



MONITORING, SURVEILLANCE AND REPORTING PLAN

KENO HILL SILVER DISTRICT MINING OPERATIONS

July 2018

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APPENDIX B PHYSICAL INSPECTION AND REPORTING PLAN (JULY 2018)

1 INTRODUCTION

This plan is comprised of the monitoring, surveillance and reporting that will be carried out to ensure that the Keno Hill Silver District (KHSD) Mining Operations are managed in a manner that provides human and environmental protection. The framework of this plan includes monitoring and reporting of:

- The local and receiving environment through scheduled inspections and monitoring programs;
- Effluent discharge points and treatment system performance;
- Site facilities and incorporated design measures to ensure structural stability and prevention of accidents and malfunctions;
- Remediation success; and
- Adaptive management responses.

If monitoring indicates that physical structures, treatment systems or mitigative measures are not performing, then maintenance or contingency plans can be implemented following an adaptive management approach as discussed in Section 11 (Access Consulting Group, 2015a).

Prior to mine development in the KHSD, a number of monitoring programs and a surveillance network were already in place as per care and maintenance activities (Water Licence QZ06-074), advanced exploration and preliminary development activities at the Bellekeno mine (Water Licence QZ07-078) as well as district-wide closure and new mine permitting studies. These programs include but are not limited to physical inspections, a water quality surveillance network, old mine workings monitoring, aquatic resources monitoring for benthic invertebrate and fisheries populations, sediment monitoring, waste rock and mine wall sampling and the Adaptive Management Plan. Monitoring, surveillance and reporting applicable to Bellekeno, Flame and Moth, Onek 990 and Lucky Queen Mines are presented in this plan. Additionally, this Plan has been updated to include the Birmingham Mine and the associated additional monitoring.

2 WATER QUALITY SURVEILLANCE NETWORK

Currently water quality monitoring is required under care and maintenance Water Licence QZ17-084, and Keno Hill Silver District Mining operations Water Licence QZ09-092-2 (amendment 2 of QZ09-092). Each Water Licence provides Effluent Quality Standards which dictate maximum concentrations of specific parameters allowed to be discharged at locations where water treatment is being undertaken. In addition to the monitoring of treated effluent discharge and associated adits, background surface water stations upstream of project facilities are also monitored along with the receiving environment. Monitoring wells are used to measure and sample groundwater in the receiving environment and have been established as per Water Licence QZ09-092-2. Refer to Type A Water Licence QZ09-092-2, which specifies Effluent Quality Standards (Part D), monitoring and surveillance (Part F and Schedule B) and Reporting (Part B) required for the Keno Hill District Mining Operations, which is available for download at www.yukonwaterboard.ca/waterline.

A Groundwater Monitoring Plan for the Bellekeno mine has been developed per Water Licence QZ09-092 in February 2011 and was last updated in July 2018 to include the Bermingham mine (see Appendix A). This plan outlines monitoring locations and frequency for the Keno District mill and Dry Stack Tailings Facility, the N-AML waste rock disposal areas (Bermingham, Bellekeno and Lucky Queen), and Onek/Keno City. Groundwater wells are scheduled for monthly monitoring for both water level and quality for 12 months to establish well conditions, followed by quarterly sampling thereafter for the duration of the project. Groundwater data will be compared to the *Yukon Contaminated Sites Regulations (YCSR)* Schedule 3: Generic Numerical Water Standards (Aquatic Life) and to the YCSR Drinking Water Standards when near potable or potentially potable aquifers.

Table 1 outlines the sampling stations and schedule for internal and external lab analysis in the area of the Bermingham, Bellekeno, Onek, Lucky Queen, and Flame and Moth mines and in the vicinity of the mill site. The Table outlines the currently established stations and the pending stations to be established prior to commencing work at the respective mine. Figure 1, Figure 2 and Figure 3 show these existing and proposed surface water and groundwater monitoring station locations, respectively. Figure 1 includes three insets and shows the respective surface water quality location by mine component for the DSTF/Mill/Flame and Moth, Onek/Keno City, Bellekeno and Lucky Queen. Figure 2 shows the groundwater locations for the District while Figure 3 provides a zoomed in view of Flame and Moth, Mill and DSTF groundwater monitoring locations.

Hydrology monitoring is undertaken on a continuous basis during the open water season at stations on Christal Creek (KV-6 and KV-7) and Lightning Creek (KV-41). In June 2015, a water level recorder with staff gauge were installed in Christal Lake and KV-51 (Christal Creek downstream of Hinton Creek). Instantaneous measurements of flow are also collected during monthly/quarterly sample events at all stations possible. Flow monitoring stations will be established for all locations where water is withdrawn from surface or ground for use with mining activities and discharged into the receiving environment.

Quality assurance and quality control (QA/QC) protocols have been implemented during collection, storage and shipping of samples. Standard QA/QC procedures conducted by field and laboratory staff including duplicate, relative percent difference analysis, analytic matrix spikes, spike blanks, and field, trip and method blanks.

Laboratory quality control analysis includes method blanks, laboratory duplicates, matrix spikes and blank spikes which are required to be reported by the laboratory showing acceptability criteria prior to issuing Alexco the data.

One field blank is collected per monthly event and is completed by taking de-ionized water (analyte free media) to the sample station, opening it and exposing it to ambient air and ‘collecting’ it in the sample bottles. These samples are treated the same as the actual water samples, preserved and filtered as necessary, and their analysis can provide an indication of contamination that may affect the actual samples. Additionally, one travel blank will accompany the samples for each monthly event and will be analysed for the same parameters as the routine samples.

Field duplicates are collected at a rate of 10% or 1 for every 10 samples. Relative Percent Difference (RPD) is used to determine field variability and is the difference between the sample result and replicate result, divided by the average of the sample result and replicate result and expressed as a percentage. Where analyte results have RPD greater than 25% a subsequent check is done against the laboratory detection limit (DL) to establish if the practical quantitation limit (PQL) was met. The PQL is five times the DL and is defined as the minimum concentration that can be measured within specified limits of precision and accuracy. Both results need to be above the PQL for the analyte to be considered as ‘meeting the PQL’. If one result from the sample or duplicate is greater than 5X DL and the other result is less than 5X DL then the ‘PQL is not met’. An analyte with results not meeting the PQL indicates that the constituent being analyzed is not present in a sufficient amount to be reliably quantified. Typically, as parameters approach their detection limit, high variability is more likely to occur. The RPD of 25% can be used as a benchmark whereby an RPD greater than 25% warrants further comment or consideration.

All water quality data is stored in an EQwin database and additional QA/QC steps to determine potential outliers are identified from the preparation of a variance report that outlines the comparison off field vs laboratory pH and conductivity, and comparison to recent samples collected (i.e. RPD compared to samples from last 12 months).

2.1 WATER QUALITY NETWORK BY MINE COMPONENT

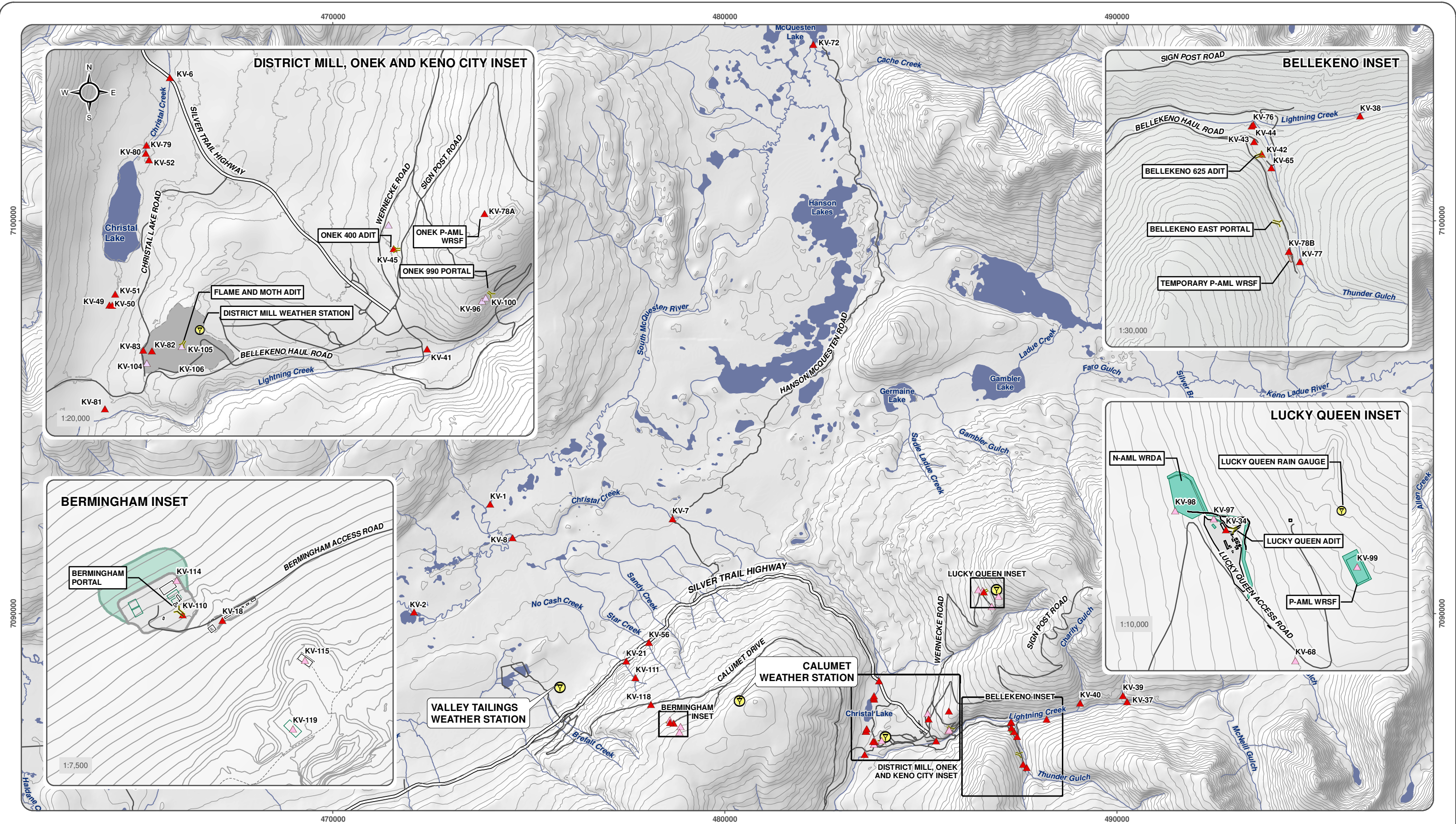
As part of evaluation of the data a number of environmental models are updated with the water quality and quantity information outlined in Section 2, which include groundwater models, water quality models, water balances and water quality objectives for Christal Creek and Lightning Creek. These tools are updated with additional water information available on an annual or as needed basis to inform decision making process or to further evaluate adaptive management responses. As an example, a number of stations (i.e. KV-6, KV-7 and KV-41) record continuous stream flow measurements. This information, in combination with the meteorology data, is used to refine the parameters and assumptions used in the water balances.

The surface water quality monitoring locations by mine are presented in Table 2. The water quality information collected under this plan is integrated into the existing water quality models to verify or adjust calibration factors used in the model. This advances the understanding of the dynamic nature of the district and numerous load sources including evaluation and determination of natural attenuation capacity in the receiving environment. Additionally, the water quality data are compared with established thresholds (i.e. WQO) and Adaptive Management Plan triggers as part of the routine review.

The groundwater monitoring locations per mine is presented in Table 3. The groundwater levels collected as part of this program will be used to prepare groundwater contours maps twice per year and refinements to the groundwater models as required.

Table 1 Keno Hill Silver District Mining Operations Water Quality Monitoring Program Summary

SITE	SITE DESCRIPTION	WATER LICENCE	INSITU MEASUREMENTS / INTERNAL ANALYSIS									EXTERNAL LAB ANALYSIS														Acute Lethality LC50 Rainbow Trout 96 Hour
		Q209-092 Existing & Proposed Monitoring	Level	Synoptic Levels	Flow	pH	Temperature	Conductivity	Total Zn	Ammonia	Turbidity	Total Metals	Dissolved Metals	Hardness	pH	Conductivity	TSS	Alkalinity	Sulphate	Nitrate	Nitrite	Ammonia-N	DOC	Total Phosphorous	Radium 226	
Mine Treatment / Effluent Discharge Sites																										
KV-42	Bellekeno 625 Adit	Existing	-		C	D	D	D	D	D	D	W	W	W	W	W	W	W	W	W	W	W	M	W	-	-
KV-43	Bellekeno 625 Settling Pond Decant	Existing	-		C	D	D	D	D	D	D	W	W	W	W	W	W	W	W	W	W	W	W	W	W/Q	M
KV-82	Flame and Moth Mill Site Collection and Sediment Pond	Existing	D		-	D	D	D	D	D	D	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KV-83	Flame and Moth Mill Treatment Plant Discharge	Existing	-		C-WD	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	Q-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W/Q	M
KV-96	Onek 990 Settling Pond Decant	Pending	D-WD		C-WD	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	SA
KV-34	Lucky Queen Adit (underground)	Existing	-		C	D	D	D	D	D	D	W	W	W	W	W	W	W	W	W	W	W	W	W	-	-
KV-97	Lucky Queen Settling Pond Decant	Pending	-		C-WD	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	SA
KV-100	Onek Settling Pond	Pending	D		-	W	W	W	W	W	W	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KV-101	Lucky Queen treatment plant discharge	Pending	-		C-WD	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	SA
KV-102	Lucky Queen Settling pond	Pending	D		-	W	W	W	W	W	W	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KV-105	Flame and Moth Adit	Pending	-		C	D-WD	D-WD	D-WD	D-WD	D-WD	D-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	-	-
KV-104L	Flame and Moth Settling Pond Decant discharge to Lightning Creek	Pending - revised	D		C-WD	D	D	D	D	D	D	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	M-WD
KV-104C	Flame and Moth Settling Pond Decant discharge to Christal Creek	Pending -revised	D		C-WD	D	D	D	D	D	D	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	M-WD
KV-110	Birmingham Portal	Existing -proposed	D		C-WD	D	D	D	D	D	D	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	-
KV-114	Birmingham Pond Decant	Pending -proposed	D		C-WD	D	D	D	D	D	D	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD	W-WD/Q	M-WD
Mine Surface Water Surveillance Sites																										
KV-1	South McQuesten River u/s Christal Creek	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-2	South McQuesten River @ Pumphouse	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-6	Christal Creek @ Keno Highway	Existing	-		C	W-WD/M	W-WD/M	W-WD/M	-	-	-	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	-	-
KV-7	Christal Creek @ Hanson Road	Existing	-		M	M	M	M	-	-	-	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KV-8	Christal Creek @ mouth	Existing	-		M	M	M	M	-	-	-	M	M	M	M	M	M	M	M	-	-	-	M	M	-	-
KV-21	No Cash Creek at Silver Trail Highway	Existing- Proposed	-		M	M	M	M	-	-	-	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KV-37	Lightning Creek u/s Hope Gulch	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-38	Lightning Creek u/s Thunder Gulch	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-39	Hope Gulch u/s Lightning Creek	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-40	Charity Gulch u/s Lightning Creek	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-41	Lightning Creek u/s Bridge @ Keno City	Existing	-		C	M	M	M	-	-	-	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-
KV-44	Bellekeno 625 Seep	Existing	-		Ms	Ms	Ms	Ms	-	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	Q
KV-45	Onek 400 Adit	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-
KV-49	Hinton Creek u/s Christal Creek	Existing	-		M/Q	M/Q	M/Q	M/Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-50	Christal Creek u/s Hinton Creek	Existing	-		W-WD/M	W-WD/M	W-WD/M	W-WD/M	-	-	-	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	-	-	-	W-WD/M	W-WD/M	-	-
KV-51	Christal Creek d/s Hinton Creek	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-
KV-52	Natural spring to Christal Lake @ Old Mackeno Pumphouse	Existing	-		M	M	M	M	-	-	-	M	M	M	M	M	M	M	M	-	-	-	M	M	-	-
KV-56	Star Creek at Silver Trail Highway	Existing - Proposed	-		M	M	M	M	-	-	-	M	M	M	M	M	M	M	M	-	-	-	M	M	-	-
KV-65	Thunder Gulch u/s of Bellekeno 625	Existing	-		M	M	M	M	-	-	-	M	M	M	M	M	M	M	M	-	-	-	M	M	-	-
KV-72	South McQuesten River at McQuesten Lake	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-76	Thunder Gulch d/s Bellekeno 625	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-77	Thunder Gulch u/s Bellekeno East	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-78A	Onek P-AML Waste Rock Storage Facility	Existing	Ms		-	Ms	Ms	Ms	-	-	-	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	-	-
KV-78B	Bellekeno East Temporary Waste Rock Storage Facility	Existing	Ms		-	Ms	Ms	Ms	-	-	-	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	-	-
KV-79	Christal Creek d/s Mackeno Tailings	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-80	Christal Creek u/s Mackeno Tailings	Existing	-		Q	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-81	Lightning Creek Southwest of Mill Site	Existing	-		M-WD	M-WD	M-WD	M-WD	-	-	-	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	W-WD/M	-	-	-	W-WD/M	W-WD/M	-	-
KV-98	Lucky Queen N-AML WRDA Seep Survey	Pending	-		Ms	Ms	Ms	Ms	-	-	-	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	Ms	-	-
KV-99	Lucky Queen P-AML WRSF	Pending	-		Ms	Ms	Ms	Ms	-	-	-	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q	-	-
KV-106	Flame and Moth Temporary Waste Rock Storage Facility	Pending	Q		-	Q	Q	Q	-	-	-	Q	Q	Q	Q	Q	Q									



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1:90,000 (when printed on 11 x 17 inch paper)

0 1 2 3 4 5 Kilometers

- ▲ Monitored Water Quality Station
- ▲ Pending/Proposed Water Quality Station
- Ⓜ Weather Station
- Y Adit
- Mine Feature Footprint
- To Be Constructed Feature
- == Silver Trail Highway
- Other Road
- Watercourse
- Waterbody



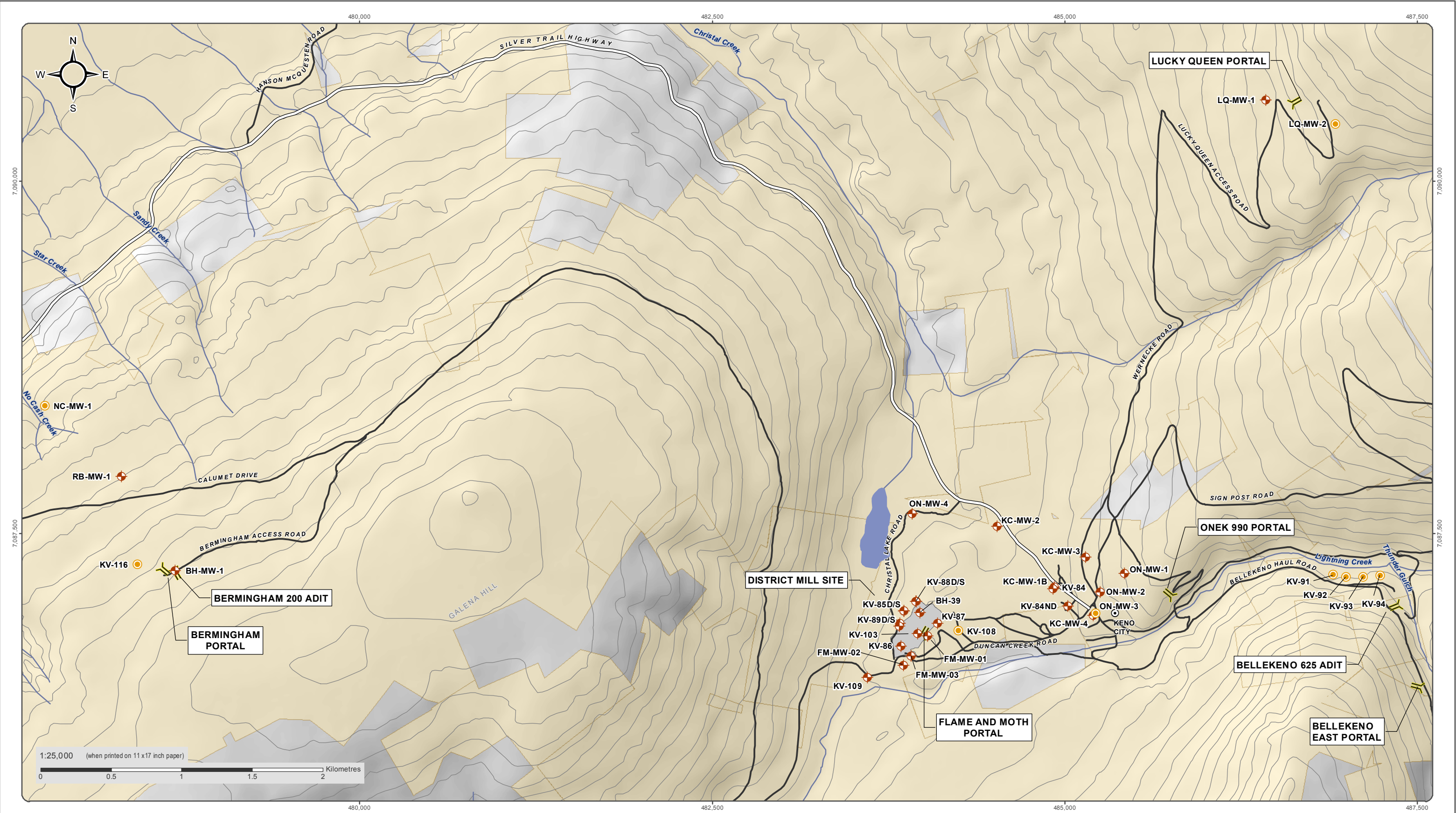
ALEXCO KENO HILL MINING CORP.

