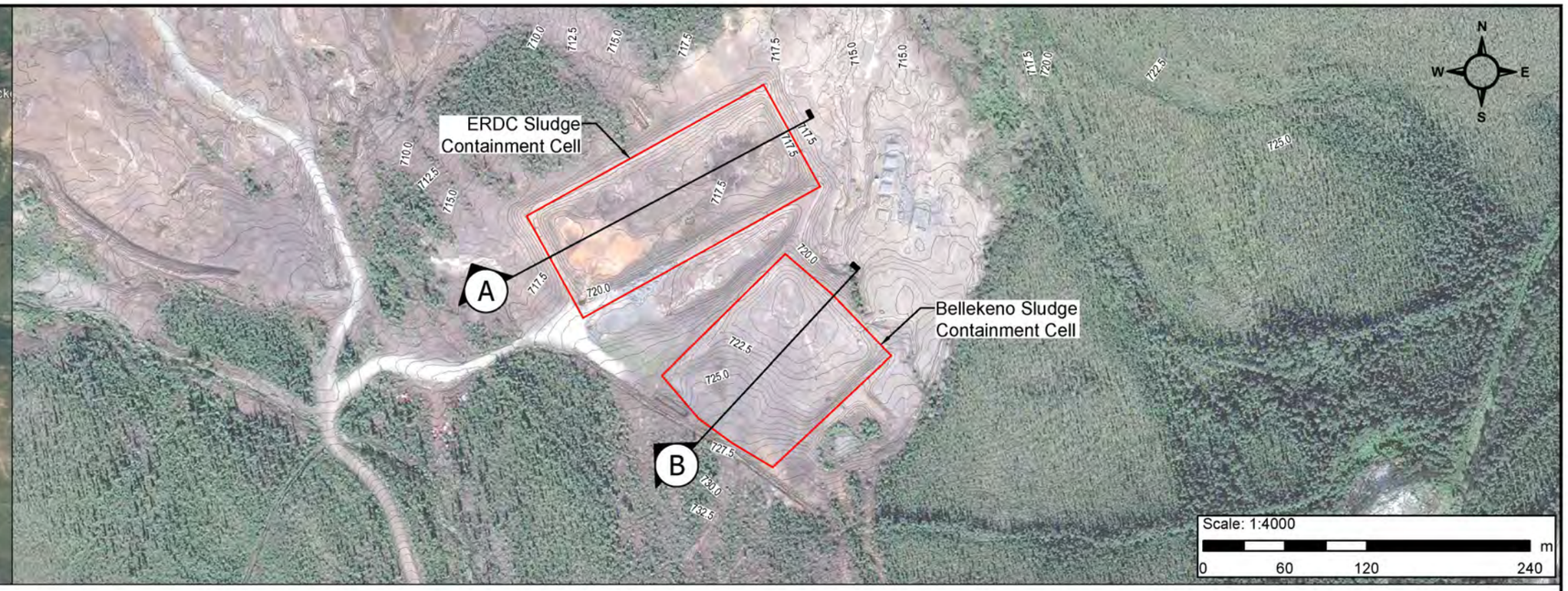
The management response strategy for AMI #3 is to assess, characterize and define a potential problem at the low action level. At the moderate action level, assess the potential impact to the receiving environment and design of mitigation measures. At the high action level, the MRP will be implemented with on-going monitoring and reporting.

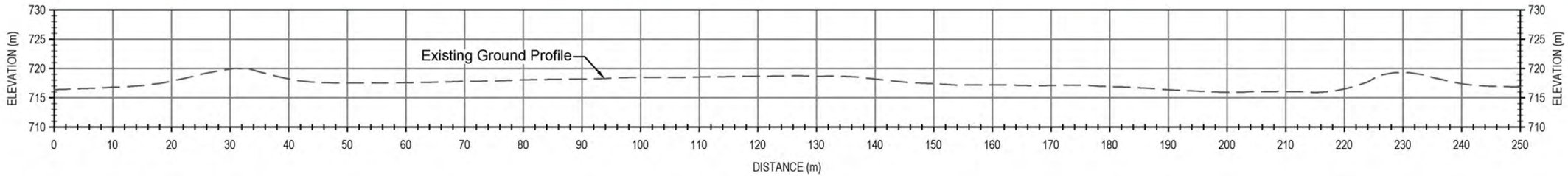
Depending on the results of the evaluations, the MRP may consider the following measures:

- If seepage is depositing a load into a fish bearing stream or creek, ditching, berming, or pumping may be implemented to prevent this.
- An increase to the facility capacity by increasing berm height for example.
- Alternative sludge storage area approved and use of the current one would cease.

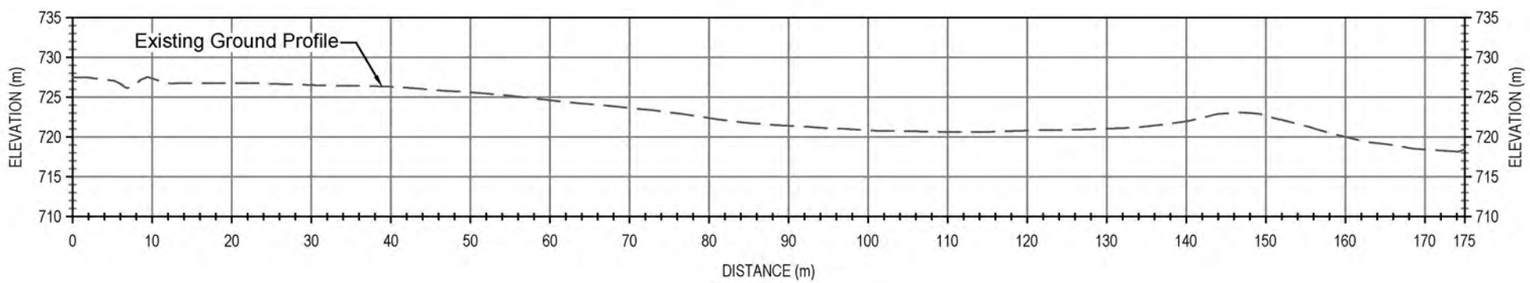
3.3.5 AMI #3 Reporting

Reporting will be completed in accordance with the Environmental Monitoring, Surveillance and Reporting Plan, Appendix B Physical Inspections and Reporting Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-10 and management's response and next steps to be taken included in water licence monthly reports. The Sludge Management Plan would be revised to incorporate any new sludge storage areas and any additional water quality monitoring sites. Revisions to the WTP operating manuals would occur as necessary to address any modifications or changes to operating activities.





Section A



Section B

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22.5
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Notes:
1. Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on 2020-10-22.
2. Topographic contours and profiles derived from LiDAR data acquired by Eagle Mapping Ltd., September 25th, 2014

ENSERO solutions

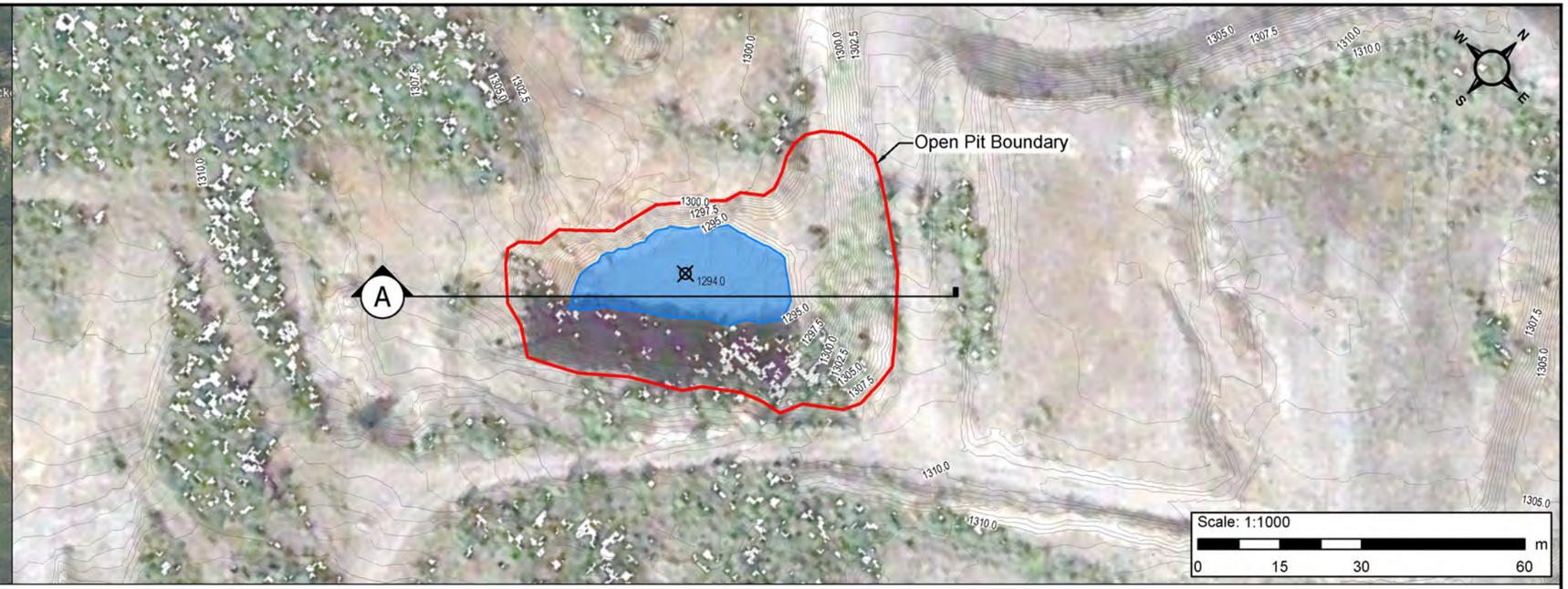
Keno QZ18-044 Management Plans
Sludge Containment

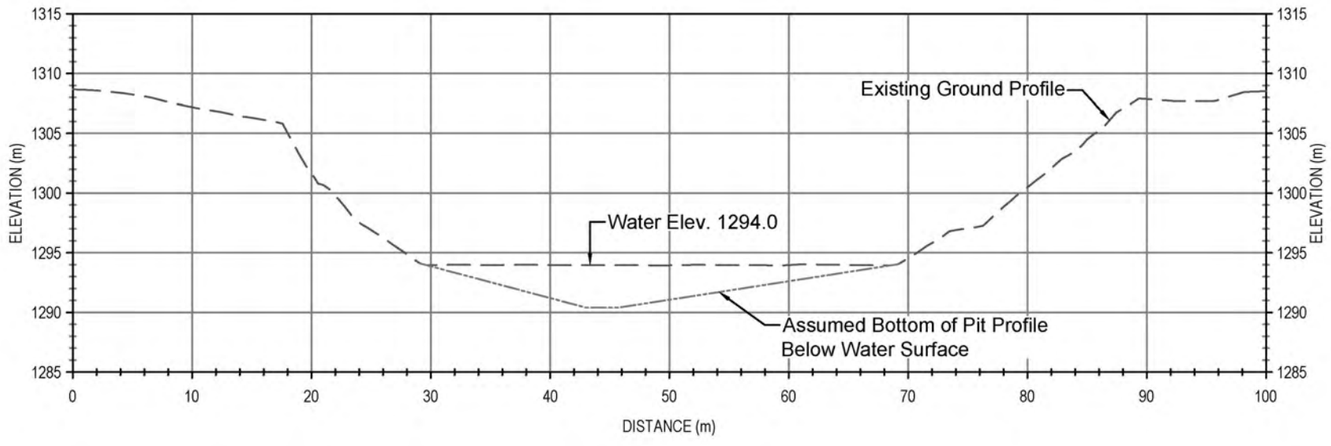
Figure 3-2

Valley Tailings
Sludge Containment Area

PROJECT No.: ECA20YT00030-223		2022-05-04
DRAWN BY: KB	DESIGNED BY: KW	REVIEWED BY: KW

D:\Users\KBoldt\Projects\Alexco-Keno Mines\Production Drawings\5-Bermingham\ECA20YT00030-223-G1020.dwg (last edited by: KBoldt, 2020/10/22 - 3:11 PM





Section A

Scale: 1:500
m
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7.5
15
30

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Notes:
1. Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on 2020-10-22.
2. Topographic contours and profiles derived from LiDAR data acquired by Eagle Mapping Ltd., September 25th, 2014

ENSERO solutions

Keno QZ18-044 Management Plans
Sludge Containment

Figure 3-3

Bermingham SW
Sludge Containment Area

PROJECT No.: ECA20YT00030-223		2022-05-05
DRAWN BY: KB	DESIGNED BY: KW	REVIEWED BY: KW

D:\Users\KBoldt\Projects\Alexco-Keno Mines\Production Drawings\5-Bermingham\ECA20YT00030-223-G1010.dwg (last edited by: KBoldt; 2020/10/22 - 3:11 PM

Table 3-10: AMI #3 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Specific indicators monitored in any seeps from the Bermingham SW pit and Valley Tailings Bellekeno Sludge Storage Area seepage • Flow rate • pH • alkalinity • sulphate • zinc • cadmium • hardness Visual observation of Bermingham SW Pit and VTBSSA freeboard Determine if there is seepage from the sludge storage area as per the visual inspection.	**Low** New seeps are identified from the Bermingham SW pit or the VTBSSA Freeboard in the Bermingham SW Pit has risen to within 1.5 m of decant point Freeboard in the VTBSSA is within 1.0 m of the decant point	**Notification** • AKHM site management within 24 hours of receipt of results or observing freeboard **Evaluation** • Sample the seep, conduct field tests, and submit sample for analysis • Document the occurrence of the seep with photographs and estimate flow rate • Inspect the area to improve understanding of the cause of the trigger activation **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring or data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes
	Moderate Seep water quality • pH <7.0, • total zinc > 0.5mg/L, • total cadmium > 0.01 mg/L Freeboard within 0.5 m of decant point	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in annual QML report and quarterly physical inspection WL report **Evaluation** • Document the flow path to determine if flow is reaching surface waters • Where appropriate, increase monitoring of freeboard to daily and cease depositing sludge • Identify potential mitigative actions **Management Response** • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions
	High Freeboard is at the decant point Significant increase in seepage flow rate and holes on the surface of the sludge indicating possible piping of material	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • AKHM management immediately • YG inspector within 24 hours **Evaluation** • Determine appropriate mitigation measures **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP if necessary

3.4 AMI #4 – PHYSICAL INSTABILITIES

3.4.1 Description

The stability of waste rock slopes is a function of the natural strata on which they are founded, the properties of the waste rock being deposited and climate. Slope failure could result in a landslide. The possibility for ice-rich permafrost foundation soils beneath the N-AML waste rock disposal facilities was assessed in their design and the risk of permafrost thaw and elevated porewater pressure in foundations considered.

The deposition of N-AML waste rock in the KHSD Mining Operations is being done in areas where engineering assessments were performed for suitability. However, it is possible that waste rock piles can shift due to changes in foundation conditions. Even though it is remote or unlikely, a significant amount of material can potentially block access to a site.

Settlement or collapse of the ground surface can occur as a result of subsidence where underground workings have come close to the surface. While AKHM does have a Ground Control Management Plan in place to address underground mining operations, it does not address movement of ground resulting in surface subsidence.

3.4.2 Risk Narrative

Physical instability of waste rock disposal areas or underground workings endangers the health and safety of site employees or visitors, or leads to an increase in contaminant loading to the receiving environment.

3.4.3 Monitoring Requirements and Evaluation of Results

The inspection of the physical stability of waste rock disposal facilities and the underground workings are conducted annually by independent engineers. Observations and measurements made during daily physical inspections of the structural integrity of underground working sand changes to conditions are evaluated by the Engineering Department and reported AKHM management.

Inspections of waste rock disposal facilities are conducted monthly between May and October by the Engineering Department to ensure their structural integrity and that runoff and discharge is being appropriately managed. The following rating system (Table 3-11) is used to evaluate the structural integrity of the areas inspected:

Table 3-11: Physical Inspection Rating System

CONDITION RATING	DETAILS
Excellent	"As New" Condition.
Good	System or element is sound and performing its function; although it shows signs of use and may require some minor repairs, mostly routine.
Fair	System or element is still performing adequately at this time, but needs "priority" and/or "routine" repair to prevent future deterioration and to restore it to good condition. A fair rating will be reported to site manager after the inspection.
Poor	System or element cannot be relied upon to continue to perform its original function without "immediate" and/or "priority" repairs. A poor rating will be reported to site manager after the inspection.

The purpose of the physical inspection is to observe and record sufficient information to permit development of a course of action; repair or rehabilitation if it is required. If issues are identified during the monthly inspections AKHM management will be informed immediately and the appropriate mitigative measures will be implemented.

3.4.4 Indicators, Action Levels, Management Response

Severity triggers are not easily defined and therefore any conditions and/or trends observed to be uncharacteristic would be handled with urgency to seek a better understanding of risk. Once the risk has been defined, appropriate steps can be engineered and implemented to rectify any nonconformance.

The presence of ice lenses in construction areas where no permafrost was anticipated, ground deformations, slumps, soil creep are examples of uncharacteristic conditions that warrant the notification of a qualified geotechnical engineer for further investigation.