FIGURE 1

SURFACE WATER QUALITY STATION LOCATIONS

AUGUST 2018

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- Proposed Monitoring Well
- Monitoring Well
- Adit

- Alexco/ERDC Quartz Claims
- District Mill Footprint
- Silver Trail Highway
- Other Road



ALEXCO KENO HILL MINING CORP.

FIGURE 2 KHSD GROUNDWATER MONITORING LOCATIONS

JULY 2018

D:\Project\AP\Project Keno_Area_Mines\ALL_SITES\02_Map\01_Overview\02-Specific_Topical\WG_Monitoring\GW_monitoring_locations_District_20180726.mxd
(Last edited by: mducharme 7/26/2018 1:17 PM)



- | | | | |
|--|-------------------------------|--|----------------------------|
| | Monitoring Well | | Proposed Road |
| | Pending Monitoring Well | | DSTF 322k Tonnes Design |
| | Public Drilled Well | | Current DSTF |
| | Surface Water Quality Station | | To Be Constructed Features |
| | Adit | | Infrastructure Footprint |

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

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ALEXCO KENO HILL MINING CORP.

FIGURE 3
FLAME AND MOTH/DISTRICT MILL
GROUNDWATER MONITORING LOCATIONS

JULY 2018

D:\Project\AllProjects\Keno_Area_Mines\ALL-SITES\02-Map\01_Overview\02-Specific_Topics\WQ
Monitoring\GW\GW_monitoring_locations_District_Mill_20180731.mxd
(Last edited by: amattashevsk, 31/07/2018/08:58 AM)

Table 2 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
Onek	Christal Creek	KV-78a, KV-100	KV-6, KV-50, KV-45	KV-6 and KV-7
Lucky Queen	Christal Creek	KV-34, KV-97, KV-98, KV-99, KV-101, KV-102	KV-6, KV-7	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
Birmingham	No Cash Creek	KV-114, KV-115	KV-56, KV-111, KV-118	KV-21

Table 3 Groundwater Monitoring Stations per Mine

Mine	Mine Infrastructure Monitored	Upgradient Wells	Downgradient Wells
Bellekeno	N-AML WRDA	-	KV-91, KV-92, KV-93, KV-94
Flame and Moth	Mine and P-AML WRSF	KV-108	FM-MW-1, FM-MW-2 and FM-MW-3, KV-109
Onek	P-AML WRDA	-	ON-MW-2, ON-MW-3 , KV-84Nd, KC-MW-4
Lucky Queen	N-AML WRDA and P-AML WRSF	-	LQ-MW-1, LQ-MW-2
District Mill/DSTF	Mill and DSTF	KV-87, KV-108	KV-85D/S, KV-86, KV-88D/S, KV-89D/S, BH-39, KV-107



Birmingham	N-AML WRDA and P-AML WRSF	-	KV-116 , BH-MW-1, RB-MW-1, NC-MW-1
Flat Creek Camp	Camp	ST-MW-1	-

Bold wells are pending

3 ENVIRONMENTAL EFFECTS MONITORING (UNDER MMER)

The KHSD mines are subject to the Metal Mining Effluent Regulations (MMER), administered under the federal Fisheries Act, which apply to mining and milling operations that discharge effluent(s) at a rate greater than 50 m³/day. The MMER outline requirements for routine effluent monitoring, acute lethality testing, Environmental Effects Monitoring (EEM) and provides maximum authorized limits of deleterious substances.

Effluent monitoring under MMER tends to overlap with that required under Water Licence QZ09-092; although, unlike the Water Licence a reduction or increase in monitoring frequency may be triggered based on analysis results. Maximum authorized concentrations of deleterious substances for MMER Schedule 4 is presented below in Table 4 below. The MMER also requires *Daphnia magna* monitoring tests at the same time as acute lethality testing.

Table 4 MMER Authorized Limits of Deleterious Substances

	Column 1	Column 2	Column 3	Column 4
Item	Deleterious Substance	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
1.	Arsenic	0.50 mg/L	0.75 mg/L	1.00 mg/L
2.	Copper	0.30 mg/L	0.45 mg/L	0.60 mg/L
3.	Cyanide	1.00 mg/L	1.50 mg/L	2.00 mg/L
4.	Lead	0.20 mg/L	0.30 mg/L	0.40 mg/L
5.	Nickel	0.50 mg/L	0.75 mg/L	1.00 mg/L
6.	Zinc	0.50 mg/L	0.75 mg/L	1.00 mg/L
7.	Total Suspended Solids	15.00 mg/L	22.50 mg/L	30.00 mg/L
8.	Radium 226	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L

NOTE: All concentrations are total values.

The objective of EEM is to determine whether mining activity is causing an effect on fish or fish habitat, benthic invertebrate communities and/or the use of fisheries resources. A Bellekeno Mine Cycle 2 Environmental Effects Monitoring Study Design has been developed with Environment Canada and the interpretive report has been provided (March 2016; see Appendix D of 2015 QML annual report http://www.emr.gov.yk.ca/mining/pdf/mml_keno_2015_annual_report_20160330.pdf). Effluent monitoring, acute lethality testing and EEM Study Designs will also be implemented as required by MMER for other mines brought online in the KHSD including Birmingham, Flame and Moth, Lucky Queen and Onek.

Sampling requirements under the EEM program are as follows:

Part 1. Effluent and Water Quality Monitoring Studies

- a) Effluent Characterization: Quarterly sampling from final discharge point includes extra parameters;
- b) Water Quality Monitoring: Quarterly sampling of sites within reference and exposure areas;
- c) Reference Area: Water frequented by fish that is not exposed to effluent and that has fish habitat that, as far as is practicable is most similar to the exposure area.
- d) Exposure Area: All fish habitat and waters frequented by fish that are exposed to effluent; and
- e) Sublethal Toxicity Testing: Semi-annual sampling required at each final discharge point and analysis of effects on reproduction or growth of a fish species, a plant species, an invertebrate species and an algal species as acceptable to MMR.

Part 2: Biological Monitoring Studies

A number of study cycles that each include:

- A study design;
- Environment Canada and stakeholder review;
- A Field Sampling Program; and
- Submission of an Interpretive Report that indicates whether or not an effect is observed.

Within each cycle, studies are conducted to determine if the effluent is having an effect on the following biological components including:

- a) Fish Population: Studies conducted in exposure and reference areas;
- b) Fish Tissue Studies: Only required if concentrations in effluent is equal to or greater than 0.1 µg/l or ppb – as determined by the effluent characterization program);
- c) Benthic Invertebrate Community: Studies conducted in exposure and reference areas following the Canadian Aquatic Biomonitoring Network's (CABIN) protocols; and
- d) Sediment sampling for analysis of particle size distribution and total organic carbon content. Sediment samples will be collected in replicates of three from active channels, placed in plastic containers and sent to an accredited laboratory where they are dried and sieved. Frequency of benthic and sediment sampling is presented in Table 5.

The first study cycle (Cycle 1) is 30 months in duration, while subsequent cycles are 24 to 72 months in duration, depending on previous results (i.e. if an effect is indicated). A final cycle is required if notification of mine closure is issued. To avoid redundancy in sampling sites and monitoring programs, final discharge points for MMR will be considered final discharge points under Water Licence QZ09-092.

Table 5 KHSD Sediment and Benthic Invertebrate Sampling Frequency

Station	Sediment Sampling	Benthic Sampling
KV-37	Annual	-
KV-38	Annual	Annual
KV-41	Annual	Annual
KV-43	Annual	-
KV-6	Biannual	Biannual
KV-81	Biannual	Biannual
KV-83	Annual	-
KV-21	Biannual	Biannual

4 PERMAFROST MONITORING

While the broad region in which the KHSD is located is generally characterized by discontinuous permafrost, Alexco Resource Corp. has not encountered significant permafrost anywhere in the District. Notwithstanding, geotechnical programs have identified areas of permafrost within operational areas; specifically, some permafrost was encountered beneath the Bellekeno mine N-AML Waste Rock Storage Area (WRSA) and in the vicinity of the Dry Stack Tailings Facility (DSTF). Ground temperature and permafrost monitoring is currently in place at these locations. Details on monitoring for the DSTF are included in the DSTF Operation, Maintenance, and Surveillance Manual, which forms a part of the DSTF Development and Operations Plan. Details on permafrost monitoring for the N-AML WRDA and P-AML WRSF are included in the KHSD Mining Operations Mine Development and Operations Plan. Appendix A provides analysis for potential effects from blasting occurring during the development of the Flame and Moth decline to the monitoring wells in the vicinity of the District Mill and DSTF. The analysis shows that with appropriate management of the blasting the integrity of the monitoring wells including the ground temperature and slope indicator monitoring will not be compromised. Monitoring outlined in the analysis will be undertaken as part of the plan to ensure the integrity of the instrumentation is not compromised.

Similarly, permafrost monitoring will be implemented should it be encountered during construction of facilities for new mine development in the District. Monitoring activities will consider the use of ground temperature and slope indicator monitoring devices to track potential changes in the ground conditions. Since much of the surface development is likely to occur on previously disturbed areas, the likelihood of encountering permafrost at surface is relatively low. However, if significant permafrost is encountered in areas of development an engineer will be consulted on the best practice to mitigate further degradation and plan around the permafrost laden material.

Specifically, for the final design, construction and operations of the phase 2 of the DSTF permafrost characterization and monitoring will be undertaken per Water Licence clause 45 (below) and subsurface investigation program listed in Schedule C 1.5 (d) in the Quartz Mining Licence.

45. Prior to construction of the DSTF expansion, the Licensee shall conduct a subsurface investigation program and submit the results of that investigation to the Board. The program shall provide for representative sampling from the entire footprint of the DSTF expansion and include, but not be limited to:

- a) a minimum of 12 holes advanced to bedrock using a drill capable of recovering undisturbed frozen overburden samples;
- b) installation of sub-surface monitoring instrumentation including slope indicators and ground temperature cables; and
- c) laboratory testing of samples for shear strength, particle size and moisture content,

as described in the Application in exhibit 1.13 .4 of Register QZ09-092-2.

5 PHYSICAL INSPECTIONS AND REPORTING PLAN

The purpose of physical inspection is to observe and record sufficient information for mine related structures to determine a course of action, repair or rehabilitation if it is required. Physical inspections are conducted under the Physical Inspections and Reporting Plan updated in July 2018 (Appendix B). Photo documentation at photo hubs is undertaken on a monthly basis in order to aid in identifying temporal changes and as a record keeping tool. The Physical Inspection and Reporting Plan describes scheduled physical inspections of infrastructure associated with the Bermingham, Bellekeno Mine, Flame and Moth, District Mill, Onek 990 Mine and Lucky Queen Mine operations. Information is collected through use of weekly and monthly checklists and reporting forms and any damage or movement is noted. If any seepage is noted from any water retaining structures it will be noted on the next monthly inspection report and a plan will be in place sample, test and manage the discharge within 60 days of the discovery. All annual monitoring and inspections for water conveyance and retaining structures and associated mine waste and earthworks structures will be conducted by a professional engineer.

In the vicinity of the Bellekeno mine, physical inspections include the Bellekeno 625 settling ponds, the Bellekeno East Temporary Waste Rock Storage Facility, the non-AML Waste Rock Disposal Area, and the haul road and Lightning Creek Bridge along the Keno City Bypass road. In the vicinity of the mill, physical inspections include the water supply and discharge pipelines and infrastructure, the mill site water collection and diversion structures, the mill site collection and sedimentation pond, and the dry stack tailings facility.

The Physical Inspection and Reporting Plan was updated in accordance with an amended Water Licence QZ09-092-2 to include provisions for the Flame and Moth, Onek and Lucky Queen structures. Such facilities would include settling ponds temporary ore stockpile, N-AML waste rock disposal area, and P-AML waste rock storage facilities.

6 METEOROLOGICAL MONITORING

Meteorological data have been collected in the KHSD since 2007 at the Calumet weather station (Figure 4) as part of the development of the ESM Reclamation supporting studies), since 2011 at the Keno District Mill meteorological station (installed as part of Bellekeno mining operations) and since 2012 at the Valley Tailings meteorological station. All three stations collect air temperature, relative humidity, rainfall, solar radiation, wind speed and wind direction. In addition, the Keno District Mill station has a snowfall conversion adaptor and calculates evapotranspiration, while the Valley Tailings station collects barometric pressure and soil water content. The Calumet station collects soil temperature. Instrumentation used at each of the weather stations is listed in Table 6 to 8.

Alexco conducted manual snow surveys from 2011 to 2017 at thirteen monitoring stations (with the addition of one station in 2016 and two stations in 2017 in order to adequately represent the varying snow conditions as a function of aspect, elevation, etc. A Yukon Government monitored snow course station located at 1,310 masl elevation also exists in the area and has been monitored for over 30 years.

Data collected from these stations will be used to update meteorological/hydrological information and water balances.

Table 6 Galena Hill HOBO Meteorological Station Components

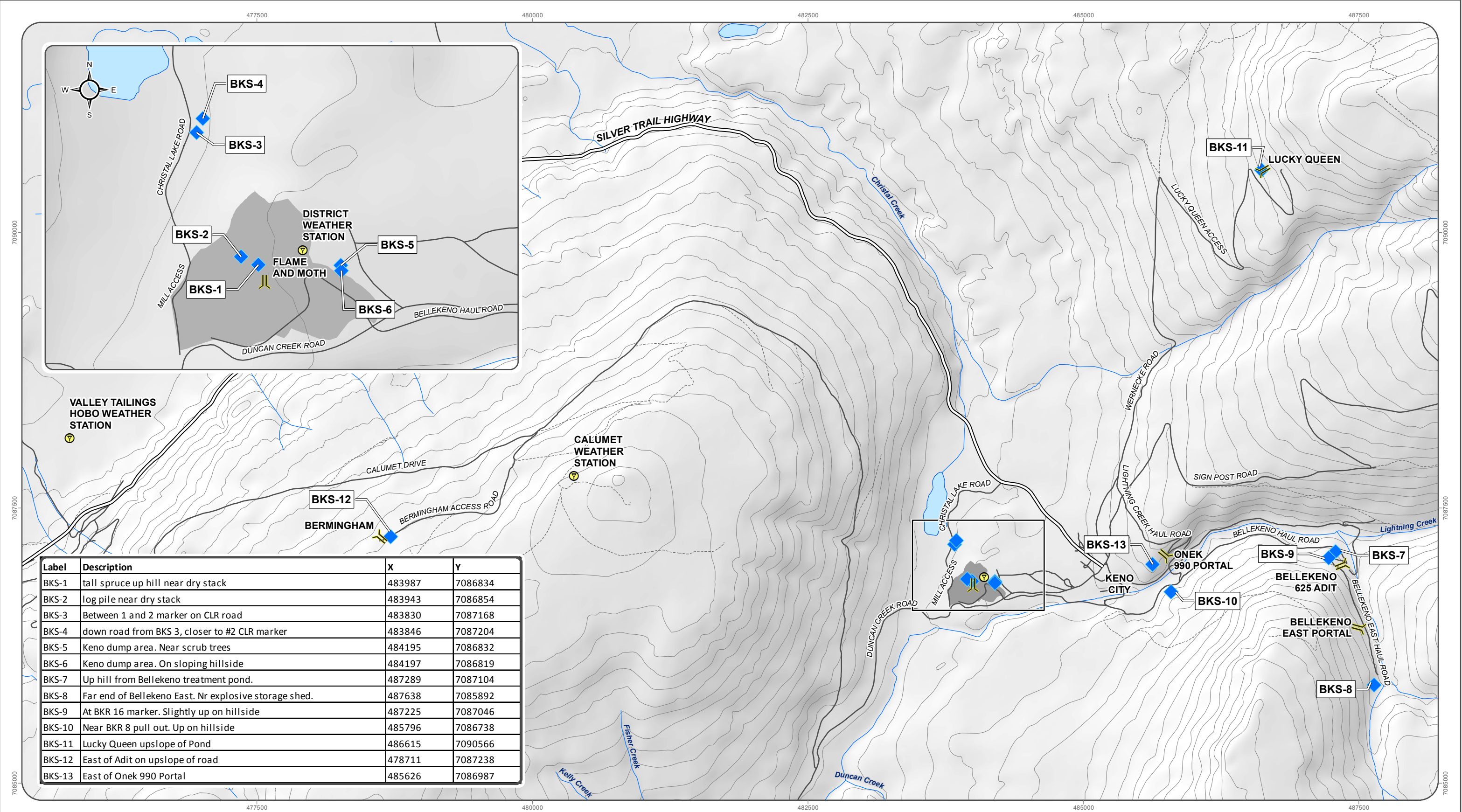
Component	Model	Serial Number
Datalogger	HOBO Weather Logger	1153440
Temp & RH Sensor	S-THB-XXXX	10064003
Soil Temp Sensor	S-TMB-XXXX	985390
Pyranometer	S-LIB-XXXX	1048627
Rain Gauge	S-RGB-M002	1017667
Wind Speed & Direction Sensor	S-WCA-XXXX	1254995
BP Sensor	S-BPA-XXXX	1037089