The management response strategy for AMI #4 is to assess, characterize and define a potential problem at the low action level. At the moderate action level, assess the potential impact to public safety and the receiving environment and design of mitigation measures. At the high action level, the MRP will be implemented with on-going monitoring and reporting.

Depending on the results of the evaluations, the MRP may consider the following measures:

- Installation of barriers such as dykes or silt fencing or construction of diversion ditches or berms.
- Restriction of access to the area using fencing, barricades, or signage to alert the public and mine personnel to the danger that may exist.

3.4.5 AMI #4 Reporting

Reporting will be completed in accordance with the Environmental Monitoring, Surveillance and Reporting Plan, Appendix B Physical Inspections and Reporting Plan and the Waste Rock Management Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-12 and management's response and next steps to be taken included in monthly reports

Table 3-12: AMI #4 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Visual observation of: • A depression with defined edges is noted in the ground – ground subsidence • Break in soil/ slope creep/ sediment transport. • Slope failure, rock fall or landslide of mine sourced material • Liquefaction of a waste rock pile foundation Evidence of permafrost degradation in areas of physical disturbance; • Ground surface settlement • Ground deformations • Slumps Physical stability such as settling and excessive erosion (tension cracks, bulges at the toe; on waste rock road surfaces, washouts, rutting and culvert seating); Recording weather conditions	**Low** Unexpected encounter of permafrost for construction of new mine facilities	**Notification** • AKHM management notified as soon as damage observed • Include in quarterly physical inspection report WL report (as part of associated monthly report) **Evaluation** • Inspect the area for other signs of erosion • Increase monitoring and review to improve understanding of the cause • Investigate cause of erosion • Identify potential mitigative actions **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration or risk of erosion
	Moderate Liquefaction of a waste rock pile foundation has caused waste rock to migrate closer to a watercourse. A rock fall or landslide has blocked access to a previously monitored site	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in monthly WL report **Evaluation** • Monitoring and review will be increased • Identify potential mitigative actions **Management Response** • Engage qualified geotechnical engineer • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions, minimize further deterioration, and prevent a hazard to the public • Additional erosion and sediment controls may need to be implemented as required.
	High Opening to mine workings, area of subsidence or slope failure effects public safety or An observed rock fall or landslide effects a road right-of-way, infrastructure or intrudes into stream or effects public safety	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 24 hours of confirmation of data • AKHM corporate CEO to be notified within 24 hours of confirmation of data **Evaluation** • Determine appropriate mitigation measures **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Actions are to continue until qualified Engineer confirms they are no longer needed

3.5 AMI #5 – SITE SECURITY COMPROMISED

3.5.1 Description

In the interest of site security and public safety, access to operational areas is restricted to authorized site personnel through the usage of signs and gates where appropriate as described in the Traffic Management Plan. Every effort has been made to allow public access to the historic sites in the area. The safety of tourists, who may lack local familiarity, are a special consideration during the summer season.

Signage has been erected to alert visitors of mining activity and to provide notification of roads with restricted access. Gates installed on mine access roads serve to deny access by the public. Facilities that potentially present danger to persons or wildlife, such as the electrical substation and settling ponds, are fenced, or barricaded to deter access.

3.5.2 Risk Narrative

Public access to the site creates an unacceptable safety risk to mine employees, contractors, and the public.

3.5.3 Monitoring Requirements and Evaluation of Results

The Site Services Department is required to maintain gates, signs, and fences as part of their routine maintenance activities. Any indication of vandalism is to be reported to their supervisor. Damage to property is managed in accordance with the Incident and Action Management Standard (AKHM, 2021b).

3.5.4 Indicators, Action Levels, Management Responses

The specific indicators and triggers that are monitored to provide the information necessary to assess whether a trigger has been activated include gates being left open, fencing damage, encountering the public in restricted access areas, deposition of litter.

As per the general approach to the adaptive management plan, a staged response to the damaged security features and unauthorized access will be implemented if the threshold is triggered. The initial response to document site conditions and determine the cause, followed by identifying potential mitigative options and then implementing improved site security measures. The final stage will include monitoring of the area for signs of continued unauthorized access.

3.5.5 AMI #5 Reporting

Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-13 and management's response and next steps to be taken included in annual reports.

Table 3-13: AMI #5 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Security feature damaged, removed, or compromised including: • Signage • Fencing • Gates • Locks Solid waste management practices, including litter Physical presence or assumed presence of trespassers	**Low** Evidence of unauthorized access observed • A gate is found open • Solid household waste observed in area where public access is restricted • Damage to locks	**Notification** • Area manager or supervisor immediately **Evaluation** • Conduct an inspection of the area and document findings with photographs • Gather witness statements **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for the investigation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the investigation indicates that there was no unauthorized access; document the outcome
	Moderate A security gate, fence or structure is found to be damaged such that it no longer prevents unauthorised access The placard of a sign has been damaged either by environmental conditions or by vandalism such that the sign is no longer effective in relaying the information intended Trespassers do not appear to present a risk to site personnel	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • AKHM management within 12 hours **Evaluation** • Identify potential mitigative actions **Management Response** • Initiate incident reporting and action management as defined in the Incident and Action Management Standard • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option • Where appropriate, repair or replace security feature
	High A security gate is found to be damaged such that the gate is sufficiently disabled to prevent access to the site by authorized site personnel A signpost has been damaged to an extent where the sign is in a position which renders it ineffective in relaying the information intended. Trespassers present a risk to site personnel	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • RCMP immediately **Evaluation** • Access the need for the installation of security cameras and/or the hiring of a security guard **Management Response** • If a potential for a serious injury to occur exists do not disturbed the area until advised by the Health & Safety Department to do so • Monitor the area to confirm the success of the measures implemented

3.6 AMI #6 – HIGH PORE PRESSURE UNDERNEATH DSTF

3.6.1 Description

Precautions have been taken in the design and construction of the DSTF to prevent porewater seepage to groundwater by providing an impermeable basal layer to allow capture of any potential DSTF seepage and directing it to the mill pond. The DSTF design intent is to allow the permafrost within the foundation to thaw at a slow rate to provide time for dissipation of pore pressure resulting from the thaw.

Located beneath the DSTF is a Drainage Blanket. This feature provides drainage beneath the facility and allows excess water, whether in the stack or freed from thawing permafrost, to drain away and not allow porewater pressures to build underneath and/or within the tailings.

According to the DSTF design, the drainage blanket was constructed with gravel material obtained from excavation near the toe of the DSTF. The drainage blanket was then covered with a properly bedded geosynthetic clay liner to act as a collection layer for any seepage leaving the tailings stack. This material helps prevent tailings and tailings porewater from infiltrating the coarser gravel material of the drainage blanket.

Ground temperature data collected within the footprint of the DSTF during construction indicates that the permafrost surface has remained frozen (EBA, 2013). It shows that the OMS manual (EBA, 2010) is conservative as it is assumed a rapid rate of permafrost thaw of the fine-grained foundation soils during initial construction could lead to the inclusion of elevated porewater pressures.

Performance of the DSTF is monitored by taking regular readings on ground temperature cables and slope indicators and surficial topography surveys conducted during care and maintenance compared. A monitoring well, screened within the tailings, is used to identify if porewater is present. The locations of installed DSTF monitoring instrument installations are shown on Figure 3-4 and the groundwater monitoring wells.

3.6.2 Risk Narrative

Modelling has underestimated the foundation pore pressures leading to slope failure and exposure of tailings in the long term (~50 years).

3.6.3 Monitoring Requirements and Evaluation of Results

The Environmental Monitoring, Surveillance and Reporting Plan, Appendix A: Groundwater Monitoring Plan and Appendix B: Physical Inspections and Reporting Plan outline the monitoring and inspection requirements for the DSTF. DSTF instrumentation consists of seven ground temperature cables installed to monitor permafrost (six in natural soils adjacent to the DSTF and one through tailings placed within the DSTF footprint), and three slope indicators installed to monitor lateral movement of the foundation soils. BH39 is the monitoring well within the DSTF which is screened within tailings to identify if porewater is present (KV-107 is a proposed well for within the DSTF phase II expansion). Two shallow wells downgradient of the DSTF are KV-85S (4.2 m deep) and KV-88S (3.72 m deep) monitor groundwater in the overburden.

TetraTech Inc. (formerly called EBA Engineering Consultants Ltd.) is the DSTF designer for the DSTF Stage I and acts as a geotechnical consultant for AKHM. TetraTech Inc. conducts an annual geotechnical inspection of

the DSTF, including readings of the slope indicators and thermistor cables that are still operational within and around the DSTF.

Monitoring of water levels in the groundwater wells within and adjacent to the DSTF and the downloading of the weather station occurs in conjunction with the monthly regional surface and groundwater monitoring program which is carried out by competent, trained field operators. The water levels are entered into the EQWin database, along with comments of well conditions and water quality data.

3.6.4 Indicators, Action Levels, Management Response

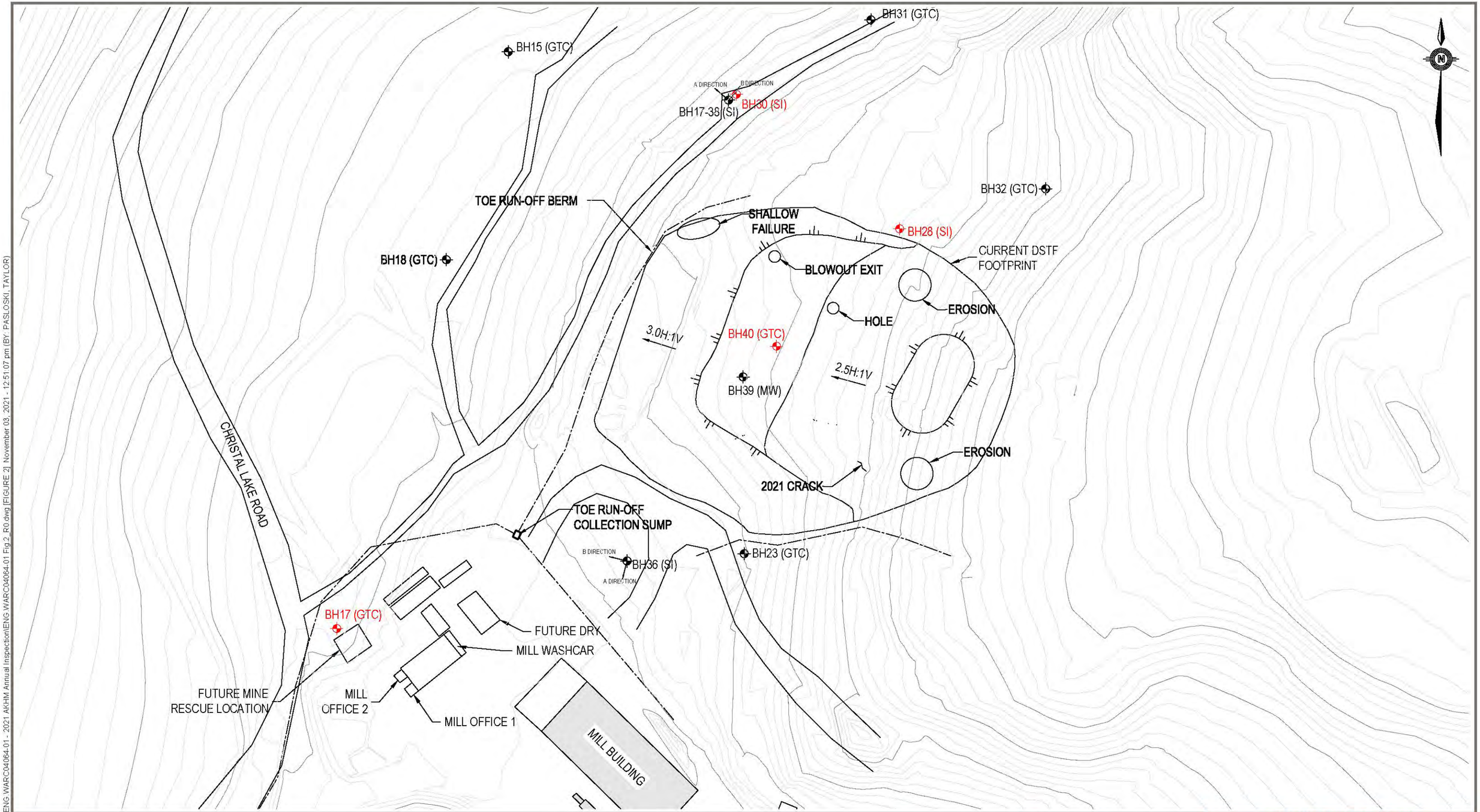
Severity triggers are not easily defined and therefore any conditions and/or trends observed to be uncharacteristic would be handled with urgency to seek a better understanding of risk. Once the risk has been defined, appropriate steps can be engineered and implemented to rectify any nonconformance.

The presence of water in the toe run-off collection ditch during dry weather conditions, measurable water in BH39 and groundwater near or at ground surface in a downgradient monitoring well are examples of uncharacteristic conditions that warrant the notification of the Engineer of Record.

In the event that the development of high pore pressure is identified underneath the DSTF one or all of the actions listed in Table 3-14 to address the identified issue will be implemented. The Engineer of Record will guide AKHM in the assessment, evaluation, option analysis, conceptual design, final design, implementation, monitoring, and initiative close out.

3.6.5 AMI #6 Reporting

Review and data quality checks is completed following each monitoring event and includes a review of the relevant monitored data from the Environmental Monitoring, Surveillance and Reporting Plan, Appendix A Groundwater Monitoring Plan and Appendix B: Physical Inspections and Reporting Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-14 and management's response and next steps to be taken included in monthly reports.



LEGEND

GTC - GROUND TEMPERATURE CABLE

SI - SLOPE INDICATOR

MW - MONITORING WELL

0 50m

Scale: 1:1,250 @ 11"x17"

NOTE

INSTRUMENTATION SHOWN IN RED HAS BEEN DAMAGED OR DESTROYED AND IS NOT READABLE. SOME OF THESE NEED TO BE REPAIRED AND/OR REPLACED. SEE ACCOMPANYING REPORT TEXT.

CLIENT

ALEXCO

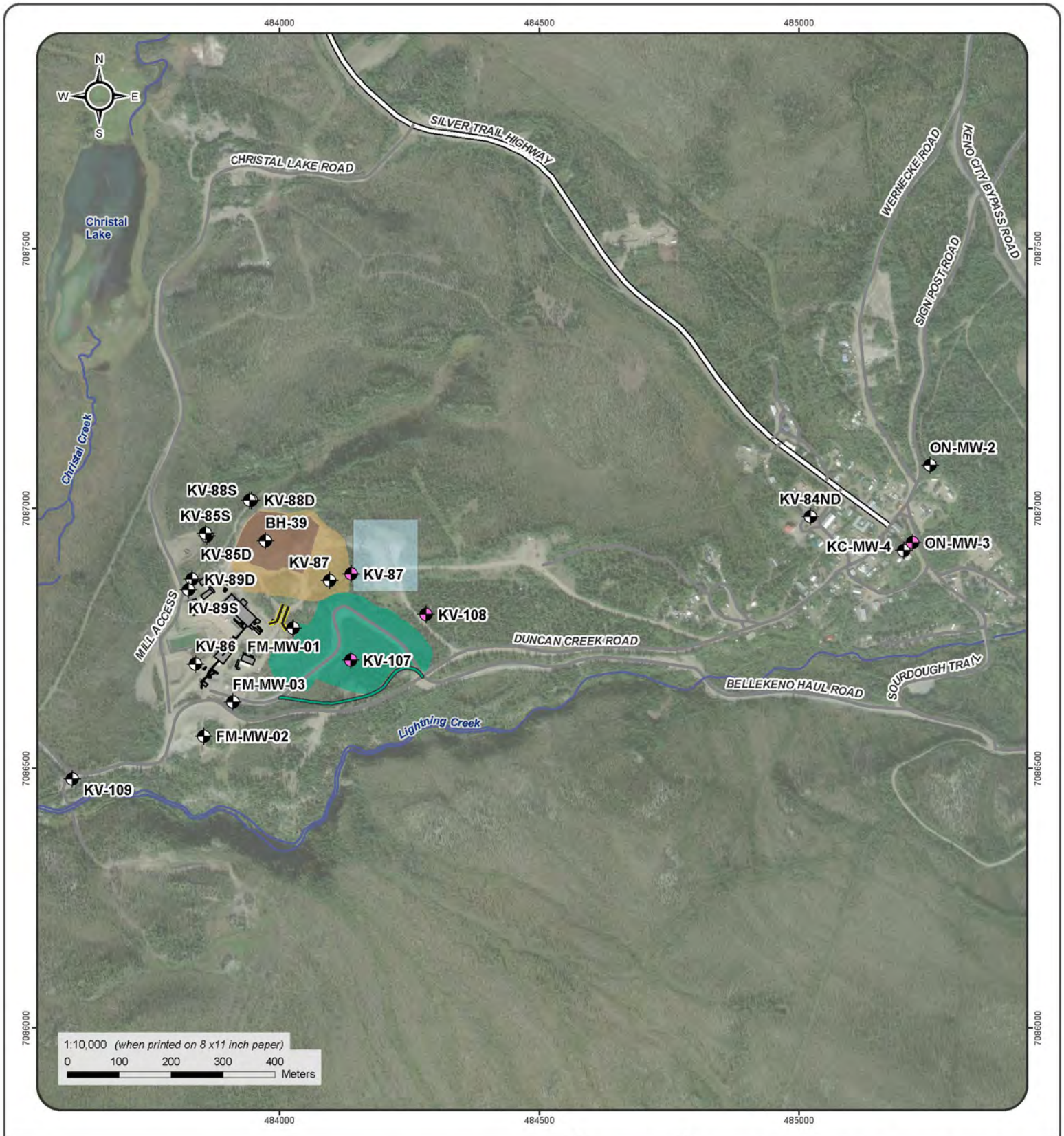
TETRA TECH

2021 AKHM ANNUAL INSPECTION
BELLEKENO MINE SITE - KENO CITY, YUKON

SITE PLAN SHOWING
BOREHOLE AND INSTRUMENTATION LOCATIONS

PROJECT NO.	DWN	CKD	REV
ENG.WARC04064-01	TP	JRT	0
OFFICE: EBA-WHSE	DATE: September 29, 2021		

Figure 3-4



Monitoring Well

Proposed Monitoring Well

Adit

Proposed Road

DSTF 322k Tonnes Design

Current DSTF

To Be Constructed Features

AKHM

ALEXCO KENO HILL MINING CORP.