Table 7 District Mill Campbell Scientific Meteorological Station Components

Component	Model	Serial Number
Air Temperature and Relative Humidity Sensor	HMP45C212	n/a
Tipping Bucket Rain Gauge	TE525M	45303-910
Wind Speed and Direction Sensor	05103AP-10-L	WM105907
Solar Panel	SX320J	T21008289B30EC8
Datalogger	CR800	16119
Battery	PS-12120 F2	06299-HC
Pyranometer	SP Lite2	125766

Table 8 Valley Tailings HOBO Meteorological Station Components

Component	Model	Serial Number
Datalogger	U30 NRC	10231016
Input Expander kit		
Solar Panel	6W	
AC Power Adaptor	120V - 60Hz	
HOBOWare	Pro	2580 2976 6309 4793
Temp & RH Sensor	THB-M002	10220040
Solar Radiation Shield	RS3	
Pyranometer	LIB-M003	10191222
Rain Gauge	RGB-M002	10222664
Light Sensor Bracket	LBB	
Light Sensor Level	LLA	
Wind Speed & Direction Sensor	WSET-A	10233230
Full Cross Arm	CAA	
BP Sensor	BPB-CM50	10212093
Soil Moisture Sensor	SMC-M005	10225679
Tripod	TPA-KIT 3m	



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

◆ Snow Monitoring Station

Y Adit

■ District Mill

== Silver Trail Highway

— Other Road

----- Limited-Use Road

— Contours (100 ft)

— Watercourse

■ Waterbody



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FIGURE 4
METEOROLOGICAL STATIONS AND
SNOW SURVEY STATIONS LOCATION

JULY 2018

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7 AIR QUALITY MONITORING

In accordance with Clause 69 of the Decision Document for the assessment of the Bellekeno Mine Project (YESAB File Number 2009-0030), dustfall monitoring was installed at two initial locations near the Keno District Mill site in March 2011 and two additional sampling locations were established in August 2011. Bergerhoff dust monitoring gauges were initially selected as the appropriate instrumentation to carry out this program. In accordance with clauses 36 and 37 of the Decision Document for the assessment of the Onek and Lucky Queen Deposit production (YESAB File Number 2011-0315), total suspended particulates (TSP) monitoring was subsequently initiated in August 2012 and dustfall monitoring was discontinued in January 2013. Additional sampling for coarse and fine fractions of particulate matter (PM₁₀ and PM_{2.5} respectively) was instigated in August 2015, in accordance with the revised Dust Abatement and Monitoring Plan required in the Decision Document (clause 19) for the assessment of the Flame & Moth Development and Production Program (YESAB file Number 2013-0161). This memorandum presents the results of the ambient air quality monitoring to date.

Two BGI Omni Ambient Air Quality Samplers (see Figure 5) were commissioned in August 2012, one to the East of the mill and crusher (TSP-1) and one at the toe of the dry stack tailings facility (TSP-2). A third sampler (TSP-3), located in Keno City, was commissioned in December 2014, in accordance with the revised Dust Abatement and Monitoring Plan required in the Decision Document for the assessment of the Flame & Moth Development and Production Program (YESAB file Number 2013-0161). The monitoring locations are shown on Figure 5.

The BGI Omni samplers are set up with TSP, PM₁₀ or PM_{2.5} inlets, and use the filter reference method. Samples are collected over 24-hour periods and sent to Maxxam Analytics laboratory for gravimetric analysis and ICP metals mass spectrometry (from TSP samples only). The sampling program aims to collect three samples per location every month, in order to capture the different weather conditions that may affect dust sources and transport. The BGI Omni Ambient Air Quality Samplers cannot collect samples below -20°C and therefore some winter months will have reduced data.

Results from TSP monitoring are compared to the Yukon Ambient Air Quality Standards (YAAQS) under the Environment Act. These standards for TSP are set at 120 µg/m³ for a 24-hour average, and 60 µg/m³ as an annual geometric mean. There are however no standards for metal concentrations in TSP in Yukon so results of metal speciation are compared to the Ontario Ambient Air Quality Criteria for reference. These criteria are summarized in Table 9 below.

Table 9 Ontario Ambient Air Quality Criteria (µg/m³)

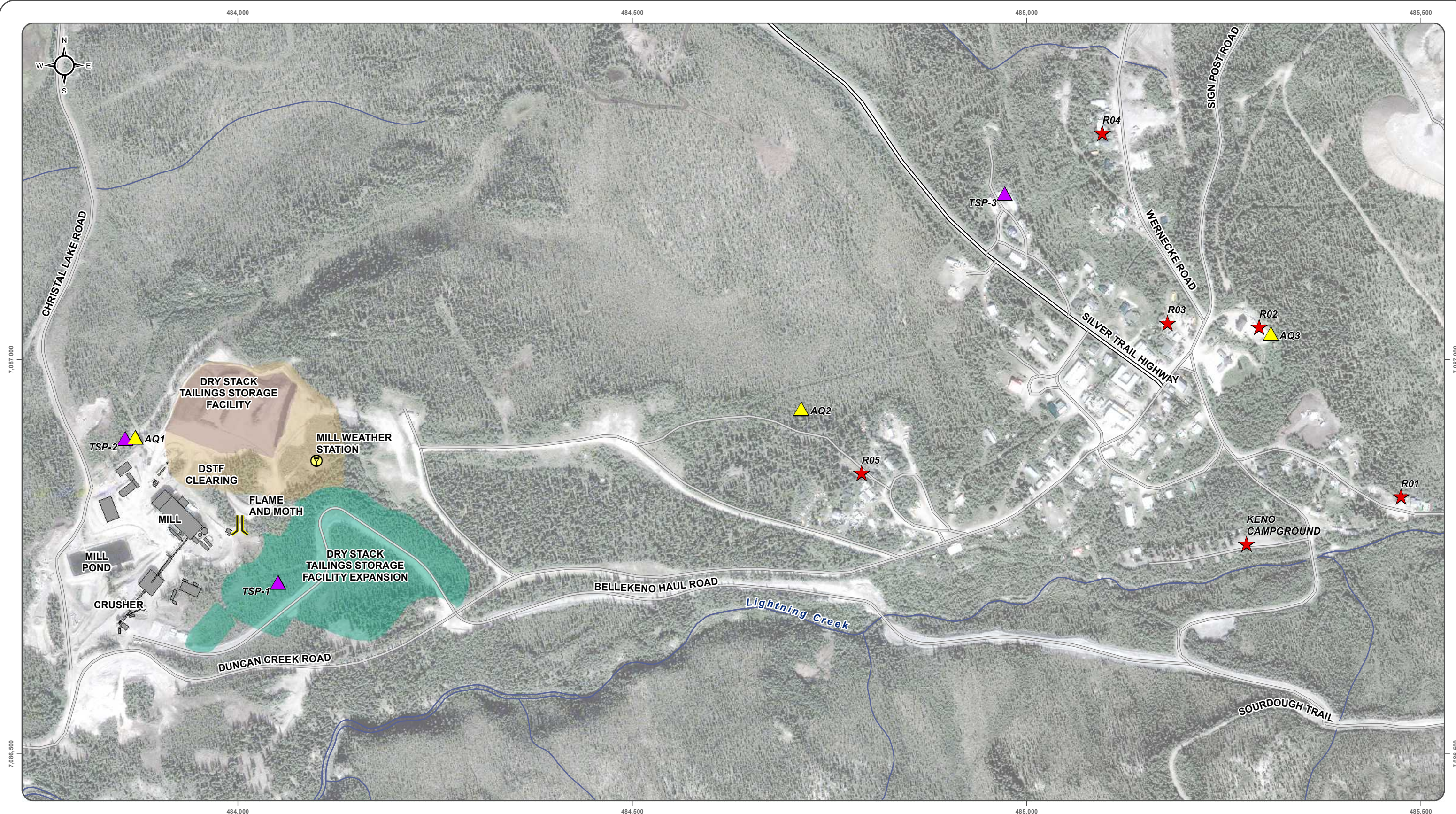
Parameter	Criteria
Antimony	25
Arsenic	0.3
Barium	10
Beryllium	0.01
Boron	120
Cadmium	0.025
Chromium	0.5

Parameter	Criteria
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

As part of the YESAA process for Flame and Moth, an air dispersion model was run to predict ambient concentration of TSP, PM₁₀ and PM_{2.5} at sensitive receptors under three different operation scenarios. The main dust sources considered in the air dispersion model included the dry stack tailings facility (DSTF), mineral processing and the traffic on unpaved roads. In consideration of the results the air dispersion model, and in response to concerns raised during the YESAA process for Flame & Moth, AKHM will implement the following changes to its air quality monitoring program prior to resuming production at the District Mill:

- In addition to TSP monitoring which allows for metal speciation and comparison with the Ontario Ambient Air Quality Criteria, monitoring for PM₁₀ and PM_{2.5} will be carried out, as it represents the coarse and fine fractions of TSP that are inhalable and that may therefore have health impacts. This can be done by changing the inlet on the BGI Omni Samplers. Three samples per month will be collected from each location, for TSP, PM₁₀ and PM_{2.5}. The 24-hour Yukon Ambient Air Quality Standard for PM₁₀ is 50 µg/m³ and 30 µg/m³ for PM_{2.5}.
- The sampler located at TSP-1 will be relocated to the western limit of Keno City (AQ2; near receptor R05) to characterize ambient concentrations at sensitive receptors in Keno City (see Figure 5). Of the six discrete receptors used in the model, receptor R05 is where the highest concentrations were estimated under the three different scenarios.
- The sampler located at TSP-3 will be relocated to the eastern end of Keno City (AQ3; near receptor R02), to provide an understanding of how ambient concentrations vary throughout town (see Figure 5).
- The sampler located at TSP-2 (see Figure 5) remains in operation at the same location (renamed AQ1) to provide information on ambient concentrations within the Project area and to provide data continuity as this site has been monitored for TSP since August 2012.

In addition to air quality monitoring, continuation of pre-emptive and reactive dust control procedures as outlined in the DSTF Construction and Operation Plan, and Traffic Management Plan, will ensure that fugitive dusting does not become an issue.



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

Datum: NAD 83; Projection: UTM Zone 8N

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1:4,500 (when printed on 11 x17 inch paper)

0 50 100 150 200 250 Meters

- ★ Noise Monitoring Stations
- ▲ Former Air Quality Monitoring Station
- ▲ Proposed Air Quality Monitoring Station
- Ⓢ Weather Station
- Y Adit
- DSTF 322k Tonnes Design
- Current DSTF
- To Be Constructed Features

- Silver Trail Highway
- Secondary Road



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FIGURE 5

AIR QUALITY AND NOISE MONITORING STATIONS

JULY 2018

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8 NOISE MONITORING

AKHM has monitored noise at the five locations selected in the NIA as being potential noise receptors within a 2 km radius study area around Keno City. Since November 2013, noise has also been monitored at a sixth location, the Keno City Campground. These monitoring locations are listed in Table 10 and shown in Figure 5.

Table 10 Representative Locations Assessed in Keno City

Monitoring Location	GPS Location	Description
R01	N63.90827 W135.29599	East end Residence, north side of Lightning Creek Road
R02	N63.91019 W135.29968	Residence, east side of Sign Post Road
R03	N63.91023 W135.30205	Town Center, north from the Snack Bar
R04	N63.91239 W135.30376	Residence, west side of Wernecke Road
R05	N63.90851 W135.30993	Residence, about 850 m east from the Mill
Campground	N63.90772 W135.29998	Keno City campground

The background noise levels experienced by these locations vary considerably, depending on location and local activities. Climate parameters, such as relative humidity, temperature, and temperature inversions impact the sound level and propagation experienced by each of these receptors.

All readings prior to December 2014 were taken using an Extech integrating sound level datalogger model 407780 to measure average dBA over 10 minutes. All results were found to be below 70 dBA, and only occasionally exceeded 50 dBA. Results were however difficult to generalize due to the short sampling period, and interpretation can be confounded by extraneous events contaminating the noise record.

As of December 2014, noise monitoring was converted to 24-hr periods on a monthly basis, using a Casella CEL-63X Sound Level Meter and Casella CEL-495 Microphone (which includes a wind screen for outdoor use). Longer sampling periods were recommended by PAAE (2014), as well as measurement of Leq, percentile noise levels, octave and 1/3 octave band readings recorded. The isolation of contaminated noise sources is facilitated by the use of statistical noise levels in addition to Leq. This instrument also allows for the monitoring of low frequency noise (C-scale), which can now also be considered when assessing noise impacts.

Supporting information recorded at time of sampling includes detailed recording of mining intensity and wind conditions at time of noise measurements.

Additionally, AKHM will conduct instantaneous monitoring at specific locations, if it is warranted by a noise complaint.

Noise Impacts and sound monitoring are further discussed in the Noise Monitoring and Management Plan. The plan has been updated for Flame and Moth and includes the District Mill, Onek and Lucky Queen (Access Consulting, 2015b).

9 WASTE ROCK MONITORING

All waste rock management facilities are subject to monitoring for physical and geochemical stability (acid rock drainage and/or metal leaching) including seep surveys. The waste rock management plan presents rock characterization processes, field screening protocols, rock management, confirmatory testing and rock monitoring. A complete Waste Rock Management Plan was first prepared in 2009 and includes detailed descriptions of waste rock monitoring and mine wall testing. The waste rock monitoring plan was implemented in 2012 at the Bellekeno Mine with a detailed report testing and describing the effectiveness of waste rock screen procedures as presented in the plan (Access Consulting, 2013). The Waste Rock Management Plan was updated in July 2018 include the Bermingham deposit (AEG, 2018).

As part of annual reports for the Quartz Mining License and Water Licence a waste rock management summary report will be submitted presenting the results for all of the static and kinetic data generated from the Waste Rock Management Plan in a given year. The report will compare the field screening and on site classification of waste rock to the laboratory analysis outlining the effectiveness of the implementation of the plan including tonnage of rock misclassified as N-AML and P-AML.

10 SPILL CONTINGENCY PLAN

The Spill Contingency Plan has been updated per clauses 4 to 9 of Water Licence QZ09-092-2 that specifies:

4. Where a spill or an unauthorized discharge occurs, that is of a reportable quantity under the Yukon Spills Regulations, the Licensee shall immediately contact the 24-hour Yukon Spill Report telephone number (867) 667-7244, and implement the most recent Spill Contingency Plan that has been filed with the Board. A detailed written report on any such event, including but not limited to, dates, quantities, parameters, causes and other relevant details and explanations, shall be delivered to the Board not later than 10 days after its occurrence."

5. The Licensee shall apply the relevant procedures in the Spill Contingency Plan. The Licensee shall review the Spill Contingency Plan annually and shall provide a summary of that review, including any revisions to the plan, as a component of the annual report.

6. The Licensee shall maintain a log book of all spill or unauthorized discharge occurrences, including spills that are less than the reportable quantities under the Yukon Spills Regulations. The log book shall be made available at the request of an Inspector. The log book shall include, but not necessarily be limited to the:

- a) date and time of the spill;
- b) substance spilt or discharged;
- c) approximate amount spilt or discharged;
- d) location of the spill;
- e) distance between the spill or discharge and the nearest Watercourse; and
- f) remedial measures taken to contain and clean-up the spill area or to cease the unauthorized discharge.

7. The Licensee shall include a summary of all spills or unauthorized discharges that occurred during the year reported, as part of the annual report.

8. All personnel shall be trained in procedures to be followed and equipment to be used in the containment of a spill.

9. Prior to the commencement of construction, the Licensee shall update the Spill Contingency Plan and provide the updated plan to the Board. The Spill Contingency Plan shall be posted on site for the duration of the works.

For more details, see the Spill Contingency Plan and the Emergency Response Plan updated in July 2018. All incident reports including the occurrence of a spill, should it occur, will be forwarded to the First Nations of Na-Cho Nyak Dun (FNNND).

11 ADAPTIVE MANAGEMENT PLAN (AMP)

The updated Bellekeno Adaptive Management Plan (AMP) was prepared in April 2011 to fulfill Water Licence QZ09-092 conditions. An Adaptive Management Plan inclusive of the activities at Onek and Lucky Queen was submitted to the Water Board in January 2014 as part of the Licence requirements. The AMP was updated as required in Water Licence QZ09-092-2 and Quartz Mining License QML-0009 for Flame and Moth, and was submitted March 21, 2018. The most recent AMP was prepared in July 2018 for Birmingham and outlines the quantitative thresholds which trigger implementation of Adaptive Management with the summary AMP table provided below as Table 11.

Table 11 AMP Summary

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
1. CHANGE IN WATER QUALITY OR QUANTITY					
a. Significant change in water quality of Bellekeno water treatment plant discharge, District Mill decant pond, Onek settling pond decant, Lucky Queen settling pond decant, or Flame & Moth water treatment pond decant	Decline in discharge pH noted or effluent quality trending towards possible exceedance of standards or exceeds licenced standards.	All effluent quality standard parameters	Bellekeno, Onek, Lucky Queen and Mill discharge: Treated effluent: TSS>20 mg/L for three consecutive days; OR Total Zinc > 0.40 mg/L, or pH < 7.0 for three consecutive days; OR Ammonia > 4.0 mg/L and pH > 9.0 for three consecutive days; OR weekly samples exceeds Effluent quality standards. Flame& Moth or Bermingham Discharge: Treated effluent: TSS>20 mg/L for three consecutive days; or pH < 7.0 for three consecutive days; OR and pH > 9.0 for three consecutive days; OR weekly sample exceeds Effluent quality standards.	Bellekeno Water Treatment Facilities (KV-43), Mill Decant pond (KV-83), Lucky Queen settling pond decant (KV-97), Onek settling pond decant (KV-96), Flame & Moth settling pond decant (KV-104), Bermingham settling pond decant (KV-114)	Routine in-situ including ammonia and on-site total zinc, external multi-element ICP, hardness, pH, conductivity, TSS, ammonia
b. Significant change in water quality of adit discharge	Significant decline in field pH or increase in conductivity, zinc, cadmium or ammonia from mine adit discharge to treatment plant	Field pH and conductivity, zinc, cadmium, ammonia	Adit discharge field pH more than 1 pH standard unit lower than historical average or increasing trend towards historical maximum for ammonia, conductivity, cadmium, and zinc	Bellekeno adit (KV-42), Lucky Queen adit (KV-34), Onek 990 settling pond (KV-96), Flame & Moth adit (KV-105), Bermingham adit (KV-110)	Same as indicators
c. Bellekeno adit discharge quantity significantly increases	Observed or measured flows display a sustained and statistically significant increase over historical flow conditions	Flow	Increase of flow to greater than 95% upper confidence level when compared to the average for previous 24 months or 90% licence flow discharge criteria exceeded for seven consecutive days	Bellekeno Water Treatment Facilities (KV-43)	Same as indicators

d. Lucky Queen underground workings inflow rate significantly greater than expected resulting in greater discharge than predicted	Observed or measured flows display a sustained and statistically significant increase over predicted monthly inflow conditions	Flow	Increase of flow rate to within 10% of 172.8 m ³ /day for seven consecutive days	Lucky Queen adit (KV-34)	Same as indicators
e. Onek 990 portal discharge	The Onek 990 settling pond discharges water after the decline is developed	Flow	Flow from the Onek 990 portal pad settling pond	Onek 990 Settling pond (KV-96)	Same as indicators
f. Flame and Moth or Birmingham underground workings inflow rate significantly greater than expected resulting in greater discharge than predicted	Observed or measured flows display a sustained and statistically significant increase over predicted monthly inflow conditions	Flow	Increase of flow rate to within 10% of 3,200 m ³ /day for seven consecutive days for Flame and Moth or increase of flow rate to within 10% of 1,200 m ³ /day for seven consecutive days for Birmingham	Flame and Moth adit (KV-105) and Birmingham adit (KV-110)	Same as indicators
g. Identification and assessment of trends in water quality in discharges from the District Mill or the Birmingham, Bellekeno, Lucky Queen, Onek or Flame & Moth Mine sites for parameters without effluent discharge standards	Effluent quality trending towards decreased water quality	Parameters without effluent discharge standards (i.e. aluminium, chromium, nitrate, iron, selenium, uranium, sulphate)	Increasing trend resulting in exceedance of water quality objectives in receiving environment	Bellekeno Water Treatment Facilities (KV-43), Mill Decant pond (KV-83), Lucky Queen settling pond decant (KV-97), Onek settling pond decant (KV-96), Flame & Moth pond decant (KV-104), Birmingham pond decant (KV-114)	Same as indicators
2. WASTE ROCK SEEPAGE EXHIBITS AML					
a. Waste rock seepage or runoff trending to AML conditions	Seepages from waste rock disposal areas or from works constructed or upgraded with non AML material show significant decline in pH or alkalinity and/or an increase in conductivity, sulphate, zinc or cadmium OR approaching licenced effluent quality standards	pH, conductivity, zinc, cadmium, sulphate, alkalinity	Significant decline in pH between measurements or pH <7.0 and/or conductivity, zinc, cadmium, or sulphate or showing a significant increasing trend or alkalinity shows a significant decreasing trend; OR indicators approaching licenced effluent quality standards	Waste rock disposal areas (Lucky Queen N-AML dump (KV-98), Bellekeno WRDA, Flame & Moth WRDA, Birmingham WRDA and works or features constructed from N-AML material including Bellekeno Haul road,	pH, conductivity, alkalinity, sulphate, routine multi-element ICP

b. Identification of water quality changes from N-AML Waste Rock or tailings, including results from kinetic testing	Kinetic testing of N-AML waste rock or tailings shows significant decline in pH or alkalinity and/or an increase in conductivity, sulphate, zinc or cadmium	pH, conductivity, zinc, cadmium, sulphate, alkalinity	Significant decline in pH between measurements or pH <6.0 and/ or conductivity, zinc, cadmium or sulphate showing a significant increasing trend or decreasing trend in alkalinity; OR indicators approaching licenced effluent quality standards	Field bins or humidity cells with N-AML waste rock or tailings, DSTF and waste rock disposal areas (KV-98)	pH, conductivity, alkalinity, sulphate, routine multi-element ICP
3. SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED					
a. Seepage observed near sludge storage areas	Routine inspection of sludge storage area shows seepage	Total zinc, cadmium, pH	pH >8.5, total zinc > 0.5 mg/L, total cadmium > 0.01 mg/L	Valley Tailings sludge storage cell	Same as indicator
b. Sludge storage area approaching capacity	Sludge storage area approaching minimum freeboard of 1.0 metre below the decant point	Visual observation of freeboard	Freeboard is at 1.5 metre below decant point	Valley Tailings sludge storage cell	Same as indicator
4. PHYSICAL INSTABILITIES					
a. Area of significant surface subsidence has occurred	An observed subsidence has exposed an opening to surface or resulted in slope failure	Visible slope failure, ground subsidence or opening on surface	Opening to underground workings or area of subsidence effects public safety or down gradient environment	Keno Hill Silver District Mining Operations	Same as indicators
b. Rock fall or landslide is observed that affects road right-of-way or intrudes into stream	An observed rock fall or landslide effects a road right-of-way, infrastructure or intrudes into stream	Mine source material movement	Source material effects road or stream	Keno Hill Silver District Mining Operations	Same as indicators
5. SITE SECURITY COMPROMISED					
a. Security gate, fence, sign damaged	Public health and wildlife safety measure damaged or removed	Sign, fence, gates, locks	Security feature damaged, removed, or compromised	Keno Hill Silver District Mining Operations	Same as indicators
6. DEVELOPMENT OF HIGH PORE PRESSURES UNDERNEATH OR WITHIN THE DSTF					
a. High porewater pressure within groundwater	Porewater pressure is observed in groundwater monitoring wells in the DSTF	Porewater pressure	Tip @1.0m or 1.7m depth – Porewater pressure parameter (Ru) exceeds 0.15	Groundwater monitoring wells in the DSTF	Same as indicators

monitoring wells in the DSTF					
7.0 DEVELOPMENT OF SIGNIFICANT EROSION OF EXPOSED DSTF SURFACES					
a. Area of significant erosion on exposed DSTF surface	An observed movement of tailings caused by erosion on surface	Visual inspection of tailings surface	Geotechnical engineer or operator inspection identifies adverse operating condition	DSTF	Same as indicators
8. DEVELOPMENT OF EROSION AT THE DISTRICT MILL OR FLAME & MOTH SITE DISCHARGE AREAS					
a. Erosion at the District Mill or Flame & Moth site discharge areas	Erosion and ground degradation is observed in area downgradient of the discharge locations	Visual inspection of area downgradient of discharge location	Geotechnical engineer or operator inspection identifies adverse operating condition	Visual inspection of area downgradient of discharge locations	Same as indicators
9. TRANSPORT OF SEDIMENT FROM THE DISTRICT MILL SITE OR FLAME & MOTH DISCHARGE AREAS INTO CHRISTAL CREEK					
a. Transport of sediment from the Mill site or Flame & Moth discharge areas to Christal Creek	An observation of significant erosion is observed in area downgradient of the discharge location resulting in high TSS discharge	TSS in discharge after final control point and visual inspection of area downgradient of discharge locations	TSS of 20 mg/L in daylighted discharge. TSS of 15 mg/L greater than monthly seasonal average calculated from existing conditions concentration at KV-50. TSS at KV-81 in Lightning Creek is 25 mg/L higher than upstream of Flame and Moth discharge area on Lightning Creek.	Area downgradient of Mill pond discharge (KV-83), and Flame & Moth pond decant (KV-104)	TSS
10. DEVELOPMENT OF LARGE DIFFERENTIAL SETTLEMENTS AT THE DSTF					
a. Significant differential settlements are observed in the DSTF	An observation of significant differential settlements is observed at the DSTF	Displacement of survey monitors and slope indicators	Displacements greater than 25 mm in any direction	Survey monuments and slope inclinometers	Same as indicators
11. DEVELOPMENT OF LARGE DIFFERENTIAL SETTLEMENTS ALONG THE CONVEYANCE FLUME FROM THE DSTF TO DISTRICT MILL SITE COLLECTION AND SEDIMENT POND					
a. Significant differential settlements are observed along the conveyance flume	An observation of significant differential settlements is observed in the conveyance flume	Displacement of survey monuments	Displacements greater than 25 mm in any direction	Survey monuments	Same as indicators
12. EXCEEDENCE OF WATER QUALITY OBJECTIVES IN THE RECEIVING ENVIRONMENT OCCURRING IRRESPECTIVE OF COMPLIANCE WITH EFFLUENT QUALITY STANDARDS					
a. A significant increasing trend is observed in receiving environment even though authorized	Receiving environment water quality are trending towards exceeding the water quality objectives.	Arsenic, cadmium, copper, lead, nickel, selenium, silver, zinc, ammonia,	Trending towards or exceedance of water quality objective at a receiving environment monitoring station based on seasonal norms	Receiving environment monitoring stations (Christal Creek at KV-50, KV-6, and KV-7,	Same as indicators

licenced discharges are within effluent quality standards		nitrate, nitrite, sulphate	compared to preceding 3 years data.	Lightning Creek at KV-81, No Cash Creek at KV-21, and Star Creek at KV-56)	
13. IDENTIFICATION OF GROUNDWATER QUALITY IMPACTS WITHIN THE KENO HILL SILVER DISTRICT MINING OPERATIONS					
a. A significant increasing trend is observed in groundwater near the District Mill (including DSTF) or N-AML Waste Rock Disposal Areas	Total zinc, cadmium or ammonia significantly exceeds baseline measurements for a given monitoring well, and exceeds licenced effluent discharge standards	Total zinc, cadmium and ammonia	Exceedance of the 95th percentile for dissolved constituents that have a surface water quality objective. Statistically significant increasing trend compared to past three years of data	KV-85 to KV-94, LQ-MW-01, LQ-MW-02, KV-116, RB-MW-1, NC-MW-1	Same as indicators
b. Water level within groundwater monitoring wells in the DSTF	Water level is observed in monitoring wells within the DSTF	Water level, total zinc	More than 30 cm of water is in well and water quality trending towards KV-83 EQS	Groundwater monitoring wells in the DSTF (BH39, KV-107)	Same as indicators
14. IDENTIFICATION OF WATER QUALITY IMPACTS TO KENO CITY WATER WELLS					
a. A significant increasing trend is observed in groundwater near Keno City due to the Onek 990 mine	Total zinc, arsenic or cadmium significantly exceeds baseline measurements for a given monitoring well, or parameters listed in the Canadian Drinking Water quality guidelines are exceeded	Total zinc, arsenic, cadmium, and parameters listed in the Canadian Drinking Water Guidelines	Exceedance of the 95th percentile for total cadmium, and zinc Statistically significant increasing trend compared to past three years of data; or Sample result exceeds YCSR drinking water standards.	Groundwater monitoring wells (ON-MW-02, KC-MW-4, KV-84Nd)	Same as indicators
15. DEVELOPMENT OF EROSION AND/OR PERMAFROST DEGRADATION AT THE DISCHARGE TO GROUND AREAS AT THE BIRMINGHAM, LUCKY QUEEN AND ONEK MINE SITES					
a. Erosion is observed at the discharge to ground areas at the Birmingham, Lucky Queen and Onek mine sites	An observation of erosion is made at the discharge to ground areas	Visual inspection of discharge to ground areas	Geotechnical engineer or operator inspection identifies adverse operating condition	Birmingham, Lucky Queen and Onek discharge to ground areas	Same as indicators
16. OPERATION OF THE CONTINGENCY LUCKY QUEEN WATER TREATMENT PLANT					

a. The use of the contingency Lucky Queen water treatment plant is required	The Lucky Queen water treatment plant is required for treatment and deposit of water as the adit discharge has degraded and the settling ponds are not effectively reducing the metal load in the discharge.	Effluent quality standard parameters and discharge rate	3 consecutive results above 3 standard deviations of the historical average	Lucky Queen adit, (KV-34), Lucky Queen Settling Pond (KV-102), Lucky Queen Settling Pond Decant (KV-97)	Same as indicators
17. FUGITIVE DUST GENERATED FROM THE DSTF RESULTS IN THE EXCEEDANCE OF YUKON AMBIENT AIR QUALITY STANDARDS					
a. Dust generated from the DSTF exceeds Yukon ambient air quality standards and metal guidelines	An increasing trend in fugitive dust from the DSTF and/or haul roads is observed	TSP, PM10, PM2.5 and metals	An increasing trend in TSP, PM10 or PM2.5 measurements or in metal concentrations towards Yukon Ambient Air Quality Standards or Ontario Ambient Air Quality Criteria for metals; An exceedance of the Yukon Ambient Air Quality Standards for particulate matter or the Ontario Ambient Air Quality Criteria for metals in TSP at AQ3.	AQ1, AQ2 and AQ3	Same as indicators
18. ATTENUATION OF THE FLAME AND MOTH OR BIRMINGHAM DISCHARGE TO CHRISTAL CREEK AND NO CASH CREEK, RESPECTIVELY, DOES NOT PERFORM AS PREDICTED					
a. Natural attenuation does not remove metals to the degree expected from Flame and Moth or Birmingham Mine discharge and water quality in Christal Creek or No Cash Creek may be degraded and not meet the water quality objectives	The calculated natural attenuation at KV-50 or KV-21 is less than 50% for any of these elements and the WQOs in Error! Reference source not found. are exceeded for KV-50 or KV-21	Cadmium, nickel and zinc for Christal Creek and silver, arsenic, copper, nickel, lead and ammonia For No Cash Creek	Calculated natural attenuation at KV-50 or KV-21 is less than 50% for any of these elements and the WQOs for KV-50 or KV-21 are not met	KV-6, KV-50, KV-104, KV-21, KV-111, KV-114	Same as indicators

12 RECLAMATION EFFECTIVENESS MONITORING PROGRAM

With the cessation of mining, the monitoring and surveillance programs will be tailored to assess closure measures and continue as necessary. At closure, Water Licence QZ09-092-2 will undergo amendment to regulate activities around reclamation and reclamation monitoring. Post closure reclamation benchmarks should be well defined, measurable and documented. A thorough effectiveness monitoring program will allow for recognition of restoration successes and needed improvements.

The Conceptual Reclamation and Closure Plan for Keno Hill District Mining Operations (Revision 4 – June 2015) states:

“Monitoring activity will be required to determine the on-going and continued success of closure measures in meeting the closure objectives for a period of 10 years. The adaptive management approach will be used to determine thresholds identifying when remedial action have been triggered, and then the success of the remedial measures will need to be incorporated into the monitoring and surveillance regime.”

Proposed closure monitoring activities include:

- Water quality monitoring at some of the stations identified in the Water Licence;
- Monitoring of road bank and drainage along access road;
- Physical inspection of the passive water treatment systems;
- Physical stability of all waste rock disposal areas;
- Success of revegetation measures (principally portal area, DSTF and mill pad area);
- Monitoring of cover system integrity (P-AML WRSFs and DSTF); and
- Physical inspection of impacted earthen surfaces for evidence of erosion, gulying or sediment transport to watercourses.

Permafrost beneath the waste rock disposal areas will be monitored at least 10 years post closure, after which time the necessity of the requirement will be reviewed. An annual geotechnical inspection should be conducted on the waste rock disposal areas for at least 5 years post closure, after which time the necessity of this requirement will also be re-evaluated. Success of implementation of final reclamation will be measured by the ability to achieve stated closure objectives in the Reclamation and Closure Plan. The Reclamation and Closure Plan has been updated to include Flame and Moth.

As part of progressive reclamation monitoring will be completed to assess the effectiveness of the progressive reclamation activities completed on an annual basis. For example the progressive reclamation completed for the DSTF cover, monitoring has been conducted and will continue to be conducted to assess the cover effectiveness including infiltration, stability/erosion, vegetation establishment and metal uptake in cover vegetation. The vegetation monitoring program will be established to measure the success of interim revegetation and gain information about cover effectiveness, vegetation health and metal uptake to inform final closure revegetation prescriptions. Vegetation monitoring will occur on a reoccurring timeline to build a temporal dataset of vegetation success and performance.

13 REPORTING

Reporting on water quality monitoring and management issues will be directed to the Yukon Water Board (YWB) and YG Energy, Mines and Resources in accordance with the requirements of the Water Licence (Part B) and Quartz Mining License (Condition 13). Monthly and annual reporting will be carried out during mine development activities and through the implementation of site decommissioning until it can be demonstrated through the monitoring results that the final closure objectives have been achieved.

Alexco also continues to liaise with the regulatory agencies, FNNND, the Mayo Renewable Resource Council and the local communities on environmental issues relating to KHSD mining operations; all monthly and annual reports are provided to FNNND.

14 REFERENCES

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APPENDIX A

GROUNDWATER MONITORING PLAN (JULY 2018)



KENO HILL SILVER DISTRICT MINING OPERATIONS

GROUNDWATER MONITORING PLAN

July 2018

Prepared for:

ALEXCO KENO HILL MINING CORP.

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1 INTRODUCTION

1.1 PURPOSE OF THE PLAN

This plan was originally submitted to fulfill the conditions set out in Part H, Clauses 85, 86, and 87 of Water Licence QZ09-092 issued to Alexco Keno Hill Mining Corp. (AKHM) on August 19th, 2010. This plan was subsequently updated to fulfill the conditions set out in Part G, Clauses 94, 95, 96 and 97 of Water Licence QZ12-053 issued to Alexco Keno Hill Mining Corp. (AKHM) on May 16th, 2013. This revised version of the Plan has been updated to fulfill the conditions set out in Part G, Clauses 105, 106, 107, 108 and 109 of Water Licence QZ09-092-2 (hereafter referred to as the Licence) issued to Alexco Keno Hill Mining Corp. (AKHM) on December 22, 2017.

105. Within 90 days of the effective date of this licence, the Licensee shall submit to the Board an updated Groundwater Monitoring Plan for the Keno Hill District Undertaking, including at a minimum the Bellekeno Waste Rock Disposal Area, Keno Hill Silver District Mill Site, and Lucky Queen, Onek, and Flame and Moth Mines, and shall implement that plan.

106. The plan for the Bellekeno Waste Rock Disposal Area shall include the installation of at least four groundwater monitoring wells prior to placement of material.

107. The plan for the Lucky Queen P-AML shall include the installation of at least one downgradient groundwater monitoring well prior to placement of P-AML.

108. The plan for Flame and Month shall include the installation of the following:

- a. one well within the DSTF Phase 2 Expansion area (KV-107) to be installed as part of the DSTF expansion;*
- b. one well upgradient of the DSTF Phase 2 Expansion area (KV-108) six month prior to the expansion; and*
- c. one well in the Lightning Creek watershed located near KV-81 (KV-109), down-gradient of the Lightning Creek diffuser, prior to construction of the expanded mill area and development of the underground mine.*

109. For the Keno Hill Silver District Mill Site, the plan shall be developed by considering existing knowledge of geological structures at the site and the consideration of groundwater table mapping based on sampling of KV-85, KV-86, KV-87 and KV-88. The developed plan shall include, but not necessarily be limited to the following:

- a. installing at least three multi-level groundwater monitoring wells down gradient of DSTF;*
- b. coring of bedrock, where wells are installed into bedrock;*
- c. development of detailed geological logs for all new well installations including: identification of soil or rock types; soil condition or rock quality; and geological and hydrogeological features such as joints and fractures. The logs are also to include details of the well installations; and*
- d. based on baseline groundwater quality, development of trigger levels that would be used to enact the adaptive management strategy and provide early warning of the need for mitigative measures and/or changes in facility design/operations.*

In addition, Part F Clauses 67, 68, 69 and 70 of the Licence provided additional guidance on the groundwater monitoring program:

67. Groundwater monitoring shall follow the schedule defined in Schedule B of this licence, with the exception that:

- a. Sampling of all wells shall be completed monthly for the first twelve months that they contain water. Sampling can revert to quarterly as show in Schedule B, following the first twelve samples.
- b. The Licensee shall monitor the water level in all groundwater monitoring wells where water is present at least monthly for the first year. Level monitoring can be reduced to quarterly after the first twelve monthly readings are completed.