FIGURE 3-5
MILL SITE, FLAME AND MOTH, KENO CITY GROUNDWATER MONITORING LOCATIONS

May 4, 2022

Satellite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on October 2020

Datum: NAD 83; Projection: UTM Zone 8N

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(Last edited by: amatlashevska; 2020-10-08/10:51 AM)

Table 3-14: AMI #6 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Depth to water in monitoring wells within the DSTF • BH39 • KV-107 Toe run-off collection ditch • Observations of water in the ditch Depth of water in downgradient monitoring wells: • KV-85S • KV-88S District Mill weather station daily temperature and precipitation records	**Low** Water observed in ditch during dry weather conditions	**Notification** • AKHM management notified as soon as observations are confirmed • Engineer of Record notified as soon as observations are confirmed **Evaluation** • Increase monitoring to bi-weekly to confirm results and improve understanding of the cause of the trigger activation **Management Response** • Engage the Engineer of Record • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • Continue bi-weekly monitoring and review until the Engineer of Record determines unnecessary
	Moderate Water depth is greater than 30 cm in DSTF monitoring wells BH-39 or KV-107 Water depth is less than 1 m below ground surface in monitoring wells KV-85S or KV-88S	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in quarterly physical inspection report WL report (as part of associated monthly report) **Evaluation** • Monitoring and review will be increased to daily until determined unnecessary. • Engineer of Record reviews well data • Engineer of Record will determine if monitoring frequency is to increase. • Engineer of Record will complete analysis of mitigative measures should exceedance continue. **Management Response** • Initiate implementation of recommendations of the Engineer of Record upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration
	High Water depth is at surface in monitoring wells KV-85S or KV-88S	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 24 hours of confirmation of data • AKHM corporate CEO to be notified within 24 hours of confirmation of data **Evaluation** • Engineer of Record must conduct a site visit • Placement of tailings on hold until the Engineer of Record advises otherwise • Determine if tailings placement and /or construction plan requires modification. • Engineer of Record will determine if additional instrumentation is required. **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Actions are to continue until Engineer of Record confirms they are no longer needed

3.7 AMI #7 – SIGNIFICANT EROSION OF EXPOSED DSTF SURFACES

3.7.1 Description

Runoff surface water entering the DSTF is managed through the construction of the outer diversion berms, toe runoff collection ditches, the conveyance pipe, and the water collection pond. The DSTF ditches have been designed for the 1 in 200 year return period as described in the Water Management Plan.

To reduce the potential of surface erosion and to direct any surface water to areas in which it can drain away from the facility the design included the construction of the drainage blanket beneath the facility and the OMS specifies how the tailings are to be stacked, graded, and compacted. In addition, snow is to be removed from the tailings stack throughout the winter prior to placement of the tailings; therefore, the potential for surface water issues during spring thaw are reduced.

The Engineer of Record has provided directions listed in Table 3-15 to reduce the risk of conditions that could cause erosion when operating in challenging conditions (EBA, 2010).

Table 3-15: DSTF Adverse Operating Conditions

CONDITION	MITIGATION MEASURE
High rainfall	• Erosion control – grade control and compaction of tailings stack during construction to seal lifts and prevent pooling of water • Compaction – may require drying out material prior to achieving compaction. At the discretion of the Geotechnical Engineer, material requiring additional compactive effort will be moved to less critical areas of the DSTF; i.e., south portion of the placement area away from the ultimate tailings slope, if required
High snow accumulation	• Removal prior to lift placements • Snow dumps will be sited to minimize any erosional impacts during thaw conditions
Freezing temperatures	• Location of placement – east portion of placement area away from the ultimate tailings slope as compaction prior to freezing problematic • Compaction – must be completed prior to the tailings freezing
Tailings characteristics (higher moisture)	• Location of placement – south portion of placement area away from the ultimate tailings slope • Compaction – may require drying out material prior to achieving compaction. At the discretion of the Geotechnical Engineer, material requiring additional compactive effort will be moved to less critical areas of the DSTF; i.e., south portion of the placement area away from the ultimate tailings slope, if required

An adaptive management initiative can be triggered if significant erosion of exposed DSTF surfaces occurs. Close monitoring of the DSTF is critical in determining if and when action is required

3.7.2 Risk Narrative

Large precipitation event erodes through the surface cover, resulting in transport of tailings that impede mine operations.

3.7.3 Monitoring Requirements and Evaluation of Results

Monitoring of the physical stability of the DSTF is described in the Environmental Monitoring, Surveillance and Reporting Plan Appendix B Physical Inspections and Reporting Plan. The plan provides the inspection and instrumentation data collection frequencies, instrument locations, as well as the data collection procedures.

Routine monitoring of the DSTF includes surveys, inspections, and turbidity analysis of surface water runoff collecting in the sump. Anything observed to be outside of normal operating parameters are to be reported immediately to AKHM management.

Inspection observations are reported on a quarterly basis by AKHM in accordance with WL QZ18-044. TetraTech Inc. conducts an annual geotechnical inspection of the DSTF and reports on the stability, integrity, and status of the DSTF and provides recommendations for remedial actions.

3.7.4 Indicators, Action Levels, Management Response

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated are observations of physical damage or turbidity in run-off water and recent weather conditions.

Any conditions and/or trends observed to be uncharacteristic would be handled with urgency to seek a better understanding of risk. AKHM ,management is to be notified immediately upon observation of possible erosional features. Once the risk has been defined, appropriate steps can be engineered and implemented to rectify any nonconformance.

3.7.5 AMI #7 Reporting

Observations outside of normal operating conditions, are to be reported immediately to AKHM management.

Review and data quality checks are completed following each monitoring event and includes a review of the relevant monitored data from the Environmental Monitoring, Surveillance and Reporting Plan, Appendix A Groundwater Monitoring Plan and Appendix B: Physical Inspections and Reporting Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-16 and management's response and next steps to be taken included in monthly reports.

Table 3-16: AMI #7 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Visual observations of physical damage: • Checking for sinkholes, cracks, depressions on the surface; • Checking for exposed tailings in covered portions of the DSTF: • Checking for a failure or breach of berms; • Water or tailings flowing down the stack; and • Tailing accumulating in the outer diversion berms and toe run-off collection ditches. Visible turbidity in runoff reporting to the sump or mill pond or in the natural drainages around or downstream the DSTF. Surveying DSTF components • Displacement of survey monuments; • Measuring slope inclinometers. Recording weather conditions	**Low** Observation of occurrence of physical damage or turbidity in runoff.	**Notification** • AKHM management notified as soon as damage observed • Include in quarterly physical inspection report WL report (as part of associated monthly report) **Evaluation** • Inspect the area for other signs of erosion • Collect surface water runoff samples and test for turbidity • Increase monitoring and review to bi-weekly to improve understanding of the cause • Investigate cause of erosion • Identify potential mitigative actions **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration or risk of erosion
	Moderate Area of significant erosion of the cover on the DSTF or area of significant erosion of exposed tailings Significance will be defined based on the judgement of AKHM's Chief Engineer, Operations Manager or General Manager	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Engineer of Record notified as soon as confirmation of data complete **Evaluation** • Monitoring and review will be increased to daily or as recommend by the Engineer of Record until determined unnecessary. • Engineer of Record will complete analysis of mitigative measures should erosion of the DSTF continue. **Management Response** • Engage the Engineer of Record • Implementation of recommendations of the Engineer of Record upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further erosion
	High Erosion of DSTF results material outside of the footprint and encroaching on infrastructure	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 24 hours of confirmation of data • AKHM corporate CEO to be notified within 24 hours of confirmation of data **Evaluation** • Engineer of Record must conduct a site visit • Placement of tailings on hold until the Engineer of Record advises otherwise • Determine if tailings placement and /or construction plan requires modification. **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP • Actions are to continue until Engineer of Record confirms they are no longer needed

3.8 AMI #8 – EROSION AT WATER TREATMENT PLANT OR MILL POND DISCHARGE SITES

3.8.1 Description

Storage and settling ponds have been constructed to provide water for the operation of the District Mill, to collect runoff from the surface of the DSTF and to allow effluent from the Bellekeno, Flame & Moth and Bermingham WTPs to settle prior to discharge to the environment.

- The Bellekeno Mine is near the confluence of Thunder Gulch with Lightning Creek. Bellekeno 625 WTP discharge reports to ground, flowing via a diffuse surface pathway into Lightning Creek, downstream of Thunder Gulch;
- The District Mill pond is located south of Christal Lake, and immediately north of Lightning Creek. When required, the pond discharges to ground in the Christal Creek catchment;
- The Flame & Moth Mine is located adjacent to the District Mill along Lightning Creek. The Flame & Moth WTP can discharge to Christal Creek or Lightning Creek. Discharge into Christal Creek reports to ground, while discharge into Lightning Creek is into surface water; and
- The New Bermingham WTP discharges to ground in the upper No Cash Creek catchment.

Routine monitoring is conducted as described in the Environmental Monitoring, Surveillance and Reporting Plan, the Christal Creek Attenuation Study Plan (CCASP), and the No Cash Creek Attenuation Study Plan (NCCASP). The objectives of these plans are to monitor activities to detect and mitigate potential risks to the receiving environment prior to an affect occurring and to provide a baseline dataset with which to assess environmental impacts.

3.8.2 Risk Narrative

Permafrost degradation and soil erosion develops because of water being discharged from the District Mill Pond or the WTP settling ponds.

3.8.3 Monitoring Requirements and Evaluation of Results

When the treatment ponds are discharging, daily water quality samples are taken and visual observations of the discharge location made. Evidence of erosion is noted during their daily site activities and reported to the Mill Manager or Mill Superintendent. Monitoring of the effluent discharge site aims to identify areas of erosion prior to any significant sediment loading, significant erosion or slope degradation and requirement to relocate the discharge area being required.

WQOs that are broadly protective of aquatic resources for the receiving environment have been established for Christal Creek (KV-50, KV-6, and KV-7), Lightning Creek (KV-81), and No Cash Creek (KV-21, KV-111). Monitoring at the receiving sites is part of the monthly regional surface and groundwater monitoring program, which is carried out by competent, trained field operators.

External laboratory water quality monitoring results are evaluated upon receipt by AKHM's Environment Department. In addition, a QP completes quality checks and uploads water quality monitoring results weekly into the EQWin database where set point triggers and trends are programmed to be flagged for notification and action.

3.8.4 Indicators, Action Levels, Management Response

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated are observations of the condition of the soil and vegetation below the discharge site. Channelization, depressions in the ground and poor vegetation growth or signs of dieback will trigger an adaptive management response

Soil erosion can lead to the degradation of soil structure and soil aeration. Reduced soil aeration results in less oxygen available for plant roots limiting or inhibiting their growth.

Should soil erosion be observed, the specific water quality indicators that should be monitored at the receiving environment sites include sulphate, arsenic, cadmium, copper, nickel, lead, silver, and zinc. The results are to be compared to site specific WQOs (Table 3-18).

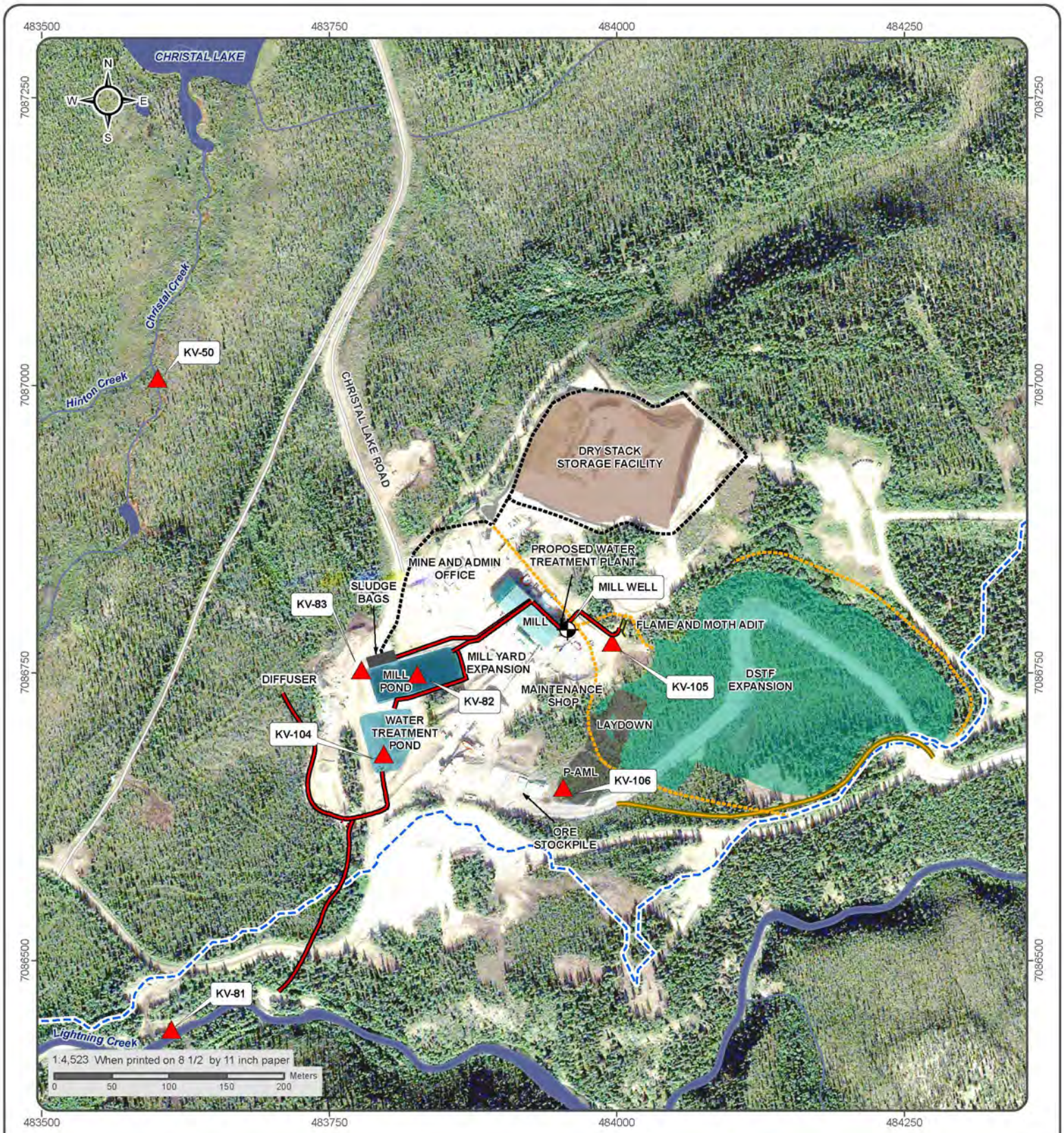
A staged response to the development of erosion and/or permafrost degradation will be implemented. The initial response to observing erosion or permafrost degradation at the discharge to ground location will be to prevent further degradation of the area. If necessary, physical repair will be performed to ensure longer term stability of the area. The final stage will be to monitor the area to watch for signs of continued erosion or degradation.

Depending on the results of the evaluations, the MRP may consider the following measures:

- Move all WTP discharge from Lightning Creek to Christal Creek (or vice a versa) until corrective actions are implemented;
- Relocate the Christal Creek or Bermingham WTP decant or Mill Pond diffuser to an area that is not affected by flow path channelization; and
- Armour the discharge area and install enhanced energy dissipating structures.