68. Monitoring results should be reviewed after each sampling event to identify groundwater changes, should they occur.

69. Groundwater monitoring data shall be included in the annual report and shall be compared to the Yukon Contaminated Sites Regulation (YCSR) Schedule 3: Generic Numerical Water Standards (Aquatic Life). Data from wells screened in the potable, or potentially potable aquifer near Keno City shall also be compared to the YCSR Drinking Water Standards.

70. Groundwater wells determined to be subject to seasonal freezing shall have pressure transducers installed when cleared of seasonal ice.

The Plan has also been updated to include the proposed Birmingham mine.

2 MINE LOCATION AND DESCRIPTION

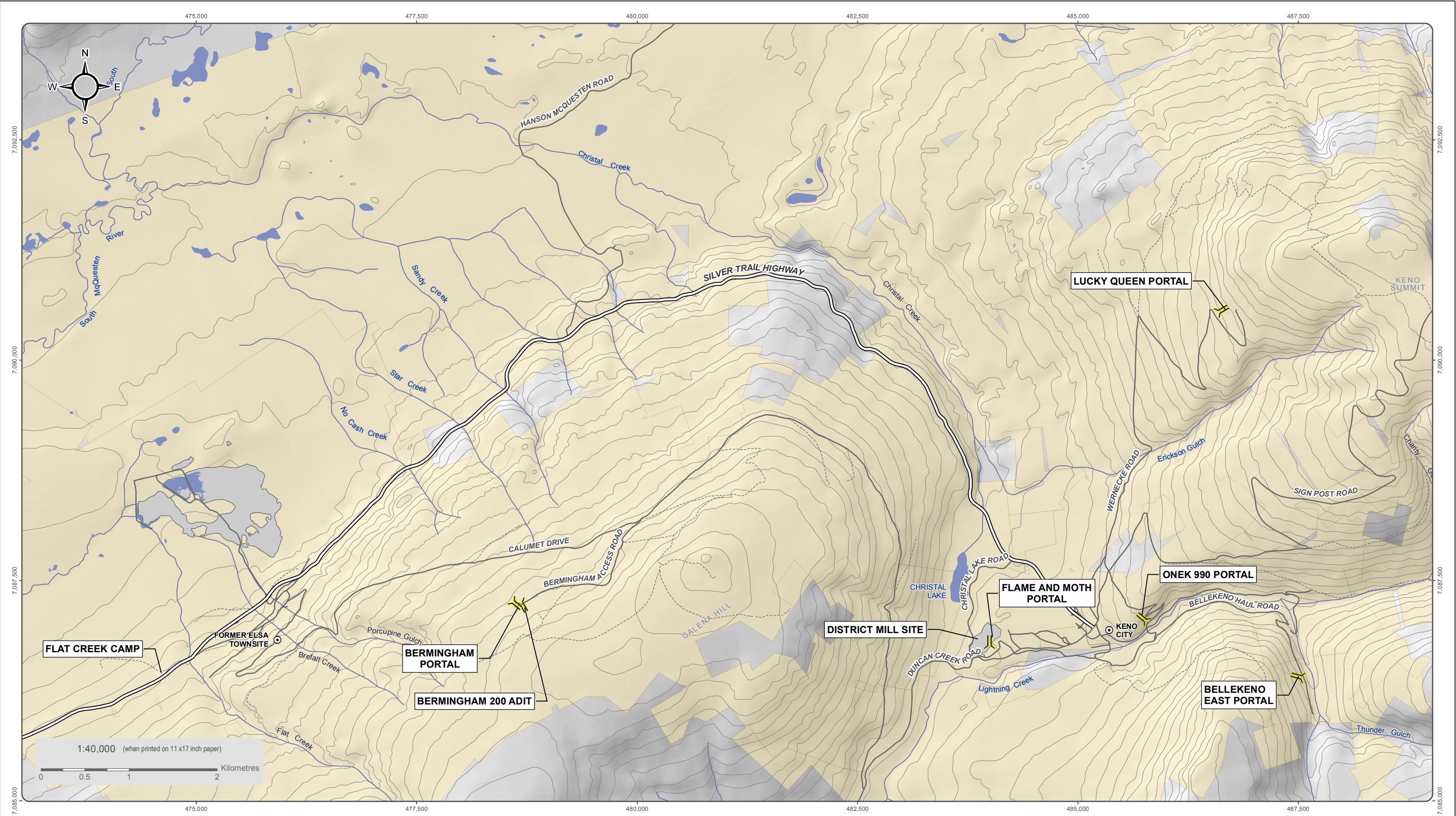
The KHSD is located in central Yukon (63° 54' 32" N, 135° 19' 18" W; NTS 105M/14 & 105M/13), 354 km due north of Whitehorse. Access to the property is via the Alaska, Klondike and Silver Trail Highways from Whitehorse to Mayo (407 km) and an all-weather gravel road northeast from Mayo to Elsa (45 km); a total distance of 452 km. The KHSD is located on and around Galena Hill, Keno Hill and Sourdough Hill and are collectively known as the KHSD. The property lies along the broad McQuesten River valley with three prominent hills to the south of the valley. The property, as well as the mines covered under the water license are located on Figure 2-1.

The Mill Site and Dry Stack Tailings Facility (DSTF) are located approximately 1 km west of Keno City. The mill site contains offices, crusher, water management ponds, water supply well, and other infrastructure. The Flame and Moth mine is located adjacent to the District Mill. Currently the portal and the first 20 m of ramp down towards the ore body have been constructed. Up to 8,000 m³ of mine workings are planned for future development.

The Bellekeno portal is located on a slope in Thunder Gulch, which is narrow tributary of Lightning Creek. The mine site is ~ 3km to the mill site, which crosses over Lightning Creek. The Flame and Moth mine is located adjacent to the District Mill.

The Onek 990 Mine portal is situated about 500 m northeast of Keno City. Currently, the portal and 265 m of the decline have been constructed to facilitate advanced underground exploration drilling. Future underground development may occur if a positive economic assessment is indicated by underground exploration; however, the Onek 990 mine is not currently part of the Keno District mine plan. The Lucky Queen portal is situated on Keno Hill ~4km northeast of Keno City. The Lucky Queen mine is in the Christal Creek catchment.

The Bermingham deposit is located on northwest slope of Galena Hill ~6.8 km east of Keno City in the No Cash Bog catchment. Bermingham Mine is located up gradient from the Ruby Mine and is drained by the Bermingham 200 adit, which is located at an elevation of 1,255 masl. The Bermingham 200 adit is near the plateau area of Galena Hill, which limits the available gradient towards the mine opening and there is some recharge from the overlying pit.



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 license 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 October 2017

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

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- Place of Interest
- Adit

- Valley Tailings
- Alexco/ERDC Quartz Claims
- Waterbody

- Watercourse
- Silver Trail Highway
- Other Road
- Limited-Use Road



**ALEXCO KENO HILL MINING CORP.
BERMINGHAM**

FIGURE 2-1

**KENO HILL SILVER DISTRICT MINING OPERATIONS
AREA OVERVIEW**

OCTOBER 2017

D:\Project\AllProjects\Keno_Area_Mines\BERM\Map01-Overview\03-Overview Silver District Overview BERM_overview_20170225.mxd
(Last edited by: amaleahavka, 26/10/2017 10:41 AM)

3 PREVIOUS GROUNDWATER STUDIES

Surface and underground mining conducted throughout the KHSD have altered natural groundwater flow such that mine workings dictate recharge/discharge. Groundwater is most likely to travel from high elevation to low elevation, resulting in a water table (phreatic surface) that is a muted image of the surface topography. Much of the groundwater flow is concentrated at relatively shallow depths, as shallower material typically has higher hydraulic conductivities.

Extensive groundwater studies have been conducted throughout the KHSD, which include reasonably extensive mapping of the geology and mine development in the District, hydrogeological investigations and ongoing monitoring, as well as a Conceptual Model and Preliminary 3D Groundwater Model that also includes preliminary particle tracking to map of the potential groundwater flow paths.

The following subsections summarise the main findings for groundwater flow paths from the AKHM proposed and license mines.

3.1 FLAME AND MOTH, ONEK, AND KENO CITY

In 2009, SRK Consulting Canada Inc. (SRK) was retained by AKHM to investigate groundwater conditions at the Mill Site in relation to Keno City and Lightning Creek. Three groundwater monitoring wells were installed for this program (PH2, PH5, and PH6). These wells will be referred to in this plan according to their KV station numbers as listed in Schedule A of the Licence (KV-85D, KV-86 and KV-87), respectively. Key findings of the SRK groundwater investigation (SRK, 2010) include the following:

- The water table is in bedrock beneath the site. South of the site, the water table is in a relatively thick overburden unit at a depth of greater than 25 meters below ground surface;
- Water-level data from monitoring wells at site and Keno City indicate that groundwater flows from east to west/northwest); that is, from Keno City towards the Mill Site and Christal Lake;
- Water level data also indicate ground water flow from Lightning Creek towards the Keno City area; and
- The probability of groundwater wells in Keno City being affected by Mill activities is very low given the current understanding of local groundwater gradients and large distance between the Mill Site and Keno City.

Interralogic, Inc. conducted a groundwater evaluation for Keno City between October 2010 and March 2012. During this program, two trenches were excavated within the dry stream channel downstream of the Onek 400 adit, and these verified that the adit discharge was not flowing within the channel alluvium. As part of the groundwater evaluation, Interralogic installed five monitoring wells in the Keno City area (KC-MW-1a, 1b, 2, 3, and 4) to determine water levels, water chemistry, and approximate material transmissivities. Interralogic sampled these five wells, as well as a monitoring well, ON-MW-1, installed in 2011. to understand groundwater elevations near the historic Onek waste rock dumps and open pit.

To evaluate groundwater flow paths, water levels in available wells were measured and water-level contour maps were prepared (ITL, 2012). Based on this evaluation, Interralogic set forth the following conclusions:

- There is a convergence of southwest and northward flowing groundwater below the central portion of Keno City.
- The groundwater below Keno City is conveyed northwest along a postulated feature that appears to have higher permeability than adjacent geologic units. Evidence for this is:
 - The interpretation that groundwater converges toward this feature;
 - The change in hydraulic head is relatively small between upgradient wells in Keno City and downgradient wells MW-1A, MW-1B, and MW-2; and
 - The relatively high initial yield of the Firehall well (57 to 96 litres per minute), which is located within the postulated high permeability feature.
- Water-level contours suggest that groundwater discharges to Lightning Creek east of Keno City. However, South of Keno City, there appears to be seepage loss from the stream that recharges the groundwater system below the townsite. The zone of seepage loss from the stream could be associated with the southeast extension of the postulated higher permeability feature.
- At and downgradient (west) of the Onek 400 portal, the groundwater flow direction is generally southwest towards the postulated higher permeability feature, but not towards any of the Keno City water wells.

In February 2013, Interralogic completed a preliminary conceptual groundwater model for the proposed Onek 990 mine workings and two potential pathways were identified (ITL, 2013a). The first was a direct pathway from the mine to Keno City, with bedrock monitoring well ON-MW-02 providing an adequate monitoring location to identify if Onek 990 mine water were to migrate in that direction. The second pathway was perpendicular to the water-level contours, but following a trajectory where groundwater would veer east of the mine before migrating through Keno City. The overburden monitoring well KC-MW-4 is along this pathway; however, a bedrock well (ON-MW-3), was recommended as an additional monitoring point along the pathway. The overburden/bedrock well combination was considered adequate to monitor if Onek 990 mine water were to migrate along this pathway (ITL, 2013a).

During August and September 2013, three deep monitoring wells (FM-MW-1, FM-MW-2 and FM-MW-3) were installed in and around the Flame and Moth deposit. Interralogic Inc. summarised the results from the drilling and associated air-lift testing of these wells (ITL, 2013b). A long-term (72 hour) air-lift pump test was conducted on well FM-MW-1 to provide data for estimating the potential mine inflows for the Flame and Moth Mine. At maximum mine depth of about 270 mbgs the computed inflow rate is 35 L/s (ITL, 2013b). The Interralogic report concludes that Flame and Moth Mine dewatering would not have a significant impact on surface water flows in Lightning Creek and it is highly unlikely that mine dewatering would have an effect on groundwater levels and the availability of water supply in the Keno City area.

Morrison Hershfield (MH) was retained by Yukon Government (YG) Community Services (CS) in 2015 to upgrade the Keno City Firehall well to meet current well-head construction standards. During the rehabilitation, an open portion of the hole collapsed and had to be re-bored with steel casing driven down the hole to prevent further collapse. Following the rehabilitation work, the Fire hall well was sampled and it was found that the water quality had deteriorated such that concentrations of arsenic and uranium no longer met the Guidelines for Canadian Drinking Water Quality.

In 2016 MH was retained by YG CS to conduct a review of the groundwater resources around Keno City and provide support for future water supply options. MH created a conceptual hydrogeological model which

describes two distinct aquifer systems below Keno City; the overburden aquifer and the bedrock aquifer (MH, 2017).

- The saturated thickness of the overburden aquifer within Keno City is thin, generally less than 10 m, and is not suitable for water production, even for low-flow, small scale, municipal groundwater supply. The groundwater chemistry of the overburden aquifer is variable from well to well, but is typically quite mineralized and contains parameters that do not meet the aesthetic and health-related parameters of the GCDWQ.
- The bedrock aquifer is fractured and has a greater potential for groundwater production; however, the wells are typically low-yield (produce only a few gallons per minute). The bedrock groundwater is typically of lower quality than the overburden aquifer, with water chemistry that is very mineralized and contains parameters that do not meet the aesthetic and health-related parameters of the GCDWQ.

The overarching conclusion of the MH report was that any groundwater in the Keno City area used for municipal water supply would likely require advanced treatment to meet the GCDWQ (MH, 2017).

3.2 BIRMINGHAM

In 2016, Piteau Associates Engineering Ltd (Piteau) conducted a preliminary groundwater model for the KHSD for Elsa Reclamation and Development Corporation for mine reclamation. The preliminary model included particle tracking to determine probable groundwater flow paths from historic mine workings. The particle tracking indicates that regional groundwater derived from the Ruby, Birmingham, and No Cash Mine workings discharges downgradient between the lower reaches of Star Creek and Christal Creek (Piteau, 2017).

In October 2016 drilling and testing of two boreholes at Birmingham were preformed. After each hole was drilled, one or two airlift pumping tests were performed. After a period of sustained pumping, the airlift was discontinued and time was allowed for water-level recovery in the borehole. The best-estimate hydraulic conductivities were calculated for the two boreholes and were found to be similar, providing evidence that the rock mass is relatively homogeneous with regard to hydraulic properties. The average of the calculated hydraulic conductivities is 4.3×10^{-6} cm/s, which is taken as the best-estimate of the large-scale (bulk) hydraulic conductivity for rock within the mine area. Based on the average hydraulic conductivities a portal discharge rate during closure was estimated to be 2.5 l/s.

4 REGIONAL GEOLOGY AND HYDROGEOLOGICAL IMPLICATIONS

The long history of mining and exploration in the KHSD means that regional geology has been well studied. Although no comprehensive studies specific to groundwater have been completed in the district, a number of observations can be made relating to bedrock and surficial geology and their hydrogeological characteristics. Some background information pertinent to district geology and groundwater, are summarized below from the Environmental Conditions Report (ACG, 2009).

The Keno Hill District is underlain primarily by Yukon Group metasedimentary rocks, locally divided into three formations; Upper Schist, Central Quartzite and Lower Schist. The Upper Schist (Hyland Group, pre-Cambrian to Cambrian age) overlies the quartzite in what is inferred to be a thrust contact (Robert Service Thrust) and consists of quartz-mica schist, quartzite, graphitic schist and minor limestone. The Central Quartzite (Keno Hill Quartzite, Mississippian age) contains thick-and thin-bedded quartzite, massive quartzite, graphitic phyllite, graphitic schist, calcareous schist and minor Triassic greenstone. This unit is approximately 700 m thick and is host to most of the past producing ore bodies. Structurally juxtaposed below the quartzite is the Lower Schist which has been correlated with the Devonian-Mississippian Earn Group. The Lower Schist includes graphitic schist, argillite, thin-bedded quartzite, calcareous schist, phyllite, slate, sericite schist, minor thick-bedded quartzite and locally significant intervals of Triassic greenstone. The greenstone forms sills and / or boudins and consists of metadiorite and metagabbro. The sills and boudins form bodies up to one kilometre long and thirty metres thick. Regional, greenschist facies metamorphism of all units is believed to have occurred in the Middle Cretaceous, about 105 million years ago.

A number of quartz-feldspar porphyritic sills have intruded the stratigraphy parallel to schistosity. The sills are most common in the Lower and Upper Schists and can reach thicknesses of up to fifty metres; reports of occurrences in the Central Quartzite are inconclusive and vague. The quartz-porphyry sills are believed to be of Cretaceous age.

Structurally, the property is characterized by four sets of faults; many of which have been filled by hydrothermal minerals, forming veins. The oldest fault set consists of south dipping structures that are generally parallel to foliation and are apparently associated with the Tombstone Thrust Fault since movement was contemporaneous or slightly later. Locally, brittle deformation has been observed along these structures. A second fault set, known as "longitudinal veins" strikes north east to east northeast and dips steeply southeast. The latest movement along these faults is sinistral with offsets locally reaching more than 150 metres; however, more than one episode of movement commonly is indicated. Depending on the competency of the host rock, longitudinal veins can be up to thirty metres wide in an anastomosing system of sub-veins. Essentially all mineralized rock was mined from these longitudinal veins. A third set of faults, known as "transverse faults", is north-west striking and dips steeply to the north. Transverse faults typically do not contain silver and lead mineralization but are commonly filled by quartz with trace to minor arsenopyrite, pyrite and jamesonite.

A younger set of faults, known as cross faults, strike north to north west with a dip of sixty degrees west to south west and offset vein or longitudinal faults by up to 2,000 metres. In the western part of

the property, dextral movement is the most recent event along these structures, whereas in the eastern part of the property sinistral movement with less magnitude prevails."

SRK (2009a) further described the bedrock geology of the site as it relates to hydrogeological characteristics:

"The bedrock geology of the area around Keno consists predominantly of layered metasedimentary rocks consisting mainly of quartzite, schist and phyllite. Unlike high yielding aquifer rocks such as sandstone, where groundwater can flow through connected 'pores' in the rock mass, the metasediments typically found in the Keno Hill district have a very low permeability, with little or no space between rock grains due to the metamorphosed character. The main medium through which water travels in these metasedimentary rocks therefore is via fractures and joints within the rock. The permeability of the rock (or the ease at which groundwater can flow through the rock formation) in this case is dependent on how many fractures are within the rock, and how well they are connected to each other, and how well connected to a water source (such as rainfall, a lake or a river) these fractures are."

SRK (2009a) also describes surficial sediments and their hydrology:

"Shallow surficial sediments are found locally and typically are present in topographic lows which control surface drainage patterns. These overburden deposits have limited thickness and lateral extent, and likely form only small local aquifers. It is generally recognised that metasedimentary rocks do not commonly form high yielding aquifers. Fractures are not typically well connected and the resulting permeability is low. Evidence for this around Keno City can be seen in the characteristic marshy conditions seen in the area. The surface water found within these marshy areas is unable to drain easily down through the underlying rocks. The regional groundwater flowpaths can be generally described as mimicking surface water pathways."