3.8.5 AMI #8 Reporting

Review and data quality checks is completed in accordance with the Environmental Monitoring, Surveillance and Reporting Plan and the Water Management Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-17 and management's response and next steps to be taken included in monthly reports



Ground Water Monitoring Station

Surface Water Quality Station

Existing Diversion Ditch

To Be Constructed Diversion Ditch

Current DSTF

To Be Constructed Features

Water Treatment Pond

Infrastructure Footprint

Watershed Boundaries

To Be Constructed DSTF Access Road

Satellite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on April 2019

Datum: NAD 83, Projection: UTM Zone 8N

AKHM

AEG

ALEXCO KENO HILL MINING CORP.
WATER MANAGEMENT PLAN

FIGURE 3-6
FLAME AND MOTH
WATER MANAGEMENT SCHEMATIC

May 2022

Table 3-17: AMI #8 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Observations of ground conditions below discharge locations TSS in receiving environment Vegetation health Recording weather conditions	**Low** Erosion at a WTP or the Mill Pond discharge to ground site results in flow path channelization A depression with defined edges observed below a discharge to ground site Impaired plant growth below the discharge to ground site observed Erosion at the Flame & Moth discharge site into Lightning Creek results in degradation of the uphill slope	**Notification** • AKHM management notified as soon as erosion at discharge site is observed • Include in quarterly physical inspection report WL report (as part of associated monthly report) **Evaluation** • Inspect the area for other signs of erosion • Increase monitoring and review to improve understanding of the cause • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome
	Moderate Erosion at a WTP or Mill Pond discharge site results in flow path channelization and TSS at station KV-6, KV-21, KV-50, or KV-111 15 mg/L greater compared to seasonal norms of preceding 3 years data. or TSS at station KV-81 is 25 mg/L higher than upstream at KV-41	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in monthly WL report **Evaluation** • Identify potential mitigative actions **Management Response** • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration
	High Erosion at a WTP or Mill Pond discharge site results in flow path channelization and WQO exceedance in two consecutive sample events at KV-6, KV-50, KV-21, KV-81 or KV-111 (Table 3-18)	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 1 week of confirming results **Evaluation** • Determine appropriate mitigation measures **Management Response** • Engage a QP • Initiate implementation of recommendations of the QP upon receipt • Obtain permits if necessary and implement mitigation measures as outlined in the MRP • Actions are to continue until WQOs are no longer exceeded

Table 3-18: Water Quality Objectives for Christal Creek, Lightning Creek, and No Cash Creek

PARAMETER	KV-50	KV-6	KV-7	KV-81[A]	KV-21[A]	KV-111[A]
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Ammonia-N	CCME	CCME	CCME	CCME	CCME	CCME
Nitrate-N	CCME	CCME	CCME	CCME	CCME	CCME
Nitrite-N	CCME	CCME	CCME	CCME	CCME	CCME
Arsenic	0.0432[b], 0.0277[c]	0.0167[b], 0.0098[c]	0.0102[b], 0.0043[c]	0.005	0.025[f]	0.005
Cadmium	BCMoE	0.00218[b], 0.00142[c]	0.00251[b], 0.000945[c]	BCMoE	0.0445[d], 0.0209[e]	0.000541[b], 0.000258[c]
Copper	0.00602[b], 0.00280[c]	0.0321[b], 0.00115[c]	0.00726[b], 0.00216[c]	0.00148[b], 0.00070[c]	0.00359[d], 0.00193[e]	BCMoE
Lead	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE
Nickel	CCME	CCME	CCME	CCME	CCME	CCME
Silver	CCME	CCME	CCME	CCME	CCME	CCME
Uranium	CCME	CCME	CCME	CCME	CCME	CCME
Zinc	0.271[b], 0.205[c]	0.367[b], 0.207[c]	0.220[b], 0.120[c]	CCME	4.94[d], 2.28[e]	0.179[b], 0.0602[c]
Sulphate	544[b], 409[c]	BCMoE	BCMoE	BCMoE	539[d], 349[e]	BCMoE
Selenium	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE
Radium	-	0.037 Bq/L	-	0.037 Bq/L	-	0.037 Bq/L

Notes:

a) Objectives for KV-81, KV-21, and KV-111 metals are dissolved

b) 95th percentile from July 2011 to August 2021 data set, except for KV-111 which ranges from September 2017 to August 2021

c) Upper confidence level mean from July 2011 to August 2021 data set, except for KV-111 which ranges from September 2017 to August 2021

d) 95th percentile from July 2017 and June 2018 to August 2021 data set for KV-21 and KV-56, respectively

e) Upper confidence level mean from July 2017 and June 2018 to August 2021 data set for KV-21 and KV-56, respectively t

f) Site specific based on Golder (2013) presented in Bermingham Water Quality Model (AEG, 2019)

3.9 AMI #9 – TRANSPORT OF SEDIMENTS FROM MILL POND OR WATER TREATMENT PLANT DISCHARGE AREAS

This adaptive management initiative is closely related to erosion at a discharge area and therefore has been included as part of AMI #8 Erosion at Water Treatment Plant or Mill Pond Discharge Sites.

3.10 AMI #10 – LARGE DIFFERENTIAL SETTLEMENTS AT DSTF

3.10.1 Description

Many factors contribute to uneven surface settlement. As the permafrost undersurface is not uniformly distributed by thickness and ice content, after dry tailing placement, differential surface settlement overtime is possible. The weight of an un-uniform thickness of dry tailings may also contribute to uneven surface settlement at the DSTF.

3.10.2 Risk Narrative

Large differential settlement in the long-term (~50 years) leads to tailings exposure on the surface from compromised cover.

3.10.3 Monitoring Requirements and Evaluation of Results

DSTF instrumentation consists of seven ground temperature cables installed to monitor permafrost (six in natural soils adjacent to the DSTF and one through tailings placed within the DSTF footprint), and three slope indicators installed to monitor lateral movement of the foundation soils.

The Environmental Monitoring, Surveillance and Reporting Plan, Appendix B: Physical Inspections and Reporting Plan outline the monitoring and inspection requirements for the DSTF. Inspection results are summarized on a quarterly basis by AKHM and submitted under WL QZ18-044. An annual report is also submitted under QML-0009. All monthly and annual reports are provided to FNNND.

TetraTech Inc. conducts an annual geotechnical inspection of the DSTF, including a review of monthly survey records, readings of the slope indicators and thermistor cables that are still operational within and around the DSTF and provides recommendations for remedial actions.

3.10.4 Indicators, Action Levels, Management Response

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated are:

- Survey monuments and slope indicators
- Visual observations
- Monthly topography survey
- Ground temperature cable measurements
- District Mill weather station daily temperature and precipitation records

3.10.5 AMI #10 Reporting

Review and data quality checks is completed in accordance with the Environmental Monitoring, Surveillance and Reporting Plan, Appendix B: Physical Inspections and Reporting Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-19 and management's response and next steps to be taken included in monthly reports.

Table 3-19: AMI #10 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Survey monuments and slope indicators Monthly topography survey Ground temperature cable measurements Visual inspection of DSTF for • Sinkholes • Bulges • Cracks • Holes District Mill weather station daily temperature and precipitation records	**Low** Displacement of survey monuments or slope indicators Observations of sink holes, slope sliding, crack, and ditching over the top of the DSTF	**Notification** • Engineering Department within 24 hours of inspection or survey • AKHM site management within 1 week of confirming results **Evaluation** • Confirm results • Engineering Department to assess material properties, survey results, ground thermistor readings and climate interactions • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome
	Moderate An observation of a localized instability within the DSTF footprint. Impact to equipment operation or cover impaired	**If not already done so, complete the activates outlined for a low action level trigger** **Notification** • AKHM site management immediately • Engineer of Record within 24 hours of observation of impact • Include in quarterly physical stability WL report **Evaluation** • Identify potential mitigative actions **Management Response** • Engage the Engineer of Record • Initiate implementation of recommendations of the Engineer of Record upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration • Continue additional monitoring and review until the Engineer of Record determines unnecessary
	High An observation of a slope failure that extends beyond the DSTF footprint and impacts infrastructure	**If not already done so, complete the activates outlined for a moderate action level trigger** **Notification** • YG inspector within 24 hours of observing failure outside the facility footprint • AKHM corporate CEO to be notified within 24 hours of observing failure **Evaluation** • Engineer of Record must conduct a site visit • Placement of tailings on hold until the Engineer of Record advises otherwise • Determine if tailings placement and /or construction plan requires modification. • Engineer of Record will determine if additional instrumentation is required. **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Mitigate by cleaning up the tailings released

3.11 AMI #11 – DIFFERENTIAL SETTLEMENT OF WATER CONVEYANCE OR RETAINING STRUCTURE

3.11.1 Description

Many factors contribute to uneven surface settlement. As the permafrost undersurface is not uniformly distributed by thickness and ice content, differential surface settlement overtime is possible. Differential settlement along the conveyance pipe from the DSTF to the District Mill pond or at the WTP settling ponds could impede the management of mine discharge or mill process water.

Routine monitoring is conducted as part of the Monitoring, Surveillance and Reporting Plan, and the resulting observations and measurements are used to document any changes to the structural integrity of water conveyance or water retaining structures.

3.11.2 Risk Narrative

Differential settlement of a water conveyance or water retaining structure leads to an uncontrolled release of contact water to the environment or effluent to the environment.

3.11.3 Monitoring Requirements and Evaluation of Results

The Environmental Monitoring, Surveillance and Reporting Plan, Appendix B: Physical Inspections and Reporting Plan outline the monitoring and inspection requirements for the water conveyance and water retaining structures. Anything observed to be outside of normal operating parameters are to be reported immediately to AKHM management. Inspection results are summarized on a quarterly basis by AKHM and submitted under WL QZ18-044. An annual report is also submitted under QML-0009. All monthly and annual reports are provided to FNNND.

TetraTech Inc. (formerly called EBA Engineering Consultants Ltd.) conducts an annual geotechnical inspection of the water retaining structures and reports on their stability, integrity and status and provides recommendations for remedial actions.

3.11.4 Indicators, Action Levels, Management Response

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated is a visual assessment of water conveyance and retaining structures for the presence of abnormal cracking or failure or breach of berms or bulges at the toe of the structure.

Any conditions and/or trends observed to be uncharacteristic would be handled with urgency to seek a better understanding of risk. Once the risk has been defined, appropriate steps can be engineered and implemented to rectify any nonconformance.

3.11.5 AMI #11 Reporting

Review and data quality checks is completed in accordance with the Dust Abatement and Monitoring Pl Environmental Monitoring, Surveillance and Reporting Plan, Appendix B: Physical Inspections and Reporting Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-20 and management's response and next steps to be taken included in monthly reports

Table 3-20: AMI #11 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Visual observations of physical damage: • Sinkholes, cracks, depressions on the surface; • Water flowing over or seeping from the berm; • Sediment accumulating at the toe of the berm;.or • Bulges in the berm Survey components • Displacement of survey monuments	**Low** Physical damager or movement of the slope noted Significance will be defined based on the judgement of AKHM's Chief Engineer, Operations Manager or General Manager	**Notification** • AKHM management notified as soon as damage observed • Include in quarterly physical inspection report WL report (as part of associated monthly report) **Evaluation** • Inspect the area for other signs of erosion • Increase frequency of the review of monitoring data to improve understanding of the cause • Identify potential mitigative actions **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes
	Moderate Operation of WTP impaired Maintenance required to stabilize facility	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Engineer of Record notified as soon as confirmation of data complete **Evaluation** • Monitoring and review frequency will be increased as recommend by the Engineer of Record • Engineer of Record will complete analysis of mitigative measures should degradation continue. • Determine if operation of WTP requires modification. **Management Response** • Engage the Engineer of Record • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration
	High Breach of the slope observed	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 24 hours of breach • AKHM corporate CEO to be notified within 24 hours of breach **Evaluation** • Engineer of Record must conduct a site visit **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP • Actions are to continue until Engineer of Record confirms they are no longer needed

3.12 AMI #12 – EXCEEDANCE OF WATER QUALITY OBJECTIVES IN RECEIVING ENVIRONMENT

3.12.1 Description

Water quality monitoring is conducted to detect potential effects to the receiving environment from the Bellekeno, Flame & Moth and New Bermingham mine workings and the operation of the District Mill.

Impacts of the historical mining in the KHSD, placer mining on Lightning creek, deposition of waste in the Keno City municipal dump facility, and other non-mining activities has the potential to impact the same receiving environment sites.

Understanding the impact of the discharges occurring from the KHSD Mining Operation requires an understanding of the impacts of the other human activities in the area. Consequently, a monthly regional surface and groundwater monitoring program is carried out to assess the relative impacts of the various activities.

All data for current water sample stations required in WL QZ18-044 are stored in an EQWin database that allows water quality to be tracked at each site such that conditions can be identified at any point in the season. In this way, parameters can be tracked, and fluctuations out of the normal levels where management is required to respond can be monitored. Set point triggers can be placed in the database so that response parameters are flagged for notification and action. A variance report is generated on at least a quarterly basis for sitewide information that could identify sitewide trends.

The routine monitoring programs are outlined in the KHSD Mining Operations Monitoring, Surveillance and Reporting Plan (MSRP), Christal Creek Attenuation Study Plan (CCASP) and No Cash Creek Attenuation Study Plan (NCCASP).

WQOs that are broadly protective of aquatic resources for Christal Creek (KV-50, KV-6, and KV-7), Lightning Creek (KV-81), No Cash Creek (KV-21, KV-111), Star Creek (KV-56), and the South McQuesten River (KV-2) have been established.

3.12.2 Risk Narrative

Surface water quality objectives exceeded in the receiving environment occurring irrespective of compliance with effluent discharge standards.

3.12.3 Monitoring Requirements and Evaluation of Results

Water quality is monitored at mine discharges, WTP discharges, downgradient surface and groundwater monitoring stations and background monitoring stations. The results are used to calculate loading and potential effects to the receiving environment.

The WQOs have been established using generic CCME or BCMoE guidelines or using the background concentration procedure. The background concentration procedure was used to develop WQOs for constituents that frequently exceed the CCME and BCMoE guidelines (i.e., greater than 10% of samples exceed guideline). Short-term maximum and long-term average threshold concentrations were developed from the 95th percentile and upper confidence level (95%) mean of the data set (past ten years, where available),

respectively. Thus, 95th percentile WQOs are compared on a per sample basis, whereas the upper confidence level mean WQOs are compared to the rolling annual average. The WQOs for Christal, Lightning, No Cash, and Star Creeks and the South McQuesten River are presented in Table 3-23. Appendix A includes a summary of the updates made to the thresholds in comparison to the previous version of the AMP.

The monitoring locations and the associated mine operation are listed in Table 3-21. Station KV-2 is on the South McQuesten River which is downgradient of all main water courses except Lightning Creek and Thunder Gulch. These sites are shown in Figure 3-7.

Table 3-21: Surface Water Quality Stations per Mine

MINE	MAIN WATER COURSES MONITORED	MINE ASSOCIATED STATIONS	RECEIVING ENVIRONMENT STATIONS USED FOR WATER BALANCE AND WATER QUALITY MODEL	LOCATIONS FOR WATER QUALITY PREDICTIONS AND WATER QUALITY OBJECTIVES
Bellekeno	Lightning Creek and Thunder Gulch	KV-42, KV-43, KV-44, KV-78b	KV-37, KV-38, KV-39, KV-40, KV-41, KV-76, KV-77	KV-41
Flame and Moth	Christal Creek and Lightning Creek	KV-104, KV-105, KV-106	KV49, KV-50, KV-51, KV-6, KV-7, KV-41, KV-81	KV-81, KV-50, KV-6 and KV-7
District Mill/DSTF	Christal Creek	KV-82 and KV-83	KV-50, KV-6 and KV-7	KV-50, KV-6 and KV-7
New Bermingham	No Cash Creek	KV-114, KV-115	KV-56, KV-111, KV-118	KV-21

3.12.4 Indicators, Action Levels, Management Response

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated are the water quality objectives (WQOs) for No Cash Creek (KV-21, KV-111), Star Creek (KV-56), Christal Creek (KV-50, KV-6, and KV-7), Lightning Creek (KV-81), and the South McQuesten River (KV-2).

If an increasing trend towards a WQO or a WQO exceedance is detected, then further responses will be undertaken. Given that seasonal patterns are inherent to the receiving environment water quality data, the Seasonal Mann-Kendall test is recommended for use. In addition to accounting for seasonality in the data, this statistical test does not require the data to be normally distributed (i.e., it is a non-parametric test) and can accommodate instances of missing data or data below the detection limit. Where a statistically significant increasing trend is identified (i.e., p-value less than 0.05), the AMP is triggered if extrapolation of this trend indicates the WQO will be exceeded within 12 months.

The trend analysis threshold review will incorporate the five previous years of data relative to the WQOs, whereas the comparison against the UCLM will be carried out monthly on a 12 month moving average.