It is further recognized in that the presence of complex glacial and glaciofluvial sediments present in the valley bottoms and along the margins of the hills produces complex overburden stratigraphy. Overburden thickness and composition are known to vary widely, which can result in complex hydrology (e.g. perched aquifers) and generally poor drainage and low permeability. Also, the ubiquitous presence of permafrost and, in some areas, massive ground ice further complicate near surface groundwater regimes. In general, surficial sediment drainage can be described as generally poor, and complex, while bedrock hydrogeology can be described as generally low permeability with groundwater flow controlled by fractures and joints.

5 DISTRICT MILL AND FLAME & MOTH GROUNDWATER MONITORING

As per Clause 109a of the Licence, three multi-level groundwater monitoring wells were installed down gradient of the DSTF. Clause 97 specifies that three multi-level groundwater monitoring wells (e.g. Westbay type) are to be installed down gradient of the DSTF. However, because of the known challenges in the ground conditions near the DSTF (the presence of permafrost and massive ice, in some cases), AKHM believes that separate boreholes to monitor each potential groundwater zone (shallow overburden, and deep bedrock) are more likely to provide reliable results than complicated multi-level monitoring well systems, which are more likely to fail. The decision to use individual monitoring wells was also based on discussions with professional hydrogeologists experienced in monitoring well installations.

AKHM believes that the intention of Clause 109a was to ensure that three relatively shallow overburden monitoring wells and three deeper, bedrock groundwater monitoring points were installed down gradient of the DSTF to allow for monitoring of both shallow and deep groundwater. AKHM complied with Clause 109a through the use of the groundwater monitoring network described below in Table 5-1 and shown on Figure 5-1. The selection of these wells was based on a review of available geotechnical and hydrogeological information for the site and in discussion with EBA Engineering Consultants on the location of ground ice in this area.

Table 5-1 District Mill Site Groundwater Monitoring Well Summary

Station #	Hole #	Purpose	Total Depth (m)	Depth in Overburden (m)	Depth in Bedrock (m)	Northing ¹	Easting ¹
KV-85D	PH2	Deep bedrock groundwater monitoring	42.7	11.5	31.2	7,086,952	483,864
KV-85S	TBD2	Shallow or perched groundwater monitoring	4.2	4.2	-	7,086,952	483,858
KV-86	PH5	Overburden Groundwater Monitoring Well with Pressure Transducer Wire	36	36	-	7,086,707	483,836
KV-87	PH6	Bedrock Groundwater Monitoring Well with Pressure Transducer Wire	57.9	2.7	55.2	7,086,854	484,104
KV-88D	-	Deep bedrock groundwater monitoring	51.2	-	-	7,087,016	483,946
KV-88S	-	Shallow or perched groundwater monitoring	3.72	3.72	-	7,087,016	483,942
KV-89D	-	Deep bedrock groundwater monitoring	39.12	14.5	20.5	7,086,864	483,831
KV-89S	BH17	Shallow or perched groundwater monitoring	4.8	4.8	0	7,086,844	483,825
KV-103	-	District Mill Supply Well					
FM-MW-1	KAR1301	Christal Zone	182.3	12	160	7,086,770	484,026
FM-MW-2	KAR1302	Lightning Zone	244.4	0	244.4	7,086,562	483,854

Station #	Hole #	Purpose	Total Depth (m)	Depth in Overburden (m)	Depth in Bedrock (m)	Northing ¹	Easting ¹
FM-MW-3	KAR13016	Mill Fault	195.7	15	180.7	7,086,628	483,910
BH39	BH39	DSTF phase I GW monitoring	7.5	-	-	7,086,938	483,973
KV-107		Proposed well in phase II of DSTF	TBD	-	-	TBD	TBD
KV-108		Proposed well upgradient of phase II of DSTF	TBD	-	-	TBD	TBD
KV-109	-	Well near KV-81 on Lightning Creek	26.7	4.0	22.7	7,086,479	483,601

¹Coordinates are UTM Zone 8 NAD 1983

*Estimated based on nearby wells or boreholes

Well BH39 is a monitoring well within phase I of the DSTF which is screened within tailings to identify if porewater is present. Well KV-107 will be installed in phase II of the DSTF following the completion of the initial bench. Well KV-108 will be installed six months prior to the DSTF phase 2 expansion, while KV-109 will be installed prior to the construction of the expanded mill area and development of the underground mine.

KV-85D and KV-89s are monitoring wells that were installed down gradient of the DSTF. These serve as one of the deep and shallow groundwater monitoring locations (PH2 and BH17, respectively). KV 85D is located in an ice wedge and is currently frozen.

The remaining wells, KV-85S, KV-86, KV-87, KV-88D, KV-88S, and KV-89D, in accordance with Clause 109c of the Licence, which states that all new well installations will include collection of information on soil and rock types, soil condition or rock quality and geological and hydrogeological features such as joints or fractures where possible, and will include details of well installations. Since monitoring began KV-85s has been dry.

Clause 70 of the Licence states that all groundwater wells determined to be subject to seasonal freezing shall have pressure transducers installed. AHKM will install data loggers in groundwater wells deemed to be subject to seasonal freezing and these installations will be measured monthly for the first year (twelve monthly readings) as per Clause 67 and then quarterly for water level as per Schedule B (also summarized in Table 7 of this report)

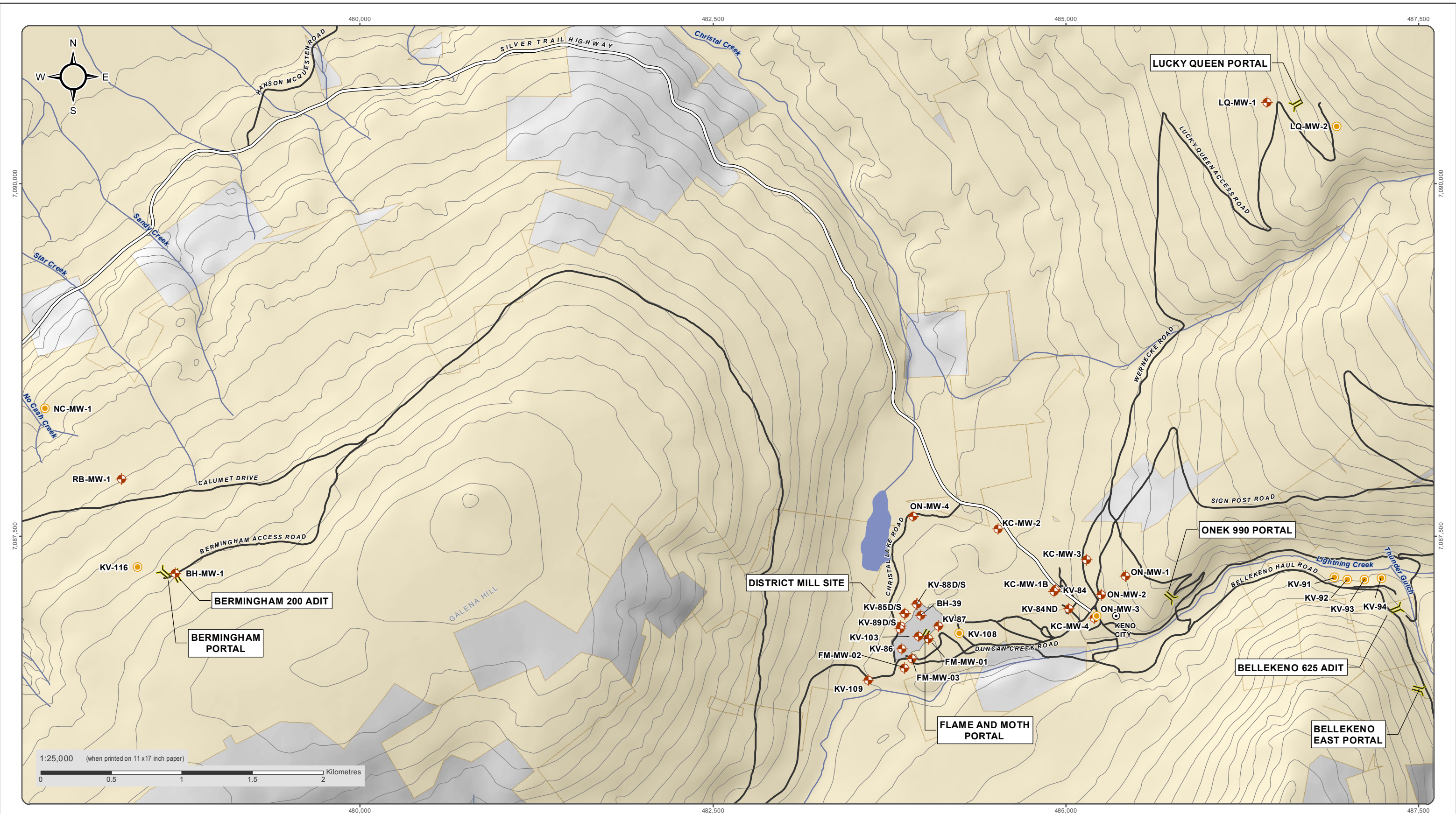
Although Clause 109b, requires that where wells are installed into bedrock, the bedrock shall be cored, AKHM's preference was to complete these groundwater well installations (including bedrock holes) using more conventional drilling technology for the installation of monitoring wells (air-rotary, ODEX). Air-rotary drilling is preferable to diamond drilling for monitoring well installation for a number of reasons including:

- More efficient drilling of both overburden and bedrock;
- Larger diameter borehole produced using an air-rotary drilling rig is preferable and reduces the chance of bridging during well completion;
- AKHM did not have a diamond drill program active at site while the monitoring wells were being installed, and;
- An air-rotary drilling rig was on site in late February for other groundwater investigations related to District Closure, which meant that costs could be optimized when combined with that program.

The Reasons for Decision document for the Licence does not provide additional information regarding Clause 109b; however, Alexco believes that the intent of this Clause was to ensure that adequate data and information regarding the subsurface conditions (overburden and especially bedrock and structural geology) of the DSTF and mill site area were collected to better inform AKHM's mill site area construction plans and ensure that the monitoring strategy was appropriate. AKHM believes that information collected in both the shallow subsurface soils and the deeper bedrock is sufficient to inform the groundwater monitoring plan. These data are presented in Sections 5.1 and 5.2 below.

No additional groundwater locations have been proposed for the Flame and Moth mine as the proposed DSTF expansion and expanded mill site foot print are located upgradient of the existing ground water monitoring network (Figure 5-1). The Plan will be revised as the Flame and Moth project is advanced in the regulatory process.

Appendix A, EBA blasting analysis, provides analysis for potential effects from blasting occurring during the development of the Flame and Moth decline to the monitoring wells in the vicinity of the District Mill and DSTF. The blasting analysis shows that with appropriate management of the blasting the integrity of the monitoring wells including the ground temperature and slope indicator monitoring will not be compromised. Monitoring outlined in the analysis will be undertaken as part of the plan to ensure the integrity of the instrumentation is not compromised.



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 license 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 July 2018 Datum: NAD 83; Map Projection: UTM Zone 8N This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental	○ Proposed Monitoring Well ⊕ Monitoring Well Y Adit	□ Alexco/ERDC Quartz Claims ■ District Mill Footprint == Silver Trail Highway — Other Road	ALEXCO KENO HILL MINING CORP. FIGURE 5-1 KHSD GROUNDWATER MONITORING LOCATIONS JULY 2018 D:\Project\AP\Project Keno_Hill_Area_Mines\ALL_SITES\02-Map\01_Overview\02-Specific_Topical\WG_Monitoring\GW_monitoring_locations_District_20180725.mxd (Last edited by: mducharme; 025/2018/11/31 AM)
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6 BELLEKENO NON-AML WASTE ROCK DISPOSAL AREA GROUNDWATER MONITORING

Commencement of construction of the (WRDA) is not scheduled at this time. Four groundwater monitoring wells below the Bellekeno WRDA (as per Clause 106 of the Licence) will be installed according to WRDA final design when. Due to the known presence of permafrost and sloping topography in the area beneath the proposed WRDA, AKHM expects any seepage to be deflected by the frozen layer, causing it to run downslope within the active layer. Because of this, relatively shallow monitoring wells are considered appropriate and most likely to intersect and monitor for any seepage from the WRDA. Proposed monitoring wells in the vicinity of the WRDA are summarized in Table 6-1.

Table 6-1 Bellekeno WRDA Groundwater Monitoring Well Summary

Station Number	Purpose	Estimated Total Depth (m)	Estimated Overburden Depth (m)	Northing ¹	Easting ¹
KV-91	Seepage/shallow groundwater monitoring	10	10	TBD ²	TBD ²
KV-92	Seepage/shallow groundwater monitoring	10	10	TBD ²	TBD ²
KV-93	Seepage/shallow groundwater monitoring	10	10	TBD ²	TBD ²
KV-94	Seepage/shallow groundwater monitoring	10	10	TBD ²	TBD ²

¹Coordinates are UTM Zone 8 NAD 1983

²TBD – “to be determined”, station not established at this time.

Appropriate layout and borehole locations for the WRDA monitoring wells will be selected based on field conditions prior to construction and will depend on final WRDA and with the input from design engineers. Conceptual WRDA monitoring well locations are shown on Figure 5-1.

7 ONEK GROUNDWATER MONITORING

The licence requirement for monitoring of KV-84 requires that a Keno City Well be monitored on a quarterly basis. This monitoring is also subject to Clause 67, requiring that all wells be sampled monthly for the first twelve months that they contain water. Initial sampling as reported in the SRK Bellekeno Groundwater Study (SRK, 2010) used Keno City Well #3 which is owned by a private resident of Keno City. Well #3 and the Keno City Firehall well have been sampled since issuance of the original Licence in order to fulfill monitoring requirements for KV-84, but due to difficulties coordinating sampling, this has not been viewed as a satisfactory solution for the duration of the Licence. In September 2013, KV-84Nd was drilled on the Firehall lot to replace KV-84 as a surrogate to the Firehall well. The details for Well KV-84Nd is presented below in Table 7-1.

Table 7-1 Onek Monitoring Well details

Station #	Purpose	Total Depth (m)	Depth in Overburden (m)	Depth in Bedrock (m)	Northing ¹	Easting ¹
KV-84	Keno City	93.9	80.2	13.7	7,087,117	484,925
KV-84Nd	Firehall well surrogate	88.4	71	17.4	7,086,984	485,022
ON-MW-2	Downgradient of Onek990 mine	68	7	61	7,087,083	485,244
ON-MW-3	Downgradient bedrock well of Onek 990 mine near KC-MW-4	TBD	-	-	TBD	TBD
KC-MW-4	Downgradient overburden well of Onek 990 mine	67.1	67.1	0	7,086,921	485,197

AKHM, through part of the District Closure Planning, has installed of five wells (KC-MW-1A, KC-MW-1B, KC-MW-2, KC-MW-3, and KC-MW-4) around Keno City as part of a hydrogeologic study of the Keno City area during March and April 2011. Monitoring well KC-MW-1A was selected for reporting for KV-84. A notification was submitted to the YWB and Water Resources to provide notification to regulators of the final sampling location of the Keno City well. The locations of the existing Keno City area wells including location for KV-84, KC-MW-1B, KC-MW-2, KC-MW-3, and KC-MW-4 are also shown on Figure 5-1. In September 2013 two additional wells were installed on the Keno City Firehall well lot (KV-84Nd and KV-84Ns) as part of District Closure Planning. Well KV-84Nd will replace well KV-84 as it is in a more suitable location then KV-84 relative to the Onek 990 mine.

Monitoring well ON-MW-02 was installed on August 5, 2012 and has been monitored on monthly frequency as part of routine monitoring for the Onek mine site (Figure 5-1). The new monitoring wells will be monitored on a monthly basis for the first year and on a quarterly basis thereafter.

8 LUCKY QUEEN GROUNDWATER MONITORING

One monitoring well at Lucky Queen that (LQ-MW-1) was installed on August 6, 2012 downgradient of the proposed N-AML Waste Rock Dump proposed adjacent to the Lucky Queen adit (Figure 5-1). This monitoring well will be monitored on a monthly basis for the first year and on a quarterly basis thereafter. The water licence requires an additional monitoring well to be installed downgradient of the Lucky Queen P-AML facility. This well will be installed when the Lucky Queen P-AML facility is constructed. The wells that make up the Lucky Queen monitoring network are described in Table 8-1.

Table 8-1 Lucky Queen Groundwater Monitoring Wells

Station #	Purpose	Total Depth (m)	Depth in Overburden (m)	Depth in Bedrock (m)	Northing ¹	Easting ¹
LQ-MW-1	Downgradient of LQ N-AML	24	11	13	7,090,576	486,426
LQ-MW-2	Downgradient of LQ P-AML	TBD	-	-	TBD	TBD

9 BIRMINGHAM GROUNDWATER MONITORING

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

Currently, groundwater in the vicinity is monitored by two wells: BH-MW-1, and RB-MW-01, with two new wells proposed (NC-MW-1, KV-116)

Table 9-1 Birmingham Groundwater Monitoring Wells

Station #	Purpose	Total Depth (m)	Depth in Overburden (m)	Depth in Bedrock (m)	Northing ¹	Easting ¹
BH-MW-1	Well d/g of Birmingham 200 Adit	21.3	3.8	17.5	7,087,273	478,690
RB-MW-1	Well d/g of Ruby 400 Adit	13.4	12.4	1.0	7,087,905	478,309
NC-MW-1	Well downgradient of No Cash 500	TBD	TBD	TBD	TBD	TBD
KV-116	Well downgradient of Birmingham Portal	TBD	TBD	TBD	TBD	TBD

10 REVIEW OF RESULTS

Results of all groundwater monitoring activities will be subject to periodic review and interpretation by AKHM as part of the monthly and the annual reports, which will compare the data to the Yukon Contaminated Sites Regulation (YCSR) Schedule 3: Generic Numerical Water Standards (Aquatic Life). Data from wells screened in the potable, or potentially potable aquifer near Keno City shall also be compared to the YCSR Drinking Water Standards. This review and interpretation is important in identifying any potential changes in baseline conditions, and if necessary, trigger mitigation and/or adaptive management measures.

11 GROUNDWATER MONITORING SCHEDULE

Groundwater monitoring will follow the schedule as described in Table 11-1. Groundwater sampling and monitoring will be carried out by competent and trained field operators. The operators will also document the condition of the well at each location and record any non-standard observations (e.g. icing, blockage, physical damage to wellhead).

A groundwater quantity monitoring plan that address assess potential effects from the Onek 990 mine and District Mill well to the Keno City and Mill areas, in terms of water levels, water contour maps, and flow paths is described under the Keno Hill Silver District Mining Operations Hydrogeological Monitoring Plan (AEG, 2018). These sites are summarised in Table 11-2.

11.1 MONITORING WELL SAMPLING

Representative groundwater samples will be collected from each identified site identified in Table 7. Below is a summary of sampling activities to take place:

- Depth to water level will be recorded prior to sampling
- The well volume will be calculated
- Purging will consist of either removal of three (3) well volumes (volume of standing water in the well) by an appropriate method (manually, submersible pump, hydrolift, etc.) or by utilizing a low-flow sampling method, such that the discharge rate does not exceed 500 ml/min, drawdown within the well is not greater than 0.1m and stabilization of water quality parameters inclusive of oxidation reduction potential (ORP), dissolved oxygen (DO), pH, conductivity, and temperature have been achieved.
- Following purging of three volumes or low flow stabilization of parameters, groundwater sample collection can then take place.
- For quality assurance/quality control, field duplicates and blank will be collected with a frequency of 1 in 10 groundwater samples collected.

11.2 GROUNDWATER SAMPLE COLLECTION AND ANALYSES

Groundwater samples will be collected in appropriately labelled laboratory grade bottleware with preservation for the analytes requested. At each monitoring well, at the point of sample collection, care will be taken to prevent contact with the inside of the sample containers. In addition, a clean pair of nitrile or latex gloves will be worn during sample collection and handling.

11.3 GROUNDWATER SAMPLE CHAIN-OF-CUSTODY RECORD, PACKING AND SHIPPING

Once the groundwater samples have been collected the sample information will be added to the chain of custody form, the bottles will then be placed in a cooler with sufficient ice content to cool the samples for shipping. When full, the cooler will be closed, and the lid tightly taped shut to reduce the rate of ice melting.

Based on the remote location of the sites, groundwater samples will be collected and shipped to coincide with immediate offsite transportation. The samples will be shipped via air courier from Whitehorse to a lab in the Vancouver area for analyses.

Table 11-1 Groundwater Monitoring Program Summary

Site	Description	Water Licence	Insitu Measurements/ Internal Analysis				External Lab Analysis												
		Proposed & Existing Monitoring	Level	pH	Temp.	Conductivity	Total Metals	Diss. Metals	Hardness	pH	Conductivity	TSS	Alkalinity	Sulphate	Nitrate	Nitrite	Ammonia(-N)	DOC	Phosphorous
KV-84Nd	Bedrock well on Keno Firehall lot to replace KV-84	Existing	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	-	-	-	Q	Q
KV-85D	DSTF and Mill Site Groundwater Well #1 (PH2) Deep	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-85S	DSTF and Mill Site Groundwater Well #1 (Shallow)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-86	DSTF and Mill Site Groundwater Well #2 (PH5)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-87	DSTF and Mill Site Groundwater Well #3 (PH6)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-88D	DSTF and Site Groundwater Well #4 (Deep)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-88S	DSTF and Mill Site Groundwater Well #4 (Shallow)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-89D	Flame and Moth Site Groundwater Well #5 (Deep)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-89S	DSTD and Mill Site Groundwater Well #5 (Shallow)	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	-	-	Q	Q	Q
KV-91	Bellekeno Waste Rock Disposal Area well #1	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	-	-	M/Q	M/Q	M/Q
KV-92	Bellekeno Waste Rock Disposal Area well #2	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	-	-	M/Q	M/Q	M/Q
KV-93	Bellekeno Waste Rock Disposal Area well #3	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	-	-	M/Q	M/Q	M/Q
KV-94	Bellekeno Waste Rock Disposal Area well #4	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	-	-	M/Q	M/Q	M/Q
KC-MW-4	Well south of Onek 400 adit	Existing	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
ON-MW-2	Onek Monitoring Well #1 d/g Project Facilities	Existing	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
ON-MW-3	Well south of Onek 400 adit	To be developed	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q
LQ-MW-1	Lucky Queen Monitoring Well d/g N-AML WRDA	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
LQ-MW-2	Lucky Queen Monitoring Well d/g N-AML WRDA	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q
FM-MW-1	Flame and Moth Well #1 (KAR-01)	Existing	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FM-MW-2	Flame and Moth Well #2 (KAR-02)	Existing	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FM-MW-3	Flame and Moth Well #3 (KAR-16)	Existing	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH39	Phase I of DSTF	Existing	M	M	M	M	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q		M/Q	M/Q	M/Q	M/Q
KV-107	Proposed DSTF expansion area	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q		M/Q	M/Q	M/Q	M/Q
KV-108	Upgradient of proposed DSTF expansion area	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q		M/Q	M/Q	M/Q	M/Q
KV-109	Flame and Moth Lightning Creek Discharge area near KV-81	Existing	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q		M/Q	M/Q	M/Q	M/Q
BH-MW-1	Well d/g of the Birmingham 200 Adit	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
RB-MW-1	Well d/g of the Ruby 400 Adit and WRSA	Existing	Q	Q	Q	Q	-	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
NC-MW-1	Well d/g of the NC 500 Adit and WRSA	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q
KV-116	Birmingham Waste Rock Disposal Area	To be developed	M/Q	M/Q	M/Q	M/Q	-	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q	M/Q

Legend:
Q = Quarterly, M = Monthly, M/Q = Monitoring to occur monthly for first 12 months, reverting to quarterly thereafter

Table 11-2: Hydrogeological Monitoring Schedule (AEG, 2018)

Site	Alternate Well IDs	Description	Proposed & Existing Monitoring	Hydrogeology		
				Discrete WLs	Synoptic WL	Download Logger
KV-84Nd	-	Bedrock well on Keno Firehall lot to replace KV-84	Existing	Q	BA	Q
KV-85D	PH2	DSTF and Mill Site Groundwater Well #1 (PH2) Deep	Existing	Q	BA	
KV-86	PH5	DSTF and Mill Site Groundwater Well #2 (PH5)	Existing	Q	BA	
KV-87	PH6	DSTF and Mill Site Groundwater Well #3 (PH6)	Existing	Q	BA	
KV-88D	-	DSTF and Site Groundwater Well #4 (Deep)	Existing	Q	BA	Q
KV-89D	-	Flame and Moth Site Groundwater Well #5 (Deep)	Existing	Q	BA	Q
KV-103	Mill Well	District Mill Supply Well	Existing	Q	BA	
KV-109	-	<u>Proposed</u> well near KV-81 on Lightning Creek	<u>Proposed</u>	Q	BA	
KV-108	-	<u>Proposed</u> DSTF Expansion Monitoring Well	<u>Proposed</u>	Q	BA	
KV-84	MW-5	Overburden Monitoring Well	Existing	Q	BA	
KC-MW-1B	MW-1	Bedrock Groundwater Monitoring Well	Existing	Q	BA	
KC-MW-2	MW-2	Overburden Groundwater Monitoring Well	Existing	Q	BA	
KC-MW-3	MW-3	Bedrock Groundwater Monitoring Well	Existing	Q	BA	
KC-MW-4	MW-4	Well south of Onek 400 adit	Existing	Q	BA	
FM-MW-01	KAR13-02	Mill / Flame and Moth - Christal Zone	Existing	Q	BA	Q
FM-MW-02	KAR13-01	Mill / Flame and Moth - Lightning Zone	Existing	Q	BA	Q
FM-MW-03	KAR13-16	Mill / Flame and Moth - Mill Zone	Existing	Q	BA	Q
ON-MW-1	K-11-0337	Onek Monitoring Well #1 d/g Project Facilities	Existing	Q	BA	
ON-MW-2	ON-2	Downgradient of Onek990 mine	Existing	Q	BA	Q
ON-MW-3	-	<u>Proposed</u> bedrock well downgradient of Onek 990 mine, near KC-MW-4	<u>Proposed</u>	Q	BA	Q*
ON-MW-4	KAR13-005	Bedrock monitoring well	Existing	Q	BA	

*Quarterly once the monitoring well is installed, BA = Bi-annual, in May and November

12 REPORTING

As per Clauses 25, 26 and 27 of Water Licence QZ09-092-2:

25. The Licensee shall provide to the Board one unbound, single-sided, paper copy of all reports required by this licence. All reports must be reproducible by standard photocopier.

26. The Licensee shall upload electronic copies of all reports required by this licence to the Board's online licensing registry, the WATERLINE. Electronic copies shall be submitted in one of the following formats: Word 97 - 2003, Excel 97 - 2003 workbooks, or Adobe .pdf format.

27. All water quality, water quantity and water level data shall also be submitted in Excel format. Water quality results must be uploaded to Waterline in the format outlined in the most recent version of Yukon's "Laboratory Data Submission Standards for Water Quality". This guide is available on the Board website.

13 REFERENCES

- Access Consulting Group, 2009. *Keno Hill Silver District Environmental Conditions Report Version 1*. Report prepared for Alexco Resource Corp.
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- Interralogic Inc. 2013. *Flame and Moth Groundwater Evaluation*. November 27, 2013
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- SRK Consulting (Canada) Inc. (2009b) *Assessment of Potential Groundwater Impacts from the Bellekeno Mill Site and Dry Stack Tailings Facility*. Letter to Alexco Resource Corp. SRK Project # 1CE012.003.

APPENDIX A

KENO HILL DISTRICT MILL SITE – BLASTING PLAN ANALYSIS

APPENDIX B

PHYSICAL INSPECTION AND REPORTING PLAN (JULY 2018)



Alexco Keno Hill Mining Corp. Keno Hill Silver District Mining Operations

Physical Inspection and Reporting Plan

Water Use Licence QZ09-092-2

July 2018

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1.0 INTRODUCTION

1.1 Purpose of Plan

This plan is submitted to fulfill the conditions set out in Part G, Clauses 117 to 119 of Water Licence QZ09-092-2 issued to Alexco Keno Hill Mining Corp. on December 22nd, 2017:

117. Within 90 days of the effective date of amendment to this licence, the Licensee shall submit to the Board an updated, Physical Inspection and Reporting Plan for all water retaining and conveying structures, and associated mine waste and earthworks structures in the Keno Hill Silver District that is consistent with this licence, and shall implement that plan.

118. Inspections will be conducted at least on a weekly basis for all structures identified in the Keno Hill Silver District Physical Inspection and Reporting Plan.

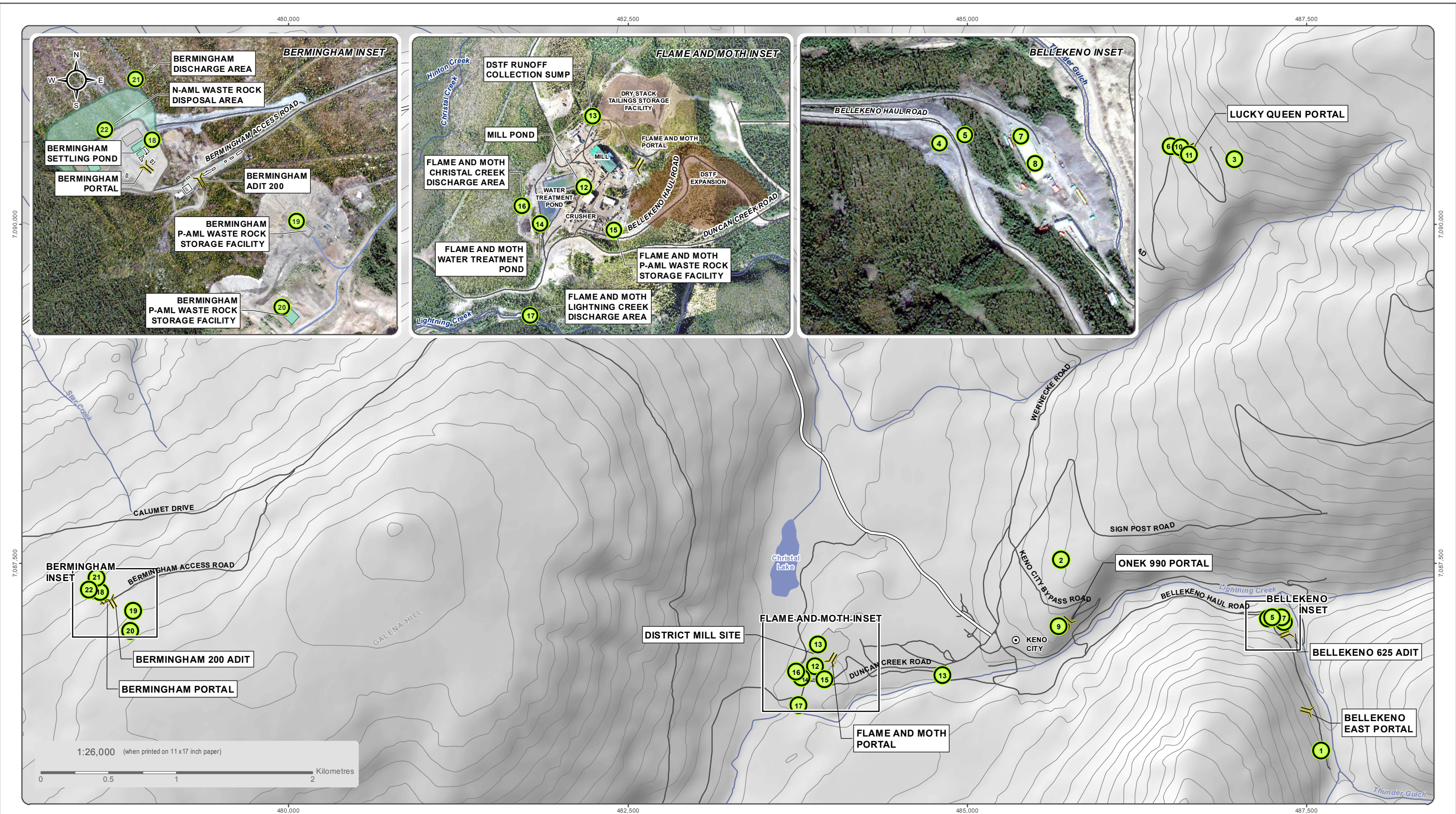
119. The Physical Inspection and Reporting Plan shall include the Bellekeno 625 settling ponds, the Lucky Queen and Onek water storage ponds, the Flame and Moth Water Treatment Pond, all N-AML Waste Rock disposal areas and all P-AML Waste Rock storage facilities, the access roads, the Flame and Moth Christal Creek and Lightning Creek discharge areas, DSTF, and Mill Pond.

This plan outlines the Physical Inspection and Reporting methodology that will be used during mining and milling operations at Alexco's Keno Hill Silver District mining operations.

2.0 MINE LOCATION AND DESCRIPTION

The Keno Hill Silver District is located in central Yukon Territory, 354 km (by air) due north of Whitehorse. The Bellekeno mine area is located approximately 3 km east of Keno City within the Keno Hill Silver District. The Flame and Moth mine, District Mill site and Dry Stack Tailings Facility (hereinafter referred to as the "DSTF") are located approximately 1 km west of Keno City.

The portal at Bellekeno East is located on a steep slope above Thunder Gulch, a narrow tributary of Lightning Creek, and the haul road access to the mill site is provided by an approximately 3 km access road which crosses Lightning Creek approximately 2200 meters downstream from the confluence of Thunder Gulch and Lightning Creek. Lucky Queen is located approximately 4 km northeast of Keno City and Onek is situated about 500 m northeast of Keno City. Please refer to see Figure 1 for the site map.



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 license 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://maps.services.gov.yk.ca/ArcGIS/services> on July 2018. Aerial imagery obtained in 2018.

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

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent.

Photo Hub Locations

Adit

Permitted Mine Footprint/Infrastructure

Proposed Mine Footprint/Infrastructure

Silver Trail Highway

Other Road

Waterbody

Watercourse

Contours (100 ft intervals)

ALEXCO KENO HILL MINING CORP.

FIGURE 1

PHYSICAL INSPECTIONS AND REPORTING PLAN SITE MAP

JULY 2018

D:\Project\AKHM\Projects\AKHM-05-01\gms\Overview_Map\Spec\c\c\Physical_Inspection_PhotoHub_Location_20180725.mxd
(Last edited by: mducharme 7/25/2018 5:36 PM)

3.0 PHYSICAL INSPECTION LOCATIONS

As per Part G, Clause 119 of Water Licence QZ09-092-2, the areas to be inspected include:

- Bellekeno 625 settling ponds;
- Lucky Queen settling ponds;
- Onek 990 water storage pond;
- Flame and Moth Water Treatment Pond;
- Bellekeno N-AML Waste Rock Disposal Area (WRDAs);
- Lucky Queen N-AML Waste Rock Disposal Area (WRDAs);
- Bellekeno temporary P-AML Waste Rock Storage Facilities (WRSFs);
- Onek 990 P-AML Waste Rock Storage Facilities (WRSFs);
- Lucky Queen P-AML Waste Rock Storage Facilities (WRSFs);
- Access roads;
- Flame and Moth Christal Creek and Lightning Creek discharge areas;
- Mill pond; and
- Dry stack tailings facility (DSTF).

The plan has also been update to include proposed sites at the Bermingham mine including the WRDA, WRSF and settling ponds.

4.0 PHYSICAL INSPECTION SCHEDULE

The physical inspection for the all water retaining structures will be conducted on a weekly basis (once constructed). The water ponds include the Bellekeno 625 settling ponds, the Lucky Queen ponds, Onek 990 pond, Flame and Moth Water Treatment Pond and Mill Pond. The P-AML Waste Rock Storage Facilities at Bellekeno East, Flame and Moth, Onek and Lucky Queen. Additionally, the Bellekeno and Lucky Queen N-AML waste rock storage areas (once constructed) and access roads will be inspected weekly

The physical inspection schedule is shown in Table 1 below.

Table 1 Physical Inspection Schedule

Physical Inspection Location	Inspection Schedule
	Weekly
Bellekeno 625 settling ponds	X
Mill pond	X
Flame and Moth Water Treatment Pond	X
Onek 990 storage pond	X
Lucky Queen settling ponds	X
Bellekeno temporary P-AML waste rock storage facility	X
Onek P-AML waste rock storage facility	X
Lucky Queen P-AML waste rock storage facility	X
Flame and Moth P-AML waste rock storage facility	X
Bellekeno N-AML waste rock disposal area	X
Lucky Queen N-AML waste rock disposal area	X
Access roads	X
DSTF	X
Bermingham Settling Pond	X

Birmingham P-AML waste rock storage facility	X
Birmingham N-AML waste rock disposal area	x

*See Appendix B for DSTF inspection schedule

5.0 PHYSICAL INSPECTION METHOD

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.

The physical inspection will comprise of completing visual inspection methods by competent and trained field operators. Maintaining clear and accurate records is as important as the physical inspection process itself, so documentation is carried out by the use of an inspection checklist. This will ensure that the inspections, even if carried out by different field personnel on different days, will record information of a similar nature.

5.1 Photo Documentation

Photo hubs (physical locations where photos are to be repeatedly taken) will be selected to document the features as listed in Section 3 above. Approximate locations of photo hubs are shown in the overview map (Figure 1), and a detailed list and description of these photo hubs is included in Table 2 below.

Table 2 Photo Hub Descriptions

Photo Hub #	Photo Hub Description
1	Bellekeno Temporary P-AML waste rock storage facility
2	Onek P-AML waste rock storage facility
3	Lucky Queen P-AML waste rock storage facility
4	Bellekeno N-AML Waste Rock Staging Area 1 (BKR 16 facing North)
5	Bellekeno N-AML Waste Rock Staging Area 1 (BKR 17 facing South)
6	Lucky Queen N-AML Waste Rock Disposal Area
7	Bellekeno 625 settling pond 1
8	Bellekeno 625 settling pond 2
9	Onek 990 storage pond
10	Lucky Queen settling pond 1
11	Lucky Queen settling pond 2
12	Mill pond (from S corner, facing Mill)
13	DSTF runoff collection sump (on road, facing NW)

14	Flame and Moth Water Treatment Pond
15	Flame and Moth P-AML waste rock storage facility
16	Flame and Moth Christal Creek Discharge Area
17	Flame and Moth Lightning Creek Discharge Area
18	Birmingham Settling Pond
19	Birmingham P-AML Waste Rock Storage Facility North
20	Birmingham P-AML Waste Rock Storage Facility South
21	Birmingham Discharge Area
22	Birmingham N-AML Waste Rock Disposal Area

GPS coordinates of the photo hubs will be uploaded onto the Site Inspection Map, to accompany inspection to ensure the inspections can be conducted by different personnel. The photo hub sites will be visited for photographic documentation on a monthly basis. The photos will be kept with the onsite Environmental Department for review as needed.