It is recognized that the implementation of the reclamation plan for the historical United Keno Hill Mines site will result in marked improvements to water quality in No Cash Creek. This will result in lower constituent concentrations (primarily cadmium and zinc) at station KV-21 as following treatment of the historical No Cash 500 adit discharge. AKHM has proposed to convene a workshop with the Yukon Government, Government of Canada, and the FNNND to develop a mechanism to update the WQOs for KV-21 as water quality in No Cash Creek improves. Such changes would likely focus on those constituents for which the background concentration procedure was used to develop the WQOs (i.e., constituents that often exceed generic water quality guidelines)

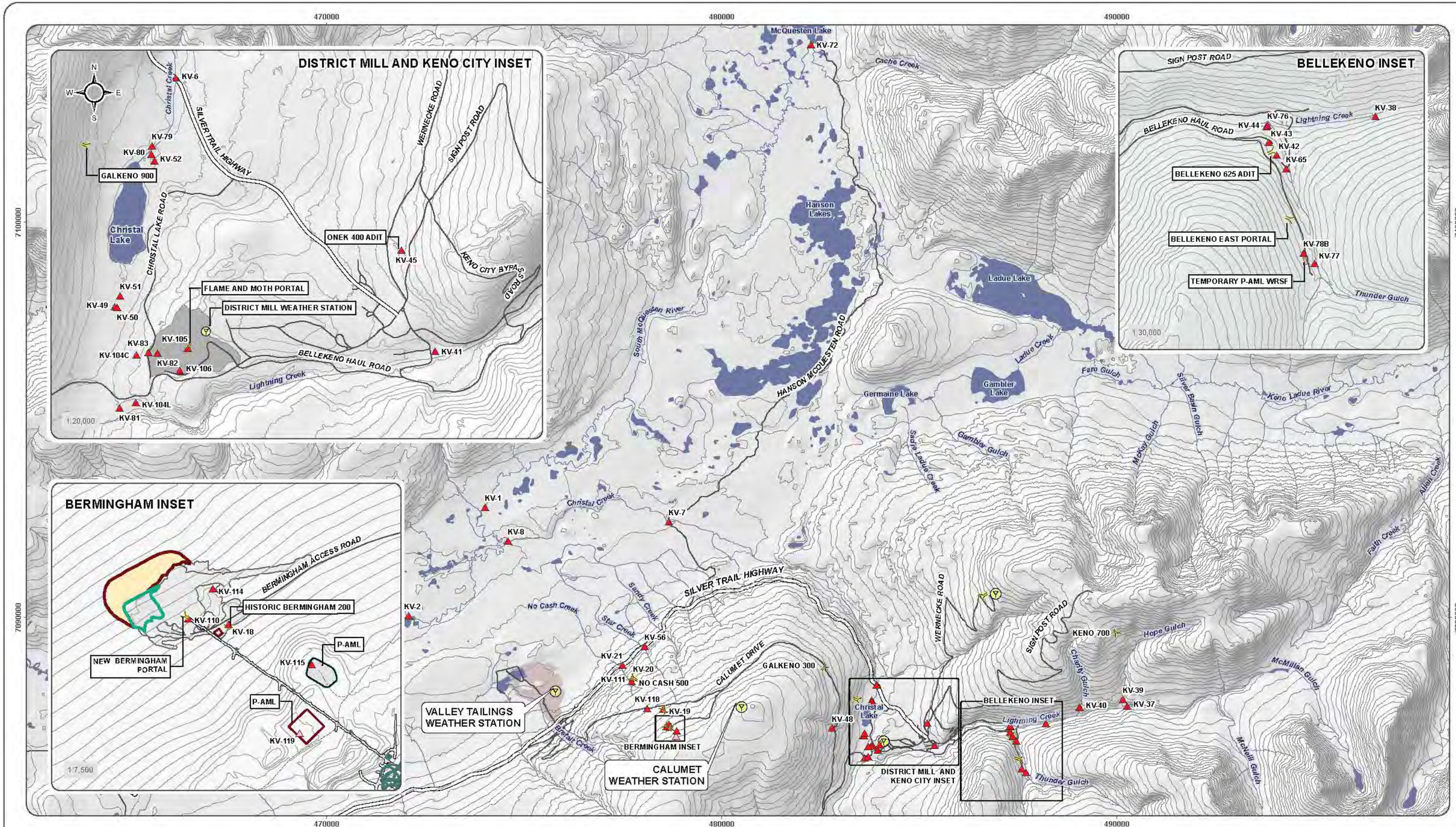
and for which treatment of the historical No Cash 500 adit discharge may result in lower concentrations at KV-21 (i.e., cadmium and zinc). Although the approach to update the WQOs at KV-21 would be reached via a collaborative effort with the three government stakeholders, a potential method might involve the development of "preliminary" WQOs extracted from a one-year data set of monthly samples collected at KV-21 in the first year since the successful implementation of treatment at the No Cash 500 adit. These WQOs would be updated annually until a three year data set is available from which the "final" WQOs may be derived.

Depending on the results of the evaluations, the MRP may consider the following measures:

- Increased sampling frequency to help determine potential causes;
- Investigation of the root cause of the exceedance including utilizing the Goldsim model to understand the loadings of the system of concern. Compare the monitoring results to the Goldsim predicted concentrations;
- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the inspector notified of the remedy implementation in a timely manner according to permit requirements; and
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

3.12.5 AMI #12 Reporting

Review and data quality checks are completed following each monitoring event. Set point triggers are in place in the site tracking spreadsheet and EQWin database so that response parameters are flagged for notification and action. Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-22 and management's response and next steps to be taken included in monthly reports.



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

1:90,000 (when printed on 11 x17 inch paper)

0 1 2 3 4 5 Kilometers

- Active Surface Water Quality Station
- Pending/Proposed Water Quality Station
- Weather Station
- Adit
- As Built Mine Feature
- Valley Tailings
- Silver Trail Highway
- Other Road
- Watercourse
- Waterbody

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FIGURE 3-7
SURFACE WATER QUALITY STATION LOCATIONS

MAY 2022

Table 3-22: AMI #12 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Arsenic, cadmium, copper, lead, nickel, selenium, silver, uranium, zinc, ammonia, nitrate, nitrite, sulphate Receiving environment monitoring stations (Christal Creek at KV-50, KV-6, and KV-7, Lightning Creek at KV-81, No Cash Creek at KV-111 and KV-21, and Star Creek at KV-56)	**Low**	**Notification** • AKHM site management within 1 week of receiving results **Evaluation** • Confirm results • Assess potential mine related sources and external environmental interactions • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome
	Moderate Trending towards or exceedance of water quality objective at a receiving environment monitoring station based on seasonal norms compared to preceding 3 years data.	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in monthly WL report **Evaluation** • Initiate review of associated catchment background and receiving environment monitoring data • Visual inspect the effluent discharge flow path to Christal Creek or No Cash Creek for evidence of significant channel formation that may be limiting interaction with soil and vegetation substrate, potentially limiting natural attenuation • Assess any water quality changes in effluent discharge (KV-83, KV-104C or KV-114) that may be limiting effectiveness of natural attenuation • Identify potential mitigative actions **Management Response** • Engage a QP • Initiate implementation of recommendations of the QP upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration
	High Exceedance of WQO	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 1 week of receiving results **Evaluation** • Calculate natural attenuation at KV-6, KV-50, KV-21, or KV-111 and compare to the water quality model predictions **Management Response** • Engage a QP to revise the water quality models and linked operating management plans to reflect the decrease in natural attenuation • Engage a QP to evaluate the potential effects to aquatic resources • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Actions are to continue until WQOs are no longer exceeded

Table 3-23: Water Quality Objectives for Christal Creek, Lightning Creek, No Cash Creek, Star Creek, and South McQuesten River

	KV-50	KV-6	KV-7	KV-81[A]	KV-21[A]	KV-56	KV-111[A]	KV-2
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Ammonia-N	CCME	CCME	CCME	CCME	CCME	CCME	CCME	CCME
Nitrate-N	CCME	CCME	CCME	CCME	CCME	CCME	CCME	CCME
Nitrite-N	CCME	CCME	CCME	CCME	CCME	CCME	CCME	CCME
Arsenic	0.0432[b], 0.0277[c]	0.0167[b], 0.0098[c]	0.0102[b], 0.0043[c]	0.005	0.025[f]	0.005	0.005	0.005
Cadmium	BCMoE	0.00218[b], 0.00142[c]	0.00251[b], 0.000945[c]	BCMoE	0.0445[d], 0.0209[e]	0.000297[d], 0.000132[e]	0.000541[b], 0.000258[c]	0.000941[b], 0.000647[c]
Copper	0.00602[b], 0.00280[c]	0.0321[b], 0.00115[c]	0.00726[b], 0.00216[c]	0.00148[b], 0.00070[c]	0.00359[d], 0.00193[e]	BCMoE	BCMoE	0.00651[b], 0.00376[c]
Lead	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE
Nickel	CCME	CCME	CCME	CCME	CCME	CCME	CCME	CCME
Silver	CCME	CCME	CCME	CCME	CCME	CCME	CCME	CCME
Uranium	CCME	CCME	CCME	CCME	CCME	CCME	CCME	CCME
Zinc	0.271[b], 0.205[c]	0.367[b], 0.207[c]	0.220[b], 0.120[c]	CCME	4.94[d], 2.28[e]	CCME	0.179[b], 0.0602[c]	0.152[b], 0.103[c]
Sulphate	544[b], 409[c]	BCMoE	BCMoE	BCMoE	539[d], 349[e]	BCMoE	BCMoE	BCMoE
Selenium	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE
Radium	-	0.037 Bq/L	-	0.037 Bq/L	-	-	0.037 Bq/L	-

Notes:

a) Objectives for KV-81, KV-21, and KV-111 metals are dissolved

b) 95th percentile from July 2011 to August 2021 data set, except for KV-111 which ranges from September 2017 to August 2021

c) Upper confidence level mean from July 2011 to August 2021 data set, except for KV-111 which ranges from September 2017 to August 2021

d) 95th percentile from July 2017 and June 2018 to August 2021 data set for KV-21 and KV-56, respectively

e) Upper confidence level mean from July 2017 and June 2018 to August 2021 data set for KV-21 and KV-56, respectively t

f) Site specific based on Golder (2013) presented in Bermingham Water Quality Model (AEG, 2019)

3.13 AMI #13 – IDENTIFICATION OF GROUNDWATER QUALITY IMPACT

3.13.1 Description

Understanding impacts to groundwater quality because of underground mine development and mineral processing by AKHM is important to help determine risks to surface water.

The District Mill monitoring wells have been installed to collect baseline information on groundwater conditions, as well as information on the potential impacts of ancillary activities, construction, and impacts from the DSTF. Precautions have been taken in the design and construction of the DSTF to prevent porewater seepage to groundwater by providing an impermeable basal layer to allow capture of any potential DSTF seepage and directing it to the mill pond.

Groundwater monitoring is carried out within Keno City to better understand the potential impact of the Onek 400 adit discharge to the Keno City groundwater table. There are known to be private wells within the community that provide domestic water to individual cabins; the use of these wells is currently unknown.

Monitoring wells have been installed at Flame & Moth and Bermingham to collect baseline information on groundwater conditions, as well as information on the potential impacts from underground mining, N-AML waste rock disposal, along with potential impacts from the storage of P-AML waste rock on surface and the use of the Bermingham Southwest open pit for sludge disposal.

Routine monitoring is conducted as part of the Environmental Monitoring, Surveillance and Reporting Plan, Appendix A Groundwater Monitoring Plan. Existing and proposed groundwater monitoring wells at the Flame & Moth Mine, District Mill and DSTF, are shown on **Error! Reference source not found.**. The groundwater monitoring well network at the New Bermingham Mine are shown on Figure 3-9. The objectives of the groundwater quality monitoring program are to provide a continuous baseline dataset and monitor effects on the quality of groundwater.

3.13.2 Risk Narrative

Flux of geochemical load from the mines, waste rock disposal areas, or DSTF via groundwater pathways causes surface water quality objectives to be in exceeded downgradient.

3.13.3 Monitoring Requirements and Evaluation of Results

Routine monitoring requirements for groundwater are described in detail in the Groundwater Monitoring Plan. Quarterly measurement of field parameters including water level, pH, temperature and conductivity and analysis by an external laboratory includes dissolved metals, alkalinity, ammonia, phosphorous, sulphate, uranium, selenium dissolved organic carbon (DOC) and hardness. Groundwater sampling and monitoring will be carried out by competent, trained field operators.

Identifier for the groundwater monitoring wells and the associated mine feature being monitored are listing in Table 3-24. Wells KV-107 and KV-108 will be installed in phase 2 of the DSTF. Monthly sampling is undertaken for each new monitoring well until a minimum of one year of data points are available. After which the sampling frequency reverts to quarterly.

Table 3-24: Groundwater Monitoring Stations per Mine

MINE	MINE INFRASTRUCTURE MONITORED	UPGRADIENT WELLS	DOWNGRADIENT WELLS
Bellekeno	-	-	-
District Mill/DSTF	Mill and DSTF	KV-87N, KV-108	KV-85D/S, KV-86, KV-88D/S, KV-89S, BH-39, KV-107
Flame and Moth	Mine and P-AML WRSF	KV-108	FM-MW-2, FM-MW-3, KV-103, KV-109
New Bermingham	Mine, N-AML WRDA, P-AML WRSF and Bermingham SW Pit	-	KV-116, BH-MW-1, RB-MW-1, NC-MW-1, KV-122, KV-123, KV-124, KV-125, KV-126, KV-127
Keno City	P-AML WRDA	-	ON-MW-2, KC-MW-3N, KV-84ND

Groundwater monitoring is a critical component of the water-resource management program for the KHSD Mining Operations. The hydrologic connections between groundwater and surface water mandate that the monitoring program for all water resources be closely linked.

Results of all groundwater monitoring activities are subject to a quarterly review by QP when the analytical results are received. The data is compared to the Yukon Contaminated Sites Regulation (YCSR) generic water standards for aquatic life. Data from wells screened in the potentially potable aquifer near Keno City are also compared to the YCSR drinking water standards. External laboratory water quality monitoring results are evaluated upon receipt by AKHM's Environment Department. In addition, the QP completes quality checks and uploads water quality monitoring results weekly into the EQWin database where set point triggers and trends are programmed to be flagged for notification and action.

An annual review and interpretation of groundwater monitoring results is submitted under WL QZ18-044. This annual report identifies potential changes in baseline conditions and evaluates trends that may trigger adaptive management measures. All annual reports are provided to FNNND.

3.13.4 Indicators, Action Levels and Management Responses

The specific indicators that are monitored to provide the information necessary to assess whether a trigger has been activated are: water level, sulphate, ammonia, arsenic, cadmium, copper, lead, nickel, selenium, silver, uranium, and zinc.

Groundwater quality action level triggers for adaptive management are based on the past 10 years of water quality data (where available). Where greater than 10% of samples exceeded a YCSR groundwater quality standard the 95th percentile has been employed, otherwise the triggers are based on the YCSR standard as listed in Table 3-26. A summary of the updates made to the thresholds in comparison to the 2020 version of the AMP is provided in Appendix A.

Additional thresholds have been established for increasing trends and water quality present in the monitoring wells for the phase 1 and 2 of the DSTF based on the EQS for the mill pond (KV-43).

Depending on the results of the evaluations, the MRP may consider the following measures:

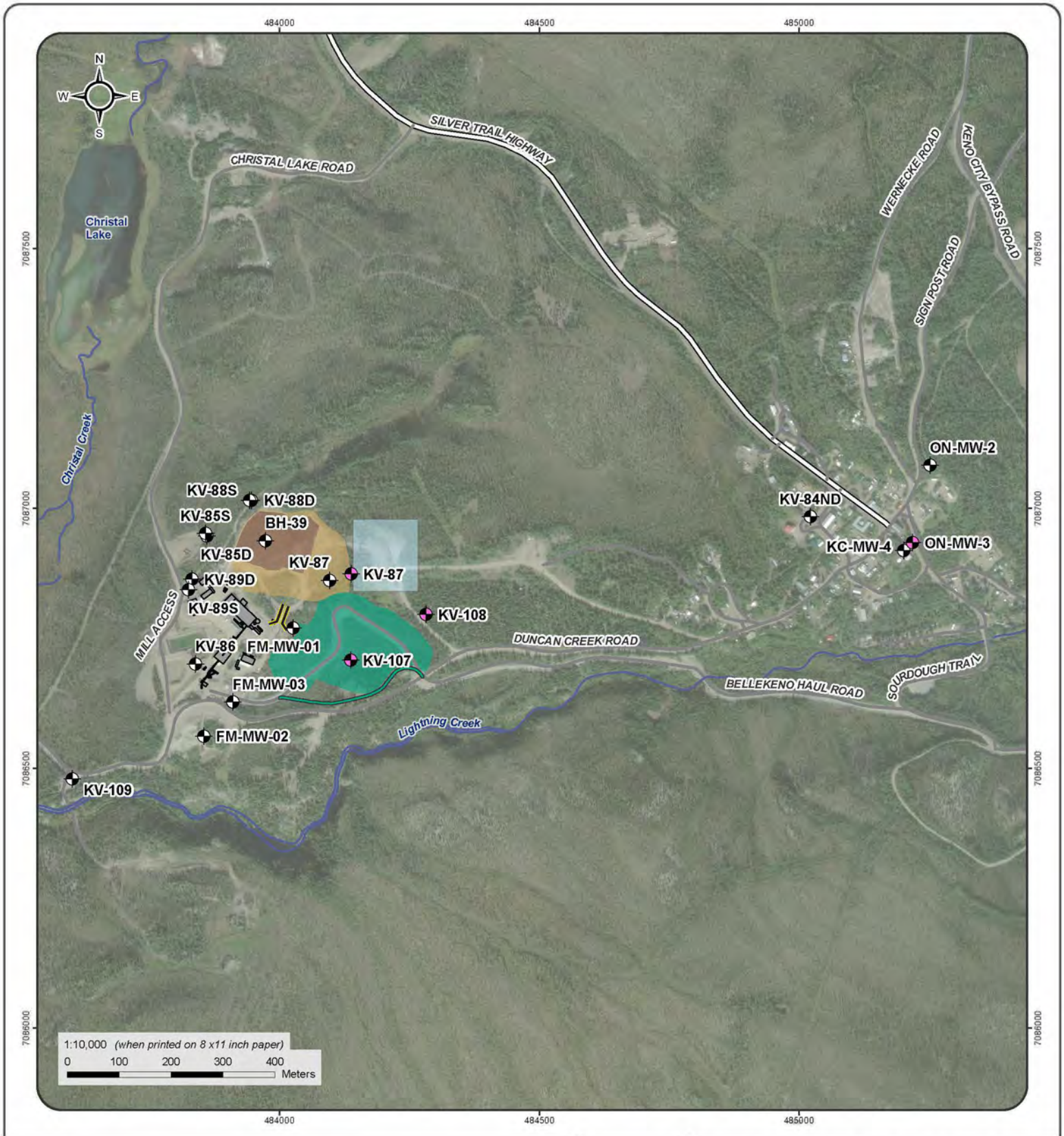
- Increased sampling frequency to help determine potential causes;

- Investigation of the root cause of the exceedance;
- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the inspector notified of the remedy implementation in a timely manner according to permit requirements; and
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

The AMP triggers for newly installed wells are to be updated annually until three years of data have been collected upon which future triggers can be based. The updates are to be provided in the annual report under WL QZ18-044.

3.13.5 AMI #13 Reporting

Review and data quality checks is completed following each monitoring event and includes a review of the relevant monitored data from the Environmental Monitoring, Surveillance and Reporting Plan and the Attenuation Study Plans (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-25, Table 3-33, and management's response and next steps to be taken is included in monthly reports.



Monitoring Well

Proposed Monitoring Well

Adit

Proposed Road

DSTF 322k Tonnes Design

Current DSTF

To Be Constructed Features

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FIGURE 3-8
MILL SITE, FLAME AND MOTH, KENO CITY GROUNDWATER MONITORING LOCATIONS

May 4, 2022

Satellite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on October 2020

Datum: NAD 83; Projection: UTM Zone 8N

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(Last edited by: amatlashewska; 2020-10-08/10:51 AM)

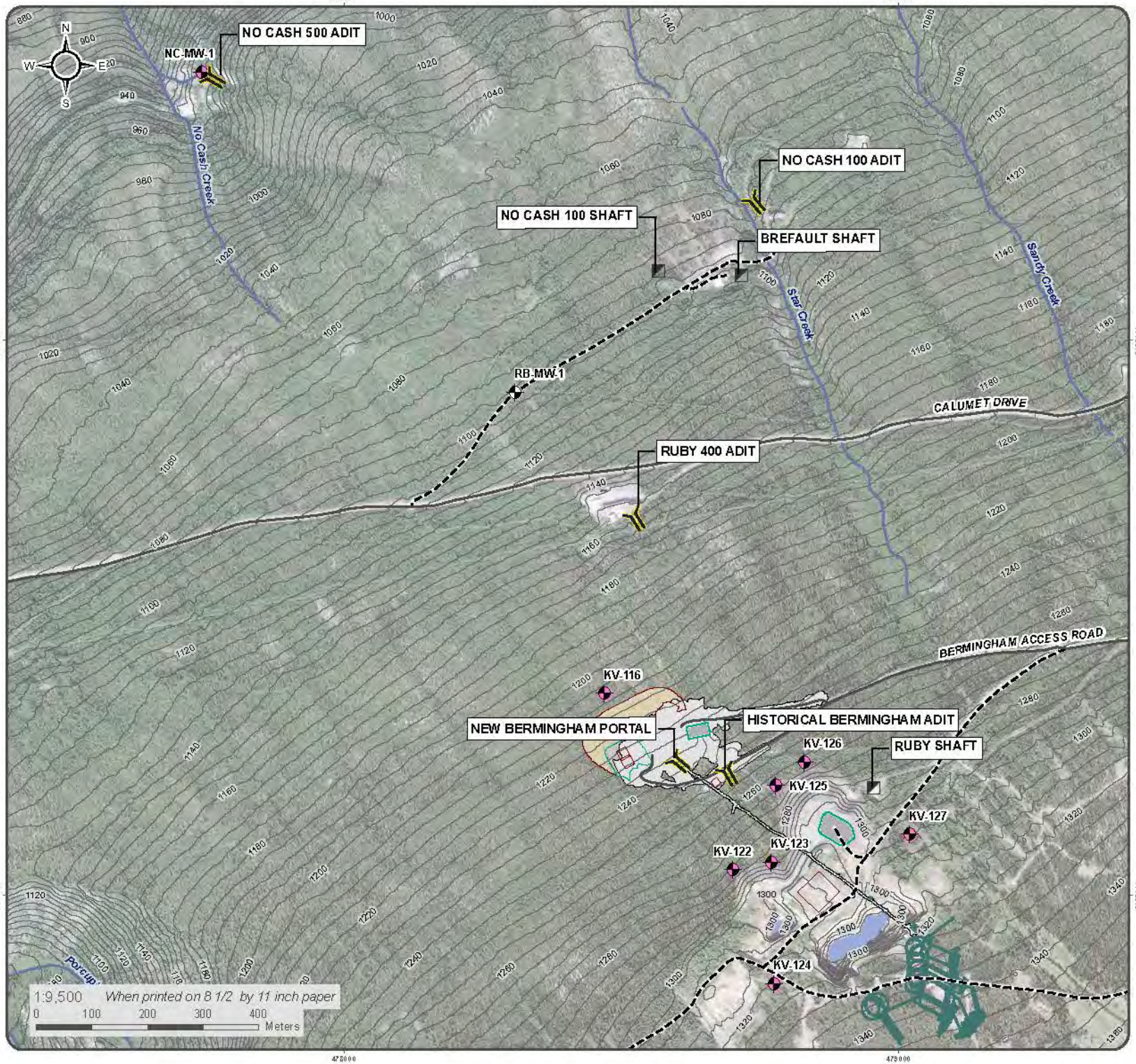

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FIGURE 3-9

BERMINGHAM GROUNDWATER MONITORING LOCATIONS

MAY 2022

- Adit/Portal
- Shaft
- Groundwater Quality Monitoring, Existing
- Groundwater Quality Monitoring, Proposed
- Pond
- Permitted To Be Construced Mine Features
- Proposed Mine Feature
- Proposed Underground Workings
- Road
- Limited-Use Road
- Contour (5m interval)

Satellite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on October 08 2020

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

AKTIM

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(Last edited by: sarah.sacks; 2020-10-08 08:32 AM)

Table 3-25: AMI #13 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATGEY
Water level Parameters sulphate, ammonia-N, nitrite-N, nitrate-N, arsenic, cadmium, copper, lead, nickel, selenium, silver, uranium and zinc <u>District Mill and DSTF</u> KV-85D/S, KV-86, KV-87N, KV-88D/S, KV-89S, KV-108, BH-39, KV-107 <u>Flame & Moth</u> FM-MW-2, FM-MW-3, KV-103, KV-108, KV-109 <u>New Bermingham</u> BH-MW-1, NC-MW-1, KV-122, KV-116, KV-123, KV-124, KV-125, KV-126, KV-127 <u>Keno City</u> ST-MW-1, ON-MW-2, KC-MW-3N, KV-84ND	**Low** Exceedance of the AMP trigger (Table 3-26) for sampling event within the respective quarter three years in a row or Water depth is greater than 30 cm in DSTF monitoring wells BH-39 or KV-107	**Notification** • AKHM site management within 1 week of receiving results • Include in monthly WL report **Evaluation** • Confirm results (review laboratory QA/QC report and validate original result) • Assess potential mine related sources and external environmental interactions **Management Response** • Engage a QP to review groundwater monitoring data (trend analysis included) at quarterly intervals • Initiate implementation of recommendations of the QP upon receipt • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome
	Moderate Modelling determines a significant increasing trend compared to past ten years of data (use of Seasonal Mann Kendall test if there is seasonality evident in the data set; if not, then the Mann-Kendall test should be used) and the timing for an exceedance of surface water quality objectives as a result of groundwater flux predicted or Water quality in DSTF monitoring wells BH-39 or KV-107 is approaching EQS for KV-83 (Table 3-28)	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Submit recommendations of the QP and Engineer of Record to the water board, EMR and YG inspector within 1 week of receipt **Evaluation** • QP to model timing of exceedance of surface water quality objectives as a result of groundwater flux • Visual inspect conditions at and upgradient of the monitoring well • Identify potential mitigative actions **Management Response** • Engage DSTF Engineer of Record if appropriate • Initiate implementation of recommendations of the Engineer of Record upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration of groundwater quality
	High Modelling by QP determines a high action level trigger reached or Water depth is greater than 30 cm in DSTF monitoring wells BH-39 or KV-107 and water quality exceeds EQS for KV-83 (Table 3-28)	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • Where required, submit mitigation plan to the water board, EMR and YG inspector for review and approval **Evaluation** • Gather additional data to finalize the mitigation design **Management Response** • Obtain permits and implement mitigation measures as outlined in the MRP

Table 3-26: AMP Triggers for Dissolved Constituents in Groundwater Monitoring Wells

	SULPHATE	AMMONIA-N	NITRITE-N	NITRATE-N	ARSENIC	CADMIUM	COPPER	LEAD	NICKEL	SELENIUM	SILVER	URANIUM	ZINC
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
KV-85D [b]	YCSR	YCSR	nm [a]	nm [a]	0.16	0.00066	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-85S [c]	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-86 [d]	YCSR	YCSR	YCSR	YCSR	YCSR	0.00089	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-87/87N [e]	1320	YCSR	YCSR	YCSR	0.052	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-88D [c]	1809	YCSR	YCSR	YCSR	1.03	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-88S [f]	YCSR	YCSR	nm [a]	nm [a]	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-89D [g]	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-89S [h]	2191	YCSR	YCSR	YCSR	YCSR	0.074	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	114
KV-109 [i]	YCSR	YCSR	YCSR	YCSR	0.17	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
RB-MW-1 [j]	YCSR	YCSR	YCSR	YCSR	0.089	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-116 [k]	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
NC-MW-1 [k]	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-122 [k]	YCSR	YCSR	YCSR	YCSR	YCSR	0.00062	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-123 [k]	YCSR	YCSR	YCSR	YCSR	YCSR	0.0164	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	1.29
KV-125 [k]	YCSR	YCSR	YCSR	YCSR	YCSR	0.00070	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR
KV-126 [k]	YCSR	YCSR	YCSR	YCSR	0.067	0.00221	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR	YCSR

Notes:

[a] nm indicates no data available as parameter not monitored

[b] Data range from September 2011 to June 2013; Well has been frozen or dry since 2013

[c] Data range from October 2011 to July 2021

[d] Data range from July 2011 to November 2020

[e] Combined data range from September 2011 to May 2018 for KV-87 and December 2020 to August 2021 for KV-87N which replaced KV-87

[f] Data from June 2012; Well has been mostly frozen or dry between 2011 and 2020

[g] Data range from October 2011 to October 2017

[h] Data range from June 2018 to July 2021

[i] Data range from June 2018 to July 2021

[j] Data range from September 2013 to July 2021

[k] Data range from November 2020 to August 2021

Table 3-27: YCSR Groundwater Guidelines

CONSTITUENT	YCSR GUIDELINE (mg/L)		CONSTITUENT	YCSR GUIDELINE (mg/L)
Sulphate	1,000			0.04 at H < 50
	1.31 at pH ≥ 8.5			0.05 at H = 50 to < 100
	3.70 at pH 8.0 to < 8.5		Lead [c]	0.06 at H = 100 to < 200
Ammonia-N [a]	11.3 at pH 7.5 to < 8.0			0.11 at H =200 to < 300
	18.5 at pH 7.0 to < 7.5			0.16 at H ≥ 300
	18.4 at pH < 7.0			0.25 at H < 60
	0.2 at Cl < 2			0.65 at H = 60 to < 120
	0.4 at Cl = 2 to < 4		Nickel [c]	1.1 at H = 120 to < 180
	0.6 at Cl = 4 to < 6			1.5 at H ≥ 180
Nitrite-N [b]	0.8 at Cl = 6 to < 8		Selenium	0.01
	1.0 at Cl = 8 to < 10			0.0005 at H ≤ 100
	2.0 at Cl ≥ 10		Silver [c]	0.015 at H > 100
Nitrate-N	400		Uranium	3
Arsenic	0.05			0.075 at H < 90
	0.0001 at H < 30			0.15 at H = 90 to < 100
	0.0003 at H = 30 to < 90		Zinc [c]	0.90 at H = 100 to < 200
Cadmium [c]	0.0005 at H = 90 to < 150			1.65 at H = 200 to < 300
	0.0006 at H = 150 to < 210			2.40 at H = 300 to < 400
	0.02 at H < 50			
	0.03 at H = 50 to < 75			
	0.04 at H = 75 to < 100			
	0.05 at H = 100 to < 125			
Copper [c]	0.06 at H = 125 to < 150			
	0.07 at H = 150 to < 175			
	0.08 at H = 175 to < 200			
	0.09 at H ≥ 200			

[a] Standard varies as a function of pH and temperature. Values in table assumes a temperature of 10°C

[b] Cl is chloride as mg/L

[c] H is hardness as mg/L $CaCO_3$

Table 3-28: Groundwater Quality Thresholds and Triggers for the DSTF

PARAMETER	AMI MODERATE ACTION LEVEL (mg/L)	MAXIMUM CONCENTRATION IN A GRAB SAMPLE (mg/L)
pH	<7.0 pH Units	6.5 to 9.5 pH Units
Ammonia Nitrogen (as N)	>4.0 mg/L and pH >9.0 units	5
Arsenic	>0.075 mg/L and pH <7.0 units	0.1
Cadmium	>0.0075 mg/L and pH <7.0 units	0.01
Copper		0.1
Lead		0.2
Nickel		0.5
Silver		0.02
Zinc	>4.0 mg/L and pH >9.0 units	0.5

3.14 AMI #14 – AIR QUALITY IN KENO CITY EFFECTED BY DUST FROM MINE OPERATIONS

3.14.1 Description

Addressing the potential effects of fugitive dust on community health and well-being is of key importance given the location of the KHSD Mine Operations to Keno City. The main dust sources in the proximity of the village of Keno City include the DSTF, mineral processing (crushing) and mine traffic on unpaved roads.

The DSTF contains fine grained material that could be subject to wind-blown transport. Degraded air quality results from dust generation and the presence of metals in the tailings contained in the DSTF present a potential risk to human health and the environment.

Air dispersion modelling was conducted to identify the potential dust sources from mining-related activities, as well as the sensitive receptors, and predict the anticipated ambient concentrations under different operation scenarios (AEG, 2017).

The AKHM Dust Abatement and Monitoring Plan has been developed based on results of the air dispersion modelling and has been updated in response to concerns raised during the YESAA processes for Flame & Moth and New Bermingham and from consultation with Keno City residents.

Routine monitoring is conducted as part of the Dust Abatement and Monitoring Plan and is used to monitor the level of risk to the community. In the event of any traffic incidents or complaints, AKHM will investigate and take appropriate policy modification and/or disciplinary action.

Dust mitigation measures implemented include, but are not limited to, work area inspections for dust emission concerns, progressive reclamation of the DSTF, dust suppression on haul roads and minimizing traffic through Keno City. Routine dust monitoring and meteorological monitoring is used to confirm the modelling results and determine if additional mitigations measures are required in the vicinity of Keno City. The location of the air dispersion model receptors in Keno City, and the meteorological and dust monitors are shown on Figure 3-10.

Concentrations of particulate matter and metals in fugitive dust from the DSTF, District Mill and/or haul roads increase to levels beyond those predicted by the air dispersion model, to concentrations that may cause adverse human health effects.

3.14.2 Risk Narrative

Fugitive dust generated exhibits potential effects on the community of Keno City.

3.14.3 Monitoring Requirements and Evaluation of Results

Dust or particulate matter (PM) is divided into different sized fractions for air quality monitoring. AKHM collects for three filter inlet sizes (TSP, PM_{10} and $PM_{2.5}$) at each air quality monitor and sent to an analytical laboratory for gravimetric analysis. Metals analyses by ICP metals mass spectrometry are conducted on the total suspended particulate (TSP) sample. Samples stored on site and submitted for analysis every at least quarterly.

The gravimetric results are compared to the Yukon Ambient Air Quality Standards (YAAQS) (Table 3-30). Since there are no standards for metal concentrations in TSP in Yukon, metal results are compared to the Ontario Ambient Air Quality Criteria (Table 3-31).

The District Mill weather station records hourly temperature, relative humidity, total precipitation, wind speed and direction (Figure 3-10) to access wind-blown transport potential.

To provide better understanding of how ambient concentrations vary throughout town, in Q2 2022 AKHM made the following changes to its air quality monitoring program:

- The dust monitor located at the north side of Keno City was relocated to the west side;
- A third sampler was installed at the eastern end of Keno City;
- Monitoring was increased from running for 9 days a month to 18 days per month; and
- In Q2 2023 a statistical analysis will be completed to evaluate the appropriate monitoring frequency.

Data quality checks are completed following the receipt of laboratory results. The results of the dust monitoring are reviewed on a quarterly basis by a QP and any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-29.

3.14.4 Indicators, Action Levels, Management Responses

The indicators that are monitored at the air quality monitoring stations to assess whether a trigger has been activated are: TSP, PM_{10} or $PM_{2.5}$ measurements and metal concentrations.