5.2 Inspection Checklists

Inspection checklists will be filled out on a weekly basis to ensure structural integrity of mine components and that runoff and discharge is being appropriately managed (see Appendix I). The following rating system will be used in the field reporting to evaluate the structural integrity of the areas to be physically inspected:

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.

If issues are identified during the weekly inspections the site manager will be informed immediately and the appropriate mitigative measures will be implemented. An inspection by a qualified geotechnical engineer would be undertaken for physical stability if necessary. Additional erosion and sediment controls may need to be implemented as required.

If geotechnical inspections are required, they will be carried out during the summer months when the surface and sides of the various rock-fill structures are not obscured by snow.

5.3 DSTF Surveillance, Inspection and Monitoring

As a requirement of QML-0009, a dry stack tailings facility Operation Maintenance and Surveillance (OMS) manual was prepared by EBA Engineering Consultants Ltd. on behalf of Alexco. The OMS Manual forms part of the Dry Stack Tailings Facility Construction and Operation Plan under QML-0009. In addition to physical inspection and monitoring measures described in this plan, the OMS Manual describes more detailed operational physical inspection and monitoring.

Section 9 of the OMS Manual deals with surveillance and physical inspection of the DSTF, and is provided attached as Appendix B.

6.0 REPORTING

As per clause 25 and 26 of Water Licence QZ09-092-2:

25. The Licensee shall provide to the Board one unbound, single-sided, paper copy of all reports required by this licence. All reports must be reproducible by standard photocopier.
26. The Licensee shall upload electronic copies of all reports required by this licence to the Board's online licensing registry, the WATERLINE. Electronic copies shall be submitted in one of the following formats: Word 97 - 2003, Excel 97 – 2003 workbooks, or Adobe .pdf format.

The results of the weekly physical inspection check list will be summarized and incorporated into the annual reports. Requirements of the annual reports are outlined in section 16 of the Water Licence.

The weekly and monthly physical inspection checklists in addition to monthly photo documentation will be kept on file internally for proof of inspections and for reference as required.

Additionally, a Physical Inspections and Monitoring Report will be prepared certified by a Professional Engineer and submitted as part of the annual report that includes the information outlined clauses 17 and 18 below.

17. The Licensee shall submit a report titled, "Physical Inspections and Monitoring Report" certified by a Professional Engineer. The report shall be submitted as a part of the annual report. The report shall include, but not necessarily be limited to:

- a) documentation of the inspection locations and methodologies;
- b) the results of the inspection;
- c) all problems identified;
- d) remedial measures recommended; and

e) the status of any remedial measures recommended in the previous year's report with an explanation regarding any recommendation not implemented.

18. Actions taken or planned in response to any identified issues and/or to prevent recurrence will be reported annually as part of the annual report.

Alexco Keno Hill Mining Corp.

Physical Inspections and Reporting Plan

Water Use Licence QZ09-092-2

Appendix A

Physical Inspections Checklist

Physical Monitoring Program
Inspection Checklist

	MINE								FLAME AND MOTH			DISTRICT MILL				ROADS							
	BK N-AML Waste Rock Disposal Area	BK P-AML Waste Rock Storage Facility	BK 625 Treatment Ponds	LQ N-AML Waste Rock Disposal Area	LQ P-AML Waste Rock Storage Facility	LQ Treatment Ponds	Onek P-AML Waste Rock Storage Facility	Onek Treatment Ponds	F&M P-AML Waste Rock Storage Facility	F&M WTP Pond	F&M Discharge Areas	Mill Pond	DSTF	Water Diversion Structures	Water Collection Structures	CLR 0-8	BKR 0-5	BKR 5-15	BKR 15-18	Onek Laydown to Onek Portal	Onek Portal - LC Bridge BKR	Onek Laydown to LQ1	LQ 0-5
General																							
Checked visually?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Photo(s) taken?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey		Y								
Checked after storm event?																							
Soil / Rock Structures																							
Materials being disposed of properly?	Y	Y		Y	Y		Y		Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Check for movement?	Y	Y		Y	Y		Y		Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Crest checked?	Y	Y		Y	Y		Y		Y					Y	Y								
Toe checked?	Y	Y		Y	Y		Y		Y					Y	Y								
No tension cracks?	Y	Y		Y	Y		Y		Y					Y	Y								
No creep?	Y	Y		Y	Y		Y		Y					Y	Y								
No failure?	Y	Y		Y	Y		Y		Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safe for use next 24 hrs?	Y	Y		Y	Y		Y		Y					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Water Conveyance Structures																							
No loose material or exposed liner?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y								
Spillway clear?			Y			Y		Y		Y	Y	Y		Y	Y								
Good runoff management?			Y			Y		Y		Y	Y	Y		Y	Y								
Diversion clear?			Y			Y		Y		Y	Y	Y		Y	Y								
No seepage?			Y			Y		Y		Y	Y	Y		Y	Y								
No failure?			Y			Y		Y		Y	Y	Y		Y	Y								
Safe for use next 24 hrs?			Y			Y		Y		Y	Y	Y		Y	Y								
Limits adhered to?			Y			Y		Y		Y	Y	Y		Y	Y								
Piping																							
No leaks?			Y			Y		Y		Y	Y	Y											
No sags or deformation?			Y			Y		Y		Y	Y	Y											
Comments (recommendations / corrective actions required):																							

Inspected By:

Date:



N/A



MONTHLY



WEEKLY

Alexco Keno Hill Mining Corp.

Physical Inspections and Reporting Plan

Water Use Licence QZ09-092-2

Appendix B

Dry Stack Tailings Facility Surveillance and Physical Inspection



ALEXCO

Alexco Keno Hill Mining Corp.

REVISION 2010-1
OPERATION, MAINTENANCE, AND SURVEILLANCE MANUAL
DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL, YT

EBA FILE: W14101178.008

September 2010
PREPARED BY EBA ENGINEERING CONSULTANTS LTD

9.0 SURVEILLANCE

9.1 OBJECTIVE

Surveillance involves inspection and monitoring of the operation, structural integrity, and safety of the DSTF, and must be consistent with the life cycle and regulatory requirements of the facility. Surveillance of the DSTF consists of both routine and event-driven activities.

Key surveillance parameters and procedures must be identified for:

- Monitoring the operation, safety, and environmental performance of the DSTF;
- Promptly identifying and evaluating deviations from expected behaviour that affect operation safety, structural integrity, and environmental performance of the facility; and
- Reporting significant observations for response.

The DSTF surveillance program will continue to evolve as the facility changes in design or performance criteria, site conditions and/or the operation it is accommodating.

All personnel working at the DSTF will be involved in surveillance as a routine part of daily activities, maintaining visual awareness of the facility in the course of their regular and/or routine duties, in addition to surveillance-specific site engineering, instrument monitoring, analysis, inspection, periodic review and oversight.

It is the combination of all the regular inspections assisted by the eyes of all site personnel that ensures continued integrity and performance of the facility.

Outside consultants will also be on site periodically inspecting the facility as part of a regular program of expert review.

9.2 RESPONSIBILITY

A number of personnel conduct routine inspections of the DSTF. The Construction Monitor, or his designated replacement is assigned the responsibility of obtaining the monitoring information and preparing a monthly report for the facility designer and geotechnical consultant to review.

9.3 SURVEILLANCE PARAMETERS

Key parameters of surveillance are identified through identifying and describing potential failure modes of the DSTF.

Visual observations of the DSTF can indicate potential failure modes such as:

- Surface – cracking, bulging, depressions, sink holes;
- Seepage – new seepage areas, changes in seepage areas;
- Turbid water in the natural drainages around or downstream of the facility;
- Water or tailings flowing down the stack indicating improper grading; and

- A failure or breach of a component of the facility.

Routine monitoring for ensuring facility performance include:

- Checking for settlement or holes in embankment crest or benches;
- Checking for holes on the surface of the tailings indicating possible piping of material to outside;
- Checking for dust;
- Measuring water levels in monitoring wells located in the foundation soils during operation;
- Measuring ground temperatures using cables in the foundation soils during operation;
- Surveying DSTF components - displacements of survey monuments;
- Measuring slope inclinometers located in the foundation soils;
- Water sampling of Christal Creek; and
- Recording weather conditions.

These parameters are further described in the following sections.

9.4 SURVEILLANCE PROCEDURES

Table 13 summarizes surveillance requirements for the components of the DSTF. These surveillance requirements are the licensed monitoring requirements and conditions regarding the tailings presented in Alexco's Quartz Mining and Water Use licenses.

TABLE 13: OPERATIONAL MONITORING SCHEDULE FOR DSTF					
Frequency	Provision	Source/Location	Personnel	Scope	Deliverable
Periodically During Construction	EBA Design Report and Quality Assurance Program	Entire Facility	Engineering Supervision	Follow monitoring and inspection procedures in Quality Assurance Program	Interim Reporting to Site Management with recommendations for construction process
Weekly	EBA Design Report and Quality Assurance Program	Structure of the tailings (toe, dam, tailings, etc.)	Operational personnel	Visual assessment of tailings, diversion berms, collection ditches, conveyance channel and water collection pond.	Daily Log, included in annual report.
Weekly	EBA Design Report and Quality Assurance Program	Tailings final runoff	Operational personnel	Visual inspection for suspended solids and erosion evidence.	Daily Log, included in annual report.

TABLE 13: OPERATIONAL MONITORING SCHEDULE FOR DSTF – CONT'D

Weekly	EBA Design Report and Quality Assurance Program	Toe runoff collection ditches and conveyance channel	Operational personnel	Visual inspection for failures (possible or occurring) with more frequent checks during spring breakup period	Daily Log, included in annual report.
Weekly	EBA Design Report and Quality Assurance Program	Tailings Material	Operational personnel	Record tailings moisture content	Daily Log, included in annual report.
Weekly	Type A Water Licence Q209-092	Tailings Solids ABA Testing	Operational Personnel	Split a 200-500g sample from the daily 24-dried, metallurgical composite sample and retain in a plastic bag	Send a composite sample once per month to an accredited laboratory, as per Appendix C – evaluate results
Monthly	EBA Design Report	Groundwater Piezometer	Operational Personnel	Record readings and submit to VP Engineering for review	Results included in annual report.
Monthly	EBA Design Report	Ground Temperature Cable	Operational Personnel	Record readings and submit to VP Engineering for review	Results included in annual report.
Monthly	EBA Design Report	Settlement Monument Survey	Qualified Surveyor	Record elevations and submit to VP Engineering for review	Results included in annual report.
Monthly	Type A Water Licence Q209-092	Tailings Seepage	Operational Personnel	Sample and lab analysis of tailings supernatant, inspect for seepage, estimate flow	Representative samples shall be collected for laboratory analyses according to Set A ¹ requirements outlined in the WUL. ²
Monthly	EBA Design Report	Tailings Deposit	Operational Personnel	Confirm design moisture content density is being achieved	Results included in annual report.

TABLE 13: OPERATIONAL MONITORING SCHEDULE FOR DSTF – CONT'D

Monthly	EBA Design Report	Tailings Disposal Basin	Qualified surveyor	A surface profile of the tailings along the centre line of the tailings disposal basin	Map and written description of profile. ²
Annually	QML – Section 9.3.2	Tailings Disposal Basin	Professional engineer licensed to practice in the Yukon	Thorough visual assessment and physical inspection of the tailings, review of monitoring data to confirm design assumptions, preparation of inspection report	Representative samples shall be collected for laboratory analyses of grain size distribution, densities and moisture content. ² Submission of inspection report.
Annually	Type A Water Licence Q209-092	Center Line of Tailings	Operational personnel	Full depth of tailings will be sampled at four stations along the center line.	Samples will be checked in the field for the presence of frozen tailings. Screen analyses will be done in the laboratory as a check on the homogeneity of the tailings and densities and moisture contents will be determined. ²

Notes:

- ¹ Set A - water quality analysis includes physical parameters, anions, nutrients, dissolved metals, total metals, and total suspended solids (Table 10.2 - WUL Application)
- ² All results from the operation monitoring schedule will be included in the annual report to the Water Board

9.5 ADAPTIVE MANAGEMENT

Fundamental to successful adaptive management of the tailings production, handling and placement are triggers for management action. If the tailings handling and deposition is not meeting critical performance objectives according to specific conditions within either the WUL or the QML, the General Manager will be expected to follow Table 14 for appropriate corrective action. Close monitoring of the performance of the DSTF will be critical in determining if and when action will be required. It is expected that improvements will be made to the system on an ongoing basis once initial operating experience has been gained.

TABLE 14: TRIGGERS AND ACTIONS UNDER ADAPTIVE MANAGEMENT FOR TAILINGS MANAGEMENT

Provision	Monitored Item	Triggers/Thresholds	Action
EBA Design Report	Groundwater Monitoring Wells	Tip @ 1.0 m or 1.7 m depth - Porewater pressure parameter (Ru) exceeds 0.15	Facility designer will review well data. Monitoring and review will be increased to semi-weekly until determined unnecessary.
		Tip @ 1.0 or 1.7 m depth - Porewater pressure parameter (Ru) exceeds 0.25	Facility designer will review existing well data Facility designer will conduct a site visit and determine if tailings placement and/or construction plan requires modification Monitoring and review will be increased to daily until determined unnecessary. Facility designer will determine if additional instrumentation is required. Facility designer will complete analysis of mitigative measures should exceedance continue.
EBA Design Report	Ground Temperature Cables	Temperature > 0°C at 1.5 m depth	Facility designer will review temperature data.
EBA Design Report	Ground Temperature Cables	Temperature > 0°C at 2.0 m depth and greater	Facility designer will review existing temperature data Facility designer will conduct a site visit and determine if tailings placement and/or construction plan requires modification Facility designer will determine if additional instrumentation or analysis is required. Facility designer will complete analysis of mitigative measures should exceedance continue. Alexco to complete survey of area of interest to monitor any future displacement, if any.

TABLE 13: TRIGGERS AND ACTIONS UNDER ADAPTIVE MANAGEMENT FOR TAILINGS MANAGEMENT – CONT.

Provision	Monitored Item	Triggers/Thresholds	Action
EBA Design Report	Survey Monuments and Slope Inclometers	Displacements greater than 25 mm in any direction	Facility designer will review existing piezometer, temperature, and survey data. Facility designer will conduct a site visit and determine if tailings placement and/or construction plan requires modification. Monitoring and review will be increased to semi-weekly until determined unnecessary. Alexco to complete survey of area of interest to monitor any future displacement, if any. Facility designer will determine if additional instrumentation is required. Facility designer will complete analysis of mitigative measures should exceedance continue.
Water Licence Q209-092	Toe runoff collection ditches, conveyance channel and water collection pond	Presence of abnormal cracking or failure	Report to general manager, take corrective action as required
Water Licence Q209-092	Tailings Runoff	Visible turbidity in runoff and/or excessive erosion evidence	Address runoff at source; report to Water Board within 60 days Apply appropriate runoff, erosion or sediment control measures
Water Licence Q209-092	Tailings Solids	AML potential is indicated	Expand monitoring program Conduct study of options to minimize acid generation

9.6 DOCUMENTATION

Routine reporting of surveillance results is essential to provide time to make adjustments to existing systems or to initiate Emergency Response Plans. It is imperative that any unusual information (outliers) gathered from these undertakings be communicated to the facility designer, the General Manager and Chief Operating Officer.

Document control is vital to ensuring the ongoing performance of the facility. The topic was presented in Section 3.0.

Table 15 identifies the overall responsibilities for surveillance record keeping:

TABLE 15: DSTF SURVEILLANCE DOCUMENTATION		
Task	Responsible Party	Information Recipients
Daily Check Sheet	Completed by Construction Monitor	General Manager – copy; Mill Manager – copy; Bellekeno Mine Engineering Server
Monthly Placement As built	Completed by Construction Monitor	General Manager – copy; Mill Manager – copy; Bellekeno Mine Engineering Server EBA - copy
Instrumentation Data	Completed by Construction Monitor	General Manager – copy; Mill Manager – copy; Bellekeno Mine Engineering Server EBA – copy
Construction Photographs	Completed by Construction Monitor	General Manager – copy; Mill Manager – copy; Bellekeno Mine Engineering Server
ABA Testing	Completed by Geology Dept	General Manager – copy; Mill Manager – copy; Bellekeno Mine Engineering Server
Water Quality Monitoring	Completed by VP Corporate Affairs	General Manager, Mill Manager and Yukon Water Board Original reports located with General Manager

9.7 REPORTING

Observation of any unusual occurrence should be reported immediately to the General Manager, facility designer, and/or the Chief Operating Officer. Unusual occurrences include but are not limited to the following;

- Triggers/Thresholds outlined in Table 13;
- Any seismic event;
- Settlement, cracks or slumping of the tailings stack;
- Slope failure of any of the slopes;
- Abnormal seepage from any of the slopes;
- Increased or high turbidity flow from the drainage blanket; and
- Damage to any component of the DSTF.

All reports are to be maintained by the General Manager and filed in a suitable format and location for easy access by authorized mine personnel, and for review by government agencies. Annual performance reviews will be copied to the regulatory agencies.

The requirements of the consulting geotechnical engineer, other departments, or governmental agencies may dictate certain items that require inspection, monitoring, or reporting.

10.0 EMERGENCY PLANNING AND RESPONSE

10.1 BELLEKENO EMERGENCY PROCEDURES

The mine site has established procedures and response plans detailing in the following reports:

- A report by Access Consulting Group entitled “Alexco Keno Hill Mining Corp. Bellekeno Project, Monitoring and Surveillance Plan, QML-0009”, dated November 2009 and submitted for the Type A Water Use License 2009.
- A report by Access Consulting Group entitled “Emergency Response Plan, QML-0009, Bellekeno Project”, dated November 2009 and submitted for the Type A Water Use License 2009.
- MSDS documentation for any material used within the DSTF.

These documents provide the detailed plans on actions to be taken in case of an emergency. They also provide notification procedures.

10.2 DSTF EMERGENCY PROCEDURES

Daily visual and routine instrumentation monitoring programs outlined in Tables 12 and 13 are expected to forewarn of potential adverse conditions to the DSTF. Triggers/Thresholds presented in Table 13 must be adhered to and reported on as outlined.

The DSTF has been designed to maintain its structural integrity throughout its operational life; however, a number of conditions can affect the performance of the DSTF. Once the DSTF operations are being completed and instrumentation data is available, the requirement for additional emergency procedures will be reviewed as a part of the annual DSTF performance and OMS manual review.

10.3 ENVIRONMENTAL EMERGENCIES

Environmental emergencies of various natures and their specific response procedures are outlined in the project’s Spill Contingency Plan. This document includes immediate response procedures and follow up and notification measures appropriate to the particular nature of the emergency.

10.4 KEY CONTACTS

Key contact information is detailed in Table A2, found in Appendix A.