Dust originating from the DSTF may contain elevated concentrations of arsenic, aluminum, calcium, iron, magnesium, manganese, lead, and zinc.

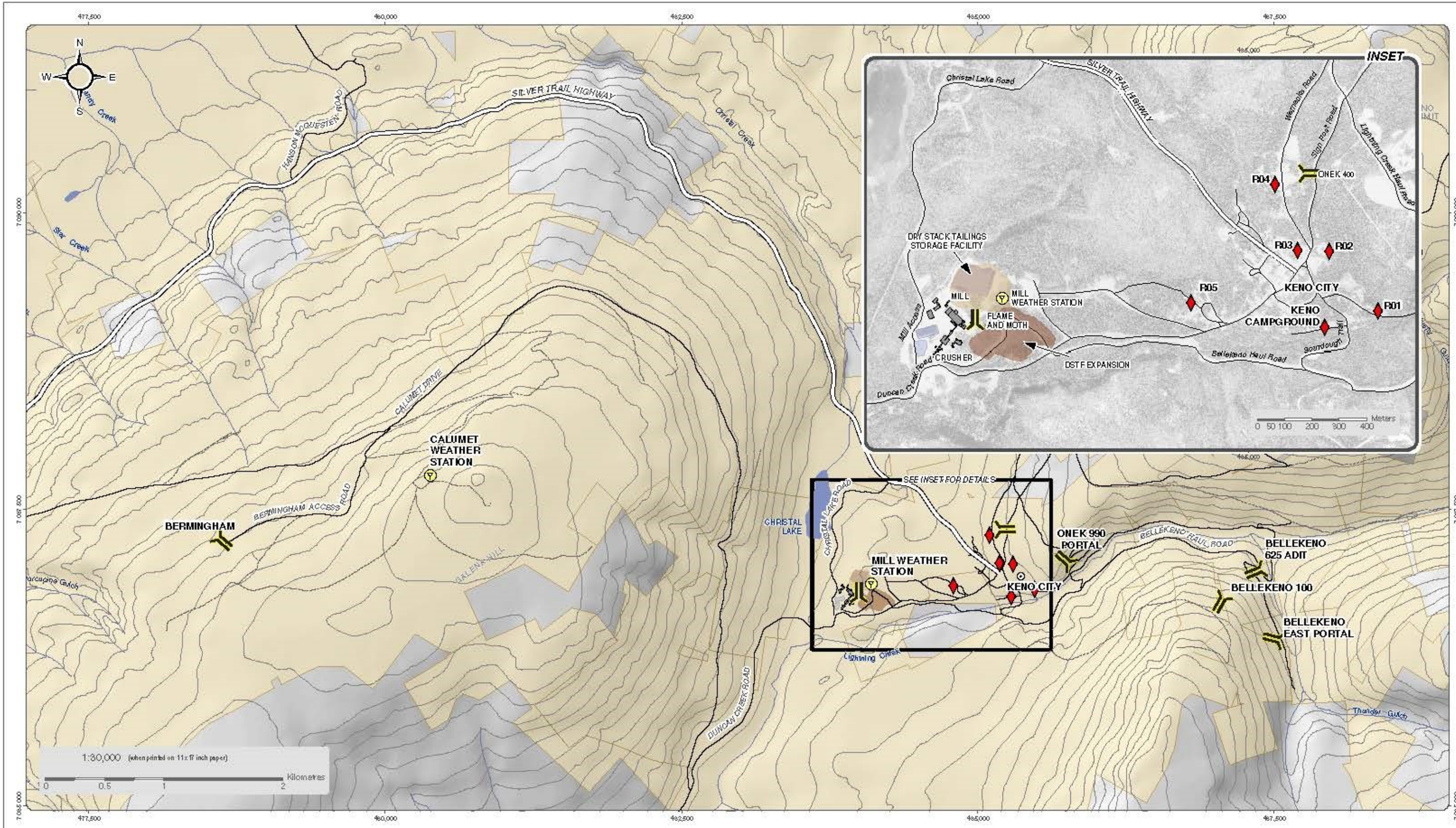
AKHM has provided Keno City residents with a means to raise their concerns formally of dust disturbance. AKHM has created a Dust Disturbance Register to track dust disturbance concerns.

As per the general approach to the adaptive management plan, a staged response to the development of air quality degradation will be implemented if the threshold is triggered. The initial response to degraded air quality from fugitive dust, is to prevent conditions conducive to dust transport, including the initiation of dust suppression activities and reducing road speed limits. If necessary, additional mitigative measures will be undertaken, including potential acceleration of the progressive reclamation of the DSTF. The final stage will be to monitor the area to watch for signs of continued fugitive dust generation.

3.14.5 AMI #14 Reporting

Review and data quality checks is completed in accordance with the Dust Abatement and Monitoring Plan (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-29and management's response and next steps to be taken included in monthly reports

Entries from the Dust Disturbance register will be summarized in the annual air quality monitoring report submitted under QML-009. A summary of all dust related incidences as reported by the public and residents of Keno City will be submitted as part of the annual reporting requirements. Results from the dust monitoring will be summarised along with any actions taken in response to any thresholds triggered.



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 under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Satellite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on January 2018

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

- Receptor
- Weather Station
- Adit
- 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

AKHM

ALEXCO ENVIRONMENTAL GROUP

ALEXCO KENO HILL MINING CORP.

FIGURE 3-10

POTENTIAL DUST SOURCES AND RECEPTORS

MAY 2022

Table 3-29: AMI #14 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Specific indicators that are monitored at the air quality monitoring stations to assess whether a trigger has been activated are: TSP, PM_{10} or $PM_{2.5}$ gravimetric measurements and metal concentrations for: • Arsenic • Cadmium • Copper • Lead • Manganese, • Silver	**Low** An increasing trend in fugitive dust at air quality monitors located at the District Mill towards Yukon Ambient Air Quality Standards or Ontario Ambient Air Quality Criteria for metals (Table 3-30 or Table 3-31); Or A dust disturbance claim from a Keno City resident	**Notification** • AKHM site management within 48 hours of receipt of results • Complainant and YG Inspector to be notified within 1 week of receipt that dust concern has been recorded **Evaluation** • Confirm analytical results • Attempt to link the identified dust disturbance or exceedance with a source (a specific event or activity conducted as part of mining or construction) • Review dust control measures for the crusher and haul roads • Expedite the timeline between sampling and analysis and review of the dust monitoring program results **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • Where appropriate prevent conditions conducive to dust transport, including the initiation of dust suppression activities • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome • Where the trigger was a dust disturbance claim, report back to the community and YG Inspector outcomes of the evaluation
	Moderate Any exceedance at air quality monitors located in Keno City of the specific indicators (Table 3-30 or Table 3-31) Or An increasing trend in fugitive dust as shown by TSP, PM_{10} or $PM_{2.5}$ measurements or in metal concentrations towards Yukon Ambient Air Quality Standards or Ontario Ambient Air Quality Criteria for metals at any of the air quality monitoring stations;	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Keno City Residents at next scheduled community meeting • YG Inspector at (of as follow up to) next compliance inspection • Include in annual QML report **Evaluation** • Conduct additional monitoring activities to improve understanding of the cause • Decrease the timeline between sampling, analysis, and data review • Identify potential mitigative actions that may lessen dust generation **Management Response** • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement further mitigation measures intended to reduce dust generation
	High An exceedance of the same specific indicator at air quality monitors located in Keno City in three consecutive sample events of: • Yukon Ambient Air Quality Standards (Table 3-30) • 0.3 µg/m³ arsenic • 0.025 µg/m³ cadmium • 50 µg/m³ copper • 0.5 µg/m³ lead • 0.4 µg/m³ manganese • 1 µg/m³ silver	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 1 week of confirming results **Evaluation** • Review all applicable air quality, meteorological data, records of activities during the exceedance period, inspection reports, field notes etc. to determine the cause • Assess compliance with the Traffic Management Plan **Management Response** • Where appropriate, accelerate progressive reclamation of the DSTF • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Actions are to continue until air quality standards and criteria are no longer exceeded

Table 3-30: Yukon Ambient Air Quality Standards (µg/m³)

PARAMETER	24-HOUR	ANNUAL
TSP	120	60
PM_{10}	50	n/a
$PM_{2.5}$	27	8.8

Table 3-31: Ontario Ambient Air Quality Criteria (µg/m³)

PARAMETER	CRITERIA
Antimony	25
Arsenic	0.3
Barium	10
Beryllium	0.01
Boron	120
Cadmium	0.025
Chromium	0.5
Cobalt	0.1
Copper	50
Iron	4
Lead	0.5
Manganese	0.4
Molybdenum	120
Nickel	2
Selenium	10
Silver	1
Strontium	120
Tin	10
Titanium	120
Vanadium	2
Zinc	120

3.15 AMI #15 – ATTENUATION OF CONSTITUENTS IN THE FLAME & MOTH DISCHARGE TO CHRISTAL CREEK OR BERMINGHAM DISCHARGE TO NO CASH CREEK, DOES NOT PERFORM AS PREDICTED

3.15.1 Description

Biogeochemical processes and interaction with soil and vegetation cover or mixing with groundwater and surface water is predicted to decrease the concentration of some metal(loid)s and constituents along the flow path from WTP discharge to downstream surface water bodies. The geochemically driven changes may include the removal of metals and constituents through direct precipitation, coprecipitation with other major metals (e.g., iron, aluminum), and adsorption on mineral and organic surfaces.

Natural attenuation of selected constituents of interest was incorporated in the modelling of the effects of the Flame & Moth and New Bermingham WTP discharge on water quality in Christal Creek and No Cash Creek, respectively. Attenuation of 50% was assumed as part of the water quality models (AEG, 2016; AEG 2019). Lower natural attenuation than predicted may result in degraded water quality. The environmental consequence is the potential to cause an adverse effect to the receiving environment.

Routine monitoring is conducted as part of the KHSD Mining Operations Monitoring, Surveillance and Reporting Plan, Christal Creek Attenuation Study Plan (CCASP) and No Cash Creek Attenuation Study Plan (NCCASP) and is used to determine the extent of natural attenuation being achieved.

Water quality, soil and moss monitoring data are used to calculate loading and potential effects to the receiving environment. Figure 3-11 shows the location of the Flame & Moth Mine Portal, WTP pond discharge locations, surface water quality monitoring locations, surficial soil and moss sampling transects, along with the District Mill and other mine components and water management structures in the CCASP study area. Figure 3-12 shows the New Bermingham Mine Portal, surface water and groundwater quality monition locations, soil and moss sampling locations, along the discharge channel and various historic mine openings in the NCCASP study area.

3.15.2 Risk Narrative

Natural attenuation of several metals in Christal Creek or No Cash Creek is reduced or stopped, which results in a risk to aquatic resources resident in the creeks.

3.15.3 Monitoring Requirements and Evaluation of Results

Water quality is monitored at mine discharges, WTP discharges and downgradient surface and groundwater monitoring stations and the results are used to calculate loading and potential effects to the receiving environment. The EQS discharge limits for the District Mill pond (KV-83, Table 3-4), the Flame & Moth WTP (KV-104C, Table 3-5) and New Bermingham WTP (KV-114, Table 3-7) and the WQOs for Christal Creek (KV-6, KV-7, KV-50) (Table 3-34) and No Cash Creek (KV-21, KV-111) (Table 3-35) are used to measure the performance.

The sampling frequency for surface water monitoring used to evaluate the extent of natural attenuation is provided in Table 3-32.

Table 3-32: Monitoring Schedule Frequency

STATION ID	FREQUENCY	TESTING LABORATORY
KV-83	Daily when discharge occurs	Field screening by AKHM
	Weekly when discharge occurs	External laboratory analysis
KV-104C	Daily when discharge occurs	Field screening by AKHM
	Weekly when discharge occurs	External laboratory analysis
KV-6	Weekly when discharge occurs	Field screening by AKHM External laboratory analysis
KV-50	Weekly when discharge occurs	Field screening by AKHM External laboratory analysis
KV-114	Daily	Field screening by AKHM
	Weekly	External laboratory analysis
KV-21	Monthly	External laboratory analysis
KV-111	Monthly	External laboratory analysis

In accordance with the Environmental Monitoring, Surveillance and Reporting Plan, field screening results are evaluated daily by the WTP operators in consultation with the Mill Manager and Mill Superintendent. External laboratory water quality monitoring results are evaluated upon receipt by AKHM's Environment Department. In addition, a QP completes quality checks and uploads water quality monitoring results weekly into the EQWin database where set point triggers and trends are programmed to be flagged for notification and action.

The results of the attenuation studies are evaluated annually by a QP (i.e., geochemist) and the need for further characterization of the topography and landcover along the discharge corridors or additional water quality monitoring recommended to AKHM.

Monthly and annual reports on water quality monitoring results are submitted under WL QZ18-044. Results of the CCASP and NCCASP are compiled and submitting in the annual report under WL QZ18-044. An annual report is also submitted under QML-0009. All monthly and annual reports are provided to FNNND.

3.15.4 Indicators, Action Levels, Management Responses

The specific water quality indicators that should be monitored in the Christal Creek system to provide the necessary information to assess whether a trigger has been activated include arsenic, cadmium, copper, nickel, and zinc. In the No Cash Creek system, the specific water quality indicators include arsenic, cadmium, copper, nickel, lead, silver, zinc, and ammonia-N.

Action level triggers for natural attenuation assessment (Table 3-34, Table 3-35) have been developed based on significance thresholds established for surface water (AMI #12) and groundwater (AMI #13) as provided in *Keno Hill Silver District Mining Operations Adaptive Management Plan Assessment of Water Quality Triggers* (Ensero 2021) included in Appendix A. The low action level triggers are derived from the 85th percentile for the specific water quality indicators as generated in the 10-year data set evaluated as part of Ensero's assessment. The moderate action level triggers are within 10% of the WQOs and the high action level triggers are set at the WQOs.

The management response strategy for AMI #15 is to assess, characterize and define a potential problem at the low action level. At the moderate action level, a QP will be engaged to assess the level of natural attenuation being achieved as compared to what was modeled and to support AKHM in the design of mitigation measures. At the high action level, the MRP will be implemented with on-going monitoring and reporting.

Depending on the results of the evaluations, the MRP may consider the following measures:

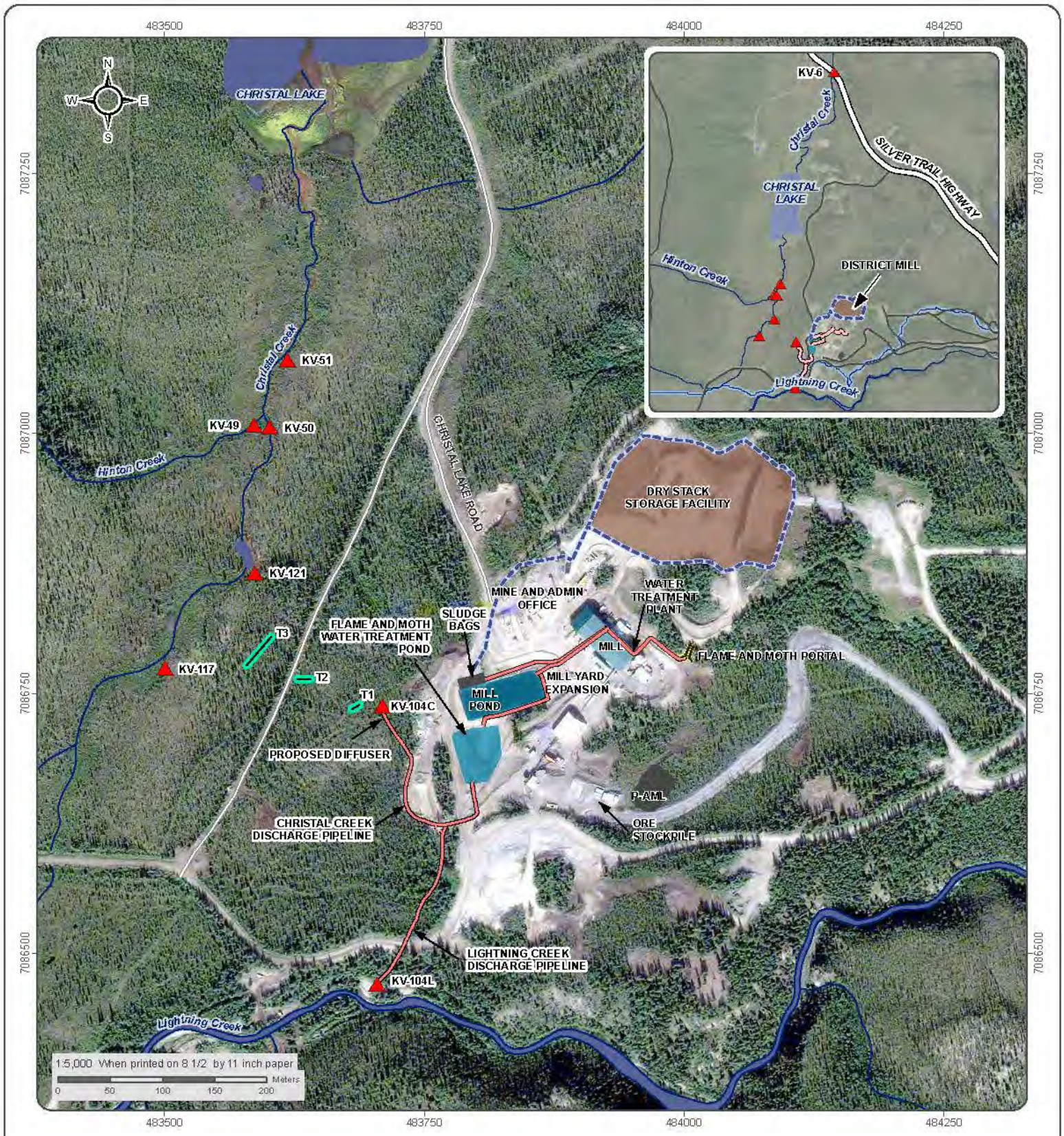
- Water treatment improvements to account for lack of natural attenuation capacity in Christal Creek and/or No Cash Creek discharge area;
- Reduce Flame & Moth Pond decant discharge rate to Christal Creek or move all discharge to Lightning Creek until corrective actions are implemented;
- Relocating the WTP decant diffuser to an area that is not affected by flow path channelization; and
- Replace with a larger diffuser to better spread the overland flow path of the discharge and enhance interaction with underlying soils.

Apart from a temporary discharge from the Flame & Moth WTP for 10 days in May 2021, Christal Creek has not received effluent since the development of the CCASP. This AMI has been developed in anticipation of discharge of effluent commencing into the catchment.

The implementation of the reclamation plan for the historical United Keno Hill Mines site will result in marked improvements to water quality in No Cash Creek. The WQOs for No Cash Creek and associated AMI triggers will be updated in future revisions to the AMP.

3.15.5 AMI #15 Reporting

Review and data quality checks are completed following each monitoring event and include a review of the relevant monitored data from the Environmental Monitoring, Surveillance and Reporting Plan and the Attenuation Study Plans (Section 1.4). Any thresholds crossed or triggers activated would be identified and the relevant parties notified as listed in Table 3-33 and management's response and next steps to be taken included in monthly reports.



Active Surface Water Quality Stations
Attenuation Study Transect
Pipeline
Existing Diversion Ditch

Current DSTF
Pond
Mine Feature Footprint
Watercourse
Waterbody

AKHM

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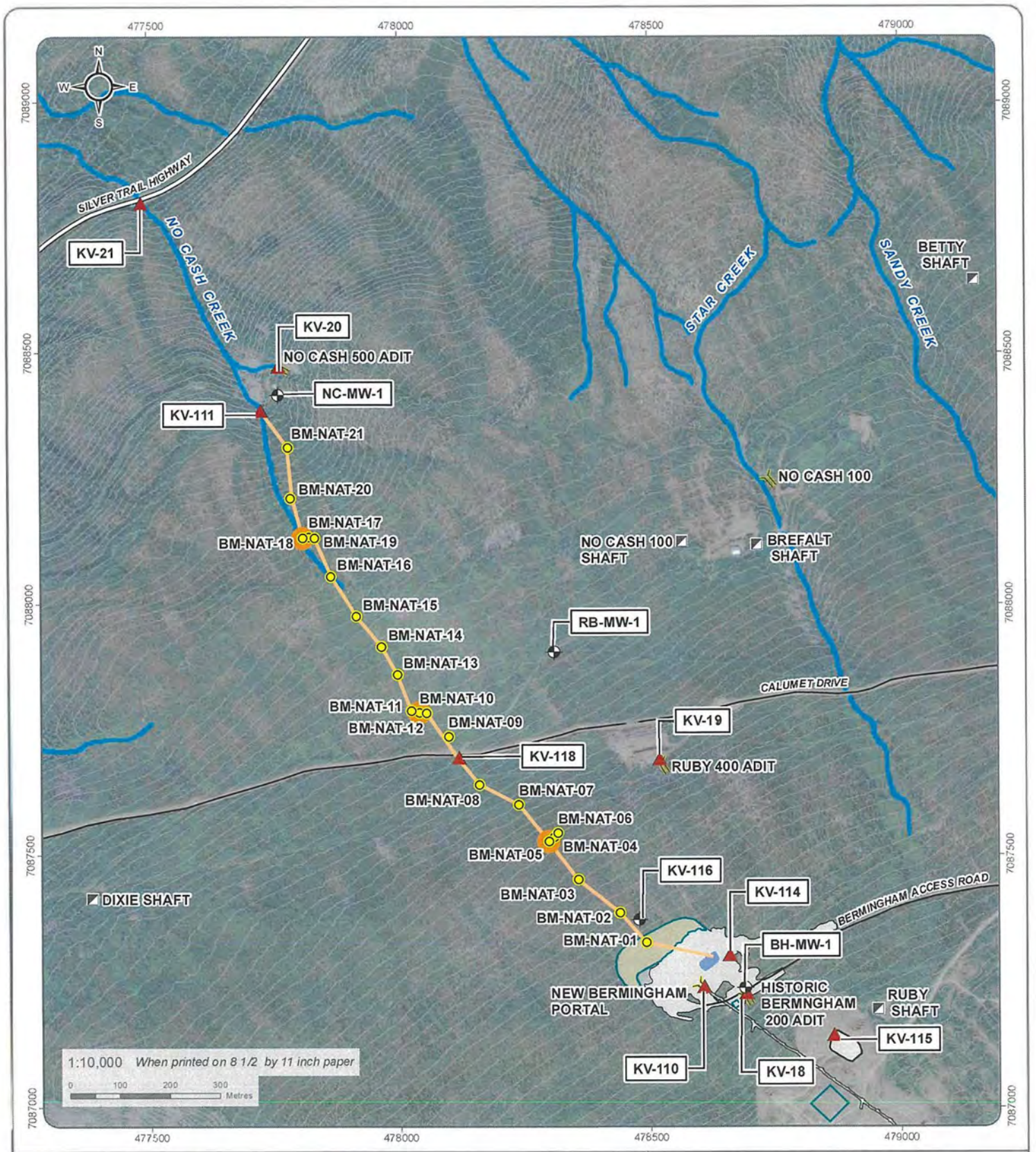
FIGURE 3-11

CHRISTAL CREEK ATTENUATION STUDY AREA

MARCH 2022

Satelite imagery obtained from Yukon Geomatics map service http://mapservices.gov.yk.ca/ArcGIS/services on March 2022

Datum: NAD 83; Projection: UTM Zone 8N



Location of Soil Sample Collected Sept 4th 2018

Surface Water Quality Station

Moss Samples Collected on October 06, 2016

Adit

Shaft

Attenuation Study Line

Contours (5m interval)

Waterbody

Permitted To Be Constructed Mine Features

Permitted To Be Constructed Mine Features

Proposed Mine Feature

Satellite imagery obtained from ESRI ArcGIS map service https://services.arcgisonline.com/ArcGIS/rest/service on March 26 2021
Datum: NAD 83. Projection: UTM Zone 8N

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FIGURE 1-2

BERMINGHAM NATURAL ATTENUATION STUDY AREA

MAY 2022

Table 3-33: AMI #15 Thresholds and Responses

INDICATORS	ACTION LEVEL TRIGGERS	MANAGEMENT RESPONSE STRATEGY
Comparison of monthly monitoring results with WQOs at KV-6 and KV-50 in Christal Creek for the following parameters: • Arsenic • Cadmium • Lead • Nickel • Zinc Comparison of monthly monitoring results with WQOs at KV-21 and KV-111 in No Cash Creek for the following parameters: • Arsenic • Cadmium • Copper • Lead • Nickel • Silver • Zinc • Ammonia-N	**Low** Concentration of parameters of interest increase above the 85th percentile at KV-6, KV-50 (Table 3-34), KV-21, or KV-111 (Table 3-35) in three consecutive sampling events	**Notification** • AKHM site management within 1 week of receiving results **Evaluation** • Confirm results • Assess potential mine related sources and external environmental interactions • Conduct additional monitoring activities to improve understanding of the cause of the trigger activation **Management Response** • Prepare preliminary MRP including action timelines and possible trigger adjustments • Identify personnel who will be responsible for monitoring data evaluation, preparing and updating the MRP, and implementation of the MRP • Complete updates to the preliminary MRP to incorporate evaluation outcomes • If the evaluation of the monitoring data indicates that the elevated concentrations are not mine related; document the outcome
	Moderate Concentration of parameters of interest increase to within 10% of WQO in a single sample event at KV-6, KV-50 (Table 3-34), KV-21, or KV-111 (Table 3-35)	**If not already done so, complete the activities outlined for a low action level trigger** **Notification** • Include in monthly WL report **Evaluation** • Initiate review of associated catchment background and receiving environment monitoring data • Visual inspect the effluent discharge flow path to Christal Creek or No Cash Creek for evidence of significant channel formation that may be limiting interaction with soil and vegetation substrate, potentially limiting natural attenuation • Assess any water quality changes in effluent discharge (KV-83, KV-104C or KV-114) that may be limiting effectiveness of natural attenuation • Identify potential mitigative actions **Management Response** • Engage a QP • Initiate implementation of recommendations of the QP upon receipt • Update the MRP to include the mitigation options evaluated and the selection of the preferred response should the trend continue, and high action level triggers reached • Prepare a conceptual design of the preferred mitigation option and assess permitting requirements • Where appropriate, implement mitigation measures intended to stabilize conditions and minimize further deterioration
	High WQO exceedance in two consecutive sample events at KV-6, KV-50 (Table 3-34), KV-21, or KV-111 (Table 3-35)	**If not already done so, complete the activities outlined for a moderate action level trigger** **Notification** • YG inspector within 1 week of confirming cause and results **Evaluation** • Calculate natural attenuation at KV-6, KV-50, KV-21, or KV-111 and compare to the water quality model predictions **Management Response** • Engage a QP to revise the water quality models and linked operating management plans to reflect the decrease in natural attenuation • Engage a QP to evaluate the potential effects to aquatic resources • Obtain permits and implement mitigation measures as outlined in the MRP if necessary • Actions are to continue until WQOs are no longer exceeded

Table 3-34: AMI #15 Surface Water Quality Thresholds and Objectives for Christal Creek

INDICATOR	KV-6			KV-50		
	AMI THRESHOLD 1 85TH PERCENTILE [f]	AMI THRESHOLD 2 90% WQO	WATER QUALITY OBJECTIVE	AMI THRESHOLD 1 85TH PERCENTILE [f]	AMI THRESHOLD 2 90% WQO	WATER QUALITY OBJECTIVE
Total Arsenic (mg/L)	0.0112	0.0105[a], 0.0088[b]	0.0167[a], 0.0098[b]	0.337	0.0389[a], 0.0249[c]	0.0432[a], 0.0277[c]
Total Cadmium (mg/L)	0.00164	0.00196[a], 0.00128[b]	0.00218[a], 0.00142[b]	0.00037	90% of the calculated WQO	$e^{[1.03 \times \ln(\text{hardness}^*) - 5.274]}$ $e^{[0.736 \times \ln(\text{hardness}^{**}) - 4.943]}$
Total Lead (mg/L)	0.017	90% of the calculated WQO	$e^{[1.273 \ln(\text{hardness}^*) - 1.460]}$ $\leq 3.31 + e^{[1.273 \ln(\text{hardness}^*) - 4.704]}$**	0.003	90% of the calculated WQO	$e^{[1.273 \ln(\text{hardness}^*) - 1.460]}$ $\leq 3.31 + e^{[1.273 \ln(\text{hardness}^*) - 4.704]}$**
Total Nickel (µg/L)	6	23[c] $0.90 * e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[d] 135[e]	25[c] $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[d] 150[e]	17	23[c] $0.90 * e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[d] 135[e]	25[c] $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[d] 150[e]
Total Zinc (mg/L)	0.247 (T) 0.235 (D)	0.330[a], 0.186[b]	0.367[a], 0.207[b]	0.256 (T) 0.242 (D)	0.244[a], 0.185[b]	0.271[a], 0.205[b]

Notes:
a) 95th percentile compared on a per sample basis
b) Upper confidence level mean compared on a rolling average basis
c) Hardness < 60 mg/L
d) Hardness > 60 to ≤ 180 mg/L the WQO is calculated
e) Hardness > 180 mg/L
f) 85th percentile from July 2011 to August 2021 data set
** long-term chronic WQG
- Short-term acute WQG

Table 3-35: AMI #15 Surface Water Quality Thresholds and Objectives for No Cash Creek

INDICATOR	KV-21			KV-111		
	AMI THRESHOLD 1 85TH PERCENTILE [J]	AMI THRESHOLD 2 90% WQO	WATER QUALITY OBJECTIVE	AMI THRESHOLD 1 85TH PERCENTILE [F]	AMI THRESHOLD 2 90% WQO	WATER QUALITY OBJECTIVE
Dissolved Arsenic (mg/L)	0.002	0.0225	0.025[f]	0.0006	0.00475	0.005
Dissolved Cadmium (mg/L)	0.036	0.0401 0.0188	0.0445[d] 0.0209[e]	0.000184	0.000487 0.000232	0.000541[b] 0.000258[c]
Dissolved Copper (mg/L)	0.0030	0.00323 0.00174	0.00359[d] 0.00193[e]	0.00174	90% of the calculated WQO	BCMoE calculated using Biotic Ligand Model
Lead (mg/L)	0.0026	90% of the calculated WQO	$e^{[1.273 \ln(\text{hardness}^*) - 1.460]}$ ≤ $3.31 + e^{[1.273 \ln(\text{hardness}^*) - 4.704]}$**	0.0003	90% of the calculated WQO	$e^{[1.273 \ln(\text{hardness}^*) - 1.460]}$ ≤ $3.31 + e^{[1.273 \ln(\text{hardness}^*) - 4.704]}$**
Dissolved Nickel (µg/L)	20	23[g] $0.90*e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[h] 135[i]	25[g] $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[h] 150[i]	0.1	23[g] $0.90*e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[h] 135[i]	25[g] $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$[h] 150[i]
Dissolved Silver (mg/L)	0.00006	0.00023	0.00025	0.000018	0.00023	0.00025
Dissolved Zinc (mg/L)	3.65	4.45 2.05	4.94[d] 2.28[e]	0.0448	0.161 0.0542	0.179[b] 0.0602[c]
Ammonia-N (mg/L)	0.0094	90% of the calculated WQO	CCME	0.0126	90% of the calculated WQO	CCME

Notes:
b) 95th percentile from July 2011 to August 2021 data set, except for KV-111 which ranges from September 2017 to August 2021
c) Upper confidence level mean from July 2011 to August 2021 data set, except for KV-111 which ranges from September 2017 to August 2021
d) 95th percentile from July 2017 and June 2018 to August 2021 data set for KV-21 and KV-56, respectively
e) Upper confidence level mean from July 2017 and June 2018 to August 2021 data set for KV-21 and KV-56, respectively
f) Site specific based on Golder (2013) presented in Bermingham Water Quality Model (AEG, 2019)
g) Hardness < 60 mg/L
h) Hardness > 60 to ≤ 180 mg/L the WQO is calculated
i) Hardness > 180 mg/L
j) 85th percentile from July 2011 to August 2021 data set

4 ANNUAL ADAPTIVE MANAGEMENT PLAN REPORTING AND REVIEW

Annual reports are submitted as part of Water Licence QZ18-044 and the Quartz Mining License QML-009. The annual reports include summaries of all activities carried out under the AMP including a summary of the comparisons and inspections conducted and any actions taken. Detailed comparisons of monitoring results to action levels, the status of responses to AMI triggers are reported in the Water Licence monthly reports. The annual reports include a description of any work carried out or planned to be carried out under the AMP. All monthly and annual reports are provided to the FNNND.

Annual reporting would include the rationale for modifying the AMP if site conditions were to change. The AMP should be modified whenever monitoring data demonstrate a sustained deviation from previous trends in the data or there is an identification of physical conditions of mine workings or infrastructure that may lead to adverse effects. Technological developments, system changes and changing environmental conditions warrant a modification to the AMP.

Environmental Effects Monitoring (EEM) studies conducted for the Bellekeno, and Flame & Moth mines as required by the *Metals and Diamond Mining Effluent Regulations* (MDMER) are not fully captured in this AMP. The results of the EEM studies required by the MDMER, are provided to Environment and Climate Change Canada (ECCC) and the activities are summarized in the QML-009 annual report.

5 ENGAGEMENT PLAN

Alexco conducts ongoing consultation and stakeholder engagement with respect to its activities within the KHSD. Consultation and engagement are conducted in a variety of forms, including:

- Community meetings (Whitehorse, Mayo, Keno City),
- FNNND Chief and Council meetings,
- Technical meetings with multiple stakeholders and consultants,
- Site tours, and
- Meetings with regulators.

The focus of the consultation events and topics varies, to address the relevant issues at the time and activities within the KHSD. AKHM's operation management plans are routinely updated based on feedback received from these consultation and engagement activities.

Alexco has proposed to convene a workshop between Alexco, YG, Government of Canada, and the FNNND to develop a mechanism to update the WQOs in No Cash Creek improves because of the implementation of the ERDC District-wide closure and reclamation plan. The update to WQOs in No Cash Creek would be reached via a collaborative effort with the three government stakeholders. The AMP will be modified to incorporate updated WQOs.

6 REFERENCES

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APPENDIX A:

ASSESSMENT OF WATER QUALITY TRIGGERS (2021)